COMPRESSED AIR MOTIVE POWER SUPPLY AT BIRMINGHAM.

IN our last impression we gave some particulars of the scope and objects of the compressed air power supply scheme for which an Act has been obtained to supply the town of Birmingham. We now continue that part of the article which dealt with the compression and conveyance of the air.

By adiabatic compression the mean forward pressure is found, by the formula given by Professor Cotterill—"Steam Engine as a Heat Engine," page 339—where for adiabatic compression of air $n = \gamma = 1{\cdot}41$.

$$P_m = \frac{\gamma}{\gamma-1} \times \frac{P_1}{r} - \frac{1}{\gamma-1} \times P_2 \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Where

P_m = the mean forward pressure per square inch, absolute.

P_1 = the pressure resulting from compression = 59·7 lb. per square inch = 8596·8 lb. per square foot.

P_2 = the pressure of the atmosphere = 14·7 lb. per square inch = 2116·8 lb. per square foot.

γ = 1·41 (a number on which the velocity of sound depends, irrespective of any special theory of heat, found by experiment to have this value for air and other simple gases).

$$= \frac{\text{specific heat of air at constant pressure}}{\text{specific heat of air at constant volume}} = \frac{183{\cdot}4}{130{\cdot}2} = 1{\cdot}41.$$

r = ratio of compression, the volume of air to be compressed at 14·7 lb. pressure and 60 deg. F. being, as in the former case, 4·0612 cubic feet, the resulting volume is found in the following way:—

Temperature due to compression = T_1

$$= \left(\frac{\text{ultimate pressure}}{\text{initial pressure}}\right)^{0{\cdot}29} \times \text{absolute initial temperature}$$

$$= \left(\frac{59{\cdot}7}{14{\cdot}7}\right)^{0{\cdot}29} 521 \text{ deg.} \quad \text{Log. } T_1 = 0{\cdot}29 \text{ log. } 4{\cdot}0612 + \text{log. } 521 \text{ deg.}$$

Temperature = 782·3 deg. F.

Rise of temperature = 782·3 − 521·0 = 261·3 deg. F.

261·3 + 60 = 321 deg. F.

$$\text{Resulting volume} = \frac{14{\cdot}7 \text{ lb.}}{59{\cdot}7 \text{ lb.}} \times \frac{4{\cdot}0612 \text{ cub. ft. } (782{\cdot}3^\circ - 28^\circ)*}{521^\circ - 28^\circ}$$

$$= 0{\cdot}246 \times 6{\cdot}213 = 1{\cdot}53 \text{ cubic feet.}$$

$$\text{Ratio of compression} = \frac{4{\cdot}0612}{1{\cdot}53} = 2{\cdot}654.$$

Therefore

$$P_m = \left(\frac{1{\cdot}41}{0{\cdot}41} \times \frac{59{\cdot}7}{2{\cdot}654}\right) - \left(\frac{1}{0{\cdot}41} \times 14{\cdot}7 \text{ lb.}\right)$$

$$= (3{\cdot}439 \times 22{\cdot}49) - (2{\cdot}439 \times 14{\cdot}7 \text{ lb.})$$

$$= 77{\cdot}346 - 35{\cdot}843 = 41{\cdot}498 \text{ lb. per square inch,}$$

(See diagram of compression.)

Mean effective pressure = 41·498 − 14·700 = 26·798 lb. per square inch = 26·798 × 144 − 3859 lb. per square foot.

Total power exerted in compressing 4·0612 cubic feet of air adiabatically = 4·0612 cubic feet × 3859 lb. per square foot = 15,672 ft.-lb.

Assuming friction, leakage, and resistance of valves to be about 24 per cent.,† in addition to the load, then each foot-pound in the compressor requires 1·24 foot-pounds steam pressure. Friction due to 12,048 foot-pounds = 12,048 × 0·24 . . . . . 2,892 ft.-lb.

Total power required for 1 cubic foot compressed air . . . . . 18,564 ft.-lb.

The loss in distribution caused by friction in the mains can, of course, only be calculated approximately, by estimating the average quantity of air going through each pipe. By doing this and calculating the friction according to M. Stockalper's rule, we find, for instance, for the 20in. main going through Bradford-street, the total quantity of air delivered per second from the compressing works is 247 cubic feet = 7 cubic metres. The pipes from Stratford-street branch off in three principal directions, of which about 35 per cent. will go to the northern part of the district, 25 per cent. to the southern part, and the remaining 40 per cent. through the 20in. main in Bradford-street, constantly supplying air to the minor streets. Therefore, 2·8 cubic metres air will pass through the first portion of the 20in. main per second; the total length from the compressing works to the end of the district is 6000ft. = about 1830 metres; the quantity of air going through the main is constantly decreasing, until at the end there will, of course, pass none at all; so that the average quantity may be taken as half of the initial quantity = 1·4 cubic metres. The friction is then found from the formula—

$$J = 1830 \times q^2 \times \delta \times a.$$

Where

J = loss of head, in metres height of water column

δ = density of compressed air compared with water.

= 4·06 × 0·0013 = 0·00528.

q = volume of compressed air at the density 0·00528 flowing through the main per second = 1·4 cubic metres.

a = Darcy's coefficient for water = $\frac{3{\cdot}2423}{D^5} \times \left((0{\cdot}000507 + \frac{0{\cdot}00001294}{D}\right)$, where D = diameter of pipes in metres = 0·508.

$$= \frac{3{\cdot}2423}{0{\cdot}508^5} \times \left(0{\cdot}000507 + \frac{0{\cdot}00001294}{0{\cdot}508}\right) = 95{\cdot}84 \times 0{\cdot}0005325 = 0{\cdot}05104.$$

Therefore

$$J = (0{\cdot}05104 \times 1{\cdot}4^2 \times 0{\cdot}00528 \times 1830) = 0{\cdot}967 \text{ metres.}$$

The effective pressure = 45 lb. per square inch = 31·6 metres head of water. The loss due to friction is, therefore, for this whole length of 6000ft.

$$\frac{100 \times 0{\cdot}967}{31{\cdot}6} = 3{\cdot}06 \text{ per cent.}$$

To allow for all contingencies, however, an average loss of 5 per cent. is reckoned for friction in the mains, though it is believed that in practice it will be found much less.

Loss by friction in the mains, therefore	5 per cent.
Loss by leakage in the mains is estimated at...	10 ,,
Loss by friction and wire-drawing in the consumer's engine and service pipes	5 ,,

The compressed air will, therefore, on the average, before it comes to act in the driven engine, be reduced 10 per cent. by friction, from 45 lb. to 40·5 lb. per square inch, and 10 per cent. by leakage, or 1 cubic foot is reduced to 0·9 cubic foot.

The power given out by various ways of using the compressed air at the driven engine may now be considered.

Case 1.—When the air is heated to 320 deg. F. and expanded to atmospheric pressure. Absolute initial temperature = 781 deg. The average pressure is found from equation (2).

$$P_m = \frac{\gamma}{\gamma-1} \times \frac{P_1}{r} - \frac{1}{\gamma-1} \times P_2.$$

Where, as in the former case,

$$\frac{\gamma}{\gamma-1} = 3{\cdot}439$$

$$\frac{1}{\gamma-1} = 2{\cdot}439$$

P_2 = 14·7 lb.

P_1 = 40·5 lb. + 14·7 lb. = 55·2 lb.

We have only to find r = ratio of expansion. The volnme of the compressed air becomes by being heated from 521 deg. to 781 deg. = 260 deg.

$$\text{initial volume} = 0{\cdot}9 \text{ cubic feet} \times \frac{781 \text{ deg.} - 28 \text{ deg.}}{521 - 28} = 0{\cdot}9 \times 1{\cdot}5274 = 1{\cdot}3746 \text{ cubic feet.}$$

T_1 = temperature of the expanded air $\left(\frac{14{\cdot}7}{55{\cdot}2}\right)^{0{\cdot}29} \times 781^\circ$.

Log. T_1 = 0·29 log. 14·7 − 0·29 log. 55·2 + log. 781 T_1 = 532·12 = 71 deg. F.

Volume of the expanded air

$$= \frac{55{\cdot}2}{14{\cdot}7} \times 1{\cdot}3746 \text{ cubic feet} \times \frac{532 \text{ deg.} - 28 \text{ deg.}}{781 \text{ deg.} - 28} = 5{\cdot}162 \times 0{\cdot}67 = 3{\cdot}458 \text{ cubic feet.}$$

Ratio of expansion

$$= r = \frac{3{\cdot}458 \text{ cubic feet}}{1{\cdot}3746 \text{ cubic feet}} = 2{\cdot}516.$$

Then

$$P = \left(3{\cdot}439 \times \frac{55{\cdot}2 \text{ lb.}}{2{\cdot}516}\right) - (2{\cdot}439 \times 14{\cdot}7) \text{ lb.}$$

$$= (3{\cdot}439 \times 21{\cdot}94) - (2{\cdot}439 \times 14{\cdot}7).$$

$$= 75{\cdot}45 \text{ lb.} - 35{\cdot}85 \text{ lb.} = 39{\cdot}60 \text{ lb.}$$

Average effective pressure = 39·60 lb. − 15 lb. = 24·60 lb.

With 8 per cent. loss by clearance and back pressure, the effective pressure becomes 24·60 × 0·92 = 22·63 lb. per square inch = 3258·7 lb. per square foot—see diagram of expansion.

The effective volume is 0·96 of the total volume = 0·96 × 3·4578 = 3·320 cubic feet.

Power given out by the air = 3258·7 lb. × 3·320 cubic feet = 10,818·7 foot-pounds.

$$\text{Useful effect} = \frac{10{,}818{\cdot}7 \times 100}{18{,}564} = 58{\cdot}3 \text{ per cent.}$$

Case 2.—When boiling water is available for heating the compressed air.

Initial temperature in the cylinder, 461 deg. + 212 = 673 deg. absolute.

$$\text{Initial volume per cubic foot} = 0{\cdot}9 \text{ cubic foot} \times \frac{673 - 28}{521 - 28} = \frac{0{\cdot}9 \times 645}{493} = 1{\cdot}1775 \text{ cubic feet.}$$

Initial volume per cubic foot of air on reaching the driven engine = 0·9 cubic foot.

Temperature of the expanded air $= \left(\frac{14{\cdot}7}{55{\cdot}2}\right)^{0{\cdot}29} \times 673$ deg. = T_2.

Log. T_2 = $\overline{1}{\cdot}83336 + 2{\cdot}82802 = 2{\cdot}66138$; T_2 = 458·5 deg. = − 2·5 deg. Fah.

Volume of the expanded air $\frac{55{\cdot}2}{14{\cdot}7}$ lb. × 1·1755 × $\frac{673 \text{ deg.} - 28 \text{ deg.}}{458{\cdot}5 \text{ deg.} - 28 \text{ deg.}}$

$$= 4{\cdot}4216 \times \frac{430{\cdot}5}{645} = 2{\cdot}9512 \text{ cubic feet.}$$

Ratio of expansion = $r = \frac{2{\cdot}9512}{1{\cdot}1775} = 2{\cdot}506$.

Then

$$P = \left(3{\cdot}439 \times \frac{55{\cdot}2 \text{ lb.}}{2{\cdot}506}\right) - (2{\cdot}439 \times 14{\cdot}7 \text{ lb.})$$

$$= (3{\cdot}439 \times 22{\cdot}025) - 35{\cdot}85 = 75{\cdot}74 - 35{\cdot}85 = 39{\cdot}89 \text{ lb.}$$

Mean effective pressure = 39·89 − 15 lb. = 24·89 lb. per square inch.

With 8 per cent. loss by clearance and back pressure, 24·89 lb. × 0·92 = 22·90 lb. per square inch = 3297·5 lb. per square foot.

Effective volume = 0·96 × 2·9512 cubic feet = 2·833 cubic feet.

Power given out by the air—

3297·5 lb. per square foot × 2·833 cubic feet = 9342·0 ft.-lb.

$$\text{Useful effect} = \frac{9342{\cdot}0 \times 100}{18{,}564} = 50{\cdot}3 \text{ per cent.}$$

Case 3.—When the air is used expansively without reheating, whereby intensely cold air is exhausted, which may be used for making ice, &c.

Initial temperature in the cylinder = 521 deg. (absolute) = 60 deg. F.

Initial volume per cubic foot of air on reaching the driven engine = 0·9 cubic foot.

Temperature of the expanded air $= \left(\frac{14{\cdot}7}{55{\cdot}2}\right)^{0{\cdot}29} \times 521$ deg. = T_2.

Log. T_2 = $\overline{1}{\cdot}83336 + 2{\cdot}71684 = 2{\cdot}55020$; T_2 = 355 deg. (absolute) = − 106 deg. F.

Volume of the expanded air = $\frac{55{\cdot}2}{14{\cdot}7} \times 0{\cdot}90$ cubic foot × $\frac{355 - 28}{521 - 28} = 3{\cdot}379 \times \frac{327}{493} = 2{\cdot}242$ cubic feet.

Ratio of expansion = $\frac{2{\cdot}242}{0{\cdot}9} = 2{\cdot}49$.

$$P_m = \left(3{\cdot}439 \times \frac{55{\cdot}2}{2{\cdot}49}\right) - (2{\cdot}439 \times 14{\cdot}7) = 76{\cdot}22 - 35{\cdot}85 = 40{\cdot}37 \text{ lb.}$$

Mean effective pressure = 40·37 − 15 lb. = 25·37 lb. per square inch.

With 10 per cent. loss by clearance and back pressure—

= 25·37 × 0·90 = 22·83 lb. per square inch = 3287·5 lb. per square foot.

Effective volume = 0·96 × 2·242 = 2·152 cubic feet.

Power given out by the air—

= 3287·5 lb. per square foot × 2·152 cubic feet = 7074·5 foot-pounds.

$$\text{Useful effect } \frac{7074{\cdot}5 \times 100}{18{,}564} = 38{\cdot}1 \text{ per cent.}$$

Case 4.—When the air is reheated to the temperature of boiling water, but instead of expanding down to atmospheric pressure, the driven cylinder is filled so far that the terminal pressure becomes 26 lb. absolute = 11·3 lb. above atmosphere.

Initial temperature as in Case 2 = 461 deg. + 212 = 673 deg. absolute.

$$\text{Initial volume} = 0{\cdot}9 \text{ cubic foot} \times \frac{673 - 28 \text{ deg.}}{531 - 28 \text{ deg.}} = 0{\cdot}9 \text{ cubic foot} \times \frac{645 \text{ deg.}}{493 \text{ deg.}} = 1{\cdot}1775 \text{ cubic feet.}$$

$$\text{Terminal temperature} = \left(\frac{26{\cdot}0}{55{\cdot}2}\right)^{0\,29} \times 673 \text{ deg.} = T_2.$$

log. T_2 = 0·29 log. 26·0 − 0·29 log. 55·2 + log. 673.

= $\overline{1}{\cdot}90518 + 2{\cdot}82802 = 2{\cdot}73320$. T_2 = 541 deg. = 80 deg. F.

Volume of the expanded air:

$$= \frac{55{\cdot}2 \text{ lb.}}{26{\cdot}0 \text{ lb.}} \times 1{\cdot}1775 \times \frac{541 \text{ deg.} - 28 \text{ deg.}}{673 \text{ deg.} - 28 \text{ deg.}} = \frac{33{,}344}{16{,}770}$$

$$= 1{\cdot}9883 \text{ cubic feet.}$$

Ratio of expansion

$$= r = \frac{1{\cdot}9883}{1{\cdot}1775} = 1{\cdot}6886; \text{ cut-off about } 0{\cdot}6.$$

FIG. 1.

DIAGRAM OF COMPRESSION

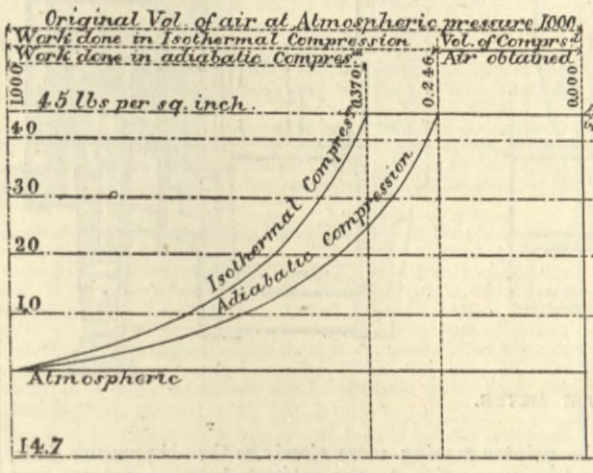
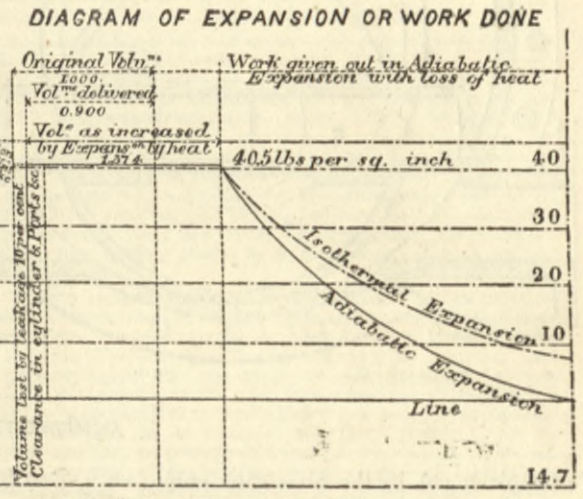


FIG. 2.

DIAGRAM OF EXPANSION OR WORK DONE



Adiabatic Expansion of compressed Air heated to 321.3°F.

Mean effective Pressure: "Case 1" in the Calculations 22·63 lbs per sq. in.

* If the standard volume of these calculations were taken at 32 deg. F. the changes of volume would be proportional to the absolute temperature, but if taken at 60 deg. F., 60 deg. − 32 deg. = 28 deg. has to be deducted from all the absolute temperatures.

† According to Sir F. Bramwell, in the Mekarski air compressors at Chautenay, only 18 per cent. of the gross indicated horse-power of the engines was absorbed in friction of the engine, friction of the compressing pumps, and working the condenser air pump. In the compressors erected at Froud Colliery to the designs of Mr. Sturgeon, these losses amount to only 10·87 per cent.

Then

$$P_m = \left(3{\cdot}439 \times \frac{55{\cdot}2 \text{ lb.}}{1{\cdot}6886}\right) - (2{\cdot}439 \times 26 \text{ lb.}).$$
$$= (3{\cdot}439 \times 32{\cdot}69) - (2{\cdot}439 \times 26).$$
$$= 112{\cdot}42 - 63{\cdot}413 = 49{\cdot}01.$$

Mean effective pressure = 49 lb. – 15 lb. = 34 lb. per square inch.

With 8 per cent. loss of pressure for clearance and back pressure:

= 34 lb. × 0·92 = 31·28 lb. per square inch = 31·28 × 144 = 4504 lb. per square foot.

Effective volume 0·96 × 1·6886 cubic feet = 1·621 cubic feet.

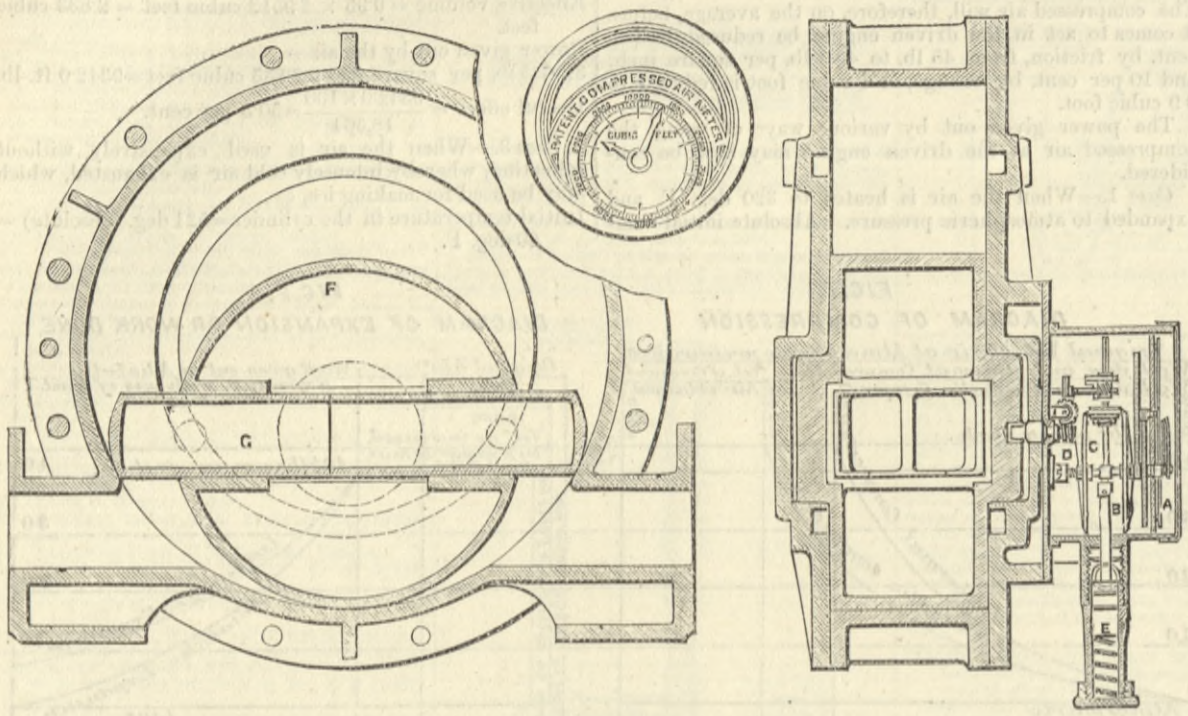
Power given out by the air: 1·621 cubic feet × 4504 lb. per square foot = 7302 foot-pounds.

$$\text{Useful effect} = \frac{7302 \times 100}{18{,}564} = 39{\cdot}3 \text{ per cent.}$$

Case 5.—When the air is used quite cold, without any expansion.

Mean effective pressure = 40 lb. per square inch = 5760 lb. per square foot.

Effective volume 0·95 × 0·9 cubic foot = 0·855 cubic foot.



COMPRESSED AIR METER.

Power given out by the air = 0·855 cubic foot × 5760 lb. per square foot = 4924·8 foot-pounds.

$$\text{Useful effect} = \frac{4924{\cdot}8 \times 100}{18{,}564} = 27{\cdot}1 \text{ per cent.}$$

The annexed diagrams show the compression, heating, and expansion of air. Fig. 1 gives the compression—that is, the work done—at the central station. The formulæ for adiabatic compression and for isothermal compression are each represented graphically by curves of the respective equations, set out by means of rectangular co-ordinates. The abscissæ are the volumes in terms of the original volume of air at atmospheric pressure; the ordinates are the corresponding pressures in pounds per square inch. P_m is the mean forward pressure in the compressing cylinder. Fig. 2 is the diagram of expansion or effective result at the driven engine, according to Case 1 of the calculations; the expansion is taken in terms of the original volume at the driven engine, and is measured horizontally; the corresponding pressures are set out vertically. In each diagram the remarks upon it show the relation of work done to effective result obtained."

In the same pamphlet the authors calculate the surface required to heat the air to 321 deg. Fah., arriving at the conclusion that 6·66ft. of heating surface will be required wherever it is desirable to heat to this temperature. In many places, however, the heating could be done at little trouble or expense, while the heating to a moderate temperature by passing the pipes through hot water could be effected anywhere. This, however, must add somewhat to the cost of the compressed air as a motive power.

With respect to the working of the system, there is no reason to think that the loss by leakage should be more than at the St. Gothard, where the friction and leakage together amounted to but 5 per cent. on a length of 3·75 miles, while experience at other places, including extensive use at the Westminster Collieries near Wrexham, and many others, where the air is not heated at the driven motors, is greatly in favour of air at a comparatively low pressure in consequence of its cleanliness, general applicability, and freedom from the necessity for attention which belongs to steam or gas-driven motors.

For measuring the air as used by consumers the meter shown in the accompanying engraving is proposed to be employed. Its action is clear at a glance. The rotation of the piston in the cylinder gives motion to the friction-wheel D, which transmits motion to the wheel B through the friction pinion C. The latter assumes a position which is determined by the pressure of the air delivered, this pressure acting on the piston E. As the hands of the indicator at A are driven by the wheel B, the indications are varied in accordance with the pressure, the effect of the radial movement of C-E on the speed of rotation of B being proportionate to the density of the air delivered, the pointer moving more slowly as the air pressure falls, and in proportion to the relation between volume and pressure.

To prevent any general stoppage of the air supply throughout the district, should a pipe or connection at any time burst, self-acting valves are to be placed at intervals. These valves will be made so that they keep off their seats while the air moves at the ordinary velocity or at a velocity somewhat higher than this, but will fly to a seating as soon as the velocity has increased, as it would do in case of a broken pipe. By this means the result of the breakage of a pipe would not be to deprive the entire district of the air supply, but would be confined to that portion only supplied from the short length of main lying between two of these valves. The pipes will, however, never be subject to a pressure which will of itself tend to the fracture, and its elastic contents will act much less distinctively on the connections than water at a very low pressure. It may be well, as some fear of danger from the bursting of a compressed air pipe has been expressed, to mention that all experience shows that the bursting of pipes or vessels containing air at even high pressures is attended with very slight effects. Unlike even a weak explosive mixture of gas and air, pure air compressed to but 50 lb. or so, when suddenly liberated, so easily finds the room it requires for expansion that very little harm is likely to result. In this respect it is wholly different from a vessel containing steam and water. The pipes to be employed at Birmingham will be many times stronger than mere internal pressure requires, and the joints will be made with the long socket and india-rubber ring now most generally used for the purpose.

SIDE ARMOUR V. HORIZONTAL ARMOUR.

On Wednesday, January 21st, Captain FitzGerald, R.N., captain of the Royal Naval College, read an able and spirited paper on "Side Armour *versus* Armoured Decks," at the United Service Institution. This subject is now one of special interest, involving fundamentally, as it does, the construction of all our new ships. Consequently the audience was a large one, and some of the highest authorities took part in the discussion—namely, Sir E. Reed, Admiral Elliot, Sir Spencer Robinson, and Mr. White. Captain FitzGerald classed the calamities that might happen to a ship in action as follows:—The most serious, the blowing up of magazines or sinking; next, the perforation of a boiler or destruction of steering gear; then the disablement of the guns and slaughter of a large part of the crew; these last leaving open the possibility of ramming, or, on the other hand, escaping from an adversary. Horizontal armour had been adopted to protect the so-called vital parts of a ship from the indirect blow of a partly descending projectile or from the explosion of a shell that had passed through the ship's side above it. Sir W. Armstrong had said that every improvement in guns, projectiles, &c., had tended to lower the value of armour; hence he deprecated a lavish expenditure on armoured ships, and advocated protected cruisers with horizontal armour. Captain FitzGerald held that armour which will not keep out solid shot striking direct will still keep out large capacity shell and projectiles striking obliquely, and that it is absurd because all shot cannot be kept out to give up keeping out any. It was, in fact, like a man whose roof let in some rain pulling it off to let all in. Dealing with chances of injury, Captain FitzGerald held that the rapidity of gun fire was in inverse ratio to the size of the gun. While, therefore, he did not under-estimate the effect of heavy guns, he believed that smaller guns, including quick-firing field guns, would play so prominent a part in attack that 3in. of steel will keep out about two-thirds of the projectiles fired. The fact that a portion extending for two-thirds of the water-line of our citadel line-of-battle ships is unplated, and therefore certain to be penetrated in a hundred places by the terrible hail of light gun and machine-gun fire, is so serious that Captain FitzGerald would have all so-called citadel ships altered at once and the necessary weight of horizontal armour, coal, or guns and ammunition removed to enable a complete water belt of armour to be given. Citadel ships were built before the introduction of quick-firing guns; these latter are likely to riddle their unarmoured sides, including the water-line, without even specially aiming at it. Captain FitzGerald compared the Hercules and Italia's powers of fighting, and concluded that the former, though a belted ship of old date, would probably disable the latter before she could fire her heavy guns twice. He reminded his audience of the grave question that had been raised as to the condition and safety of citadel ships with ends riddled and water-logged, and of the probability of their turning bottom up. He had been informed that a ship of the Admiral class could carry 9in. of armour on her water-line if the horizontal armour and thwart bulkhead were removed. Without claiming to speak in the name of the Navy generally, Captain FitzGerald thought he might say that no naval officer would at all object to be sunk by a shot from a 100-ton gun delivered in the proper place, but to be liable to be sunk by the fire of every popgun carried in an enemy's gunboats would be more than the honour of the British Navy could survive. Is it not probable that our enemies would be sufficiently intelligent to develope light gun fire and take advantage of our weak points? Captain FitzGerald did not approve of cork and other contrivances for meeting the evil of water entering. He preferred to deal with it as he would with a burglar coming to break into a house while it was still outside. In some of the new designs he observed that, happily, the armoured decks were better formed than in the older vessels—that is, rising above the water-line and providing a reserve of buoyancy. Finally, he invited the views of naval officers or others who had studied the subject. For himself, he observed that our fathers did not "rule the waves" in tin pots with numerous holes in their sides, and he did not expect us to do so.

In discussion, Sir Spencer Robinson called attention to the steady increase of the armoured proportion of the sides given to our citadel ships as time went on. Class A, comprising the Inflexible, Ajax, Agamemnon, Edinburgh, Colossus, and Collingwood, had only 42 per cent. of the area of the side armoured; Class B, the Howe and Rodney, with 54 per cent.; and C, the Camperdown, Benbow, and Anson, with 56 per cent. armoured. This, he argued, showed that our designers were gradually recognising the view of the case that had been taken by combatant officers. He specially urged the necessity of experiment with cork and contrivances to ascertain its real value. The maximum quantities of water that could be contained in the unarmoured ends of the three classes of citadel ships are given respectively as 750, 580, and 420 tons. Sir Spencer would be relieved to know that this was the worst that could happen. He feared that matters might be worse when coal was nearly used up. Sir S. Robinson advocated a belt, but thinner at the ends than amidships.

Colonel Hope suggested that double plate sides with fibre packing between might keep water out when shot perforated.

Admiral Colomb observed that the question was certainly one for naval officers, on the principle that the owner of a house who was to live in it was concerned in the architect's designs. He specially advocated experiments being made. He complained of the unsteady platform offered by ships with high metacentres. He did not take an alarmist's view of the question; even the old wood ships were seldom sunk. The proportion of shots that missed was much greater than was generally supposed. He quoted experiments in which 75 per cent. of the shot had missed a target 15ft. high. He considered that horizontal deck plates should be used at level of top of armour belt.

Admiral Sir G. Elliot objected to be sent to the bottom even by 100-ton gun shot. He spoke in favour of the system of strongly protected citadels and horizontal armour.

Admiral Boys spoke on the chances of hitting a water-line and of the probable effect of small holes; he said that the 100-ton gun fired much faster than had been reckoned on by previous speakers.

Sir E. Reed observed that there was abundant means of constructing ships as ordered. It was for the naval officer to state his needs as clearly as possible. He spoke of the powers required in a ship being the starting point for calculation. He held that the size given should depend entirely on the power of the vessel. Referring to armoured citadels, Sir E. Reed pointed out that the turning across the ship of armour in preference to carrying it up to the bows has been advocated by him. His objection to our citadel ship was that the citadel was made too short to float the ships unaided by the end.

Admiral Selwyn spoke of the advantages to be derived from using the fuel advocated by him.

Mr. White was prepared to defend the Admiral class of ship. With regard to these designs, he reminded them that cost had to be a primary element in the designs made at the Admiralty. He also pointed out the low vertical space covered by the armour of French ships. He also explained that the amount of water dealt with by Mr. Barnaby thoroughly represented the worst possible condition, *i.e.*, that of space filled with coal and water. He appealed to Sir E. Reed to endorse his statement that bunkers filled with water represented a less evil.

Lord Clanwilliam said a few words as to the natural introduction of machine and quick-firing guns after the armour had been withdrawn from parts of our vessels' sides.

It may be seen from this brief notice that the lecture attracted considerable attention, and it deserved it, being good in matter, and the treatment spirited. Probably many naval men will feel that rapid gun fire from light pieces calls for thin armour along the water-line. Nevertheless, when Captain FitzGerald proposes to give up deck armour we think that he goes too far. A ship so exposed might be sent to the bottom by comparatively trumpery shells fired either as plunging fire or else vertically. Against forts such a system of construction would be especially fatal. Ships can scarcely seriously damage a strong fort by firing on the move, because the firing practice consists in continually aiming at an object chosen at the moment the smoke clears away, chosen, it should be remembered, from a new aspect of the works and from a new range. Those who reflect on the difficulties of carrying out an effectual attack under these conditions will admit that the ship for real serious work must generally anchor. Another reason may drive them to do so, namely, the presence of submarine mines and the necessity for keeping within spaces ascertained to be clear of them. When ships anchor they become liable to be attacked by vertical fire, which is, under any circumstances, serious enough. With unarmoured decks the most trumpery kind of projectile would be likely to produce the most serious effect in a ship. At sea fire from tops and at close ranges from the high barbette towers of French ships would be terribly destructive. Even the heel of a ship would expose her deck to be struck obliquely. Altogether it seems probable that Captain FitzGerald himself would hardly push his suggestion to the full length of removing plated decks on further consideration.

Naval Engineer Appointments.—The following appointments have been made at the Admiralty:—William T. Paul, assistant engineer, additional, to the Temeraire; Francis Ford, chief engineer, to the Alexandra, additional, for transport duties; Thomas Burnes, chief engineer, to the Raleigh; John F. Ryder, engineer, to the Raleigh; Frederick Mitchell, engineer, additional, to the Pembroke; and William G. Mogg, assistant engineer, to the Raleigh.

The Bell Telephone Patents.—The Canadian Minister of Agriculture has delivered decision in the Bell Telephone Company's case, voiding the patent for the reasons: (1) That the company or their representatives had imported the patented articles after twelve months from date of patent; also (2) for not having manufactured in Canada such articles to the extent required by law, after two years of existence of their privilege; (3) also for having refused to sell or deliver licences to persons willing to pay a reasonable price for the private and full use of their patented invention.

RAILWAY MATTERS.

THE production of Bessemer steel rails in the United Kingdom in 1884 was 784,968 tons, against 1,097,174 tons in 1882. There has therefore been a diminished make of 312,206 tons in 1884.

THE directors of the Hull and Barnsley Railway and Dock Company report that the whole of the new capital—£1,500,000—has been applied for and allotted at par. Satisfactory progress has been made with the work since December, and the contractors have undertaken to have the line ready for traffic by the end of June next.

THE contract for the girder rails for the Melbourne tramcars has been placed, we understand, in the hands of Messrs. Dick, Kerr, and Co., of London, this being the second contract that has been placed in connection with these tramways, the present one amounting to about 9000 tons. The same firm have also just shipped the whole of the ironwork for the Brisbane tramways.

EVERY traveller in France will welcome a long expected railway reform effected by the Minister of Public Works. A circular has been sent to the Boards of all the railway companies, requesting them to arrange by the 1st of April that free access shall be given to the platform and trains to all passengers provided with tickets. The misery of prolonged incarceration in *salles d'attente* will, therefore, soon become a thing of the past.

ON the 2nd inst. was opened the new line of railway from Surbiton to Guildford, with a branch to Leatherhead, with new stations at Claygate, for Claremont, Oxshott, Fair Mile, Stoke D'Abernon and Cobham, Horsley and Ockham, Clandon and Ripley, Guildford, and at Bookham Common for Effingham, on the Leatherhead extension line. The new railway forms part of the system of the London and South-Western Company, and will open up some of the least known and hitherto most secluded portions of Surrey.

WITH the exception of a mishap with a derailed coach at the start, the opening of the extensive new portion of New-street station, Birmingham, has this week been satisfactorily performed. It will, of course, be some time before the working arrangements are in sound order, but progress is being made daily. Some trouble is being experienced with the interlocking signalling apparatus, but it is no cause for surprise that with a new system so elaborate as to have cost for one station between £11,000 and £12,000, there should be at first some trifling inconvenience.

AN influential meeting of traders was held in Birmingham on the afternoon of the 5th inst., to organise a vigorous opposition to the new Bills of the railway companies dealing with terminals. Mr. P. H. Muntz, M.P., who presided, advised the formation of a Parliamentary Committee to protect traders' interests. The Mayor of Birmingham proposed, Sir E. H. Lechmere, M.P., seconded, and it was carried unanimously that the Bills were bad in principle and unjust and prejudicial to the interests of the traders. It was also decided to oppose the Bills, and a subscription list was opened. Much indignation was expressed.

THE Alexandria correspondent of the *Times*, speaking of Egyptian railways, says:—"It is high time that some change should be effected in the railway administration. Important letters from chiefs of departments remain for five months without notice, passing from one member of the board to another for translation, and being finally shelved. Some idea of the state of this department may be formed from the fact that the president of the board, and the chief engineer of the permanent way, decline to travel by the only fast train running between Alexandria and Cairo, because they deem it unsafe—although it takes four hours and a half to proceed 137 miles."

THE proportion of new lines constructed during the period 1879-1883, compared with those previously existing, was 5 per cent. for Great Britain, 6½ per cent. for Belgium, 12½ for Holland, 12 for Switzerland, 18 for France, 42 for the United States, 67 for Brazil, and 335 per cent. for Mexico. At the close of 1883 the United States was a long way ahead of all other countries in railway mileage, possessing 191,356 kilometres, Germany had 35,800, while France and Great Britain ran a pretty equal race with 29,688 and 29,890 respectively. The smallest railway owner was Greece, which possessed but 22 kilometres, though this proportion is now raised by the opening last year of 100 kilometres between Volo and Larissa.

THE Great Western Railway Company has obtained a rule *nisi* in the Queen's Bench Division calling upon Messrs. Josiah Kempson and others, of Birmingham, to show cause why a writ of prohibition should not stop them from acting upon the order issued by the Railway Commissioners. It will be remembered that Messrs. Kempson combatted a charge of 5s. 10d. per ton made by the railway company on the carriage of certain wire coils from Shropshire to Birmingham. The Commissioners decided partly in favour of Messrs. Kempson, but on the terminal charges question they gave no decision. The company now seeks to obtain a decision upon this vexed question, and much interest is evinced as to the probable result.

THE Wolverhampton Town Council have this week determined to co-operate, as much as lies in their power, with the Railway and Canal Traders' Association in their opposition to the new Railway Rates Bills. During the meeting of the Council on Monday the expressions which fell from several of the members were particularly strong; for instance, Alderman W. Kendrick held that if the Bills were passed, they would altogether shut out the pig iron firms from trade beyond their own neighbourhood; while Alderman W. Jones—japanner—believed that they would be wholly at the mercy of the companies. Alderman Bantock—a railway carrier—believed that the spirit of competition, with respect to railway companies, always ended in a combination; consequently, no good would result to the traders by fostering it.

IN the railway mileage of each country in proportion to every square kilometre of land, Belgium comes first with 14·5 kilometres of railway, Great Britain with 9·5, France with 5·6, Germany with 6·6, the smallest European States being Russia and Norway with 0·5. The United States, with all its enormous network, now only figures for 2·1, and Canada for 0·2, while Brazil, the Argentine Republic, Paraguay, Japan, and Queensland are only 0·1 each. But if we view the subject from another standpoint—viz., that of the proportion of the mileage to every 10,000 inhabitants—the position of affairs is singularly reversed. Queensland, which was at the bottom of the world's list in the former instance, now stands at the top with 70·8 kilometres of rail to every 10,000 people, South Australia 56·1, West Australia 49·6, New Zealand 47·7, New South Wales 31·1. The United States show for 36·8, and Canada 29·4. Naturally the European States are very low in the scale under this aspect, Great Britain being only 8·5, France and Germany 7·9 each, Belgium 7·7, Holland 6·0, and Russia 3·0. The lowest of all is India with 0·7.

IN the second half of last year the Great Eastern Railway Company added twenty locomotives and eleven tenders to its locomotive stock. In the same period the South-Eastern Railway Company placed three new engines and four new tenders upon its system, while the London and South-Western Railway Company increased its locomotive plant by twenty-one engines and fifteen tenders. At the close of 1884, the Great Eastern Company owned 655 engines and 417 tenders; the South-Eastern, 328 engines and 262 tenders; and the London and South-Western, 487 engines and 303 tenders. The aggregate mileage run by trains in the half-year ended December 31st, 1884, upon the Great Eastern Railway was 7,620,314 miles; the corresponding aggregate distance run by trains on the South-Eastern Railway was 3,486,271 miles; and upon the London and South-Western Railway, 5,741,923 miles. It follows that, taking as the basis of the calculations the number of locomotives upon each system, at the close of 1884 the average performance of each locomotive during the six months ending with that date was:—Great Eastern, 11,649 miles; South-Eastern, 10,629 miles; and London and South-Western, 11,790 miles.

NOTES AND MEMORANDA.

THE imports of iron ore into the United Kingdom in 1884 reached a total of 2,728,672 tons, being a decrease of 449,638 tons on the imports of the previous year.

BY burning diamond in oxygen, Herr C. Friedel found the atomic weight of absolutely pure carbon to be between 12,007 and 12,017, if the atomic weight of oxygen is assumed to be 16.

FOR a waterproof paper varnish, one part Dammar resin and six parts acetone are digested in a closed flask for two weeks, and the clear solution poured off. To this four parts of collodion are added, and the whole is allowed to clear by standing.

MR. JAMES JACKSON, of the Paris Geographical Society, has issued a new and much extended list of various speeds in metres per second. It begins with the Mer de Glace at 0·0000099 m. per second, and concludes with the current from a Leyden jar in a copper wire of 0·0017 m. at 443,500,000 m. per second.

FOR a fireproof cement the following are said to give good results:—(1) Iron filings, 140 parts; hydraulic lime, 20; quartz sand, 25; sal-ammoniac, 3, formed into a paste with vinegar and then applied; (2) iron filings, 180 parts; lime, 45; common salt, 5, made into a paste with strong vinegar, as in the former receipt. In both cases the cement is to be dried slowly, and to be perfectly dry before being submitted to heat, after which it is stated to become as hard as stone.

THE British Iron Trade Association report on the Bessemer steel industry in 1884 gives the total production of Bessemer steel ingots in Great Britain during 1884 as 1,299,676 tons, against a total production of 1,553,380 tons in 1883. The decrease in 1884 therefore amounted to 253,704 tons, which is the greatest decrease that has occurred in any one year in the history of the trade. In 1883 there was a decrease of 120,269 tons on the make of 1882, so that the total decrease of 1884 on 1882 is not less than 373,973 tons. Details are appended.

THE average value per ton returned for the whole of the iron ores raised in the United Kingdom in 1883 was 7s. 7d., against an average value of 7s. 3d. per ton in 1864. The increase of value in 1883 was therefore only 4d. per ton. It may further be remarked that, while the average value ascertained for the ores raised in the United Kingdom in 1883 at mines was 7s. 7d. per ton, the average official value of the iron ores imported into the United Kingdom for the same year at home ports was 17s. 2d. per ton, the difference between the two being thus 9s. 5d. per ton against imported ores.

DURING a recent fog in London, ninety-six million cubic feet of gas were sent out by the Gas Light and Coke Company during the twenty-four hours. This quantity was an increase on that of the corresponding day of 1884, which may be taken to have been an ordinary January day, of 37 per cent., or over 35,000,000ft. The price being 3s. per 1000ft., the public had to pay to this one company £5250 extra on account of the fog. Nine thousand five hundred tons of coal were carbonised during the twenty-four hours to produce the 96,000,000ft.—the largest quantity ever sent out in one day.

A PROCESS for nickel-plating zinc is described in the *Journal of the Society of Chemical Industry*. The zinc is cleaned by dilute hydrochloric acid and thoroughly washed. It is then hung in the nickel bath for a short time, and on taking out is rinsed and thoroughly scraped, so removing all that does not adhere firmly. This is repeated till the zinc is covered with a thin film of nickel, which can afterwards be made as thick as required. The suitable current strength is easily found. When the zinc is once thoroughly covered, the current may be increased without any risk of peeling off.

THE French Société d'Encouragement have had under prolonged examination the process, invented by M. Clemandos, for working and hardening steel. This process, which we described some time since, consists in heating the metal until it acquires sufficient ductility, and then subjecting it to high pressure during cooling. M. Clemandot heats steel simply to a cherry red, and submits it, by means of hydraulic press, to pressures of from 4·5 to 5·5 tons per square inch. After having allowed the steel to cool between the two plates of the press, it is withdrawn, and does not require any further treatment.

THE removal of iron rust from marble, an operation which depends upon the solubility of iron sulphide in a solution of potassium cyanide, is thus effected:—Clay is made into a thin paste with ammonium sulphide, and the rust spot smeared with the mixture, care being taken that the spot is only just covered. After a lapse of ten minutes this paste is washed off and replaced by one consisting of white bole mixed with a solution of potassium cyanide—1 : 4—which is in its turn washed off after a lapse of about two and a-half hours. Should a reddish spot remain after washing off the first paste a second layer may be applied for about five minutes.

OF the quantity of heat obtained on the combination of hydrogen and oxygen in forming water, two-thirds are furnished by the former of these gases and one-third by the latter. The water formed does not absorb any latent heat. For 9 drams of water formed the gram of hydrogen liberate 23 calories, and the 8 drams oxygen 11·5 calories. In the formation of oxygenated water each of the component gases liberates the same number of calories, *i.e.*, for 17 grams of oxygenated water formed the gram of hydrogen gives 11·85 calories, and the 16 grams of oxygen also 11·85 calories. The latent heat of this quantity of oxygenated water is 22·3 calories, of which the half comes from each of the elements. M. Boillot deduces from his investigations the density of liquid oxygen as=0·888. Mr. Wrobleski found this density as intermediate between 0·89 and 0·9.

THE following figures relating to the colouring matter in coal tar are of interest. Fuchsine is one of the leading colours made from coal tar, and on an average, 5 kilogrammes of coal yield 5 per cent., or 250 grammes of benzole and toluole, which, theoretically, yield about 2·9 grammes of aniline oil, or 3·2 grammes of fuchsine. In reality, only one gramme of fuchsine is obtained from 5 kilogrammes of coal, or only two-tenths of 1 per cent. Acoording to C. Engler, of Karlsruhe, Germany, the following quantities of coal tar are worked for aniline colours annually: Great Britain, 400,000 tons; Germany, 85,000; France, 75,000; Belgium, 50,000; and Holland, 15,000. Many of the English works treat the tar only partially, selling the raw material to German works. The aniline colour industry flourishes most in Germany, where there are nineteen works. Lunge, in 1883, estimated the value of the products of the coal tar colour industry at 92,000,000 of marks, of which Germany produces 60,000,000, Switzerland 13,000,000, and France and England 19,000,000 marks.

IT is well known that the vapours of mercury are very diffusive in their nature, and some singular experiments have been devised based upon this, and upon the fact that the salts of silver and the chlorides of gold, platinum, iridium, and palladium are affected by these mercurial vapours. If any one, for instance, says *La Nature*, should write upon a sheet of white paper with chloride of platinum, no mark would be visible, as the liquid is quite colourless. If, however, the same sheet of paper should be held over a little mercury, the metal will be brought out on the paper in dark tints. This magical apparition of a figure or drawing on a sheet of paper which appears to be perfectly white is very astonishing to the spectator. On the other hand, reversing the experiment, a no less marvellous result is obtained. At first expose the drawing in writing to the gases of mercury; the lines will become charged with mercury, and then, by simply bringing the drawing in contact with a sheet of paper previously sensitised with a solution of platinum, the drawing will be reproduced, line for line, on the white paper. Drawings made in this way give a pleasing effect, the tones being very soft and the lines being distinct and clear.

MISCELLANEA.

THE footways of Blackfriars-road, 3154 superficial yards, are now being laid with Brunswick rock asphalt 1in. thick.

ABOUT £45,000 per year is lost by the wear of gold coins, chiefly at the edges. Some one has taken out a patent for a very small steel tire.

PETROLEUM deposits have long been known to exist in the Red Deer River country in the North-West of British North America, and have now been struck at a point a few miles west of Calgary, at the Eastern base of the Canadian Rocky Mountains.

THE inauguration of the new Constantinople Waterworks took place last week. The works, which have been carried out by a French company, have cost some six to seven hundred thousand pounds, and have occupied three years in their construction.

A PAPER on the recent progress in the public supply of hydraulic power has been read before the Liverpool Engineering Society, showing that great advantages accrue to users of hydraulic machinery in wharves and works when the water under pressure is supplied from a large central pumping works on a public supply system.

ANOTHER ironclad corvette of the cruiser class was on the 7th inst. added to the German navy at Kiel. Prince William of Prussia, the Emperor's grandson, who launched the vessel, named it the Alexandrine, after the Dowager Duchess of Mecklenburg-Schwerin, his Majesty's surviving sister. Afterwards, at an official banquet, the Prince eulogised the past exploits of the Imperial navy.

M. JULES BOURDAIS, architect of the Palais du Trocadero, read a paper before the Paris Society of Civil Engineers on the 23rd of January, descriptive of a project by himself of a tower of fine design, 300 metres in height, for the purposes of an electric light house. In the paper M. Bourdais entered fully into the stability of the tower, and it is noted that a wind pressure of 300 kilogs. per square metre, or about 60 lb. per foot, is allowed for in the calculations.

THE report of Dr. Frankland on the waters supplied to the inner and portions of the outer circle of the metropolis during the month of January is again very satisfactory, and shows the high character of water as now supplied by the companies. He says, the Thames water contained, on the whole, the same proportion of organic matter as the previous month's samples, the amount being, except in the cases of the Southwark and Grand Junction Companies, decidedly below the average for this time of the year. All the waters were delivered in a clear and bright condition.

THE affairs in Egypt are now again causing great activity in the works of some manufacturers. Amongst others, Mr. J. Kirkaldy received on the 10th inst. an urgent order contingent on delivery next day from the Admiralty for eight 6000-gallon "Compactum" fresh-water condensers. They will be delivered, and are to be fitted with the Compactum patent dirt-arresters, by which all grit or dirt is prevented from passing into the condenser with the steam. These condensers, to supply 6000 gallons each per day, are only 12in. by 12in. by 37in., and weigh but 370 lb. They are more compact and occupy less than half the room ordinarily required. They are to be fitted on board the transport Calabria, now getting ready as a condensing ship as well as transport.

A METHOD recently employed in replacing an iron bridge across a valley of more than 30 metres depth on the road of the "Nord de la Boheme," near Stranow, has been described in the *Annales des Travaux Publics*. This method consists in mounting each complete section of the new bridge on cars, and conveying it by means of a locomotive to the place it is to occupy. This section is raised to a higher level than that which it is to occupy permanently, so that the cars can be removed, and that a portion of the old structure can then be suspended from the new section. This permits the removal of the old, the workmen working from planks placed beforehand under the roadway of the new bridge. The old bridge being removed, it is only necessary to lower the new sections on the carriers which have been prepared to receive the same. The bridge of Stranow is 40 metres—131ft.—in length, the sections weigh 80 tons, and only forty-eight hours were occupied in the substitution of the bridges.

M. HIGNETTE, in the *Bulletin Technologique des Ecoles Nationales d'Arts et Metiers*, says an exchange, describes a new ceramic product from the waste sand of glass factories, which often accumulate in large quantities. The sand is subjected to an immense hydraulic pressure, and then baked in furnaces at a high temperature, so as to produce blocks of various forms and dimensions, of a uniform white colour, which are composed of almost pure silex. The crushing load is from 370 to 450 kilogs. per square centimetre—between 2 and 3 tons per square inch. The bricks, when plunged in chlorhydric and sulphuric acid, show no trace of alteration. It is said that the product has remarkable solidity and tenacity; it is not affected by the heaviest frosts or by the action of sun or rain; it resists very high temperatures, provided no flux is present; it is very light, its specific gravity being only 1·5, and it is of a fine white colour, which will make it sought for many architectural effects in combination with bricks or stones of other colours. Here is, indeed, a perfect firebrick at last.

HEATING by electricity is being talked about in a vague sort of way in many places. The idea of using fuel to make steam and turning dynamos to make electricity to make something hot to produce effect that could with much greater economy, simplicity, and useful effect be obtained by the steam itself, does not seem to recommend itself much, but there may be something in it that those who are not enthusiasts cannot see. The *Electrical World* speaks as follows on the subject:—"One of the latest applications of electricity is that of car heating. Recently Mr. de Meritens showed an apparatus at his works which is designed to effect the above purpose. The current was generated by a Gramme machine and the heat distributed by long metallic muffles in the shape of flat cylinders, resembling the warming bottles in present use. A special apparatus serves to concentrate the heat and to spread it equally over the whole length of the muffle, so that it radiates evenly." These "flat cylinders," and the "concentration by distribution," are examples of things not to be understood so very easily, except perhaps by a focal dissemination of the widely convergent miscellaneous system of monosyllabic thoughts on a polyscopic view of the terminating limit to an endless line bounding a circular polygon.

CONSIDERING that all English-speaking people use and prefer a 2ft. rule to any other, and the units of a foot and an inch are most appreciated in England, her Colonies, America, and Russia, the advocates of the metre and millimetre standards are not likely to thank Mr. Smyth for the paper he recently read at the Institution of Civil Engineers, in which the following amongst other no better or truer arguments were used:—"The British foot was merely a ternary sub-division of the standard yard, and in practice was often not even used as a linear unit. Carpenters, for instance, measured a plank by the number of 2ft. rule lengths it included, and had then to complete the total length by doubling the number of units they had made use of. A plank could be measured with a metre in about one-third the time occupied in measuring it with a 1ft. rule. The British inch was much too large to serve as the lowest integral unit in a scale of linear measurement, and even one-sixteenth of an inch was too large for minute work. The millimetre was, on the other hand, a convenient unit for ordinary minute work, and its decimal subdivisions were as suitable for microscopic work as thousands of an inch." Some of these statements are absolutely untrue, while the remarks about the comparative superiority of the millimetre unit and the inch unit are such as may with equal truth be reversed by one who thinks a sixteenth of an inch is small enough for ordinary minute work, while decimal subdivisions can just as easily be made of an inch as of a millimetre. How very important, too, in engineering work, must be the decimal divisions of a millimetre. Wanted twice a year by one out of 100,000 engineers.

THE HOOGHLY BRIDGE—DETAILS OF GIRDERS AND EXPANSION SLING

(*For description see page* 134.)

Sections

A.A

B.B

C.C

E.E

F.F

D.D

Cantilever end of Span.

No join in angle

Sectional Plan at H.H

Sectional Plan at G.G

Longitudinal Sectional Elevation C.C

Section H.H

Longitudinal Sectional Elevation D.D

Cross Section G.G

Section at Bearing

Cross Section E.E

Sectional Plan AA

Sectional Plan B.B

Cross Section F.F

Pin for Centre of Links.

To be used in erection

Foundation Bolt

Wrot. iron

Cast Iron

End Elevation

Section at Centre

Expansion Links and Standard.

Guide Brackets

Connecting T Bars for Longitudinal Channel Bars.

Distance Piece for Shore End of Girder.

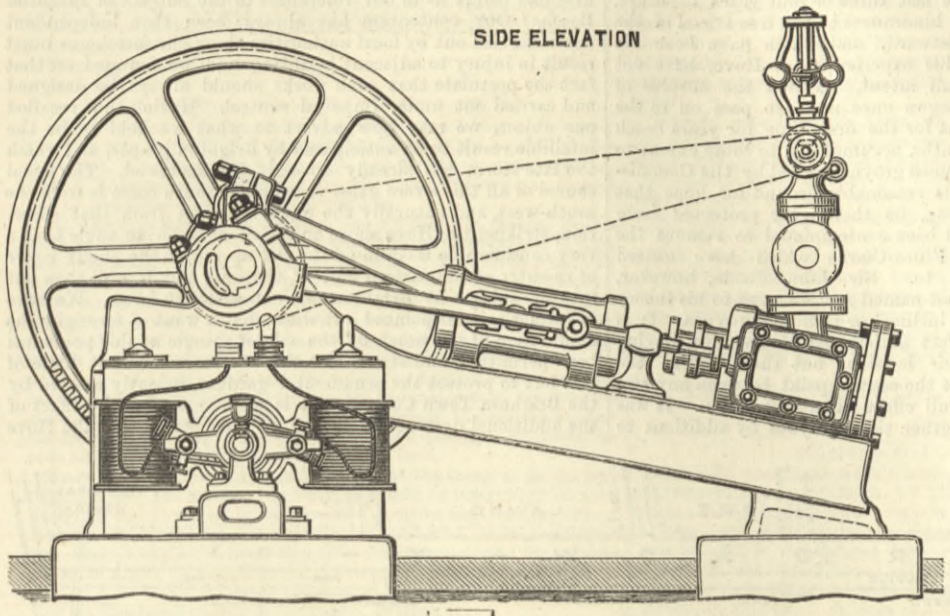
Half Section at a.a

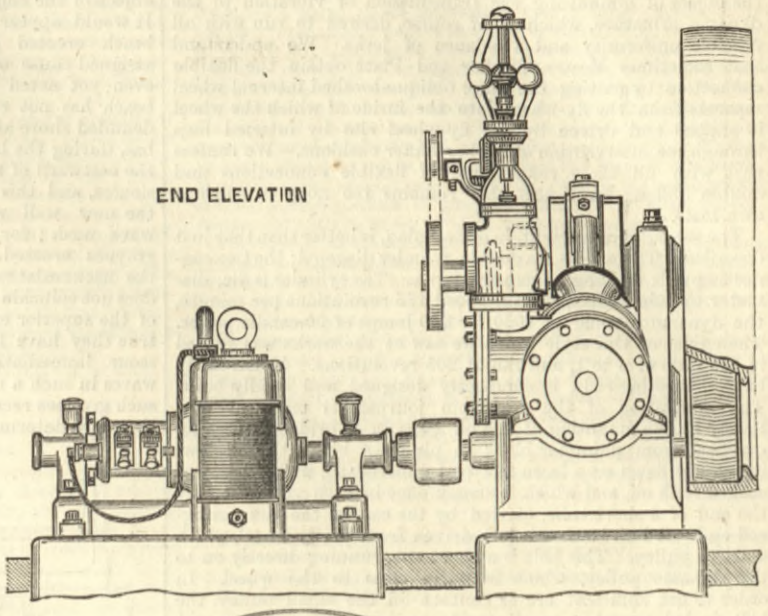
Half Plan of Bed Plate

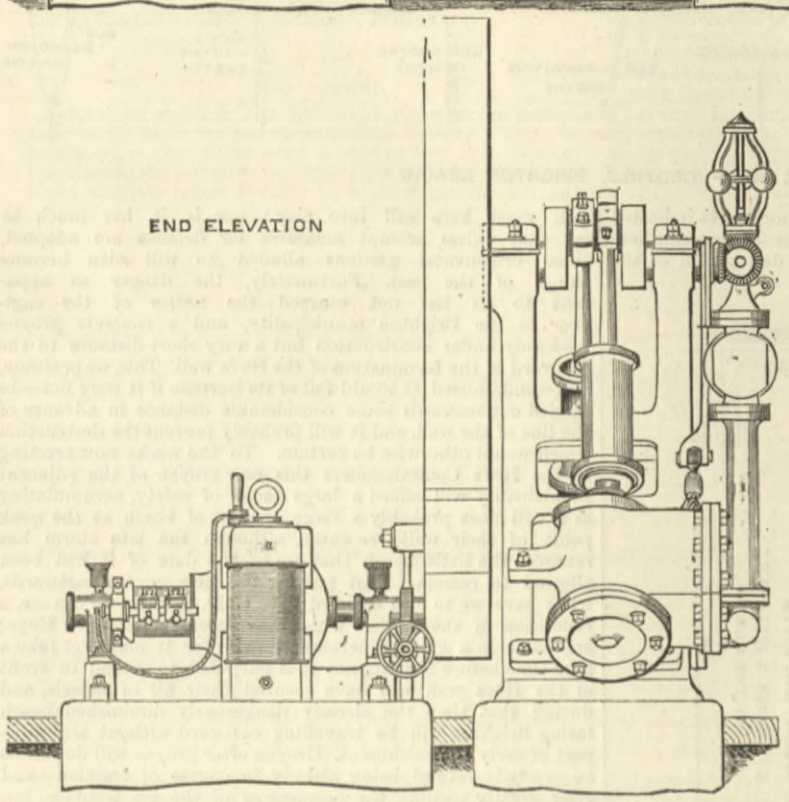
J. Swain Eng.

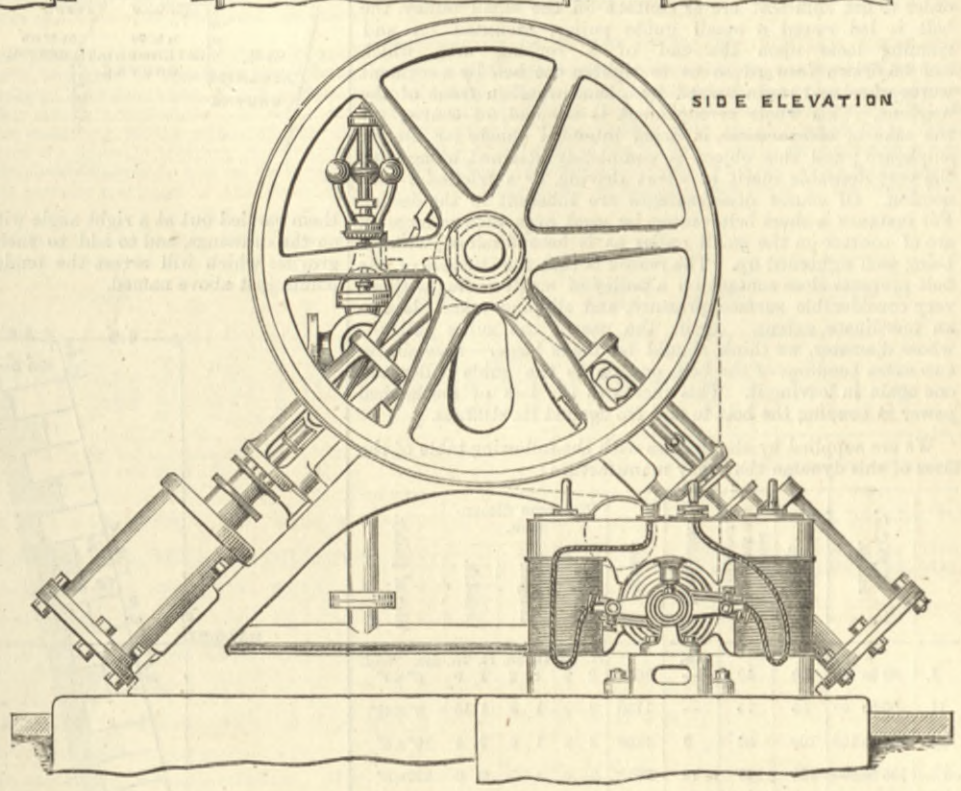
ELECTRIC LIGHT MACHINERY.

MESSRS. MATHER AND PLATT, MANCHESTER, ENGINEERS.

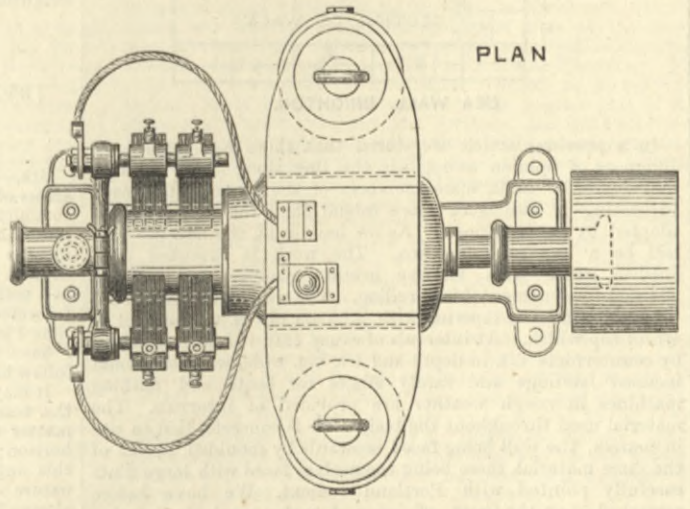


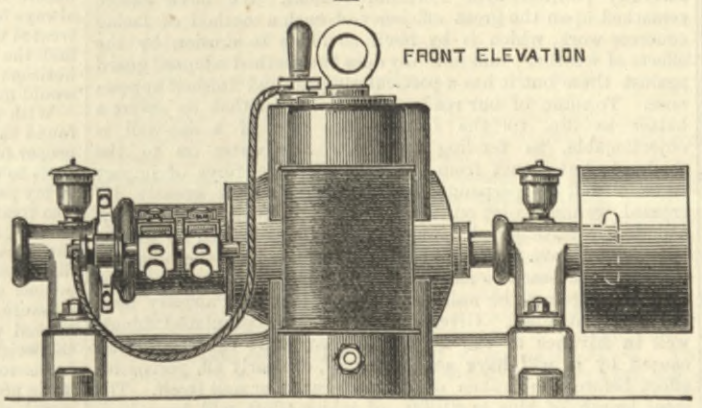






In our present issue we illustrate some dynamo machinery recently designed by Messrs. Mather and Platt, of Manchester, and which we have had an opportunity of inspecting at work. We give front and end elevations, and a plan of the type of dynamo which they are making, more especially for use in situations where the space is confined, such as on shipboard. It is built generally on the Gramme model. The two limbs of the field magnets, whose coils are 8in. outside diameter by 10in. long, stand vertically on opposite sides of the armature. The cores of these are of wrought iron, and are made larger, in proportion to the wire wound on them, than is usual, in this following the improvement made by Hopkinson on the Edison machine. These are joined top and bottom by heavy cast iron cross pieces, forming the poles. The four heavy pieces of iron thus joined form a stiff and substantial frame for the machine similar to that we find in the Bürgin-Crompton dynamo. These pole pieces arch downwards and upwards, so as to embrace closely each about 120 deg. of the circumference of the armature. The magnets are compound wound, the series coils being external to the shunt coils. The lower cast iron piece is extended to form the general bed-plate of the machine, carrying at its extremities the two pedestals, which are insulated from it by suitable packing under the pedestal and washers under the nuts of the holding-down bolts. Ample bearing surfaces are given, the journals being about 7in. long. The bosses of the driving pulleys are cut away on one side, so as to reduce the overhang. The armature is of the Gramme ring type, with specially large core. It is wound with single wire of large diameter, that of the Edison-Hopkinson machine being wound with stranded wire, six wires of fine gauge forming one strand. The armature of the present machine being hollow, with a considerable clear space between it and the shaft, plenty of ventilation is secured, a most important object in a machine that is expected to do steady, hard work, without unreasonable wear and tear. The commutator is given a large surface, and for sizes for 100 and higher lamp powers double brushes are attached, each pair on a rocking bar capable of separate adjustment with a spring forward thrust and butt contact. The illustration shows both pairs of brushes moved together on one rocking bar. The machines are compound wound for approximately constant E.M.F. between the terminals. As will be seen from the subjoined report of a test of one of these machines made last month by Mr. T. R. Williamson, this constant E.M.F. is maintained with a variation of only 1½ per cent. with extreme variation of the load. The electrical efficiency is remarkably creditable for a dynamo sold at a very moderate price, being 87¾ per cent. under full load and as much as 74½ per cent. under extreme light load. The output at 1140 revolutions and feeding 115 Edison 15 candle-power lamps was 8370 watts.

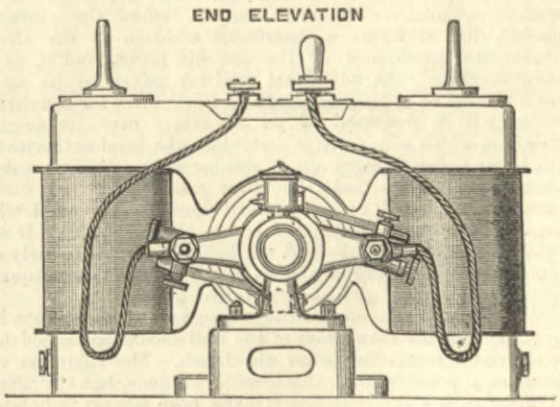




"*Report on a Test of a 100-Lamp Dynamo of Mather and Platt's New Type: made at the Salford Ironworks on January 14th, 1885, on behalf of the Manchester and District Edison Electric Light Company.*

"*Dimensions.*—2ft. 10in. long, beyond which the pulley projects 6in.; 2ft. 5in. wide; 1ft. 5in. high, or 1ft. 11in. including the switch board on the top; pulley, 8in. diameter, 6in. on face; armature, 9in. long, 9in. diameter; commutator, 5in. long, five and a-quarter inches diameter, provided with double brushes.

"*Resistances.*—Magnets, shunt coils, 41·5 ohms.; magnets, series coils, ·049 ohms.; armature, ·086 ohms. At 1140 revolutions per minute, the machine developed 79 ampères, with a difference of potential of 106 volts, maintaining 115 Edison lamps, 16 c.p., 106 and 107 volts. With this output, the electrical efficiency of the machine is 87·75 per cent. Reducing the number of lamps so that the output is only one-tenth of the above, the electrical efficiency is 74·6 per cent. The lamps were arranged in groups of 30, 31, 23, and 26, with a switch to each group. Switching off these one after another quickly the electro-motive force varied as follows:—Beginning with 98 volts it rose to 100, 103, 104, and 105, with no lamps on at all, the 105 falling quickly to 101 volts, indicating, as seemed the case,



that the engine governor was not regulating perfectly. Switching off all as above, only slowly, the electro-motive force rose 3 volts, viz., 98 to 101, showing the dynamo to be self-regulating, with a variation of 1½ per cent. The machine in all its parts kept quite cool during the entire run, and no sparking was noticeable even when groups of lamps were being switched in and out. After running for twenty-five hours continuously the working parts were all cool, and the magnet coils only slightly warm. The maximum safe working load is 8 units, or 8000 watts.

"(Signed)

"T. R. Williamson,

"Electrical Engineer of the Manchester and District Edison

"Electric Light Company, Limited."

We illustrate two modes of driving this dynamo. In one the steam engine is a single-cylinder oblique, with single slide valve and steam throttle controlled by a Pickering governor. The crank is formed of a pair of discs. The cylinder is 10in. diameter and the stroke 12in.; the fly-wheel is formed into an internal spur wheel with double helical or oblique teeth gearing with a pinion with corresponding oblique teeth, the ratio of the

gearing being four to one, and the speed of the dynamo shaft, to which the pinion is directly coupled, being 1050 revolutions per minute. The wheel and pinion have diameters 30in. and 7½in. The fly-wheel boss is let into the crank shaft bearing so as to reduce the overhang as much as possible. The coupling between the pinion shaft and the dynamo shaft is a flexible one, with the object of minimising the transmission of vibration to the dynamo armature, which is, of course, desired to run with all possible uniformity and avoidance of jerks. We understand that sometimes Messrs. Mather and Platt obtain the flexible connection by casting the large oblique-toothed internal wheel separate from the fly-wheel, into the inside of which the wheel is slipped and driven by the fly-wheel rim by internal lugs through the intervention of rubber buffer cushions. We confess that with all these refinements of flexible connections and double oblique teeth, this gear remains too noisy to suit our own taste.

The second arrangement, in our opinion, is better than that just described. The engine is a double-cylinder diagonal; the two connecting-rods working on one crank pin. The cylinder is 8in. diameter by 10in. stroke, and the speed 175 revolutions per minute, the dynamo running at 1050 for 200 lamps of 20-candle power. The engine of this style which we saw at the works was geared in the ratio of 4 to 1, and ran at 265 revolutions. It has fairly long connecting-rods, is compactly designed, and solidly built. The lubrication of the crank-pin journals is managed very neatly by the mounting of the oil cups on a bridge stretching overhead from plummer block to plummer block, the oil flowing slowly down on a loose felt pad underneath, which becomes soaked with oil, and which is struck once in each revolution by the end of a short tube, carried by the cap of the connecting-rod end. A link leather belt is driven from the fly-wheel, which serves a pulley. This belt is a short one, running directly on to the dynamo pulley, which is quite close to the wheel. In order to get sufficient arc of contact on the small pulley, the belt is led round a small guide pulley, mounted on and running loose upon the end of a rocking arm, which can be drawn forward so as to tighten the belt by a segment worm-wheel and worm turned by a hand-wheel in front of the machine. This whole arrangement is adopted, of course, for the sake of compactness, it being intended chiefly for use on shipboard; and this object is completely attained, along with the very desirable merit of silent driving, by a frictional connection. Of course disadvantages are inherent in the design. For instance, a short belt cannot be used, even with so large an arc of contact on the small pulley as is here obtained, without being well tightened up. The reason is that the stiffness of the belt prevents close contact on a pulley of small radius without very considerable surface pressure, and slipping takes place to an inordinate extent. Again, the use of the guide pulley—whose diameter, we think, should be made larger—necessitates two extra bendings of the belt, one on to the guide pulley and one again in leaving it. This increases the loss of mechanical power in bending the belt to and fro against its stiffness.

We are supplied by the makers with the following table of the sizes of this dynamo that they manufacture :—

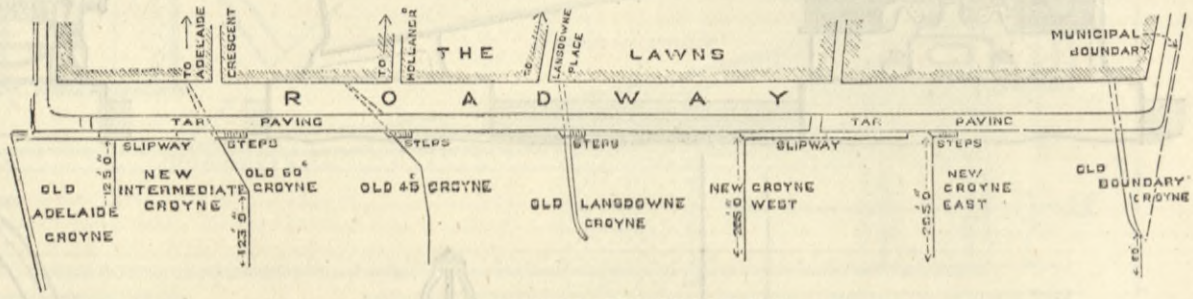
	No. of 20-C.P. lamps.	E.M.F. in volts.	External current in ampères.	Armature.	Speed.	Extreme dimension. Length.	Height.	Breadth.	Size of pulley.
				in.		ft. in.	ft. in.	ft. in.	dia. wid.
I.	30 to 40	50	50	—	1650	2 3	1 2	1 9	6″×4″
II.	50 to 60	50	75	—	1150	2 8	1 2	1 10	8″×4½″
III.	100 to 120	100	80	9	1100	3 4	1 6	2 4	10″×6″
IV.	150 to 200	100	120	10	1050	3 6	1 7	2 6	12″×8″
V.	300 to 350	100	220	—	850	4 3	1 10	3 2	14″×9″

BRIGHTON BEACH WORKS.

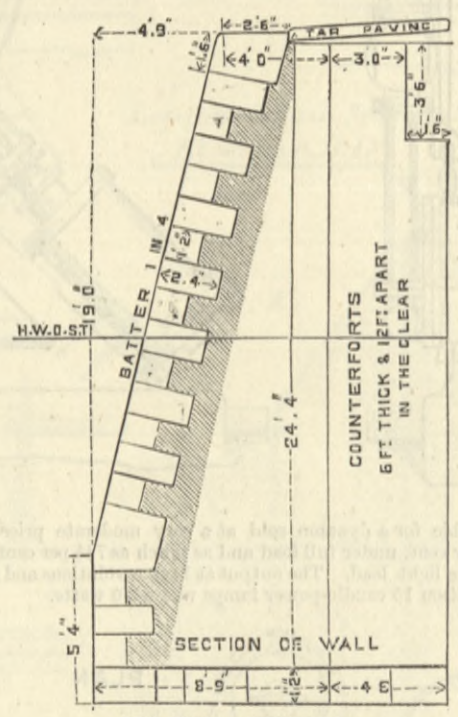
The engravings accompanying this article sufficiently illustrate the works undertaken from the designs of Sir John Coode and Mr. Ellice-Clark to obviate the danger to which the sea frontage at Hove has so long been subjected. These works are now practically completed, and their efficiency has been strongly evidenced by their subjection very recently to a very severe south-westerly gale. A reference to the plan will show that the seawall now erected extends from the old boundary groyne between the parishes of Brighton and Hove westwards for a distance of 2100ft., ensuring protection to that portion of the foreshore which has of late years suffered the most of the entire length of the Hove frontage. The appearance of this wall is striking. Not only does it afford the protection needed, but it forms a handsome addition to the already ornamental appearance of the sea-side lawns, and if, as has been suggested, the additional roadway gained by its agency from the sea be utilised as a sort of Rotten-row for equestrians, Hove will be possessed of an advantage over its neighbour Brighton which will perhaps stimulate the local authorities of the latter parish to carry out a similar work. It is most desirable, we consider, that the Hove wall should be further extended westward to its enforced limit at the point where houses have been constructed across the beach line. If such extension be carried out—and we believe it to be in early contemplation—Hove will be able to boast of a sea face unequalled by any in England, perhaps even in the world.

When last writing on this subject we named the opinion held by some that the foundation of the wall should be carried down to the chalk formation below the beach. The engineers were desirous, if possible, that this should be done, but the expense of doing so, it was found, would have been almost prohibitory, as it would have involved excavations to a depth of 24ft. It is well known, however, that no foundation for such works can be better than solid beach, always providing that it be not liable to disturbance, and there was but a limited section of the line of the intended work exposed to such a liability. At the depth at which the foundation of the wall has been laid the beach was found to be of so concrete a nature that the pick had to be used for its removal, and it was therefore held to be ample precaution to guard against any liability to disturbance over the limited section referred to by sheet piling filled in with concrete in advance of the footings. That this precaution is ample protection has been evidenced during the late gales, the works suffering no injury whatever, although we learn from a Brighton paper that "against the massive masonry the waves dashed with terrific force, and the concussion and the wind combined to carry the surf to a height of 30ft. or more." The foundation of the walling starts throughout at a level of 2ft. 4in. below Ordnance datum, and the work has been set so far within the existing beach line that, except at the points referred to above as having been guarded against it, there was from the first no fear of the shingle foundation being liable to any chance of underscour.

Before proceeding further with our description of this work, it may be as well to refer to the present condition of the beach as regards that accumulation of shingle which it has been the object of the engineer of the last three or four years to secure. It would appear that the hindrances to the free travel of the beach erected to the westward, and which have been the assigned cause of the trouble experienced at Hove, have not even yet acted to their full intent, and that the surplus of beach has not even now begun once more to pass on to the denuded shore at Hove; but for the first time for years beach has, during the last few months, accumulated to some extent to the eastward of the westernmost groyne erected by the Commissioners, and this fact affords reasonable ground for hope that the new wall will, ere long, be thoroughly protected from wave wash; for it has not been contemplated to remove the groynes erected by Mr. Ellice-Clarke which have caused the accumulation referred to. Sir John Coode, however, does not coincide with the last-named gentleman as to his theory of the superior efficiency of inclined or trending groynes. It is true they have had the effect anticipated of them of staying scour immediately to their lee-side, but they deflect the waves in such a manner that the central point between any two such groynes receives the full effect of erosive action. It was therefore determined to lengthen these groynes by additions to them carried out at a right angle with the shore, as is indicated on the drawings, and to add to their number by intermediate groynes which will arrest the tendency to destruction at the points just above named.



PLAN OF GROYNES, BRIGHTON BEACH.



SEA WALL, BRIGHTON.

In a previous article we stated that there had been some difference of opinion as regards the line along which the new wall should be built, some members of the Hove Commission advocating a site 40ft. more inland than that selected and adopted by the engineers. As we have said, the new sea-wall will be a handsome feature. The work is executed in a finished style with massive granite copings, and will be guarded by ornamental iron railing. The wall itself is 8ft. 9in. thick at the base, tapering with a batter of 3in. to the foot to 4ft. of top width. At intervals of every 12ft. it is strengthened by counterforts 6ft. in depth and 4ft. 6in. wide, while steps and inclined landings and safety stages for boats and bathing machines in rough weather are provided at intervals. The material used throughout the bodywork is concrete, laid *in situ* in courses, the wall being faced seawards by moulded blocks of the same material, these being themselves faced with large flints carefully pointed with Portland cement. We have before remarked upon the great efficiency of such a method of facing concrete work, which is by itself so liable to erosion by the effects of weather; and not only does the method adopted guard against these but it has a particularly neat and finished appearance. To some of our readers it may appear that so severe a batter as 3in. to the foot to the face of a sea-wall is objectionable, as tending to throw the water on to the roadway; but apart from the fact that the force of impact when a wall is perpendicular, or nearly so, is greatly increased, we may point out that the wall at Hove will, it is now confidently anticipated, always be largely protected by shingle from severe wave force, and the batter adopted has the object of inducing the beach to naturally form itself into a line of low curvature against the wall—an object which has already been manifestly attained. Given such a line of accumulated shingle well in advance of the work, it is clear that the gentle run caused by it will have neutralised all, or nearly all, percussive effect before the broken water can reach the wall itself. The total length of this is 2100ft., of which 600ft. will have been protected by the breastwork of sheet piling and concrete we have before named. At the eastern boundary of the beach within the jurisdiction of the Hove Commission the wall re-enters the beach, being carried up into the land as far as the toll-house at the junction of their parish with that of Brighton. Care has been taken, as will be seen by the drawings, that all projections for steps and landings should be situate at the base of a groyne, where the accumulated beach will obviate the scour which they might otherwise induce.

At this point we have to consider what the probable effect of the works we have been describing will be upon the section of the beach in charge of the Corporation of Brighton, and we may well here recall to our readers the main object we have from the first had before us in our references to the subject of Brighton Beach. Our contention has always been that independent works carried out by local authorities along our foreshores must result in injury to adjacent localities, and we founded on that fact the postulate that such works should always be designed and carried out under Imperial control. Having thus recalled our object, we may now advert to what we hold to be the infallible result to be anticipated by Brighton proper, and which the late storm has already strongly foreshadowed. The usual course of all the severe gales visiting our south coast is from the south-west, and naturally the waves will run from that direction, striking the Hove shore and wall at such an angle that a very considerable wash must be set up round the slight curve of re-entry at the eastern end of the wall, and it will then cut into the shingle at Brighton with destructive force. We have in former articles pointed out with what a want of foresight the denudation of the beach by the sale of shingle at this point has been permitted, and stated also that there is now but little of this left to protect the ornamental gardens recently erected by the Brighton Town Council. It is easy to foresee the effect of the additional destructive agency we have stated that the Hove wall must here call into play; nor is it too much to say that unless prompt measures for defence are adopted, those ornamental gardens alluded to will soon become things of the past. Fortunately, the danger so apparent to us has not escaped the notice of the engineer to the Brighton municipality, and a concrete groyne is already under construction but a very short distance to the eastward of the termination of the Hove wall. This, we presume, will—and, indeed, it would fail of its purpose if it were not—be carried out seawards some considerable distance in advance of the line of the wall, and it will probably prevent the destruction which would otherwise be certain. To the works now erecting by the Hove Commissioners this new groyne of the adjacent municipality will afford a large factor of safety, accumulating as it will most probably a large amount of beach at the weak point of their wall's re-entry, although the late storm has removed the little beach that up to the date of it had been allowed to remain. But passing the new groyne eastwards, what have we to look forward to? Only, as far as we can see, a repetition of the labours which have been forced upon Hove; and these in a greatly increased degree, for it must yet take a long time before the groynes it is purposed to extend in front of the Hove wall will have secured their fill of shingle, and during that time the already dangerously diminished beach facing Brighton will be travelling eastward without any prospect of early replenishment. Groyne after groyne will doubtless be erected—several being already in course of erection—and after greatly spoiling the appearance of the sea frontage, immunity may be secured at a cost which would have constructed a handsome sea wall. The labour of years, and the large outlay already to be incurred, would have been saved had Imperial control been exercised from the first commencement of those works to the westward of the combined parishes of Hove and Brighton which have been the immediate cause of their difficulty

LETTERS TO THE EDITOR.

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

WIND PRESSURES ON ROOFS.

Sir,—When on a former occasion I wrote to correct the various errors of fact and induction which Mr. Dorabju B. Rabadina had committed in his allusions to my series on stresses, I clearly told him that I had not read Levy's treatment of the question till months after settling the 45-lb. load. Could anything be more explicit than that? Yet Mr. Rabadina, instead of taking my word in a matter where it ought to be conclusive, reasserts his belief that I formed my judgment on a part of Levy's work—which at the time I had not read, and which, strange to say, falls short of what I have written. I fear, therefore, I must leave Mr. Rabadina to follow his own ingenious fancies and extraordinary hallucinations.

It may be interesting to some of your readers to learn that in the recent Danube competition those engineers who mention the matter take the wind as plunging at an angle of 15 deg. to the horizon; and I would remark that, if the wind really plunges at this angle, that circumstance alone would completely alter the nature of what Hutton called the horizontal component. I have always felt that the wind drove at an angle, and in the roof example treated on Plate III. of my "Graphic Statics," Mr. Rabadina will find the direction of wind drawn at an angle of 10 deg. to the horizon; so that, perhaps, I am not quite so old-fashioned as he would make me out.

With regard to uniformity, I need only remark that, having found the 45 lb. load to be a maximum, it would have been quite proper for me to have submitted the two very equally weighted roofs to that test-pressure. But, if Mr. Rabadina will kindly turn to my papers, he will find that one roof at least—the Weymouth—was treated for a 40 lb. wind. Apart, however, altogether, from this circumstance, it is not my custom to fashion every boot after the same last. Again, Mr. Rabadina fails to grasp the very simple distinction between a vertical pressure derived from a normal component and a vertical pressure derived from an absolute normal pressure. Indeed, he would seem to think I admit no kind of normal pressure at all. Then Mr. Rabadina says, "he assumed the weights in all the examples of graphic treatment of stresses in framework," which is a most reckless and ungrounded statement, made probably without any reflection. With regard to the curious moral which Mr. Rabadina inserts for my special instruction, I must leave him to derive therefrom all the profit he possibly can, merely adding that he lectures me as though he were intimately acquainted with continental engineers, their writings, and methods of work.

Some considerable time back, prior to my reply to "C. S.," and long before the appearance of Mr. Rabadina's note on the Carnac roof, Professor Unwin, with his habitual courtesy, communicated to me at my own request the steps by which he arrived at a

mathematical expression for Hutton's experiments. It is, however, perfectly unnecessary for me to enter upon this subject—first, because I have not sought Professor Unwin's permission to make public use of his note; and, secondly, because as far back as March of the year 1882, I find Professor Unwin stating—"Minutes of Proceedings," Inst. Civil Engineers, vol. lxix., Part III.—that he prefers, on the ground of simplicity, the Duchemin to the more complex Hutton formula. There is, however, a vast deal more to be said on both sides of this question which it would be impossible to compress into letter form. R. H. GRAHAM.

February 3rd.

ELECTRIC LIGHTING IN BELFAST.

SIR,—I notice with interest the description you have so kindly given in your issue of 23rd January, under the above head, of the "Belfast" (Newton) Arc Lamp, and beg to thank you for same. I shall, however, feel obliged if you will kindly allow me to correct one or two little errors that have crept in.

(1) The iron case which encloses the arc-striking magnet coil is used as a magnet, and to protect the coil from mechanical injury, not from being "burnt." (2) The interior of the clip c^1 c^2 is lined with card cloth composed of leather and steel wire, not "copper" bristles, set at an angle of about 30 deg. downwards. (3) The carbon rod is not "allowed to slip through this clip by the vibratory motion set up by the electro-magnet as the arc lengthens," but is firmly gripped by the card cloth, by which means, on account of the downward angular set of the bristles, each vibration becomes an absolute downward feed of the carbon rod, the amount of which can be set by the traverse allowed the keeper fixed at the extremity of the vibrating bar, and in practice can easily be reduced to less than the hundredth of an inch.

From the above it will be gathered that the lamp is in no way dependent on the action of gravity, as would be inferred from your description, but works by an absolute positive feed—an important feature, as it enables the lamp to be used with equal facility at any desired angle. I must apologise for trespassing so far on your valuable space. GEORGE ANNESLEY GRINDLE, M.S.T.E., Manager,

Belfast Electric Appliances Company, Belfast,
January 31st.

THE ROCKET.

SIR,—Your article in THE ENGINEER last week has made quite a stir on the Leicester and Swannington Railway. There cannot be a question that there was a Rocket on that line. Lots of the inhabitants and servants remember her well, and the company's books show the name Rocket; then show it struck out, and the name Comet written under. Mr. Stenson's sketch that you published was, I believe, a perfect representation. I am certain that the Swannington engine went back from the Liverpool and Manchester to Newcastle, and then up to West Bridge, Leicester. If there is any possible mistake at all, which I do not for a minute believe there is, it must be that when the Swannington engine ran at Manchester it was not the property of the Manchester Company. After Mr. Woods' letter I can only see this one way out of the difficulty.

As you, Sir, have said, there has never been a case with so much good evidence produced. All the years that I was on the Swannington line it was always said and accepted that our Rocket was the second one from Manchester, and I am therefore very surprised that the general report handed down for fifty years is not correct.

I beg to hand you an *exact copy* of Leicester and Swannington locomotive list made in 1832 and corrected 1835, showing change of name of Rocket. It proves the grounds upon which my former statements have been made, and which I trust you will print in THE ENGINEER. OLD SWANNINGTON DRIVER.

February 9th.

THE CONSTRUCTION OF SPECIFICATIONS.

SIR,—The right construction of specifications must ever form the really essential feature of patent law under any variations of practice in granting patents. But the new law has made considerable alterations in what may be deemed preparation for such construction by requiring preliminary examination of the documents by qualified persons possessed of technical knowledge. This change may reasonably be expected to diminish ambiguity of statement so far as regards descriptions of inventions, and may in this way have some effect in facilitating construction hereafter. It is, however, to be remembered that specifications are required not only to describe inventions accurately from a technical point of view, but also to define them in such a manner as to indicate the legal rights claimed under the respective patents; and this fact raises a question as to how far it may be right to control the use of language in the statements of claims and other parts of the documents bearing upon the claims. The Comptroller is clearly empowered to require "a distinct statement of the invention claimed," and also substantial identity of description in the provisional and complete specifications. No doubt it is important to check the use of ambiguous statements of claim that would leave them open to various interpretations, so as practically to confer on a patentee a semblance of legal rights beyond what he is entitled to; yet still it may happen that in a particular instance there may be room for legitimate difference of opinion as to what precise language ought to be used, so as to give the patent a fair chance of being supported in a court of law.

Those who have had experience in patent cases know what important consequences frequently turn on slight differences of expression in statements of claim, both as regards novelty of invention and questions of infringement; and these are points to be determined with authority by the Court, in accordance with the law as settled in former cases. The whole questions in dispute are regarded simply from a legal point of view, and specifications are construed according to the rules established for dealing with written instruments generally.

These considerations imply that great caution ought to be exercised in requiring amendments in statements of claim, except for the purpose of removing ambiguity. It is not to be supposed that an examiner in the Patent-office can be in so favourable a position for estimating the true and legitimate scope of a claim as a judge sitting in Court, and having laid before him all the evidence as to what was new at the date of the patent, together with the arguments of experienced counsel and reference to former decided cases on points analogous to those raised in the particular case before him.

In illustration of these remarks I would refer to the recent case of Westinghouse *v.* the Lancashire and Yorkshire Railway Company, and specially to the elaborate judgment of Mr. Justice Grove, from which it will be seen how many points of a collateral nature have to be taken into consideration in determining the true construction to be put on a claim, and also what constitutes infringement.

I would especially call attention to the very careful analysis of the claim, and then to the learned reference to the principles on which the question of infringement was to be tried, and finally to the discriminate manner in which the distinction was drawn between what was held to be claimed under the patent and what was alleged to be an infringement, but was decided not to be so.

When we consider the character of the sifting and testing which a claim may have to undergo eventually in a court of law, it is obvious that alterations in the language of statements of claim which are based on the reports of examiners from merely a technical point of view, are liable to prove injurious to the just interests of patentees, who have to bear the risk of whatever construction may be put upon their claims when tried in a Court of law.

WILLIAM SPENCE.

8, Quality-court, Chancery-lane, W.C.,
February 9th.

SHIPPING COAL AT BRISTOL.

SIR,—In your last week's issue, your correspondent for Wales delivers himself as follows:—"The Bristolian dream of making their coal-fields successful rivals to the Rhondda, and of becoming a great coal port, is by this time scattered to the winds. As I pointed out, it would have been remarkable that such an astute people should have allowed valuable seams of coal to remain undeveloped. Cardiff is endeavouring to get an import trade, and rival Bristol in this way. A large syndicate of shippers and merchants is forming."

Had this statement been published in a Cardiff paper, it would have been taken at its worth, but when it appears in the columns of a journal of the eminence of THE ENGINEER, it is high time to protest against it as grossly unfair and partial. He refers with such evident relish to the scattering to the winds of our ideas about exporting coal, and of the probable rivalling of our import trade by Cardiff, as to completely disqualify him as an impartial judge in this matter. His partisan treatment of the Barry Dock scheme is too well known to need more than a reference. However, as to this I am not at this moment concerned, but when your correspondent leaves his own coalfields and rambles off into others about whose circumstances he is very ignorant, the result is he can only make up a paragraph by setting up skittles created by his own imagination in order he may show the zest with which he bowls them down.

Your correspondent says we have dreamt of making our coalfields successful rivals to the Rhondda. This is his dream, not ours. Those who know our coalfield are aware that at the present moment none of our collieries are landing coals equal in all respects to the celebrated smokeless steam coals of the Rhondda. What colliery district outside the Rhondda is? What we do say is that we have coals equal in all respects to the greater part of those shipped at Cardiff, Newport, and Swansea, and that all we ask from our Dock's Committee is that they should provide some decent facilities for shipping them. We have no need to soar into "dreamland" about the qualities of some of our coals. The hard facts of long practical tests in steamships, locomotives, and steam boilers make it quite unnecessary. Cardiff, from its natural position, will always ship the bulk of the best smokeless steam coal, but is that any reason why every other coal district should refrain from shipping coals not quite equal to it in quality, but for which there is an extensive demand? If this is your correspondent's idea, why not commence nearer home and write down Newport and Swansea, and when he has succeeded in closing these coal shipping ports there are many other important ones he could turn his attention to as competitors with Cardiff, of more moment than we are at the present. Bristolians who know what important coal resources they have around them are not likely to be misled by your correspondent, whose policy is purely a "dog-in-the-manger" one. It does not require much wit to understand why Cardiff should be anxious to prevent the shipment of our local coals, any more than it does to understand her jealousy of Newport.

As to our being astute—save the mark!—one fact only need be quoted to prove that in this, as in every other part of his paragraph relating to us, your correspondent is all at sea. One of the members of our Town Council is Mr. James Inskip, who has for some time past been the chairman of the Taff Vale Railway Company, and is the prospective chairman of the combined Bute and Taff Vale interests, should the amalgamation be effected. Now, if he does his duty, he must necessarily take the deepest personal interest in furthering every effort for the development of the South Wales coalfield as affecting the interests of the Taff Vale Company, who remunerate him so handsomely for his services, whilst at the same time he must make every effort to "scotch" the progress of any scheme which may adversely affect the business of coal shipping at Cardiff. Such a scheme is the erection of coal tips at our docks. Yet Bristolians elect this gentleman to a seat in our Council, which will ultimately have to decide the question of providing coal tips for shipping local coals! And yet we are called astute. Can a parallel be found? If your correspondent is sincere and not sarcastic in his idea of our "astuteness," let me suggest that Cardiff should emulate it by electing some of our corn, timber, and provision merchants to seats on the syndicate about to be formed to further the interests of their proposed import trade.

Let me invite your correspondent to descend from the realms of fancy into the region of fact, and note what an Augean stable lies at his very doors, the cleansing of which I commend to his attention. Only very lately the Cardiff Shipowners' Association passed the following resolution:—"That the Association condemns the practice of some charterers who supply bunker coal of the very worst quality for the use of steamers, &c." So that all is not best smokeless coal even at Cardiff. From what part of the South Wales coalfield did this "very worst quality" coal come?

Bristol, February 11th. FAIR PLAY.

PRESSURES ON GUNS.

SIR,—The article in your impression of the 6th inst., on Mr. W. Anderson's paper, is so interesting that a large portion of your readers would gladly know more than is there stated as to the way in which Mr. Anderson's curve of pressures is traced. In the diagrams shown in your engraving, Mr. Anderson's curve is made to agree with his calculated mean pressure; and the "official" curve, starting from the same assumed maximum pressure, no doubt includes a smaller area. But that only shows that the mean pressure, as calculated by Mr. Anderson, exceeds the mean "official" pressure, and does not in the least affect the form of the curve, or the consequent proportions of the gun. Given the mean pressure, it is of course possible to trace any number of ideal curves to correspond with it, as far as total areas are concerned.

The rate of combustion of powder seems to be an important element in determining a curve of pressure, and it would be interesting to know how this has been dealt with. Other things being equal, and the length of the gun doubled, what form would Mr. Anderson's curve assume?

Your remarks as to the indications of crusher gauges seem just, and it appears probable that they measure work done rather than statical pressure; but if so, it is by no means clear that a curve based on such indications is less serviceable in designing the proportions of a gun than a curve of statical pressures, if such could be ascertained. The greater duration of the pressure near the breech end might probably strain the metal of the gun—as it is said to strain the gauge—apart from excess of statical pressure, and thus call for greater thickness at this part than Mr. Anderson's curve would require.

If there be, as it seems, some doubt as to correct proportions, would it not be better, as a choice of evils, to adhere to the "official" curve, and burst the gun outside rather than inside the turret?

London, February 10th. J. W.

PREVENTING SHORTNESS OF WATER IN STEAM GENERATORS.

SIR,—Although cordially acknowledging the ingenuity and value of the automatic boiler feeds which have lately been placed before the public, yet I think that if the present arrangements of feeding by injectors or force pumps were supplemented by a reliable indicator of the level of the water in steam generators they would leave little to be desired. At present when there is priming it is difficult for the stoker to judge of the level of the water by the ordinary gauge glasses. This difficulty has led me to devise an electric indicator of the level of the water, which will sound an alarm when the boiler is short of water, and continue ringing until additional water is fed into the boiler, and, if desired, can be arranged to ring an alarm at the manager's office, and thus be a check on the stoker. By means of a simple auxiliary arrangement I intend to utilise the method when desired to set the force pumps in action. I hope, with your permission, to lay particulars of my invention before your readers as soon as I have completed the patents. B. H. THWAITE.

Dartmouth Villa, Fountain-street, Tranmere,
Cheshire, January 31st.

Leicester and Swannington Railway Locomotive List, July, 1832 (*Corrected to December*, 1835.)

Number.	Name of engine.	Name of maker.	Date received.	Cylinders. Position of	Cylinders. Diameter in inches.	Cylinders. Stroke in inches.	Boiler. Tubes. Diameter.	Boiler. Tubes. Length.	Boiler. Tubes. Number.	Boiler. Tubes. Diameter.	Boiler. Tubes. Heating surface of tubes.	Fire-box. Length.	Fire-box. Width.	Fire-box. Height above bars.	Fire-box. Heating surface.	Fire-box. Area of fire-grate.	Chimney. Diameter.	Wheels. Number.	Wheels. Diameter of front.	Wheels. Diameter of driving.	Wheels. Diameter of hind.	Wheels. Number of wheels coupled.	Weight of engine. In working trim.	Tender. Number of wheels.	Remarks.
					In.		In.	ft. in.	No.	in.	super. ft.	ft. in.	ft. in.	ft. in.	sq. ft.	sq. ft.	in.		ft. in.	ft. in.	ft. in.		Tons cwt. qrs.		
*1	Rocket Comet. 17/7/32 o.v.	R. Stephenson and Co.	10th March, 1832	Outside oblique	12	16	36	6 6	97	1⅝	302·9	2 0	3 0	3 0	25·46	6·0	13	4	—	5 0	5 0	4	9 9 2	4	(Sold 12th December, 1837.)
2	Phœnix	ditto	1st July, 1832	Inside 1 in 10	12	18	36	6 6	113	1⅝	354·7	2 0	3 8	3 5	37·3	7·33	13½	4	4 6	4 6	—	4	9 11 0	4	(Sold 15th December, 1835.)
3	Samson	ditto	22nd July, 1832	Inside 1 in 10	14	18	42	7 6½	97	2¼	420·5	2 2	3 5	3 8	46·0	7·4	13½	4	4 6	4 6	—	4	10 8 2	4	(Transferred to Ibstock Branch, 31st Dec., 1835.)
4	Goliath	ditto	10th July, 1832	Inside 1 in 10	14	18	42	7 6½	97	2¼	420·5	2 2	3 5	3 8	46·0	7·4	13½	4	4 6	4 6	—	4	10 8 2	4	
5	Hercules	ditto	20th March, 1833	Inside 1 in 10	14	18	42	8 0½	125	1⅝	447·5	2 11	3 6	3 7¼	56·45	10·2	13¼	6	4 5½	4 5½	3 6½	4	12 1 0	4	
6	Ajax	The Haigh Foundry Co.	1st Jan., 1835	Inside 1 in 11	14	18	42	8 3	93	2	431·61	3 0	3 4	3 5	40·26	10·0	14	6	4 6	4 6	3 6	4	12 3 0	4	
7	Vulcan.	Taylour and Co.	10th June, 1835	Inside 1 in 11	16	20	49	8 6	105	2¼	554·71	3 1	3 4	4 6	64·13	10·2	14½	6	4 6	4 6	4 6	6	15 1 0	4	
8	Atlas	R. Stephenson and Co.	17th June, 1835	Inside 1 in 10	16	20	47	8 6½	154	1⅝	589·05	3 1½	3 3	4 5½	67·45	10·15	14½	6	4 6	4 6	4 6	6	14 19 0	4	

* Pen drawn through the word Rocket in original.

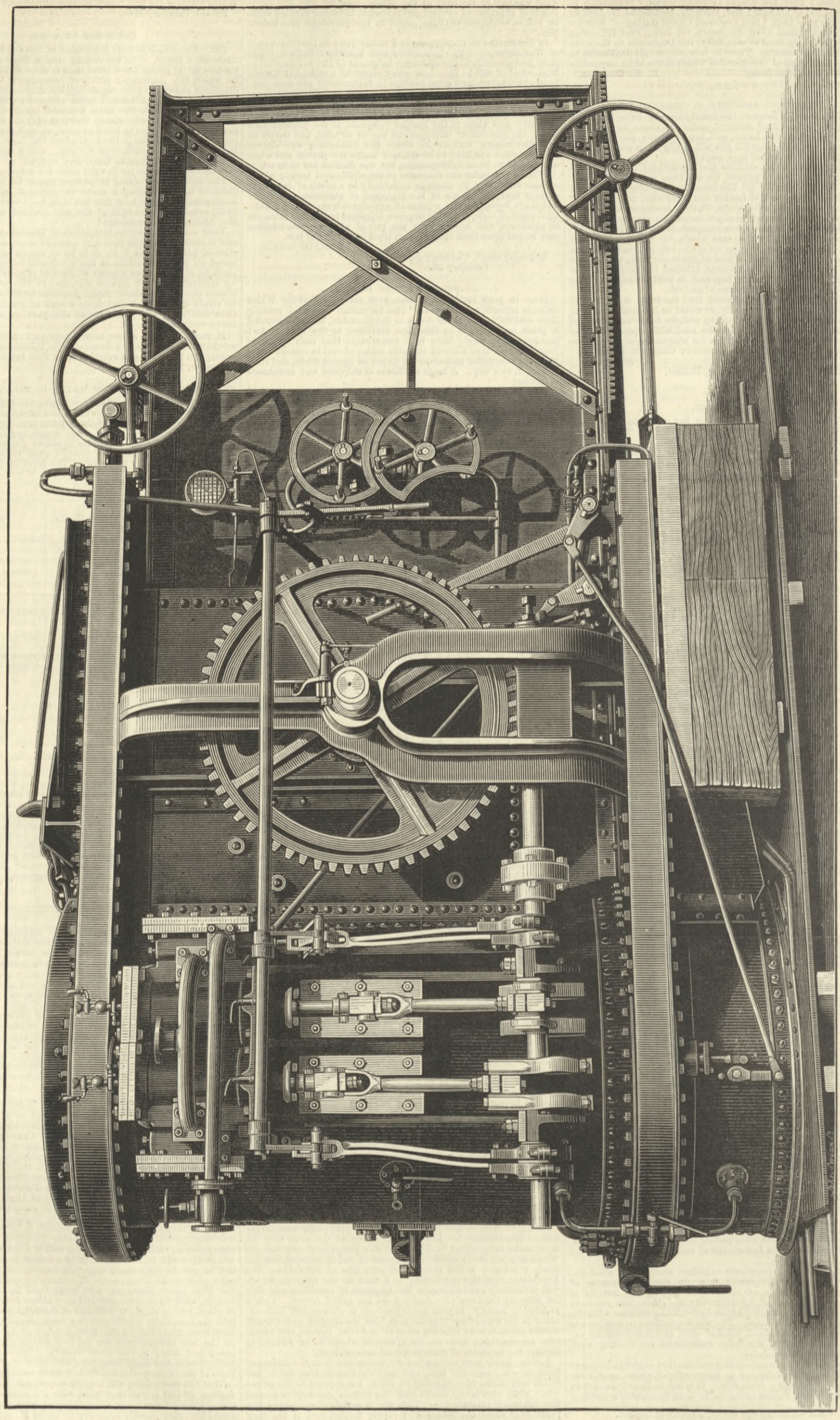
SILK CANNON.—A German inventor proposes to wrap a steel tube with silk until a diameter is attained corresponding with the ballistic power which is required for the cannon. For any given diameter silk, he says, possesses a tenacity as great as that of the best tempered steel, and has the advantage of a superior elasticity. After the tube has been made it is centered upon a lathe which turns with a great angular velocity. Above and parallel with the tube are arranged a number of spools of silk, which cover the surface in the form of a helix, by means of guides, without leaving any space between the threads. When the desired thickness has been obtained, the silk is coated with gutta-percha or hardened caoutchouc, in order to preserve it from air and dampness. The silk being a bad conductor of heat, the gun can be fired very often without getting hot, and it is stated that it can be more easily managed, since its weight is only one-third as great as if it only were of steel.

VISIT OF H.R.H. PRINCE GEORGE OF WALES TO H.M.S. BENBOW.—On Wednesday last Prince George of Wales, who is now studying at the Royal Naval College, Greenwich, paid a visit to the Thames Ironworks and Shipbuilding Company, Blackwall, to inspect H.M.S. Benbow. After an inspection of the plans and model of the Benbow in the company's board-room, where also a large collection of models of nearly all the first armour-clads built for the English and foreign Governments are to be seen, and which were a matter of great interest to the Prince, he passed through the iron rolling mills and the forge to the Benbow. A complete tour was made through the whole of the numerous compartments of this magnificent vessel, which is rapidly approaching the launching stage, the whole of the armour being completed on the hull and protective decks, amounting to about 1750 tons. The heavy plating under the barbettes is well in hand, and preparations are being made to commence their erection, but the armour will not be put in place until after the launch, which will probably take place about June next. The massive stern tube brackets for the twin screw shafts are now being fixed in place. The huge rudder, with its correspondingly heavy steam steering gear, is fixed in place, and in all about 4000 tons of material have been worked into the monster in a little over two years. Greater progress would have been made but for the delay occasioned by the substitution of the two 110-ton guns for the four 63-ton guns originally proposed and fitted in the sister vessels. The experiments now making with the rapid firing guns still somewhat retard the progress of the upper works, but these guns are daily growing in value, so that the short delay will be well compensated for by the introduction of this powerful weapon with its most approved mountings. Prince George was much pleased with his inspection of a vessel that may possibly some day be under his command.

FORTH BRIDGE—AIR LOCK FOR SINKING SEVENTY-FEET CAISSONS.

MESSRS. FOWLER AND BAKER, MM.I.C.E., ENGINEERS; CONSTRUCTED BY MESSRS. TANCRED, ARROL AND CO.

(For description see page 134.



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.*

TO CORRESPONDENTS.

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

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

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

J. C. (Grantham).—*So far as we can see, the invention described in your letter is very old.*

PERPLEXED.—*Overman's "Moulders' and Founders' Pocket Guide." London: Sampson Low and Co.*

IGNORAMUS.—*We think we now understand the arrangement. It appears to us that you have far too much piping for the size of your boiler, and as the vertical head is very small and the resistance in the pipes due to bends, &c., very considerable, the circulation must be languid. You ought to put in a larger and deeper boiler, which will in all probability cause considerable improvement.*

T. G. N. (Apsley-terrace).—*The statement that the action of dynamite is downwards was not made in* THE ENGINEER. *It is not true; its action is like that of all other explosives, in all directions. The notion that it acts downwards only, has no doubt arisen from the circumstance that if a lump of it be laid on a stone, &c., it will smash the stone. It cannot in such a case operate upwards, because it has nothing to operate upon; but if the stone were placed on top of the dynamite it would be smashed.*

ERRATUM.—*Page* 98, *col.* 3, *line* 22*nd from top, for* 75 *lb. load on safety valve per square inch, read* 85 *lb.*

TINFOIL MACHINES.

(To the Editor of The Engineer.)

SIR,—I shall be much obliged for the address of a firm making tinfoil and capsule machinery. E. Z. H.

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.*

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

Cloth cases for binding THE ENGINEER *Volume, price* 2*s.* 6*d. each.*

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, Egypt, France, Germany, Gibraltar, Italy, Malta, Natal, Netherlands, 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 in 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, Mauritius, 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.—Friday, Feb. 13th, at 7.30 p.m.: Students' meeting. Paper to be read and discussed, "The Maybole Waterworks," by Mr. Gilbert Hunter, Stud. Inst. C.E. Mr. W. Anderson, M.I.C.E., in the chair. Tuesday, Feb. 17th, at 8 p.m. Ordinary meeting. Paper to be read with a view to discussion, "The Metropolitan and Metropolitan District Railways," by Mr. B. Baker, M. Inst. C.E. "The City Lines and Extensions (Inner Circle Completion) of the Metropolitan and District Railways," by Mr. J. Wolfe Barry, M. Inst. C.E. Thursday, Feb. 19th, at 8 p.m. Special meeting. Second lecture "On the Theory and Practice of Hydromechanics—Water Supply," by Dr. William Pole, F.R.S.S., L. and E., Hon. Soc. Inst. C.E.

KING'S COLLEGE, LONDON, ENGINEERING SOCIETY.—Tuesday, Feb. 17th, at 4 p.m.: Paper by Mr. Adams, "On Aerial Navigation."

ROYAL METEOROLOGICAL SOCIETY.—Wednesday, Feb. 18th, at 7 p.m: The following papers will be read:—"How to Detect the Anomalies in the Annual Range of Temperature," by Dr. C. H. D. Buys Ballot, Hon. Mem. R. Met. Soc. "Cloud Observing," by Mr. D. Wilson Barker, F.R. Met. Soc. "A Suggestion for the Improvement of Solar Radiation Thermometers," by Mr. William F. Stanley, F.R. Met. Soc., F.G.S.

SOCIETY OF ARTS.—Monday, Feb. 16th, at 8 p.m.: Cantor Lectures. "The Distribution of Electricity," by Professor George Forbes, M.A., F.R.S.E. Lecture III.—Series mains—multiple arc series—methods which have been used—modifications proposed—economy of this system—supposed danger of high potentials—three wire system—accumulators used in two ways: (1) charge and discharge in series; (2) charge in series, discharge separately—secondary generators—example of central station lighting now accomplished—the problem an engineering problem with all the data for calculation—conclusion. Wednesday, Feb. 18th, at 8 p.m.: Eleventh ordinary meeting. "Malt-making," by Mr. H. Stopes. Lord Alfred S. Churchill will preside. Friday, Feb. 20th, at 8 p.m.: Indian Section. "The Teak Forests of India and the East, and our British Imports of Teak," by Mr. P. L. Simmonds. Colonel Michael, C.S.I., will preside.

DEATHS.

On the 2nd inst., in London, RICHARD ATKINSON PEACOCK, C.E., F.G.S., formerly of Slyne Lodge, Lancaster, and St. Helier's, Jersey, aged 73.

On the 2nd inst., at Bishopsteignton, South Devon, FREDERICK LONGSDON, of the firm of Messrs. Hy. Bessemer and Co., Sheffield, and of Beigton, Derbyshire.

THE ENGINEER.

FEBRUARY 13, 1885.

THE STRENGTH OF GUNS.

WE commented last week on Mr. Anderson's lecture delivered before the Society of Arts on the 29th ult., in which he treated guns as heat engines. The result at which he arrived was so startling that his statements cannot fail to attract attention, and will no doubt be brought before Parliament on the first opportunity. The nature of Mr. Anderson's investigation, although apparently complex, is in its essence simple enough. The work done by fired gunpowder is strictly analogous to that done by coal or gas, unless, indeed, it can be shown—which we have no reason to believe—that the action of an explosive is in some way unlike that of any other fuel. As a matter of fact, the difference between an explosion and the combustion of a lump of coal in a furnace is one of rapidity; it is a question of time. Thus, coal-dust by burning with lightning-like velocity produces all the effects of an explosion in a mine; and on the other hand, mixtures of air and coal gas can be burned so as either to produce an explosion or to give a diagram not at all unlike that proper to the action of high-pressure steam in an engine cylinder. Mr. Anderson regards any gun simply as a heat engine, the powder gas being the working fluid; and he calculates on known laws the diagram of energy necessary to do the work actually done when a gun is fired. If, for example, we take the muzzle velocity of a projectile weighing 250 lb. at 1500ft. per second, we know that its energy equals $\frac{250 \times 1500^2}{2g}$, or 8,789,062 foot-pounds. If the distance traversed by the shot in the chase of the gun were 10ft., then an average pressure of 878906·2 lb. must have been maintained on its base, and its average velocity in passing through the gun would have been 750ft. per second, and the time of its passage would have been $\frac{1}{75}$, or 0·0133 of a second. With such data available, there is no difficulty in calculating the number of heat units that must be converted into work. But besides the theoretical aspect of the question, there is the practical side, and it is known by direct experiment that the pressure in guns is greater than that required for the mere explosion of the shot. This is partly due to the friction of the projectile, and partly to the force required to make it spin on its axis. The pressure is obtained by means of crusher gauges—little discs of copper into which small cutting edges of definite form are forced by the pressure of the powder—and from the depths of the indentations so produced is deduced the powder gas pressure in tons per square inch. Grave doubts have often been entertained concerning the validity of the figures thus obtained; and Mr. Anderson rejects them without hesitation as untrustworthy. He takes very little exception, however, to the official statements as regards initial pressure in a gun, but he shows that the curve of the energy diagram is full, instead of being hollow, and that guns proportioned on diagrams of the official pattern are too weak in advance of the trunnions, and thence toward the muzzle. In this way he explains the bursting of the gun on board H.M.S. Active, and two or three of the other cases of recent failure. We may here remark that although the gun of the Active was made by Messrs. Sir William Armstrong and Co., that firm worked to official instructions; were in no way responsible for the proportions of the gun, and actually pointed out to the authorities that the gun was deficient in strength. If our readers will turn to page 112 in our last impression, they will find copies of Mr. Anderson's and the official diagrams of powder pressures, and they will see that a gun proportioned according to the former is by no means so pretty to look at as the official weapon. Possibly this fact had some influence on the designers of the gun.

It will be found, if the diagrams we give are calculated just as an engine diagram is, that the area of Mr. Anderson's diagram is very largely in excess of that of the official diagram; and Mr. Anderson states very plainly that the area of the official diagram is not sufficiently great to account for the mere expulsion of the shot, leaving every other consideration out of the question. Indeed, the work done on the shot does not greatly exceed 56 or 60 per cent. of the whole work done by the powder, which has not only to overcome friction and inertia, but to provide for recoil and for the explosion of the gas. In the case of the Active's gun, for example, we have a charge of 17 lb. of powder, the weight of the shot being 100 lb., or about six times as much. The battering charge of the same gun is, however, 34 lb., or one third the weight of the shot. In the gun when fired would be produced about 30 lb. of gas, the remaining 4 lb. being unconsumed powder. The whole has, however, to be expelled at a velocity at least as great as that of the shot, and here accordingly we find that 33 per cent. of the gross power developed in the gun is unavoidably wasted. Of this circumstance, so far as we are aware, no official cognisance has hitherto been taken. If the crusher gauges give a diagram like the official diagram, then so much the worse for the gauges. We await with some curiosity the defence of the existing proportions of the guns, official or non-official, which will be forthcoming.

It may perhaps be said that the guns are quite strong enough, even if Mr. Anderson be right in his views. As a matter of fact the 10in. gun has a factor of safety of about two to one. This is, of course, perilously minute. A gun with such a coefficient may, of course, last for years; but it may fail at any time, and this, too, with very much less stress than it at one time bore. The effect of strains, in amount very nearly touching the limit of strength, is well known, and manifested often by somewhat curious phenomena. Thus, for example, the hook of the great hydraulic crane at Woolwich Arsenal once broke with about ten tons load, having stood over thirty tons the day before; and in one instance a crane of considerable size actually tumbled down of itself when not at work, although it was considered perfectly safe, and had been in use a very short time before. We cannot for a moment think that a factor of safety of two is sufficient for any gun, and we trust that steps may be taken at once to apply what Mr. Anderson has stated in practice. As we have pointed out, his methods of calculation are simple and readily understood. But even if this were not the case, the Government has at its disposal plenty of men competent to go over the ground which Mr. Anderson has trodden, and ascertain whether he is or is not in any way in error. We believe that the authorities themselves most skilled in such matters have little faith in the accuracy of the official diagram; and if this is the case it is simply disgraceful that it should be issued. If it can be shown that our guns are wrong, then a change must be made at once, no matter whose reputation suffers. Mr. Anderson has brought the heaviest charge yet urged against those who are responsible for the design of English guns; and it is noteworthy that so celebrated a firm as that of Elswick should have doubted the sufficiency of the Government design. As we have said, the matter cannot rest where it now is, and the sooner it is brought to a definite issue the better.

NEWTON'S THIRD LAW.

NEWTON enunciated three propositions, which have come to be known as laws. These are regarded as the basis on which all dynamical truths are founded. The first of these is:—"A body continues in a state of rest or of straight uniform motion until it is compelled to alter that state by impressed force." The second law is:—"Change of motion is proportional to the impressed motive force, and takes place in the right line in which the force acts." The third law of motion is:—"Reaction is always equal and opposite action; that is, the mutual actions of two bodies are always equal, and take place in opposite directions." It is a remarkable fact that, although this last-named law is flatly opposed to the teachings of most, if not all, authorities on dynamics, the circumstance is passed over in silence, and, as a rule, the law is, for all practical purposes, ignored. This may seem to be a startling assertion; it is, however, none the less true, and we call attention to the facts in the hope that text books may yet be written which will attach the importance to the third law, and the deductions which may be drawn from it, that they deserve. How necessary it is that such a change should be made in this branch of science teaching is demonstrated by the continual publication of text-books which all follow in the same beaten path, and reproduce error with a steady pertinacity worthy of a good cause. We have now lying before us a very well written treatise on dynamics, by Benjamin Williamson, M.A., F.R.S., Fellow of Trinity College and Professor of Natural Philosophy in the University of Dublin, and Francis A. Tarleton, LL.D., Fellow and Tutor of Trinity College and Vice-President of the Royal Irish Academy. There can be no doubt that this work will maintain and increase the high reputation of Trinity. In fact, the book is one which may be safely put into the hands of all students who are acquainted with the calculus. It will aid them to pass examinations, and to take their places with men well trained in dynamical science; but, like all its predecessors, it is marred by the fact that Newton's third law is, to all intents and purposes, opposed to much that its authors have to teach. We have seen important changes made in definitions of terms, and already men's minds begin to be exercised concerning the true meaning of such terms as Force, Potential Energy, and the like. We dare to hope that the day is not far distant when those who instruct will boldly face the consequences of Newton's third law, and modify their teachings accordingly.

In order that our readers may thoroughly comprehend the true nature and scope of the point at issue between us and, let us say, Professor Williamson as the latest exponent of modern dynamics, it will suffice to point out that if Newton's law is true without qualification, force cannot by any possibility produce motion. From this conclusion there is absolutely no escape. On the precise meaning of the law as interpreted by Newton, he left no one in doubt. We quote Professor Williamson:—"On this law Newton remarks as follows:—'If any person press a stone with his finger, his finger is pressed by the stone. If a horse draw a body by means of a rope, the horse also is drawn—so to speak—towards the body; for the rope being strained equally in both directions, draws the horse toward the body as well as the body towards the horse, and impedes the progress of one as much as it promotes that of the other.'" A little further on we have the following passage:—"He—Newton—also showed that the law holds in the case of the attraction of bodies, as follows: Let A B be two mutually attracting bodies, and conceive some obstacle interposed by which their approach to one another is prevented. If the body A be acted on towards B by a greater force than B is acted on towards A, then the obstacle will be more urged by the pressure of A than by the pressure of B. The stronger pressure should prevail, and cause the system consisting of the two bodies and the obstacle to move *in directum* towards B; and as the force is uniform, the motion would be accelerated *ad infinitum*, which is absurd and contrary to the first law of motion; for by that law, as the system is not acted on by any external force, it should continue in a state of rest or of uniform rectilinear motion." If all this means anything, it is a plain statement that every force is balanced by reaction—that, in a word, resistance must always be equal to force impressed. If this be the case—and that it is the case is true beyond all shadow of doubt—how can force produce motion, or, indeed, an effect of any kind? To assert that the motion of the thing moved constitutes part of the resistance overcome by a force, as some persons have done, is to ignore what takes place when a body from a state of rest is put into motion. Because it is clear that as the body while at rest resists the force impressed on it as much as the force impresses it, no motion can result from the operation of the force. If this be so, then it is obvious that we must seek in something other than force for the cause of motion. The student is taught Newton's third law with some care, and as soon as he has mastered the fact that the resistance offered by a cart to the pull of the horse is precisely equal to the pull in question, he is told that this pull being a force produces motion. The antagonism between the two propositions is as glaring as though Euclid said in one place that the three angles of a triangle were equal to two right angles, and further on that they were equal to one right angle only. It will not do to attempt to gloss the difficulty over and assert that it does not exist. Not only does it

exist, but it is brought daily and hourly before our eyes. The train which carries us across the country resists the locomotive which hauls it with precisely as much effort. The thrust of a propeller is exactly equal to the resistance of the ship—no more and no less. It was once held that the pressure of steam on a piston must be greater than the resistance of the piston to being pushed, and Pambour caused some sensation when he showed by a masterly investigation of the performance of certain locomotive engines that the resistance was invariably equal to the impelling force of the steam. At every turn we are brought face to face with the truth that force cannot by itself produce motion.

Let us turn, however, to the text books, and what do we find? We need not go beyond the volume lying before us; we need not, indeed, search further than Newton's own utterances. His second law quoted above runs:—"Change of motion is proportional to the impressed motive force;" and he uses these words while he has taken the utmost pains to prove that, by the third law, action and reaction being equal and opposite, force cannot produce motion, or, in fact, any effect at all of any kind. Is it remarkable that the student, face to face with such contradictions, should find himself perplexed? Is it not obvious that the contradiction should be explained away by those who undertake to teach? Is it curious that a man who thinks deeply, like Tait, should refuse to accept the received definition of force, namely, "that which produces or tends to produce motion," and propounds a new definition of his own? There is no room for doubt, qualification, or explanation. If the word force is to be construed as it always is, in the sense of a push, pull, pressure, or effort, then it is certain that it is incapable, standing alone, of producing motion; yet that motion does take place is a patent fate. How, we may be asked, "do you reconcile the facts with your own statements?" It forms no part of our purpose to give explanations of this kind here. It must suffice to give the student a key by which, perchance, he may unlock the door closed against him. Is there such a thing as force apart from motion?

We may, perhaps, be pardoned if we digress here for a moment to call attention to the use of the word "attraction" as quoted above from Newton. The great philosopher has been often credited with the discovery of the "attraction" of gravitation, yet he took very great pains to prove that he did not believe in action at a distance, and he no doubt used the word attraction as above in a conventional way to express an idea, not a fact. We fail to find, however, that one word of warning has been adduced by Professor Williamson or Dr. Tarleton to prevent the student from following that *ignis fatuus*—attraction. On the contrary, we find the statement constantly repeated, that the earth "attracts" the moon. The law of attraction is laid down. The law of gravitation is mixed up with attraction in one place, while Chapter VII., on central forces, explicitly assumes the existence of such a force in nature. Now, so long as the word is employed to express certain phenomena, with proper reservations and explanations, there can be no possible objection to its use; but not one syllable of warning is to be found in any text book with which we are acquainted; and Professor Williamson and Dr. Tarleton go bravely on talking of the effects produced by attraction, with Newton's own definite statement that attraction is entirely incapable of producing any effect whatever in the way of motion, staring them in the face. So far, as we have said, was Newton from believing that one body could act upon another at a distance that, writing to Bentley, he says, "That gravity should be innate, inherent, and essential to matter, so that one body may act on another at a distance, through a vacuum without the mediation of anything else by and through which their action and force may be conveyed from one to the other, is to me so great an absurdity that I believe no man who has in philosophical matters a competent faculty of thinking can ever fall into it." Indeed, it may be shown mathematically that if one body could attract another, the doctrine of the conservation of energy is false. Surely it ought to be worth while to take care that such truths are properly put before the student. When will a text book of dynamics, free from puzzles and contradictions, be published?

WAGES OF BRITISH WORKMEN.

The signs of the times seem to point to a reduction of wages in England, at the very period, curiously enough, when the industrial classes are increasing in power. In the Yorkshire districts these indications have recently been emphasised and accentuated by the declarations of representative manufacturers and merchants. At the Sheffield Chamber of Commerce meeting the question was brought up by the president's remark that Mr. Giffen, of the Local Government Board, had asked the Chamber to give statistics of the average rate of wages paid by the manufacturers of that town. This request was not considered one to concede, and the president thought the Council had acted wisely in refusing to comply with it. Mr. George Barnsley, the ex-Master Cutler, and a large employer of labour, urged that the better plan to meet foreign competition was by taking away from the working men "that intoxication which they get in the time of good trade and high wages, and which had rather spoilt them." Mr. Barnsley holds that the time has come when manufacturers and workmen should fight the battle of trade in a business-like way, contending "that our present fiscal arrangements had resulted in decreasing the cost of many things required by working men, and this decrease in price should be used as a reason for a reduction in wages, so that manufacturers might be able to compete successfully with foreign makers." Alderman Brooksbank, one of Sheffield's most clear-headed manufacturers, believes that the great question this country has to contend with is the price of labour, which was much dearer than on the Continent, and when the struggle came the price of labour would have to go down. They could not give English workmen for four and a-half days' labour the same wages that workmen on the Continent received for six days' labour. This was the secret of a great deal of the competition that was going on. England must produce cheaper, and she could not do it without an alteration in the price of labour. The Master-Cutler—Mr. J. E. Bingham—is strongly opposed to any lowering of wages, which, he believes, will never be granted until after an inquiry into the fiscal policy of England. Mr. Bingham is an earnest Fair-trader, and regards the wages question as the battle ground on which Fair-trade as against "what people were pleased to call Free-trade" would have to be dealt with. Another representative employer, Mr. Emerson Bainbridge, of the Nunnery Collieries, while equally opposed to the reduction of wages, points out that the working classes are now in a better position than they have been for a long time. In consequence of the supply of food exceeding the demand, they had been enabled to live during the past few years in a way that was equal to 10 per cent. on their wages. He regarded the development of railways in India as of great importance, believing that enterprise of this kind would tend to give that increased demand which was required. Even Mr. Bainbridge, however, held that if good articles were to be made cheaply they must have some alterations in the workmen's wages, and this in the interest of workmen as well as any other class, for unless there was a change some of their manufactures would not survive, and then their men would be thrown idle. These significant statements by prominent Sheffield manufacturers have attracted the attention of the Sheffield Labour Association, the leading spirits of which have waxed very wrath thereat. If the summer months do not see a stiff struggle on this great question, appearances deceive the thoughtful. In the coal-field, with its tens of thousands of workmen, there is certain to be a serious conflict. At Barnsley and other places the miners' agents are warning the men that the employers will demand a return of the 10 per cent. conceded in the autumn of 1883. If the coalowners really mean what the Union officials say, there will be one of the most gigantic fights ever seen in that cock-pit of British industry—the Yorkshire coal-field. The owners have thoroughly re-organised themselves into a powerful association with no lack of funds, and the colliers have also become more firmly banded together. Their leaders are bent on going to Parliament as labour representatives, and they could scarcely command success in that direction if they did less to deserve it than urge the miners to resist. The wisdom of resistance from an economic point of view is another matter.

A SOUDAN RAILWAY.

When the history of our operations in Egypt comes to be written, it will be found that they stand out distinct and well defined as being above and beyond all past operations, military or political, lacking in foresight. No one concerned appears ever to have looked ahead. For all in power the future apparently did not exist; and even when the right thing has been done it has always been done at the wrong time—too late, never by any chance too soon. If a little foresight had been employed hundreds of lives would have been saved, Gordon would have been rescued, and the costly and difficult advance by the Nile need never have taken place. The one thing wanted was a railway from the sea coast; but the cost, we assume, was suffered to stand in the way. Yet the construction of this railway would have cost the British taxpayer nothing. A syndicate was formed more than a year ago under the auspices of Stafford House to make a railway. The Egyptian Government undertook to guarantee 4 per cent. on the capital. The money was ready, the contractors were selected, and everything was provided when the wise men of Downing-street interfered and stopped all further progress. Our readers know how much money has since been expended, which is all absolutely wasted. The railway would have represented a saving of millions even if it had never been used for other than military purposes. It is too late now to hope to realise anything like similar advantages. Yet it is worth while considering whether a light railway ought not to be pushed on with at once. Such a road could probably be laid at the rate of 15 or 20 miles a day. No one can foresee the end of the struggle in which we are engaged. We fear that the same dilatory, half-hearted mode of conducting operations, which has obtained from the first, still continues. Red tape rules supreme. Up to Wednesday no orders had been given out for water-obtaining appliances for the desert, although some inquiries had been made. No one seems to be in a hurry. We suppose that long after the necessity for them has passed away, wells will be sunk, pipes laid, and pumping machinery at work. Once more those in authority have overlooked the fact that the engineer is the principal factor in modern warlike operations.

TRADERS AND THE RAILWAY BILLS.

The ironmasters and the rest are moving in a spirited fashion in opposition to the Bills of the railway companies which seek to augment certain of the maximum rates, to bring about a reclassification of goods, and to authorise terminal charges. The conference in Birmingham, on Thursday last week, of representatives of Chambers of Commerce and Agriculture, and other organisations of traders, was conclusive that the Midlands will resolutely oppose the railway companies both in Committee and in the House upon the second reading. Following the example of Worcester, the Town Council of Wolverhampton, on Monday last, petitioned against the Bills, and appointed a committee in that interest. Ironmasters adduced grave and weighty reasons why, in the behalf of the prosperity of the trade of South Staffordshire, these steps should be taken. The influential traders of South Wales rallied round Sir Hussey Vivian, M.P., at the public meeting over which he presided at Cardiff on Saturday, and passed the needed resolutions, organising opposition and raising funds. On the same day equal determination was evinced at a representative meeting of tenant farmers from all parts of East Kent, held in the Guildhall of Canterbury. Of no less significance than the Birmingham conference was the conference held on Tuesday in the Manchester Town Hall. It had been convened by the Mayor at the request of the City Council, and was constituted of representatives of municipal corporations in Lancashire and Cheshire. It represented an aggregate population of 1,681,000. The action of the railway companies, it was determined, should be restricted in the interest of the two counties. Mr. Jacob Bright, M.P., at the Manchester, like Sir E. Lechmere, M.P., at the Birmingham, conference, was outspoken in his condemnation of the Bills, and in his expressed determination to oppose their passage through Parliament. The contest promises to be one of the sharpest of its class that has ever yet come off.

WATER SUPPLY IN LANCASHIRE.

A scheme for the water supply of the towns of South-east Lancashire within an area bounded by Wigan, Pemberton, and St. Helen's on the west; Hayfield, Glossop, Stalybridge in the east; Tottington, Bury, and Castleton on the north; St. Helen's, Warrington, Altringham, and Whalley Bridge on the south, has been formulated by Mr. H. T. Crooks, A.M.I.C.E., who has published a pamphlet upon the subject. A considerable number of the towns included in this are on the line of supply, and have power to demand water from the Manchester Thirlmere Supply Works; but Mr. Crooks urges that the combination of a number of the towns within the area defined would provide for all a good supply at much less cost, and that Manchester has gone to enormous expense for the new works is not a matter for consideration by other towns. On a catchment area of 40·36 miles, Mr. Crooks estimates a minimum available rainfall of 40,500,000 gallons daily, of which, after deduction for compensation, he has available for supply 27,000,000 gallons per day. He proposes six impounding reservoirs which will store 7500 millions of gallons. This would be equal to the combined demand for compensation and supply of 180 days. He estimates the present requirements of a large number of the towns within the area defined at 9,000,000 gallons per day, and that the works would cost £740,000. Of this sum he estimates that reservoirs, watercourses, road diversion, and other works at Ashopdale will cost £326,574; tunnels, culverts, iron pipes, and works on the line of supply, £295,193; reservoir at Matley, £51,719, or a total of £673,486, and to this is added 10 per cent. for contingencies, parliamentary, law, and engineering expenses, making the above total. This includes purchase of land, and is equal to about £82,000 per million gallons daily supplied. Interest and depreciation, &c., on this gives 3d. per 1000 gallons as the cost of the water.

HIGHGATE ARCHWAY.

Another case of suicide has been added to the long list of those which have been committed from this archway, and it may well be asked whether there is any good reason why facilities should be afforded by public structures for such distressing occurrences in the midst of a crowded population. For it may well be remembered that an "opportunity makes the man," so also in many cases opportunities present to a frenzied mind lend strong inducement to the committal of the fatal act of suicide. Were such opportunities as much as possible removed, it may be believed that many unfortunate creatures would fail in their resolution to seek them farther afield, and we cannot conceive any reason why, in the case of the Highgate Archway as in many other instances of public buildings, some obstacle may not be fitted which should effectually prevent a temporarily insane person from clambering on to parapets without in the least detracting from their appearance. We all know how example affects, and how "fashionable" certain localities become for the committal of suicidal acts. In the case of the Highgate Archway, it has been demonstrated by the returns that even one particular side of it has become far more used for self-destruction than the other. For a long time a similar mania existed for utilisation of the Monument and Duke of York's Column until it was stopped by preventive railing. We believe that precipitation from a height is often selected by intending suicides because of the belief that sense is destroyed before a fall of many feet is accomplished, and the less facilities there are for it the longer may an unbalanced mind have time for reflection. It seems, therefore, desirable that in the case of the Highgate Archway and many other buildings in the metropolis and other large towns some such plan as we have recommended should be adopted.

OUR FALLING TRADE.

Month by month our foreign trade falls away, till the decline is something alarming. Before us are the Board of Trade returns of exports and imports for the opening month of 1885, and the tale is still the same. For the last three years the January returns of exports exhibit a steady decrease—£20,608,659 in 1883, £19,352,541 in 1884, and £18,109,525 in 1885. The imports in these periods have run from £35,736,846 in 1883 to £35,645,221 in 1884, and £36,049,005 in 1885. That is to say, the exports during January last were £1,243,016 less than they were in January, 1884, and £2,499,134 less than those of January, 1883. Articles of food and drink have decreased £62,533; raw material, £108,412; metals and articles manufactured therefrom, except machinery, £780,073; machinery and mill work, £254,566. Cotton and worsted goods have been largely shipped during the month, and this gives the textile industries the honour of showing an increase—the only bit of silver lining to the sable clouds. There is a net increase, as compared with January, 1884, of £403,784 on the import side, chiefly owing to greater quantities of raw materials being imported for what are known as soft goods—textile trades. Of raw materials for various industries there has been a decreased importation during the month of £182,228. This January return is a distinct disappointment. It was generally believed that the result of the first month's industrial operations would show that the foreign market had at last revived; but an examination of the tabulated statements issued by the Board of Trade fails to reveal one gleam of comfort to lighten up the gloomy statistics. Figures, it is said, can be made to prove anything. It would be hard work for any man to prove from these figures that our foreign markets afford any symptoms of the long-expected revival.

THE WESTINGHOUSE BRAKE.

At the recent half-yearly meeting of the London, Brighton, and South Coast Railway, Mr. Laing, the chairman, spoke as follows in reply to an inquiry on the subject:—"As to the Westinghouse brake, he was glad of an opportunity of saying that his experience of it was that it was entirely satisfactory. Originally brought out in that country of inventions, the United States, it had, after trials with various competitors, by a sort of Darwinian principle of the survival of the fittest, superseded all other brakes, and come into general use. That was a strong presumption in its favour which led to its being tried on the Brighton line. There it had been tried in various ways, with results perfectly satisfactory to their excellent general manager, engine-drivers, and guards, whose lives depended very often on its efficiency. It had saved the life of one of their platelayers, who had got his foot jammed between the guard rail and a point, and stood helpless, by stopping an express train within 2ft. of him; and he was perfectly satisfied no other brake would have prevented him being killed."

LITERATURE.

The Stability of Ships. By Sir E. J. Reed. Charles Griffin and Co., London. 1884.

The chief value of this book will be found in the extensive compilation it contains of papers, memoirs, and other writings on the stability of ships and floating bodies. A very large amount of time and labour must have been bestowed upon the collection, condensation, and annotation of the scattered literature of stability, so that readers will be enabled to trace the gradual growth of investigation and knowledge, even if they are unable to consult the original authorities. Beginning with Bouguer's investigations, published nearly a century and a-half ago, the *résumé* of the earlier works notices in succession the methods of Daniel Bernoulli, Don Juan d'Ulloa, Euler, Romme, and Chapman, and includes a summary of Dupin's classic memoir on the general principles of stability. In other

portions of the book, Atwood's investigations of statical stability are described at length; and the useful work which Moseley did in connection with dynamical stability is virtually reproduced. The more modern English treatment of stability is illustrated chiefly by means of numerous extracts or abridgments from the "Transactions" of the Institution of Naval Architects, which now cover a quarter of a century; and not the least interesting portions of the book are those which contain full accounts—nearly in the original forms—of the work done by French naval architects in recent years.

This compilation has been brought up to date, not a few of the papers mentioned having actually been published while the book was passing through the press. As a result, the arrangement of the book has suffered somewhat from the late introduction of certain sections, but the disturbance of symmetry is not likely to cause complaint, and it is really unimportant. From the nature of the case, as well as on account of the great mass of material dealt with, and the endeavour to do justice to the claims of individual writers, the balance and proportion obtainable in a formal treatise are scarcely to be anticipated.

By comparison with the portions of the book drawn, with all due acknowledgment, from other sources, the amount of original work is necessarily small. At the last session of the Institution of Naval Architects, Dr. Woolley—to whom this book is appropriately dedicated—remarked that the principles of stability had long been definitely settled, only new applications of those principles being possible; and it may be added that the great attention given lately to this department of naval architecture makes it difficult to strike out in directions which are untrodden.

Sir Edward Reed in the introduction states the reasons which led him to undertake the book now completed, and his explanation will bear quotation. He says:—"In the first place, no general work on the stability of ships exists . . . . . in our language, although several authors have treated the subject satisfactorily as parts of more comprehensive works. In the next place, both the science and practice of the subject have recently undergone great developments at home and abroad, the results being scattered over many and various publications; and it was undoubtedly desirable to bring them together, and place them in due relation to each other. Again, during the present, as during the last century, French investigators have taken a leading part in the extension of this branch of the science, and it is essential to the sound education of English naval architects and others that the results of their labours should be brought within easy reach. Finally, the number of persons who are now required by their professional avocations in connection with ships to obtain some knowledge of the doctrines of stability is so great that this work may fairly be taken as a response, and a somewhat tardy response, to a demand which has long been felt for collected information on the subject, and which during the last year has become widespread and urgent." This programme has been fulfilled, with the result that the book contains a fairly complete collection of nearly all the best treatments of the various departments into which the subject of stability has been divided.

It has already been stated that the book cannot be regarded as a formal treatise, either in its method or its arrangement. Certain portions of the earlier chapters are written in a popular style, and are designed for the benefit of non-mathematical readers, who may desire to gain some acquaintance with the principles of statical stability. After a careful perusal of these chapters it seems questionable whether the volume will do much towards spreading a general notion of these principles, either among shipowners or shipmasters; but we trust we may be mistaken in this opinion, for an increase of knowledge is much to be desired amongst those classes. The book has a far better chance of proving useful to persons possessing a good mathematical training, who desire to follow out the details of work done by various investigators, and who will be spared much labour and research in musty volumes, some of which are already rare. Another very useful portion of the volume is that devoted to descriptions of various methods of making stability calculations. It is true that in some places compression might well have been exercised, and in others more details would have been welcome to those seeking guidance. In fact, there still remains an opening for a good handbook of ship calculations, and we trust the want will soon be met. Most probably Sir Edward Reed was largely influenced by the desire to do full justice to the authors of any and every method, and so accepted some amount of repetition in order to avoid any charge of unfairness, in not a few cases giving almost *verbatim* extracts from original papers. While the principles of stability are fixed and unalterable, the methods of calculation are endless, and every day some new device for saving labour or increasing accuracy is being put into practice in the drawing-offices of our shipyards. Amsler's integrator is being more and more extensively employed, and to fully utilise it requires a calculator who has a good knowledge of mathematics. But once a method of using it has been laid down by a competent man, then unskilled labour becomes available for calculations of great extent and intricacy. A capital account of this remarkable instrument is given in the volume under review, being based upon a paper by a son of the inventor. It was first exhibited and described at the Institution of Naval Architects about four or five years ago, and has since been much improved. Its value in calculations of all kinds, and more especially in calculations of stability, was at once appreciated by competent authorities. Enlarged experience has only raised the estimate of its value amongst naval architects.

Sir Edward Reed naturally devotes considerable attention to the conditions of stability in merchant ships—a matter in which great and growing interest has been taken by shipbuilders and shipowners in recent years. It is astonishing to note the change which has taken place in general practice, and the enormous amount of valuable experimental and calculated data which is being accumulated. Only seven or eight years ago exact information was scanty indeed respecting the actual stability of merchant ships, either laden or light; and it is but just to recognise the valuable assistance to the movement which has been given by the officers of Lloyd's Register of Shipping. The close connection between the conditions of stability and the load-line of a ship has often been overlooked in empirical rules for freeboard, but it is really of the essence of the question in those classes of ships where deep loading is possibly dangerous.

Another section of the book deals with the stability of warships, but this does not strike one as being nearly so satisfactory or complete as most of the sections in which actual data are given, although it contains a good deal of information. Very great prominence is given to the work of M. Reech and other French naval architects. This portion of the book will be read, as was said above, with interest by many of their English fellow-workers. It contains details not previously published in this country, although not unknown to all English naval architects. So far as the methods of calculation are concerned, it may be stated that we can bear comparison with anything that has been done in France; and so far as the actual application of those methods in practice is concerned, we are now at least as advanced as, if not ahead of, the practice across the Channel. One thing must never be forgotten: The French Genie Maritime is a corps of long standing, and has had the advantage of the continued existence of a School of Naval Architecture, presided over by gentlemen of great ability and intimate acquaintance with the theory and practice of shipbuilding. Here in England, on the contrary, the scientific training of naval architects was fitful and non-continuous until twenty years ago. We may now hope that conditions as favourable to the study of the science of the profession as those which hold in France are permanently established, and we cannot but reap the benefit in years to come, particularly in the mercantile marine.

One of the portions of the book which is least satisfactory is that which deals with the rolling of ships with sail set, and their stability among waves. Sir Edward Reed evidently realised this, and explains why he has not attempted to do more; but there are obvious objections to some of the methods placed on record, and their practical utility may be doubted.

The book has been produced in excellent style, is well illustrated, and has a number of useful tables. It will, no doubt, secure a large circulation, and cannot fail to be a benefit to the shipbuilding profession by its diffusion of the valuable information which has been brought together from so many sources within its pages.

SIDNEY GILCHRIST THOMAS.

IN one of his best essays, Gladstone remarks that "the contemporary mind may in rare cases be taken by storm, but posterity never. The tribunal of the present is accessible to influence; that of the future is incorrupt." By some such standard as this is it necessary to judge of the life's work of Sidney Gilchrist Thomas. To that gentleman, and those who were with him the means of bringing to its present stage of development and perfection the basic Bessemer process of making steel, posterity is under much greater obligations than it is now possible adequately to estimate. For it is obvious to all who are acquainted with even the rudiments of the subject, that had that process not been brought within the range of practical metallurgy—or, failing that, some other process capable of answering the purposes which it has so effectually served—not only this country, but every other, would have been within measurable distance of the serious depletion, if not the utter extinction of the available means of producing steel. In other words, the ores of iron available for that purpose under the Bessemer and every other steel-making process previous to that now known as the basic, were strictly limited in amount. In this country the only districts supplying such ores in any quantity are those of West Cumberland and North-West Lancashire, which, however, have never in any one year furnished more than 3,000,000 tons of such ore, as compared with a total output of 18,000,000 tons of iron ore of all kinds raised in the country as a whole. The coincidence of this fact with a very great extension of the Bessemer and Siemens processes of steel making, compelled our manufacturers to resort to foreign countries for the necessary supplies of suitable ores in aid of the limited supplies found at home. It was the same with France, Belgium, and Germany; and the remarkable growth of the mining industries of Bilbao, Elba, and Algiers has been the result. But the demand for the ores which these localities were capable of furnishing, has proceeded at such a rate that none of them is now believed to be capable of maintaining the present rate of supply for a much longer period; and both in Algiers and in Elba the absolute depletion of the known supplies of ore is looked upon as a very proximate event. Unless, therefore, some other deposits of iron ore equally suitable for the manufacture of steel, and capable of being delivered at our steel works at an approximately low cost, had been discovered and worked, the expansion of the Bessemer steel trade in this country would, in the course of no very remote period, have become seriously hampered, if not entirely checked; whereas the introduction of the basic process—whereby all descriptions of ore are more or less suited, and almost equally well suited, to that manufacture—has indefinitely extended the possibilities of its future growth.

Regarded from this point of view—which is the only true and just—one it is impossible to exaggerate the value of the services rendered to the country at large by the discovery and development of the basic process; and the death of one who took the foremost part in that development is, therefore, an event of concern to the metallurgic world at large. There may be differences of opinion as to the exact degree of merit assignable to each of those who have from first to last, in one capacity or another, contributed to the high estimation in which the process now stands, and the remarkable practical success which it has achieved; but none probably will be found to dispute that the task and the credit of demonstrating its practicability belongs in the highest degree to Sidney Gilchrist Thomas.

The career of that gentleman, although it seemed, from his studious nature and his scientific attainments, to give much promise for the future, was yet, so far as it went, mainly a record of the progress of the process with which his name was identified. The circumstances that led Mr. Thomas to seek to cut the Gordian knot which had baffled up to his time all who had tried to unloose the phosphorus that clung so tenaciously to the metal in which it was least wanted, are sufficiently well known. It was, indeed, a problem in the highest degree worth one's while to endeavour to solve. To make available for the manufacture of steel the fifteen million tons of iron ore raised in this country alone, that were then worthless for that purpose was perhaps one of the most promising achievements that an inventor ever essayed. But the matter was not one that concerned this country only. It was equally—nay, even more—important to Germany and some other countries; and it has been proved by the result that other countries were even more disposed than our own to seize the relief which it afforded from dependence on foreign and admittedly short-lived supplies of raw material. Thomas worked at his task with a will; but he worked under many discouragements. He was, to begin with, obscure and unknown. The arch-enemy against whom his efforts were directed had, moreover, been attacked by, and had more or less completely vanquished, many "men of light and leading," who had sought to overcome its vitiating effects. Indeed, it is not too much to say that from the time when Bessemer invented the process that bears his name in 1856, until Thomas announced his discovery of the basic process in 1878, the history of the metallurgy of iron was largely a record of struggles to get rid of phosphorus, by some cheap and readily practicable means that would render the ores of iron in which it exceeded one-tenth of a per cent. available for producing that which all the world was beginning to demand in increasing quantities—cheap and good steel. The combat raged in every European country, and in America as well. Guest and Evans, Knowles, Heaton, Hargreaves, Siemens, Bell, and Bessemer entered the lists in this country. Drown, Holley, and others made the cause their own in the United States. Krupp, Dallen, Helmholtz, Engelhart, &c., worked on its behalf in Germany. Troost, Fleury, Ponsard, Grüner, and a host of others made cause against the common enemy in France. But phosphorus still retained possession of the field. Siemens, indeed, by the use of bauxite, secured the removal of a considerable proportion of the phosphorus, at the Fourchambault Works, in France, so far back as 1863; but it was found that the lining, although crushed and rammed into the furnace, much as the basic or lime lining now is in some works, would not stand the intense heat of the furnace, and the experiments were abandoned. Mr. Henderson attained in the United States a certain amount of success with illminite. Mr. I. Lowthian Bell, using a lining of oxide of iron at a low temperature, so as to secure complete admixture of that fluid with molten pig iron, and employing something like 30 per cent. of the weight of oxide, succeeded in reducing the phosphorus in the pig from 1·6 per cent. to ·094 per cent. on an average of five trials; but although this was a highly interesting and even important scientific achievement, it was generally regarded as of comparatively little practical value, on account of the cost of the quantity of rich oxide proposed to be employed. About the same time that Mr. Bell was experimenting with his process, Krupp, of Essen, brought forward a means of ridding iron of phosphorus by washing it with oxide of manganese in a fluid state, whereby a large percentage of the phosphorus was carried into the slag. This process also gave some very good results so far as the removal of the phosphorus was concerned, but there were practical objections to its adoption on a large scale. The Danks' revolving furnaces assisted the removal of a small part of the vitiating element in the process of puddling, but that system also failed to afford the required solution. Bichromate of potash was recommended and actually tried by some, but with much the same results. A method of re-pouring the steel in the Bessemer process from one converter to another was strongly recommended by M. Harmet, of Denain, as likely to furnish the desired results, but in this case also the relief was not forthcoming in the manner prescribed. The use of alumina in the form of a phosphate was tried at Montalaire, a mixture of powdered bauxite, lime, and oxide of iron and manganese being heated strongly until they formed a cohesive lining of the kind described; but even this, perhaps the most promising of all experiments of the kind, was "not in it" when the basic process, so-called, came to the front; and so of many other experiments and processes which we cannot stay to dwell on here.

From all that has been stated, it is obvious that if Mr. Thomas entered upon his career of investigation with much to discourage him, he had also not a few valuable data to lead him towards his goal. He knew, or he had easy means of ascertaining, what had been done by previous investigation in the same direction, and what substances were and what were not likely to help him towards the end he had set himself to achieve. His knowledge of chemistry, laboriously acquired during his intervals of leisure, and his patient and plodding habits of thought and action supplied the rest. Nay, more, he was not without the means of knowing what particular properties were necessary in the mineral required to serve his purpose, for Dr. Siemens had stated to the Iron and Steel Institute as, far back as 1873, that by the use of a bauxite lining in his rotary furnace he had succeeded in reducing the 1·2 per cent. of phosphorus contained in the original Cleveland pig to ·176 per cent., thus clearly proving the tendency of the mineral in question. But no one at that time dreamt that a lime lining could be found to stand the heat of the Bessemer process even if it could be made sufficiently binding to be used at all; and Dr. Siemens has himself put it on record that "the reason why he did not persevere with the basic lining was that although for a few charges it seemed to stand exceedingly well, yet the slag containing silica and oxide of iron acted upon it more rapidly than was desirable, and it was subject, moreover, to the inconvenience that, unlike a silica lining, it could not be repaired."

Aided by his friend and cousin, Mr. P. C. Gilchrist, at that time a metallurgical chemist in South Wales, Mr. Thomas commenced his experiments, designed to eliminate phosphorus in the Bessemer converter, in 1875. The results were highly encouraging, though "not entirely conclusive as to commercially complete purification being possible," owing to the imperfect character of the appliances at command. Two years later, with a lining composed of limestone and silicate of soda, much better results were arrived at, and with these results before him, Mr. Martin, of Blaenavon, was induced to put up apparatus to carry the experiments further, with results that are now matters of history.

Having demonstrated the practicability of getting rid of the enemy that had more or less baffled the ingenuity and resources of all the rest of the world up to that time, Mr. Thomas, in 1878, communicated his discovery to the Iron and Steel Institute in a paper, wherein he stated that "It is on the production of a basic earthy slag, by the addition of large quantities of calcareous bases, and without excessive waste of lining and metal, and the construction of a durable basic lining that we venture to think the economic solution of the phosphorus problem depends."

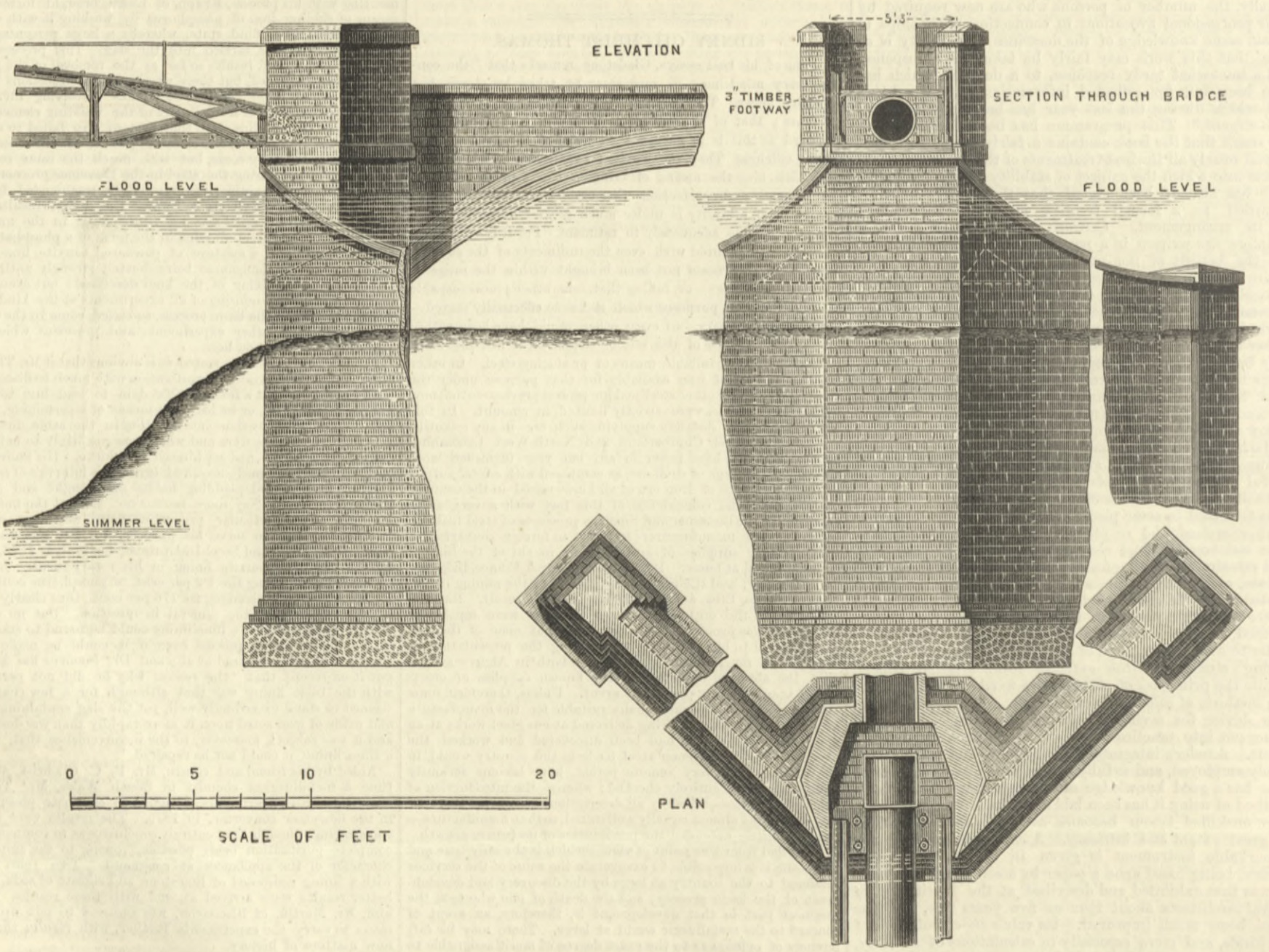
The principle thus stated has since been found to be incapable of more exact definition. But to see how the problem was to be

ABERGAVENNY SEWERAGE WORKS—FOOT AND MAIN SEWER BRIDGE OVER THE RIVER USK.

(*For description see page* 134

attacked and ultimately solved was not altogether to solve it, albeit far advanced on the way to such an achievement. The best form of lining, the most convenient and practical method of preparing it, the amount and manner of the basic additions to be made during the Bessemer blow, the description of pig iron most suitable for the process, the mechanical structure best adapted for the converting vessel, the diminution of loss from excessive boiling, and the amount of excess of earthy base required in the slag, are but a few of the problems that still remained to be worked out, and Mr. Thomas himself was always the first to acknowledge that but for the kind co-operation of others—and especially of Mr. Windsor Richards, of Messrs. Bolckow, Vaughan, and Co.—these still undetermined conditions of success might long have remained indeterminate. As it is, the mechanical difficulties which were so serious a drawback at the outset have all been overcome, and the basic Bessemer process is now as well understood and worked as regularly and successfully as if it had been in operation for as many generations as it has been years.

It needs not that much should be said of the part that Mr. Thomas himself took in opening up the difficult and often thorny path whereby his process was conducted to ultimate appreciation and success. The first steps in such a course are invariably beset by worry, anxiety, and trouble. Mr. Thomas's case did not furnish any exception to this rule, even though he had the strong moral and material support of such a firm as that of Bolckow, Vaughan, and Co. His life for several years was one of unremitting toil and anxiety. What with negotiations for the use of his process; assisting in its initial application at different works; aiding in the overcoming of the many difficulties already alluded to, as attending its first steps; and keeping its merits and its progress generally before the public, he had more to do than his delicate frame could well stand, and several journeys that he had occasion to make on the Continent in the winter of 1881 told very severely upon his health, which gave way to such an extent that in 1882 his medical advisers strongly advised a voyage to Australia as the only chance of recovery open to him. That journey was made in due course, Mr. Thomas going by India and returning by the United States, where he was received with the most flattering attention. But the effect of the journey was only very temporary. In crossing the Atlantic bad weather was encountered, and much of the good that was received in the early part of the voyage was thus undone. A sojourn in Algeria failed to bring about the necessary amount of recuperation, and in the course of last autumn Mr. Thomas, with his mother and sister—who had attended him in Algiers—travelled to Paris in the hope of getting some more effectual medical treatment. The hope was at first likely to be realised. A course of hygiene was prescribed, in which the patient himself had full faith; and to the very last he never regarded his case as being half so serious as it really was, until



ABERGAVENNY SEWERAGE WORKS—ABUTMENTS OF FOOT AND MAIN SEWER BRIDGE

ABERGAVENNY SEWERAGE WORKS—DETAILS OF FOOT BRIDGE.

(*For description see page* 134.)

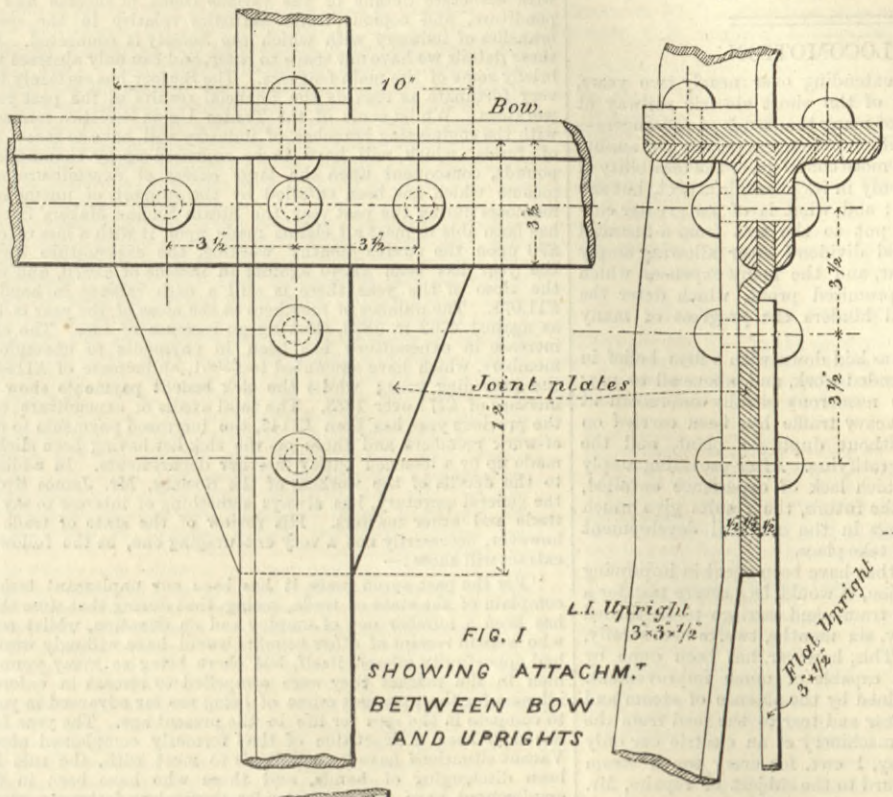


FIG. 1
SHOWING ATTACHM.T BETWEEN BOW AND UPRIGHTS

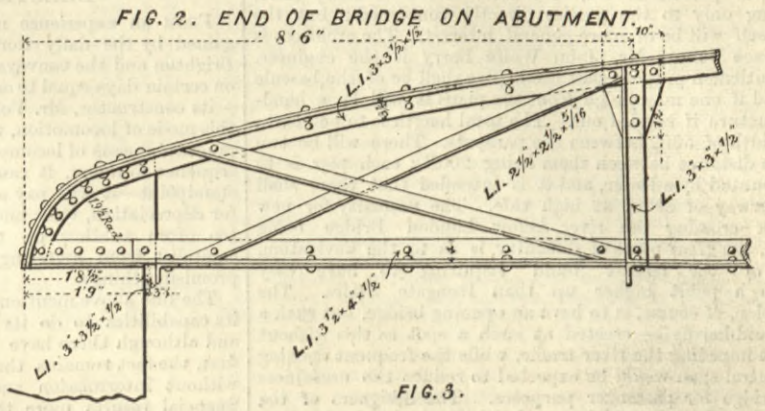


FIG. 2. END OF BRIDGE ON ABUTMENT.

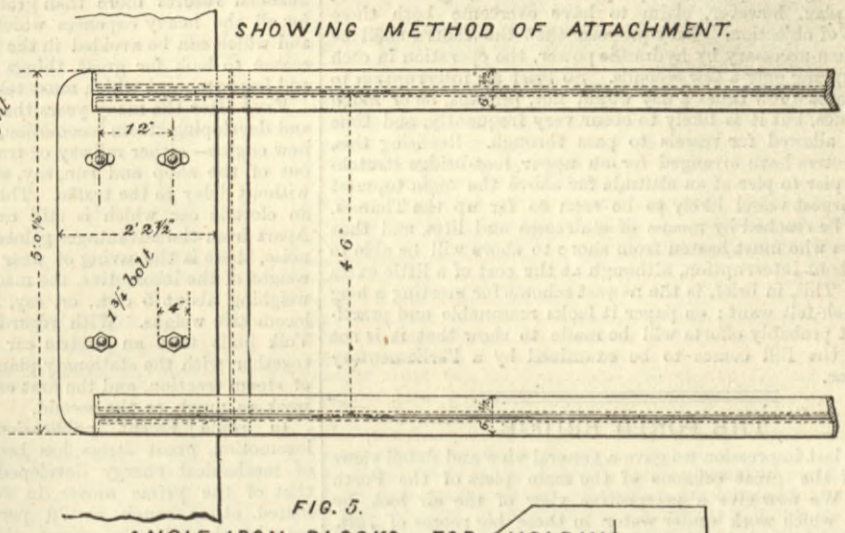


FIG. 3.
SHOWING METHOD OF ATTACHMENT.

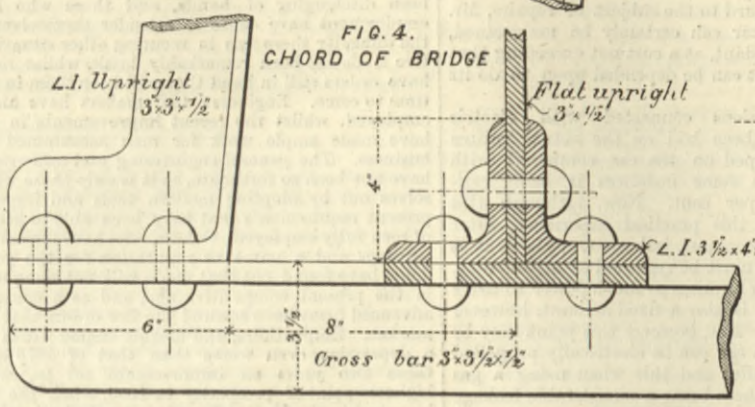


FIG. 4.
CHORD OF BRIDGE

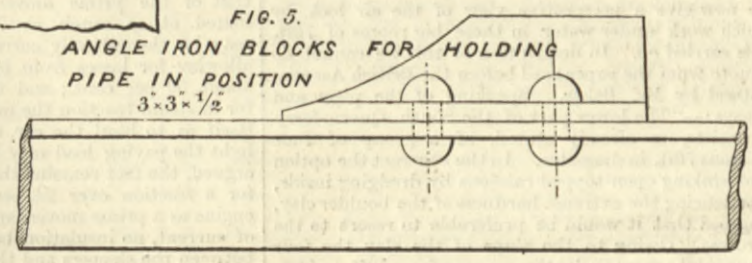


FIG. 5.
ANGLE IRON BLOCKS FOR HOLDING PIPE IN POSITION

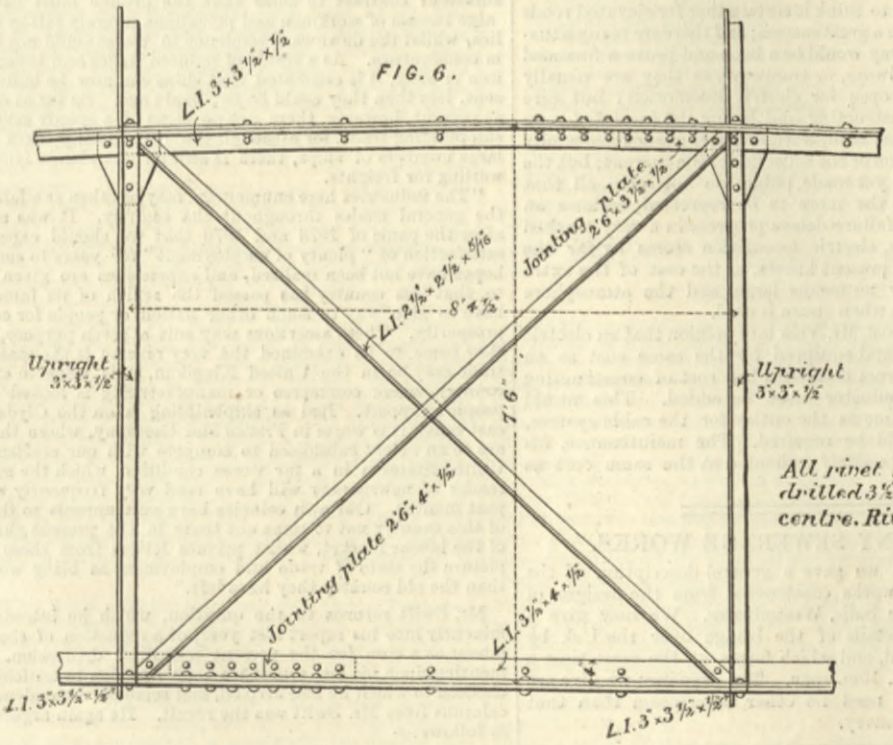


FIG. 6.

All rivet holes to be drilled 3½ Centre to centre. Rivets ¾ dia.

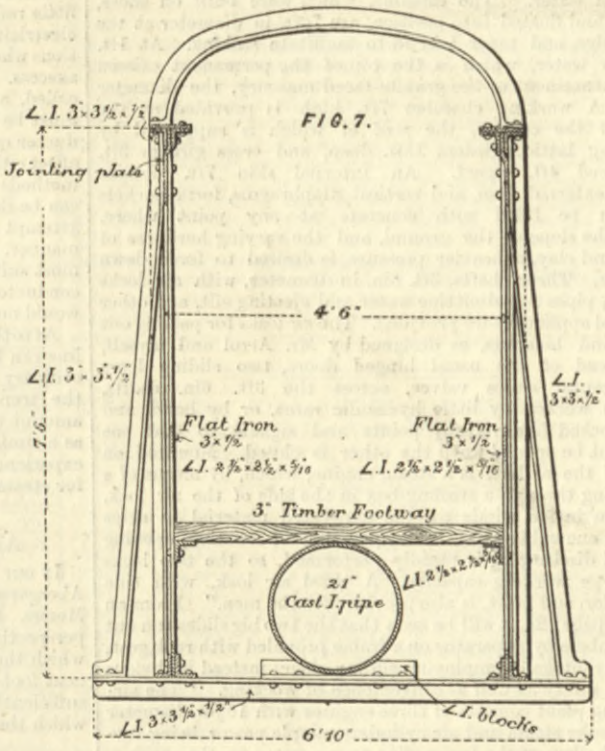


FIG. 7.

the "silver cord" was finally loosened. Mr. Thomas died on the 1st of February, and was buried on the following Tuesday in the quiet little cemetery at Passy, close to the place where he spent the last few months of his short but not uneventful life. He died in the thirty-fifth year of his age, having been born in London in 1850.

The basic process has now been fully established in England, France, Germany, Austria, Russia, and Belgium. In 1884 no less than eight and a-half million tons of steel were made under the patents of Messrs. Thomas and Gilchrist, of which nearly 150,000 tons were made in this country. It was hoped and believed by Mr. Thomas that the production of basic steel this year would be over a million tons, which is more than the whole quantity of steel annually made in the world thirty years ago. In recognition of his services to metallurgical science, Mr. Thomas received several honours, including the Bessemer gold medal of the Iron and Steel Institute; but others were withheld from him, which posterity may fairly be expected to accord.

THE TOWER BRIDGE SCHEME.

As we have mentioned on a former occasion, two of the three Bills put forward this year for the construction of a bridge or bridges across the Thames have already collapsed; not, of course, on their merits, but through the failure of certain initial formalities. The survivor, which promises at least to make a fight for success in committee, is the Corporation of London Tower Bridge Bill, having for its object the erection of a bridge from a point just to the west of Irongate Stairs to Hartley's Wharf on the opposite side of the river, "in such a manner as to admit of the passage at all times of the tide of vessels navigating the river." The preamble boldly declares that this work "would be attended with great local and public advantage," but unfortunately for promoters an *ex parte* assertion will not carry a Bill through. The proposed capital is £750,000, and the scheme, set out in 59 clauses, is as follows, in general terms:—The execution thereof to be entrusted to the Corporation. Taking the two points named for the extremities of the bridge, it is proposed, by Clause 11, that the bridge shall be constructed with the number of arches or spans, and with the headway at the centre of each arch or span described on the deposited section, and in such manner that one arch or span may from time to time be opened so as to admit at all times of the tide of the passage of vessels navigating the said river, and for such purpose the Corporation shall cause provision to be made so that one arch or span of the bridge may be opened so as to afford a clear width of 200ft., measured at the level of the roadway of the bridge, or such less width as may be approved by the Conservators, and for the machinery necessary to open and close the same from time to time and for the proper and effectual working of such machinery.

The next clause provides against any but a very slight deviation from the levels defined in the plans, except with the consent of the Conservators; and Clause 13 gives power to make such subsidiary works in respect to streets as may be necessary, reasonable compensation being insured to people who may suffer. The 15th clause empowers the Corporation to make such temporary carriage ways and footways as they may deem proper, and to dredge or deepen the bed of the river, and otherwise interfere with the stream. The usual powers are taken for stopping up streets, purchasing premises, and so on; and stringent conditions are inserted with regard to the action and responsibility of the promoters in respect to underpinning and strengthening houses and other buildings. It is stipulated, among other things, that the Corporation shall not necessarily be obliged to take over the whole of a building because they require a cellar or portion of the building. Several clauses are devoted to such considerations as the protection of sewers in the City and in the metropolis, interference with gas and water mains, purchase of lands, sale of surplus land, displacement of workpeople, maintenance and repair of the bridge, raising of money, rights and powers of the Conservators, and so on. With regard to the matter of displacing people, it is provided—by Clause 33—that —"(1) The Corporation shall not under the powers of this Act purchase or acquire in any parish twenty or more houses occupied either wholly or partially by persons belonging to the labouring class as tenants or lodgers unless and until—(*a*) They shall have obtained the approval of the Secretary of State for the Home Department to a scheme for providing new dwellings for the persons residing in such houses or for such number or proportion of such persons as the said Secretary of State shall after inquiry deem necessary, having regard to the number of persons residing in the houses liable to be taken, and working within one mile therefrom, and to the amount of vacant suitable accommodation in the immediate neighbourhood of the houses liable to be taken or to the place of employment of such persons and to all the other circumstances of the case; and (*b*) they

shal have given security to the satisfaction of the said Secretary of State for the carrying out of the scheme. If the Corporation acquire or appropriate houses in contravention of the foregoing provisions of this section they shall be liable to a penalty not exceeding £100, to be recovered summarily at the suit of the said Secretary of State and not otherwise."

All these provisions are, of course, of the ordinary kind, interesting only to the parties directly concerned; but the bridge itself will be of more general interest. The architect is Mr. Horace Jones; Mr. John Wolfe Barry is the engineer. These gentlemen propose that the bridge shall be of the bascule order, and if one may judge from the plans it will be a handsome structure if carried out. The total length is to be 880ft., with a width of 50ft. between the parapets. There will be two piers, the distance between them being 200ft.; each pier is to be surmounted by a tower, and it is intended that there shall be a waterway of 800ft. at high tide. The necessity for new means of crossing the river below London Bridge being admitted, the great point of difficulty is as to the navigation, vessels of the largest build requiring to have easy access to a point higher up than Irongate Stairs. The obvious plan, of course, is to have an opening bridge, but such a bridge could hardly be erected at such a spot as this without somewhat impeding the river traffic, while the frequent opening of the central span would be expected to reduce the usefulness of the bridge for passenger purposes. The designers of the present plan, however, claim to have overcome both these elements of objection. They propose that the centre shall be raised when necessary by hydraulic power, the operation in each case occupying only a few seconds. So brief an interruption to public traffic a few times a day would not, perhaps, be of much consequence, but it is likely to occur very frequently, and time must be allowed for vessels to pass through. Realising this, the promoters have arranged for an upper foot-bridge stretching from pier to pier at an altitude far above the main topmast of the largest vessel likely to be seen so far up the Thames. This will be reached by means of staircases and lifts, and thus passengers who must hasten from shore to shore will be able to cross without interruption, although at the cost of a little extra trouble. This, in brief, is the newest scheme for meeting a long and a much-felt want; on paper it looks reasonable and practicable, but probably efforts will be made to show that it is not so when the Bill comes to be examined by a Parliamentary Committee.

THE FORTH BRIDGE.

In our last impression we gave a general view and detail views of one of the great caissons of the main piers of the Forth Bridge. We now give a perspective view of the air lock, by means of which work under water in these big rooms of 70ft. n diameter is carried on. In description of this we cannot do better than quote from the paper read before the British Association at Montreal by Mr. Baker. Speaking of the piers and air locks, he says:—"The lower part of the South Queensferry main pier consists, as already stated, of a group of four pneumatic caissons 70ft. in diameter. In the contract the option was allowed of sinking open-topped caissons by dredging inside, but, after experiencing the extreme hardness of the boulder clay, we were all agreed that it would be preferable to resort to the pneumatic process. Owing to the slope of the clay the four caissons will be sunk to varying depths, ranging from 68ft. to 88ft. below high water. The caissons, which were built on shore, launched, and floated into position, are 70ft. in diameter at the cutting edge, and taper 1 in 46 to facilitate sinking. At 1ft. above low water, which is the top of the permanent caisson and commencement of the granite-faced masonry, the diameter is 60ft. A working chamber 7ft. high is provided at the bottom of the caisson, the roof of which is supported by four strong lattice girders 18ft. deep, and cross girders 3ft. deep spaced 4ft. apart. An internal skin 7ft. distant from the external skin, and vertical diaphragms, form pockets which can be filled with concrete at any point where, owing to the slope of the ground, and the varying hardness of the silt and clay, a heavier pressure is desired to force down the caisson. Three shafts, 3ft. 6in. in diameter, with air locks at the top, pipes for admitting water and ejecting silt, and other of the usual appliances are provided. The air locks for passing out the clay and boulders, as designed by Mr. Arrol and myself, have, instead of the usual hinged doors, two sliding doors like horizontal sluice valves, across the 3ft. 6in. shafts, which are worked by little hydraulic rams, or by hand, and are interlocked like railway points and signals, so that one slide cannot be opened until the other is closed. Mounted on the side of the air lock is a steam engine, which, by means of a shaft passing through a stuffing-box in the side of the air lock, and a drum inside, winds up the excavated material in skips containing one cubic yard. The operation of hoisting, opening slides, and discharging is rapidly performed, so the two locks have a large working capacity. A third air lock, with side doors, ladder, and hoist, is also provided for the men." From an engraving, page 128, it will be seen that the two big slides run out in flat chambers by apparatus on a frame provided with rack gear, and the advantage of employing sliding doors instead is obvious as respects safety as well as convenience of working. "The air-compressing plant consists of three engines with 16½in. diameter by 24in. stroke steam and air cylinders, ample power being furnished by boilers of the locomotive type erected on the staging. Reference has already been made to the two shallow piers at Inch Garvie, but there are also two deep piers, which, being on a very irregular and sloping rock bottom, have required much consideration. It was finally decided to level a bed roughly with bags of sand, and to float out pneumatic caissons, and excavate the rock until a level bed was cut. Probably Mr. Fowler and I would not have adopted this precise plan if we had been contracting, although we might have resorted to the pneumatic process; but as M. Coisseau, a contractor of great experience in such work, offered to sub-contract for the sinking of the caissons at fair rates, we did not object. These caissons are 70ft. in diameter at the bottom, and the rock slopes from 14ft. to 19ft. in that length, the lowest point being 75ft. below high water. All of the pneumatic caissons will be filled with concrete up to low-water mark, the mixture being 27 cube feet of broken whinstone, 7 cube feet of sand, and 5½ cube feet of cement, which together make a full yard of concrete, having a crushing resistance of about 50 tons per square foot. Above low water the cylindrical piers, which are 49ft. in diameter at the top, 55ft. at the bottom, and 36ft. high, consists of the strongest masonry, the hearting being flat-bedded Arbroath stone with both horizontal and vertical bond, and the facing Aberdeen granite, the whole set in two to one cement mortar, and built in the dry within temporary wrought iron caissons. In the shallow piers where the rock is stepped the masonry is carried down to the rock itself, and wrought iron hoops, 36in. by 1¼in., bind the bases of the piers. At the top of all the piers 18in. by 1¼in. hoops, and midway down 18in. by ¾in. hoops, are also built in, and it is believed that these cylindrical masses of masonry are as completely monolithic as can be attained or desired. In each cylindrical pier there are forty-eight steel bolts, 2½in. in diameter and 24ft. long, to hold down the bed-plates and superstructure of the main spans."

ELECTRIC LOCOMOTION.

From an experience now extending over nearly two years, gained by the daily working of the short electric railway at Brighton and the conveyance of many thousands of passengers—on certain days equal to one million passengers per car per annum—its constructor, Mr. Volk, is more confident of the feasibility of this mode of locomotion, not only in its scientific aspect, but as a practical means of locomotion; and what is of far greater consequence to many, it can be put to the test from a financial standpoint—it will pay a good dividend after allowing amply for depreciation, wear and tear, and the many expenses which too often swallow up the promised profit, which deter the capitalist from investing, and hinders the progress of many promising things.

The line above mentioned was laid down with a firm belief in its capabilities to do its intended work, and, above all to pay; and although there haye been numerous pitfalls unforeseen at first, the fact remains that a heavy traffic has been carried on without intermission and without duplicate plant, and the financial results more than gratifying. After providing amply for all the heavy expenses which lack of experience entailed, and which can be avoided in the future, the results give much reason to look for great things in the eventual development and improvement which must take place.

Even after the many years that have been spent in improving and developing steam locomotion, it would be a severe test for a new engine—either railway or tram—and carriage to be turned out of the shop and run, say, six months, twelve hours daily, without delay to the traffic. This, however, has been done by an electric car, which is still capable of much improvement. Apart from the advantages gained by the absence of steam and noise, there is the saving of wear and tear to the road from the weight of the locomotive, the machinery of an electric car only weighing about 5 cwt., or, say, 1 cwt. for every ton a steam locomotive weighs. With regard to the subject of repairs, Mr. Volk finds that an electric car can certainly be maintained, together with the stationary plant, at a cost not exceeding that of steam traction, and the first can be depended upon to do its work as much as the second.

In some recent publications connected with electric locomotion, great stress has been laid on the actual return of mechanical energy developed on the car compared with that of the prime mover, in some instances it being estimated at as much as 70 per cent. Now, although this may be theoretically correct, this practical experience, after allowing for losses from bad contacts, leakage, &c., places it at about 50 per cent.; and this must be regarded as satisfactory, for in steam traction the motor requires as much power to drive itself as to haul the car, and is also a fixed amount, however light the paying load may be. But, however this point may be argued, the fact remains that a car can be electrically propelled for a fraction over 2d. per mile; and this when using a gas engine as a prime mover, and there being a considerable leakage of current, no insulation being used beyond a layer of gravel between the sleepers and the soil. Although it would be unwise to attempt too much at first, Mr. Volk's experience with his little railway leads him to think it certain that for elevated roads electricity ought to prove a great success; and there are many situations where a light railway would be a boon and prove a financial success. For street railways, or tramways, as they are usually called, a wide field is open for electric locomotion; but care must be taken in so constructing and laying the insulated conductor or conductors that mud, dust, or water cannot materially affect either the insulation or the collection of the current; but the methods of doing this yet made public do not seem all that can be desired. This is the more to be regretted, because an attempt that ends in failure delays progress in a very marked manner. For subways, electric locomotion seems by far the most suitable means at present known, as the cost of the extra conductor would be by no means large, and the atmosphere would not be vitiated as when steam is used.

As to the question of cost, Mr. Volk is of opinion that an electric line can be constructed and equipped for the same cost as an ordinary one, but for street tramways the cost of constructing the trench for the conductor must be added. This would amount to about the same as the outlay for the cable system, as a similar trench would be required. The maintenance, his experience shows, may be safely estimated at the same cost as for steam traction.

ABERGAVENNY SEWERAGE WORKS.

In our last impression we gave a general description of the Abergavenny sewerage works constructed from the designs of Messrs. Dudley and De Salis, Westminster. We now give a perspective view and details of the bridge over the Usk by which the main is carried, and which forms at the same time a neat foot-bridge of 130ft. 10in. span. The drawings we give are sufficiently complete to need no other description than that which they themselves convey.

BRIDGE OVER THE HOOGHLY.

In our impression of the 22nd ult. we published a page engraving of the large girders of the bridge to be erected over the Hooghly to carry the East Indian Railway. We now publish another page of details of these large girders for the spans of 420ft. each, but pressure on our space compels us to defer further illustrations and descriptions until another week.

Stanford's London Improvements Map.—Mr. Stanford, of Charing Cross, has published a map of metropolitan railways, tramways, and miscellaneous improvements, Bills for which were deposited at the Private Bill Office, November 29th, 1884, for Session 1885. Railways and tramways in operation, sanctioned, and proposed, and the boundary of the Metropolitan Board of Works, are shown, and the proposed schemes for improvements, forty-five in number, are given in red on the map. It is a sheet 32in. by 37in., the shape having been altered to take in a large south of London area, in which several important tramway and railway extensions are proposed. The map is clearly printed, and, we must assume, generally correct, though we notice that south of Herne Hill Trinity-road is called Norwood-road, and Norwood-road by the old name, Norwood-lane. The scale is 3in. to a mile. Mr. Stanford has also published a new, well-finished, and clearly coloured map of the new London boroughs, as proposed in the Redistribution of Seats Bill, 1885, defining and naming the proposed new boroughs, with the parishes forming the same, the number of members, and population of each borough. In size it is 40in. by 27in.; scale, 2in. to a mile; and forms a supplementary map to Stanford's series of London Government maps on the same scale.

THE STEAM ENGINE MAKERS' SOCIETY.

The sixtieth annual report of the above Society is this week being issued to the members, and it is a volume of some 300 pages, with elaborate details of the various items of income and expenditure, and copious trade statistics relative to the special branches of industry with which the Society is connected. Into these details we have not space to enter, and can only abstract very briefly some of the main features. The Society has certainly been very fortunate as regards the financial results of the past year's workings. Whilst some of the Trades' Union Societies connected with the engineering branches of industry will have to face a loss of funds, which will have to be reckoned up by thousands of pounds, consequent upon the large excess of expenditure over income which has been entailed by the support of unemployed members during the past year, the Steam Engine Makers' Society has been able to meet all claims made upon it with a loss of only £70 upon the twelve months' working, the expenditure during the year has been £9940 against an income of £9870, and with the close of the year there is still a cash balance in hand of £11,071. The number of members at the close of the year is 4910 as against 4762 in 1883, showing an increase of 148. The chief increase in expenditure has been in payments to unemployed members, which have amounted to £3061, an increase of £1184 on the preceding year; whilst the sick benefit payments show an increase of £171 over 1883. The total excess of expenditure over the previous year has been £1142, the increased payments to out-of-work members and those on the sick list having been slightly made up by a lessened outlay in other departments. In addition to the details of the working of the Society, Mr. James Swift, the general secretary, has always something of interest to say on trade and other matters. His review of the state of trade is, however, necessarily not a very encouraging one, as the following extract will show:—

"For the past seven years it has been our unpleasant task to complain of the state of trade, seeing that during that time there has been a number out of employ and on donation, whilst some who were in receipt of other benefits would have willingly worked had opportunity offered itself, but there being so many younger men in the market they were compelled to remain in enforced idleness for the apparent crime of being too far advanced in years to compete in the race for life in the present age. The year 1884 has only been a repetition of that formerly complained about. Vacant situations have been difficult to meet with, the rule has been discharging of hands, and those who have been in full employment have cause to consider themselves fortunate, seeing the difficulty there was in securing other situations. The locomotive trade has been remarkably brisk, whilst many of these firms have orders still in hand that will keep them in full work for some time to come. Engineers' tool makers have also been fairly well employed, whilst the recent improvements in cotton machinery have made ample work for men accustomed to that branch of business. The general engineering and millwright establishments have not been so fortunate, as it is only those who have laid themselves out by adopting modern tools and improvements to meet present requirements that have been able to keep a complete staff of men fully employed. Others, who have depended upon their past earnings and a name or reputation for the good work formerly done, have found out that trade will not come to them unsolicited in the present competitive age, and as a consequence the more advanced firms have secured the few orders that have been in the market. Shipbuilding and marine engine works have experienced a depression even worse than that of 1878 and 1879. After these two years an improvement set in, which reached its highest point of prosperity in 1883, when the tonnage of vessels launched in the United Kingdom reached a total of 1,256,829 tons, but the relapse was as sudden as the prosperity had been previously, as in 1884 it had fallen to 730,819 tons. These figures are of sufficient contrast to show that the decline must have affected large masses of workmen and privations severely felt by their families, whilst the downward tendency in wages could not be resisted in consequence. As a result of reduced wages and lower prices for iron or steel, it is estimated that ships can now be built for 25 per cent. less than they could be two years ago. So far as can be seen at present, however, there are no signs of a speedy revival in the shipbuilding trade, for although the sea annually takes as its toll large numbers of ships, there is still an abundance lying in ports waiting for freights.

"The industries here enumerated may be taken as a fair sample of the general trades throughout the country. It was anticipated after the panic of 1878 and 1879 that we should experience the satisfaction of "plenty of employment" for years to come. Such hopes have not been realised, and expressions are given utterance to, that this country has passed the zenith of its fame, and will have to give way to some other nation or people for commercial prosperity. These assertions may suit a given purpose, but when they come to be examined the very reverse is the case. Bad as trade may be in the United Kingdom, it is worse in every other country where commerce or manufacturing is looked to for the people's support. Bad as shipbuilding is on the Clyde or north-east coast, it is worse in France and Germany, where the builders are to an extent subsidised to compete with our craftsmen. The United States is in a far worse condition, which the most casual reader of newspapers will have read very frequently within the past months. Our own colonies have sent appeals to the artisans of this country not to come out there in the present glutted state of the labour market, whilst private letters from these countries picture the state of trade and employment as being worse by far than the old country they have left."

Mr. Swift returns to the question, which he introduced prominently into his report last year, of a reduction of the hours of labour as a cure for the present industrial depression. In commenting upon his last report we took occasion to criticise the conclusions to which he had arrived, and some correspondence in these columns from Mr. Swift was the result. He again argues his point as follows:—

"Last year we discussed at some length in our report the need for a curtailment of the hours of labour. The facts which have been brought out in the recent discussions in favour of our supremacy as an industrial population strengthen our views on this question. The experience we have gained during the past year should convince us of the great need there is for an advance being made in this direction. It has been demonstrated times out of number that men who show the slightest signs of age are discarded for those of more muscular powers and youthful appearance. Railway companies as a rule will not engage men over forty or forty-five years of age; corporate bodies are following in the same direction; private employers can only be expected to follow suit; whilst the State, on no consideration, will engage artisans over forty-five years of age for their dockyards and arsenals, and the Civil Service closes the door to all men over forty years of age. We at the same time have to contend, on the other hand, with a superabundance of youths in the workshops; and to such an extent has this been adopted that one company, at the end of the year, had to dispense with near 200 men to make room for the youths coming into manhood. Emigration may relieve the country of a surplus population for a time, but if we leave out the consideration what becomes of them on their arrival in the new colony, there still remains the fact that abundance of workmen remain here who cannot find employment. This state of affairs is painful to admit, but being true it is our duty as artisans to consider whether a remedy cannot be effected at the first favourable opportunity. In all past trade depressions there has generally been a cause to which the effect could be attributed. These have been either bad harvests, wars, or financial panics. The present depression is not the result of any of these causes, as the harvests have been all that could be desired. War has been limited to a small scale that has only affected commerce in one or two districts, whilst the returns under the Bankruptcy

Act have been less during the past year than for a long time previously. The fact that over-production is the real cause of present depression is admitted in precept, if not in practice, even by the capital class or employers, when they resort to short time or reduction in hands owing to their stocks being so excessive.

"As is well known, the hours of labour in this country have been reduced considerably in all branches of industry within the past forty years. The question naturally presents itself, what would have been the state of the labour market to-day had such a reform not been effected by the working classes themselves? We have no hesitation in saying that were our trade only working the same hours as those in force prior to 1871 that we should have at least 7 per cent. more members out of employ, the remaining 93 per cent. performing the extra work that now devolves upon the minority by the 54 hours system.

"The question of reduced hours has been discussed in various places and under various circumstances during the past year, with the result of calling down the censure of those who are our professed superiors in theory, but when it comes to hard practice of every-day life they are wanting in strength. The working classes may be criticised severely for such views, but their reply is that a good example and good laws must start somewhere in order to spread over the earth, and our country having been in the van of all reforms, need not be afraid of such a reform as the working classes aspire to. When the Ten Hours Bill or the various Acts relating to factories or workshops have been under discussion, the greatest opposition has been raised in Parliament against them. These Acts, however, did not ruin the trade; it has flourished more than ever under the so-called restrictions. The lead has since been followed by other foreign countries, and only last year Acts relating to factories and hours of labour have been discussed or passed in Canada, Russia, Germany, Austria, and India. Should any further change be made in this country, we believe it will be soon followed by other nations, and the relative positions be unchanged from what they are at present. We do claim, however, that we as workmen are not labouring under the most favourable hours rules, as our Australasian colinies have recognised only an eight hours per day regulation since 1858. In some of the States of America there are laws on the statute book that eight hours per day shall be the limit at which their artisans or servants shall work, and in one case a second edict was passed to enforce such law, which had apparently been tampered with by officials in authority. To adopt the eight hours standard in this country it will require an amount of energy and determination. It would be madness to attempt it in the present state of affairs, but we can discuss it in all its bearings, and make note of what is passing at present, and what is the cause that creates the necessity for such a change, that we may be fortified when the time arrives for a change to be attempted, and what we hope will be secured, at no distant date."

ENGINEERING SOCIETY, KING'S COLLEGE, LONDON.—At a general meeting, held on Tuesday, February 10th, Mr. C. W. Atkinson read a paper on "Steel," in which he dealt specially with that metal as applied to cutting tools, describing in detail, with the aid of diagrams, the various modern improvements in its manufacture. The lecturer described Professor Hughes' magnetic balance, as applied to testing purposes, explaining the principle of this instrument, and directing attention to the great advantages derived from its use. The paper was concluded with a review of the chemical aspect of the subject, in which Mr. Atkinson gave an account of Sir Frederick Abel's recent experiments to determine the chemical condition of the carbon in iron under various circumstances. The paper was followed by an interesting discussion.

RAILWAY ACCIDENTS.—According to the Board of Trade report upon the accidents on the railways in the United Kingdom during the nine months ending 30th September, 1884, there were in that time reported 21 collisions between passenger trains or parts of passenger trains, by which 211 passengers and 7 servants were injured; 40 collisions between passenger trains and goods or mineral trains, &c., by which 107 passengers and 8 servants were injured; 16 collisions between goods trains or parts of goods trains, by which 5 servants were killed and 15 injured; 46 cases of passenger trains or parts of passenger trains leaving the rails, by which 5 passengers and 4 servants were killed and 62 passengers and 7 servants injured; 13 cases of goods trains or parts of goods trains leaving the rails, by which 2 servants were killed and 5 injured; 8 cases of trains travelling in the wrong direction through points, by which 4 passengers and 10 servants were injured; 17 cases of trains running into stations or sidings at too high a speed, by which 86 passengers and 11 servants were injured; 94 cases of trains running over cattle or other obstructions on the line, involving injury to 4 passengers; 41 cases of trains running through gates at level crossings, causing the death of one person and injury to another, who were passing along the public road at the time; 4 cases of the bursting of boilers of engines, by which 1 passenger was killed and 2 passengers and 3 servants were injured; 291 failures of axles, by which 24 passengers were killed, and 69 passengers and 4 servants injured; 1 failure of a brake apparatus, by which 3 passengers were injured; 8 failures of couplings, involving injury to 6 passengers and 2 servants; 2 failures of bridges, by which 7 servants were killed and 8 injured; 10 floodings of portions of the permanent way, involving injury to 1 servant; 6 slips in cuttings or embankments, causing the death of 1 passenger and 3 servants, and injury to 2 passengers an 2 servants.

THE SOCIETY OF ARTS.—At the third and final Cantor lecture of this course, on "Climate and its Relation to Health," delivered at the Society of Arts on Monday, 26th inst., Dr. Poore began by again referring to Miquel's experiments, which seemed to show that the number of microbes in the air was always proportionate to the density of population. The hospital wards, which were occupied the whole of the twenty-four hours, and where the aggregation of productive foci of microbes reached a maximum, the number was necessarily large. Many diseases which were probably caused by floating matter in the air were then passed in review. Hay fever had been proved by Mr. Blackley to be caused—at least in his own case—by pollen grains carried by the atmosphere. A notable instance of disease caused by fungoid spores was found in the potato disease. This disease is due to a fungus preying upon the leaves and other tissues of the potato plant, and there was scarcely room to doubt that the spores of this fungus might be carried by the air, and infect large districts. Epidemic influenza, which has not appeared in this country since 1847, was certainly an aërial poison, and for suddenness of onset and extent of its ravages, it was comparable to the potato disease. There was scarcely room to doubt also in the face of recent evidence that the infective particles which are the cause of small-pox may be carried some hundreds of thousands of feet at least. The commonest of all diseases, consumption, or phthisis, had been lately proved to be due to a bacillus, and, therefore, for the future, must be looked upon as an infective disorder, and not a local one. Many of the facts which had long been recognised and understood with regard to phthisis gave much support to the theory of its infective nature, and chief among these was the undoubted fact that mortality from phthisis was directly proportionate to overcrowding. Soil was a climatic factor which had considerable influence on health, especially when the combination of warmth, moisture, and decaying organic matter gave rise to malaria. After alluding to the peculiarities of mountain climates, Dr. Poore concluded by saying that he had endeavoured in these lectures to show that many diseases which we were apt to attribute to climate were in reality due to our own ignorance. A knowledge of the laws of sanitation, and a strict application of those laws, has greatly improved the health of the British soldier both on home and foreign stations, and a reference to the health returns of the army was the best proof of what he had asserted with regard to climate.

TENDERS.

WELLINGTON WATERWORKS.

CONTRACT No. 1.—Cast iron pipes and special castings. Mr. E. Pritchard, C.E., engineer, London and Birmingham.

	£	s.	d.
J. Romans and Sons, Edinburgh	1410	7	0
Willey and Co., Exeter	1388	2	7
Macfarlane, Strang, and Co., London, E.C.	1340	8	8
Butterley and Co., London, E.C.	1232	0	0
Cochrane and Co., Dudley	1223	0	0
Bishop Bros., Wellington	1215	0	0
Cochrane, Grove, and Co., Middlesbrough-on-Tees	1200	0	0
Chas. Jordan and Sons, Newport, Mon.	1172	0	0
C. E. Firmstone Bros., Stourbridge	1159	0	0
T. Spittle (Limited), Newport, Mon.	1156	0	0
*J. and S. Roberts, West Bromwich	1128	4	0
†Isca Foundry Company, Newport, Mon.	1017	0	0

* Accepted. † Incomplete tender.

DARLASTON SEWERAGE WORKS.

CONTRACT No. 3.—For the construction of cast iron and earthenware pipe sewers, manholes, boiler-house, cottage, tanks, filter beds, ejector chambers, and other works. Mr. E. Pritchard, C.E., engineer, London and Birmingham.

	£	s.	d.
John Jowett, Lancashire	20,412	16	9
B. Corringham and Sons, Wednesbury	19,264	19	3
G. B. Godfrey, Westminster	18,865	3	5
Jones and Fitzmaurice, Birmingham	17,707	0	0
J. Small and Sons, West Bromwich	17,700	0	0
Bottoms Bros., London	16,690	0	0
James Young, Skegness, Lincolnshire	16,070	0	0
Cowdery and Sons, Newent, Gloucestershire	15,733	0	0
Cooke and Co., London	15,650	0	0
W. H. R. Hill, Beckenham, Kent	14,995	0	0
W. Schofield, London, E.C.	14,960	0	0
W. Cunliffe, Leigh, Lancashire	14,957	10	0
John Jevons, Dudley	14,645	1	7
John Fereday, Wednesbury	14,376	8	0
A. Krauss, Bristol	13,999	0	0
†George Law, Kidderminster	13,991	0	0
H. Hughes, Lower Gornal	12,463	0	0
‡H. Hughes, Lower Gornal	13,661	0	0

* Withdrawn. † Accepted. ‡ Amended tender.

FARNHAM MAIN SEWERAGE.

CONTRACT No. 1.—List of tenders for the supply of a pair of horizontal steam pumping engines and boilers. Mr. James Lemon, M. Inst. C.E., engineer.

	£	s.	d.
Babcock, Wilcox, and Worthington, London	2650	0	0
S. Stott and Son, Manchester	2270	0	0
The Savile-street Engineering Company, Sheffield	2255	0	0
*The Lilleshall Company, Shropshire	2000	0	0
The Grange Iron Company, Durham	1975	0	0
Jas. Watt and Co., London	1975	0	0
G. Scott and Son, London	1973	0	0
Steele and Dodson, Horsham	1874	7	0
W. and J. Yates, Blackburn	1814	0	0
Thomas Astbury and Son, Birmingham	1749	0	0
The Coalbrookdale Company, Shropshire	1733	0	0
Manlove, Alliott, Fryer, and Co., Nottingham	1712	0	0
Thos. Horn and Sons, London	1677	0	0
W. Cawsir, Smith, and Co., Birmingham	1675	0	0
Mason and Weyman, Guildford	1660	0	0
W. Abell, Derby	1655	0	0
Pollock and Macnab, Manchester	1649	0	0
S. Kirk and Co., Stoke-on-Trent	1640	0	0
Tangye and Co., Birmingham	1639	0	0
John Fernihough, Stalybridge, Lancashire	1610	0	0
Nayler and Co., Hereford	1580	0	0
Henry Balfour and Co., London	1570	0	0
J. Wolstenholme, Radcliffe, Lancashire	1550	0	0
Napier and Son, Southampton	1490	0	0
F. Pearn and Co., Manchester	1450	0	0
Guy and Stevens, Kingston-on-Thames	1439	15	0
M. W. Hanson, Bradford	1427	0	0
Spencer and Co., Melksham, Wilts	1400	0	0
Hanna, Donald, and Wilson, Paisley	1400	0	0
The Glenfield Company, Kilmarnock	1357	10	0
Bradley and Craven, Wakefield	1201	0	0
Gimson and Co., Leicester	1187	0	0
Joseph Richmond and Co., London	1150	0	0
F. Silvester and Co., Newcastle	1137	10	0
J. E. Hainsworth, Dewsbury	1132	0	0
†Renshaw and Co., Kidsgrove	1119	0	0
‡R. Laidlaw and Son, London	794	0	0

* Too late. † Accepted. ‡ Withdrawn.

RICE MILLS FOR THE EAST.—We understand that Messrs. Douglas and Grant, of Kirkcaldy, are well employed at present on a branch of industry which by long practice they have made peculiarly their own—we mean the construction of rice mills, with all machinery of the most improved kind that is required for the production of cargo rice and white rice. It is well to know that the principal mills in British Burmah have for many years past been supplied by this firm, as well as a number of others in Siam, Chili, New Zealand, and other countries, as well as in Europe. At present we believe Messrs. Douglas and Grant are building mills in Singapore, Bangkok and Saïgon, the last named being a very extensive concern. The senior partner of the Kirkcaldy firm was all over the East a year ago, when he visited all the principal rice growing districts.

THE IMPERIAL BRAZILIAN NAVY.—In a recent number of *Revista Maritima Brazileira* is given a general list of the ships of the Brazilian Navy, from which we extract the following particulars:—"The largest ironclad is the Riachuelo, launched in 1883, and built by Messrs. Samuda. She has a tonnage of 5800, is built of steel, and has steel armour 10in. on the turrets and 11in. on the sides. Her indicated horse-power is 6000, speed 16 knots, and she is armed with four Armstrong guns of 20 tons each, six of 5½ tons, and fifteen Nordenfelt machine guns. There are two ironclads, launched in 1876, of 3600 tons each, named Solimoes and Javary. They are built of iron, and have iron armour 13in. on the turrets and 12in. on the side. Their speed is 12 knots, and they are each armed with four Whitworth guns of 25 tons each and four Nordenfelts. Two smaller ironclads are also of iron hulls—the first, the Bahia, built in 1865, is 928 tons, and has 4in. armour on the turret, 3in. on the side, and is armed with two Whitworth 7in. guns; the Maris a Barros is 1196 tons, and has 4in. armour, and carries two Whitworth 7in. guns and two smooth-bore 68-pounders. Both these vessels have a speed of 9 knots, and they are eighteen years old. A wooden ship, the Sete de Setembro, of 2179 tons, is plated with 4in. armour, carries four Whitworth 9in. guns and four Nordenfelts, and has a speed of 11 knots. She was launched in 1874. There are, in addition to these, four small monitors for river service, built of wood plated with 4in. armour, each carrying a 7in. Whitworth gun and having a speed of 7 knots. As regards unarmoured cruisers, the Brazilian Government has one of 4000 tons building, of steel, to steam 15½ knots, to carry four Armstrong 12-ton guns, ten small guns of 6in. bore, and twelve Nordenfelts. They have also seven cruisers built of wood, of which four are between 1400 and 2000 tons, and are armed with Armstrong and Whitworth rifled cannons and Nordenfelts. Three vessels of about 750 tons each are armed with Whitworth guns. The speed of these wooden vessels ranges from 9 to 12½ knots, and most of them are of recent build. Of vessels of smaller size, the *Nautical Gazette* says, Brazil has seven wooden and five iron gunboats; and also five composite gunboats in course of construction. She has in course of construction, at Jarrow, five torpedo boats built of steel, to steam 18 knots, and over 100ft. in length. Three torpedo boats are building by Messrs. Thorneycroft, but of these the dimensions are not given. Brazil provides also for the training of her seamen a wood brig, the Apprendiz Marinhein, which completes the list.

SOCIETY OF ENGINEERS.

PRESIDENT'S ADDRESS.

THE first ordinary meeting for the present year of the members of the Society of Engineers was held on Monday, February 2nd, at the Town Hall, Westminster. The statement of accounts for 1884 was read, after which the President for the past year, Mr. Arthur Rigg, member of the Royal Institution, &c., presented the premiums of books awarded for papers read during that year. These were to Mr. A. C. Engert, for his paper on "Defects in Steam Boilers, and their Remedy," and to Mr. J. Corry Fell, for his paper on "Hard *v.* Soft Water for Manufacturing Purposes." Mr. Charles Gandon, M. Inst. C.E., &c., the President for 1885, then delivered his inaugural address. After referring to the papers read at the meetings of the Society during the last session, and the summer visits to the Midland Railway Company's locomotive works at Derby, the South Metropolitan Gas Company's new works at East Greenwich, and Messrs. Siemens Brothers' works at Charlton, the President reviewed the present position of the profession, especially referring to the increasing use of steel in place of iron for structural and other purposes, as well as for heavy ordnance and armour-plating. Mention was then made of the Severn and Mersey Tunnels, the completion of the Inner Circle of the Metropolitan Railway, the Forth and Tay Bridges, and also of improvements in the steam engine. The address then dealt with water engineering, and pointed out that quantity is not the only essential of a good water supply, but that quality and pressure are also important elements; rivers are, as a rule, objectionable as a source of supply, on account of the danger of pollution, unless the supply can be drawn from or near the source. Water from the chalk formation, such as underlies London, is preferable, although recent authorities have stated that such water is not always free from pollution.

One important advantage of a good supply of water at high-pressure is the protection it affords against fire; high level reservoirs supplying by gravitation being preferred for this. Reference was also made to the assessment of water rates on the rental value of house property, and its merits considered as compared with sale by measure, which would necessitate an expensive system of meters, increasing the cost of distribution and collection, and inducing the poor to exercise undue economy in the use of water. On the vexed question of the monopoly of gas and water supply, it was contended that it is doubtful whether any advantage arises from its being undertaken by local authorities. Water being a necessary of life, there is, perhaps, less to be argued against its being so supplied; but in the case of gas, it was thought there was no more reason for the supply being in the hands of local authorities than for such bodies to acquire railways, or to undertake the exclusive supply of bread or meat. Some statistics were then given of the capital employed in the United Kingdom on gas supply, as well as the consumption of coal, the quantity of gas supplied, and the rental derived from it.

Great economies have been effected in the details of gas manufacture, resulting in considerable reductions in prices, although great differences still exist between various gas undertakings, both in cost of plant and manufacture. Sanitary engineering was referred to as another branch of the profession belonging comparatively to recent times, and, if taken to comprise sewerage, drainage, and the warming and ventilating of buildings, as still requiring much attention; the state of the Thames and other large rivers being a reflection on the failure to utilise what should be a valuable fertiliser, instead of allowing it to become a nuisance. It was pointed out how frequently ventilation was a failure in large buildings, while in ordinary dwellings the defects are still more apparent. Defects also exist in house drainage in most cases, and no general improvement can be looked for without legislative supervision. The pollution of air in towns was also alluded to, as the engineer may largely aid in preventing it by the abatement of smoke. In this connection the experiments made by Dr. H. J. Russell on the atmosphere of London were referred to, as indicating other evils besides those arising from visible impurities of the air.

Mr. Lowthian Bell's estimates of the coal output of Great Britain in 1882 were quoted to show that, with the exception of iron and steel works, the greatest consumption of coal is for domestic purposes, and it is, consequently, in this direction that reform is most urgently needed. The last subject touched upon by the address was electrical engineering, as being one of the most remarkable events of the present century, both in its application to telegraphy and its further development to electric lighting. That the electric light is at present somewhat under a cloud is due to unprincipled speculations of company-mongers and inventors, but there can be no doubt that there is a vast field for its use. In referring to telegraphy, attention was called to the great increase in the speed of transmission, and it was said that, by a system in use in Canada, as many as three thousand words had been transmitted per minute.

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

(*From our own Correspondent.*)

ON the Exchanges this week attention has been largely claimed by the painful news from the seat of war, and traders have been somewhat anxiously forecasting the probabilities of the future duration of a campaign which is seriously interfering with business with the East and with the Mediterranean markets. The opinion expressed by some authorities that we have eighteen months' work ahead in attempting a pacification of the Soudan is received by traders with feelings of regret and discomfort. Before the fall of Khartoum, it had been hoped that the obstacle to business offered by hostilities was likely to be early removed. That hope, however, has now had to be abandoned.

The additional orders for hardware stores which are early expected to be received from the Army Department, now that so much activity has been suddenly occasioned, will go but a very little way towards compensating for the loss of business arising from the unrest. Manufacturers who are accustomed to contract with the Government Departments are anticipating the receipt of fresh commands from that source. Already the Departments are telegraphing to certain of the contractors in this district to push forward the deliveries of the annual supplies previously on order.

The carrying out of these instructions is here and there causing rather more rapid deliveries to be required of sheets for working-up and stamping purposes. Apart from this business does not show more movement than a week ago. Consumers seem less inclined than ever to speculate. The only satisfaction that remains is that South Staffordshire is not alone, but that matters are equally as bad, if not worse, in the other ironmaking centres.

Some few further orders have recently arrived for sheets, bars, hoops, and other merchant sections from Australia, from certain of the South American markets, and from the East Indies, but no improvement can be reported from either the United States or Canada. Trade with the European countries continues languid, and the immediate future is regarded as discouraging.

The export orders that are placed by merchants are quickly swallowed up, and they make but little impression upon the market. The thin sheet makers' books make the best show, shipping orders in their case being considerable, and delivery being much pressed.

The demand for galvanising sheets does not materially increase, and buyers are slow in authorising deliveries. Bar makers are only quietly supplied, and the hoop and angle makers have not this week booked any considerable number of new lines. Sales of Welsh bar and other small sizes of iron from the principality are increasing in this district, consequent upon the low rates.

Staffordshire prices were without strength, and led to renewed complaints this—Thursday—afternoon in Birmingham. Common

bars were £5 10s.; average quality, £6; second-class, £6 10s.; and best, £7 10s. to £7. Sheets, singles, were £6 15s.; doubles, £7 5s.; and lattens, £8 5s. Common boiler plates were £8 to £8 10s.; and superior sorts, £9.

Steel of various makes sold this afternoon in a manufactured and a partially manufactured form. Prices are very favourable to consumers, and there is every inducement to prefer the newer metal to iron whenever it will answer the purpose equally well. The Staffordshire Steel and Ingot Iron Company, although its works are not yet in a state to re-start, is accepting local orders for basic steel which it fills from works in other parts of the kingdom where the process is in operation. A heavy sum is being expended in altering and improving the Staffordshire works as originally laid down.

In the pig branch the only new feature of the week is the manifestation of increased indifference by vendors of outside brands to book further contracts. This comes about by reason of the difficulty which exists in getting consumers to accept deliveries. Makers under these circumstances do not care to further burden their order books. Prices are easy, particularly for Derbyshire, Northampton, and other brands. Native all-mines are quoted 57s. 6d. to 60s.; part-mines, 42s. to 45s.; and cinder, 37s. 6d. to 36s. 3d.

There is no relief in the depression in the coal trade. The current "list" rates are approximately as follow:—Household and smelting coal, 9s., 9s. 6d., and 10s. per ton; steam or locomotive coal, 8s.; bright and steam nuts, 7s. 6d.; best forge, 6s. 6d.; common forge, 5s. 6d.; rough slack, 4s. to 5s. best quality. The customary amount of underselling is going on.

Wages of miners in the thick coal are 3s. 4d. "per day" or stint, those of thin coal, 2s. 8d. "per day."

It is not unlikely that some trouble will be by-and-bye experienced by ironmasters with the South Staffordshire and East Worcestershire Association of Millmen. This organisation was established seven months ago, and has now got into something like working order. "The laws have been made," says the president, "for the better protection of all classes of millmen," and he hoped that "they would be obeyed, let the cost be what it may."

Another instance of the disastrous effects of the late sixteen weeks colliers' strike is afforded this week. At the annual meeting of the Hampstead Colliery Company, the chairman, Alderman Chamberlain, stated that the strike had cost the company £2500. The loss on the year's trading had been £764, but he considered that if the price of coal did not fall, and the company sold the same quantity in the future as they had done in the past, they would next year be able to declare a dividend of 5 per cent. on the preference shares.

Messrs. J. and S. Roberts, of West Bromwich, have obtained the contract for supplying 3100 yards of cast iron mains to the Hereford Gasworks, at £4 15s. per ton.

The somewhat improved position of the shipbuilding trade is reflecting favourably upon the tackle and one or two other local industries which supply the needs of shipbuilders. Generally speaking, however, the hardware trades continue in an unsatisfactory condition.

Makers of dynamo machines for electric lighting occupy an exceptional position, in that they are quite busy.

Mechanics in the safe trade who were discharged at Christmas have not yet been taken on again, and those at work are engaged more upon Indian, South American, and Australian orders, carried over from last year, than upon business that has since come to hand.

The Birmingham Tramways and Omnibus Company is doing well. It has made a profit on the past year of £6611. The directors propose to pay an ordinary dividend at the rate of 10 per cent. per annum, put £2500 to reserve, and carry forward to next year £482.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—Business continues to drag on very slowly in all branches of the iron trade, and although prices are so low that, under ordinary circumstances, they would offer a most tempting inducement for speculation, there is so little confidence in the future that buyers hesitate to go beyond hand-to-mouth purchases to cover actual requirements. Except in one or two branches where activity is being kept up, consumers see so little new work ahead that they are naturally very cautious about buying, and in many cases they have held back from entering into the contracts which are usually given out with the commencement of the year, preferring rather, in the existing depressed state of the market, to go on for the present with small purchases, as they can see the iron is required. The principal local and district makers of the better qualities of pig iron still hold to late rates; but the absence of any weight of orders coming forward is compelling needy makers to secure business, if possible, at lower prices, and there are sellers at 1s. to 1s. 3d. per ton under the current quoted rates. The finished iron trade continues in a very depressed condition, work only comes in from hand to mouth in quantities barely sufficient to keep the local forges going about three-fourths time, and buyers who have good prompt specifications to place are in most cases able to obtain concessions upon current rates.

There was only a moderate attendance at the Manchester iron market on Tuesday, and business was flat throughout, with very little disposition to buy manifested. For the better class of local and district brands quotations were firm at about 41s. to 41s. 6d., less 2½, delivered equal to Manchester; but on the basis of these figures only occasional small orders are being got, and in some cases Lincolnshire iron is reported to have been sold at as low as 40s. 3d. and 40s. 6d., less 2½, for foundry qualities delivered equal to Manchester, with forge qualities to be got at about 6d. to 9d. per ton under these figures. Outside brands of pig iron are easier to buy, good foundry Middlesbrough being offered here at 43s. 4d. net cash, with some forge qualities to be got at about 41s. 10d. For hematites there has been so little inquiry that prices have really not been tested, and quoted rates are practically only nominal. For manufactured iron the average basis of prices remains at about £5 10s. for good qualities of bars, £6 for hoops, and £7 for sheets, delivered into the Manchester district; makers are, however, so short of work that there is a disposition to give way slightly upon these figures to secure orders.

In bridge and girder work there have been some tolerably good orders given out chiefly for railway construction, and locomotive and railway carriage builders are still kept busy, but outside this class of work, except in a few special branches, a decided slackening off continues to be reported, and any new work is being keenly sought after at very low prices. With regard to the trades union societies connected with the engineering branches of industry, I may add that further particulars I have been able to gather indicate that their position in some instances is even worse than I pointed out last week. Weekly levies from employed members have been raised 75 per cent. to meet the heavy expenditure entailed to support those out of work, and in some instances the funds have been drawn upon to such an extent as in one or two cases to practically exhaust their available resources.

Messrs. Deakin Parker and Co., of Manchester, have recently introduced an engine of the vertical inverted compound tandem type, specially designed for electric lighting, which has given very good results. In these engines the low-pressure cylinder is placed on the top of the engine frame, and the high-pressure, placed above, is separated from the low-pressure cylinder by a distance piece containing the glands, &c. One valve spindle goes through both valve chests, and works both slide valves. The crank shaft is of steel and fitted with balance weights, and the bearing surfaces throughout are very large. These engines, I understand, have been run as high as 280 revolutions per minute with perfect steadiness.

The new refreshment saloon carriages recently built by the Manchester and Sheffield Railway Company have been fitted by Mr. John Faulkner, of Manchester, with his system of Altandic electric bells, similar to those provided for her Majesty's royal saloon carriages and the Imperial carriages of Russia, for communication between different parts of the train. In the Manchester, Sheffield, and Lincolnshire carriages there are ten indicators, with, in most cases, double indications.

The Manchester "Joule" Club, which has taken up the work of the old Scientific and Mechanical Society, held its second annual meeting on Wednesday, and Mr. C. S. Allott, C.E., was elected president, and Mr. W. E. Heys vice-president for the ensuing year, Mr. R. Sowood, who has acted as secretary for both societies since their commencement, being unanimously re-elected to the post he has so well filled.

The promoters of the Manchester Ship Canal are now threatened with opposition to their scheme from a quarter which previously was little suspected. The proprietors of the Bridgewater Navigation, who, I understand, will be scheduled in the Ship Canal Bill as having entered into an arrangement to sell their property to the Ship Canal Company when the Bill was previously introduced, have since then taken initiatory steps, of which a brief outline has been given in The Engineer, for improving their own means of navigation with the view of meeting the trade requirements of Manchester, and in consequence a determined opposition is to be offered to the scheme put forward by the promoters of the Manchester Ship Canal.

In the coal trade there is a continued falling-off in the demand for all descriptions of round coal. The better qualities for house fire purposes are naturally meeting with a lessened inquiry as the result of the mild weather; whilst the depression in the chief coal-using branches of industry is appreciably affecting the demand for the common sorts for iron-making and steam purposes. Pits are not working more than four to five days a week, and in most cases stocks are being put down. The quoted list rates are without material change; but there is a general want of firmness in prices, and to effect clearances of stocks special quotations are made which in some cases are extremely low. At the pit mouth best coal can be got at from 8s. 6d. to 9s.; seconds, 7s. to 7s. 6d.; and common, 5s. 6d. to 6s. per ton. Engine fuel moves off fairly well, but notwithstanding the lessened quantity of round coal now being screened, there is no scarcity of supplies, and the common sorts of slack are, if anything, rather a drug. Burgy at the pit mouth averages 4s. 6d. to 5s.; best slack, 3s. 9d. to 4s.; and common, 2s. 6d. to 3s. per ton.

Steam coal for shipment still meets with a moderate demand, but prices are low, common qualities delivered at the high level, Liverpool, or the Garston Docks, being offered at 7s., with best qualities fetching 7s. 3d. to 7s. 6d. per ton.

Barrow.—No change can be noted in the condition of the hematite pig iron trade of this district. Orders are very limited in number, and the tonnage of pig iron which is changing hands is very inconsiderable. In some parts of the district makers are blowing out some of the furnaces which are in blast, and it is probable, before next week, the output of the works in the district will be reduced by fully 2500 tons per week. The home demand is quiet, but the continental and general foreign demand is exceedingly slow. The value of iron is easier, quotations representing 44s. per ton for mixed parcels of Bessemer iron net at works, and 42s. per ton for forge iron. Stocks remain large but are not being increased. The steel trade shows no new feature, orders are not given out with much spirit, and makers are not generally well sold forward. It is evident that the output of the mills is greater than the demand now experienced, and that only irregular time can be worked, unless new trade comes to hand in greater proportions than at present. The engineering trade is quiet, but the works are perhaps better employed than they were last year, and in the marine department especially builders of engines are better employed. Iron shipbuilders have not booked many new orders during the past month or two, but their prospects are certainly an improvement on late experiences. Iron ore slow in sale at from 8s. 6d. to 10s. per ton. Coal and coke steady.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

The Board of Trade returns for the opening month of the year were awaited with considerable interest, in the expectation that they would show some decided change for the better in those productions in which Sheffield is interested. The result is again disappointing. In January of 1884 we exported a value of £283,446; last month only £239,839; coal, £831,616, as compared with £762,401; pig iron, £175,493, against £123,980; bar, angle, &c., £169,789, against £129,858; railroad, £319,859, against £236,699; hoops, sheets, and boiler and armour plates, £299,215, against £265,101; steel, unwrought, £98,641, against £73,142; manufactures of steel and iron, £30,295 and £23,403; steam engines, £382,210 and £312,124; other descriptions of ditto, £737,287 and £552,807; plate and plated and gilt wares, £26,143 and £24,210; telegraph wire and apparatus connected therewith, £280,076 and £27,627. In every case, it will be seen, larger values were sent in the opening month of 1884 than in last month.

Turning to the imports, the chief increase has been in articles which are largely used in Sheffield. Regulus, for example, has increased from £101,105 in January, 1884, to £223,992 in January, 1885; unwrought or part-wrought, from £170,110, to £298,253. Iron ore, on the other hand, has fallen from £214,916, to £181,401, while iron bars have increased from £40,085 to £52,052; iron bars —manufactured—have decreased from £218,117 to £160,235. Steel —unwrought—has increased very considerably, from £7130 to £12,094. This is, no doubt, the quality known as Swedish Bessemer, which is largely re-sold in Sheffield for various purposes.

Hardware and cutlery again show a continuous decline:—£341,982, £283,446, and £239,839 in the respective months of January, 1883-84-85. Russia, British Possessions in South Africa, British East Indies, and the Argentine Republic show increases, the latter from £5352 to £10,738. All other markets have decreased—Germany, from £11,283 to £10,235; Holland, from £6400 to £4276; France, from £13,035 to £11,142; Spain and Canaries, from £9828 to ££7394; the United States, from £31,564 to £29,873; Foreign West Indies, from £4198 to £2871; Brazil, from £20,291 to £11,707; British North America, from £9052 to £6953; Australasia, from £61,140 to £49,807; other countries from £78,389 to £59,987.

In steel rails the results of the first month's trading are even more serious, the total value exported last January being only £153,631, as compared with £213,202 and £415,103 for the corresponding month of 1884 and 1883. Russia, Sweden and Norway, Germany, Holland, Spain, and Canaries—which took a value of £11,838 in January, 1884—Italy, and Egypt, have done no business this year as yet. The United States fell from £10,062 to to £1485; Mexico, from £1119 to £552; Brazil, from £29,907 to £7437; Argentine Republic, from £21,195 to £16,396. In January of 1883 these four markets took respectively £33,661, £25,732, £14,319, and £46,963. British North America, which took a value of £33,465 in January, 1883, was blank for January of 1884, but last month was again a customer to the extent of £24,599. British Possessions in South Africa for the opening month of the three years had £32,964, £6136, and £5067; British East Indies, £91,417, £51,253, and £26,965; Australasia, £66,325, £46,367, and £38,062.

Here is a note from a travelling correspondent to which the *Sheffield Daily Telegraph* gives prominence:—"Solingen is a remarkably busy little place, and the great manufacturers seem to have no end of orders, principally for North and South America. In goods of low and medium quality they seem to have completely driven Sheffield out of the market, but the higher and finer qualities seem to be beyond them here, and Sheffield need fear no competition in that line."

South and West Yorkshire collieries have sent to Hull during January 100,688 tons, 45,342 of which went by rail and 55,256 by river, as compared with 95,880 tons for the corresponding month of 1884. Denaby Main heads the list with 9832 tons, which is 2656 tons less than in January, 1884. The falling-off is, no doubt, attributable to the serious dispute at that important colliery. Allerton Main comes second with 6736 tons, a decrease of 2272 tons; Manvers Main is third with 6360 tons, an increase of 1686 tons; Tryston, 5752 tons, an increase of 840 tons; Peckfield, 5704 tons, an increase of 2808 tons; Shireoaks, 4984 tons, an increase of 848 tons; Wharncliffe Silkstone, 4176 tons, an increase of 424 tons; Thrybergh Hall, 4240 tons, an increase of 832 tons. From Wall Main there has been a serious decrease—688 tons, against 1080 for the corresponding month of 1884. From the Whitwood collieries there has also been a decreased tonnage—1968, against 3048; West Riding and Silkstone, 2128, against 3072; Wheldale, 1808, against 3424; Aldwarke Main and Car House, the collieries belonging to Messrs. John Brown and Co., Sheffield, both show large increases—Aldwarke having sent 3088 tons, against 680, an increase of 2408 tons, and Car House, 984 tons, against only 32. The Fitzwilliam collieries, Hemsworth, 1752 tons, against *nil* last year. Monckton Main, Monk Bretton, Roundwood, Wombwell Main, Old Silkstone, West Melton, Featherstone Main, Kilnhurst, Kiveton Park, Carlton Main, Hoyland Silkstone, and Gosforth show large increases. Twelve collieries show a united increase of 15,118 tons; the chief decreases are shown by four collieries, whose falling-off exceeds 6000 tons.

Most of the coal referred to above has been exported to foreign countries. Germany has had the heaviest portion, 9706 tons; France, 5045 tons; Denmark, 4376 tons; Sweden and Norway, 3890 tons; Belgium, 3601 tons; East Indies, 1924; and Holland, 1920 tons. Russia—north—took 4261 tons in January, 1884, and only 651 tons last month; though to South Russia—which had nothing last year—841 tons were sent. Total tonnage from Hull during January last, 34,911, as compared with 27,974 for the corresponding month of 1884.

London has taken a greater quantity of coal by rail during January last than in the corresponding month of 1884, the tonnage being 638,246 and 569,675 respectively. Messrs. Newton, Chambers, and Co., the Thorncliffe Collieries, again head the list with 31,743 tons, Clay Cross coming next with 29,127; Blackwell Colliery, 17,553; Langley Mill, 17,311; Grassmoor, 16,557; and Eckington, J. and G. Wells, 15,567.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

The ironmasters' returns for January, showing that stocks had increased 32,728 tons, were issued on Wednesday last, and have had the effect of still further depressing the market. Consumers are not yet inclined to buy in quantity, and they do not as a rule offer more than 34s. 9d. per ton for No. 3 g.m.b. for prompt delivery. What little business is being done at present is by merchants, and at that figure. For deferred delivery merchants are quoting 35s. Makers do not seem anxious to sell at all at the moment, and will not accept less than 35s. per ton for prompt delivery; for forward they want 3d. to 6d. per ton more. Forge iron has not fallen in price since last week, 33s. 6d. per ton being the usual quotation; buyers, however, hold out for 3d. per ton less. Shipments to Scotland continue at a fair rate of progress; in other directions they are light, and the prospects of trade are as gloomy as they were at the beginning of the year. There are rumours current to the effect that the smelters contemplate a further reduction of output.

There has been no change in Messrs. Connal and Co.'s stock of pig iron at Middlesbrough during the past few days. At Glasgow 1993 tons were added last week.

There is no improvement in the demand for any kind of finished iron, and prices are the same as quoted last week.

According to the statistics for January, there are only ninety-five blast furnaces in operation, or three less than at the end of December. The make of Cleveland pig iron for the month in the whole district was 154,922 tons, and of hematite, spiegel, and basic iron, 47,303 tons; total, 202,225 tons; or 1805 tons less than the make of December. The additions to stock for November, December, and January reach the large total of 83,000 tons, and are mainly due to the falling off in exports.

The use of Middlesbrough basic steel plates seems gradually to be extending. It is found that their peculiar softness fits them specially for many purposes where hitherto iron or harder steels have been employed. Among these purposes may be mentioned mineral wagon building. Over fifty wagons have already been built by a Darlington firm, and fifty more are in progress. It is clear that tipping coal and ironstone into wagons is always rather severe usage, and when the bottom boards are let down, and the workmen strike the sides with a sledge hammer, to facilitate the release of the contents, that also needs good material and sound construction to sustain it long. Basic steel plates are just what are wanted to meet the case. Another purpose similar in many respects to which they are being successfully applied is that of coke and mine barrows for blast furnaces. Here the lightness of the steel in proportion to its strength is a useful characteristic. Yet another purpose is to make the bottoms of pans for evaporating brine. In this case heavy iron rakes are continually in use for scraping the salt from the bottom of the pan as it is precipitated thereon. This means a necessity to withstand frequent blows, and for this basic steel seems to be well fitted. A basic steel plate intended for a salt pan at Port Clarence lately fell off a truck and across a rail just in front of another truck in motion. The truck wheel passed over it, crumpling it up most awkwardly. Nevertheless, it did not break and was soon flattened out again to its original condition.

The death of Mr. Sidney Gilchrist Thomas at the early age of thirty-four has been deeply felt and greatly deplored by his friends in the North. The North-Eastern steel works at Middlesbrough remain as the principal monument in England to his genius and perseverance. Unfortunately, the present times are bad for this and all other branches of the steel and iron trade. When they recover there is no doubt but that a rapid development of the basic steel industry will take place, and the more time progresses the more the world will know what a public benefactor it has lost in Sidney Gilchrist Thomas.

The North-Eastern Railway Company put down a few years since about two miles of line upon iron sleepers on Mr. C. Wood's system. The portion of the line selected was that extending from Middlesbrough to Newport, the next station west thereof. The experimental line was heavily worked under mineral traffic, such as continually passes to and from the Cleveland ironworks. The sleepers did not stand altogether satisfactorily. They were quite sufficiently elastic, and did not rust sensibly; but being seriously weakened by the large holes needed by Mr. Wood's peculiar fastenings, and these holes being situated on either side of the rail, just where the strain on the sleepers was greatest, the latter were continually breaking there. It became obvious that iron sleepers were right in principle, but that the particular system tried was not yet perfect in detail. Considering that if iron or steel sleepers come into fashion they will be made more largely in Cleveland than anywhere else, the North-Eastern Railway Company is obviously deeply interested in promoting their adoption generally. Recognising this, it is wisely continuing its experiments. It is just now laying the piece of line previously referred to—namely, that between Middlesbrough and Newport—with iron or steel sleepers, rolled at Barrow on Mr. F. W. Webb's principle. The sleepers are rolled to the requisite trough-like section. Under each rail is a sole-plate, to strengthen it there. The chair is formed of two jaws made of steel plate, stamped into form and ribbed centrally, so as to give strength to resist the pressure of the wedges. The jaws, sole-plate, and sleeper are united by rivets passing through the three thicknesses. It will be interesting to watch how this system of iron or steel sleepers endures under the North-Eastern Railway traffic. If it stands that, it will stand anything. There is nothing so likely to give a fillip to the iron and steel trade as the rapid substitution of metallic for wooden sleepers on railways generally.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THE Glasgow iron market has again been much depressed in the course of the past week, there having been very little business of any importance transacted, while the quotations are still on the decline. The shipping demand for pig iron has not been satisfactory, the orders coming to hand for delivery of iron during the spring being much smaller than was anticipated. In the past week the shipments have been poor, amounting only to 6505 tons, as compared with 8833 in the preceding week, and 8900 in the corresponding week of 1884. There are ninety-three furnaces in blast, as compared with ninety-seven at the same time last year, and as the output considerably exceeds the current consumption, stocks are accumulating. The stock in Messrs. Connal and Co.'s stores exhibits an increase for the week of fully 2000 tons, the largest addition that has taken place for many months.

Business was done in the warrant market on Friday at 42s. 2½d. per ton for cash. On Monday the price receded to 41s. 1½d., while the quotations on Tuesday were 41s. 2½d. to 41s. 2d. cash. Business was done on Wednesday at 41s. 1d. to 41s. 0½d. and 41s. 1½d. cash. To-day—Thursday—the tone was slightly firmer, with business up to 41s. 3d. cash, closing with sellers at 41s. 2½d. cash.

As a result of the backward demand, the prices of makers' iron are lower this week, as follow:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 52s.; No. 3, 47s.; Coltness, 55s. and 51s.; Langloan, 56s. and 51s. 6d.; Summerlee, 51s. 6d. and 56s. 6d.; Calder, 52s. 3d. and 47s.; Carnbroe, 49s. and 46s.; Clyde, 47s. and 43s.; Monkland, 42s. 6d. and 40s. 3d.; Quarter, 42s. and 40s.; Govan, at Broomielaw, 42s. 3d. and 40s. 3d.; Shotts, at Leith, 51s. 6d. and 51s. 3d.; Carron, at Grangemouth, 49s. (specially selected, 53s. 6d.) and 48s.; Kinneil, at Bo'ness, 44s. 6d. and 43s. 6d.; Glengarnock, at Ardrossan, 48s. 6d. and 43s.; Eglinton, 43s. 3d. and 39s. 9d.; Dalmellington, 47s. and 43s. 6d.

The demand for shipping iron is still very flat, and prices for the few contracts available are considerably below the figures quoted by merchants. The past week's shipments of iron manufactures from the Clyde included machinery to the value of £19,000, chiefly sugar-crushing, of which £18,000 worth went to Brisbane, and the rest to Trinidad. There was besides £5700 worth of sewing machines, £2000 steel goods, and £13,000 iron manufactures.

At the steel works a fair business is passing, and the prospect is, on the whole, not unsatisfactory.

The will of the late Mr. Thomas Ellis, iron manufacturer, Coatbridge, has been proved at £33,526.

The notice of a reduction of wages which caused a strike of iron moulders at Bo'ness about ten days ago has now been withdrawn, and the dispute is practically at an end. At Johnstone the master engineers have intimated a reduction of 1s. a week on the wages of all their skilled workmen. The employers deemed the reduction absolutely essential in the present condition of business, and it is not expected that it will meet with any opposition of consequence.

Several contracts for gas coal are now coming into the market. Cannel is still in request, and likely to continue so until Scotch gas makers modify their present ideas with reference to the necessity for a high illuminating standard of gas. The gas tar and ammoniacal liquor of gasworks is not in such demand as they were in some former times; but companies are still for the most part enabled to dispose of them in a satisfactory manner.

The coal trade is in a fairly active state. The shipping demand is such that the total quantity despatched exceeds that of last year up till now. This week, however, there appears to be less doing in the export department. The shipments included 6453 tons at the Queen's Dock, Glasgow, 4501 tons at Troon, 8420 at Ayr, 311 at Greenock, and 1448 tons at Irvine. In the western district the prices are nominally without change. At Leith the railway transit rates are operating against the extension of the shipping trade, there being superior facilities at some of the other Firth of Forth and Fife ports.

Several fresh contracts have been placed with Clyde shipbuilders in the course of the past few days, but there is still a great lack of employment in some of the yards.

The shipping trade of the Clyde during the month of January has been very satisfactory as regards bulk, although the freights have been much below the mark. The month's arrivals embraced 125 vessels of 112,348 tons, against 124 vessels of 106,386 tons in the same month of last year; while the sailings were 133 vessels and 130,360 tons, compared with 117 vessels and 121,990 tons in January, 1884.

WALES & ADJOINING COUNTIES.

(From our own Correspondent.)

A SPECIAL meeting of the directors and shareholders of the Taff Vale Railway was held in Bristol this week. After a very long explanation by the chairman of the features of the Amalgamation Bill, the meeting approved the same. One of the shareholders, it is true, raised a question or two, and actually moved that the subject should be adjourned for a month. Mr. Inskip, the chairman, made a most exhaustive statement ere moving his resolution, which was supported by Mr. Geo. Fisher.

It was well shown that the Taff differed in one marked respect from our railways in general. It was a great coal railway. Passengers and goods were secondary, and hence the amalgamation with the docks was a natural one and to be desired, and the control of both docks and railway by one director a matter of urgent moment. At the Bristol meeting the new railway schemes in connection with the docks were approved. I am sorry to state that there is a difficulty with the men and the contractors of the New Dock, Cardiff, and 700 are out on strike. The cause is chiefly, I hear, owing to a "society" dispute, and is not likely to be a long one.

A curious phase of the shot-firing test case took place this week. It had been arranged to try the manager of Ynyshir for a violation of the eighth general rule of the Mines Regulation Act by allowing blasting operations to be carried on under certain conditions, and H.M. inspector, prosecuting barrister, and a long array were present to hear or take part in the case. Unfortunately, the manager did not present himself, and the inquiry was adjourned. It is most desirable that an end, one way or the other, should be brought about of this vexed question. The colliers, almost to a man, maintain that blasting can be conducted at working times; the principal inspector and the Home Secretary think otherwise.

The coal trade has not recovered its tone yet, though spring prospects are opening well, and the arrangements for naval enterprise in connection with the East are congratulatory matters for our coalowners. I shall not be at all surprised at an increase in price and a good deal of spirit in the trade this spring. Already some good Government contracts have been booked. This week a total of 100,000 tons for the Admiralty was secured by the Glamorgan Coal Company, Tylor and Co., the Dowlais Company, and Lockett and Co. A good deal of activity is shown at Merthyr Vale, Harris Navigation, Cyfarthfa, Plymouth, and Dowlais Collieries. The house collieries do not share this activity, as can be seen at a glance by the Roath sidings, Cardiff, where a good deal of Monmouthshire coal has been lying of late, though offered at low rates. Coke is somewhat dull, and so also is small steam, which is again beginning to inconvenience coalowners.

There is little change to record in the state of the iron and steel trade. It is rumoured that one of the Dowlais agents has had the appointment of manager at Rhymney, but I am not able to confirm it yet. If so, the selection is a good one. On Monday the Bessemer works at Cyfarthfa were put into action, and the converters, blowing engines, &c., answered admirably—as might have been anticipated, being the best work of Tannett, Walker, and Co., and Galloway and Co., of Leeds. I have never seen such fine machinery at any steel works. The chief feature at Cyfarthfa is unlimited water supply; the next, the latest machinery. Add to this an immense capital, and it will be seen that Cyfarthfa will be able to do more than hold its own. I am afraid of some of the limited companies. Large quantities of iron plant are leaving Plymouth Works, which are being gradually dismantled, and will soon be in the same category as Penydarran—that is brushed away. I hear that the same energetic contractor who has bought Plymouth has bought Abernant Works. Several yet remain, Gadlys, Treforest, and Llwydcoed, and the sooner the castings are in the furnace and the ground utilised the better. There is no possibility of revival of the old iron works. The last blow has been a preference for steel bars for tin-plate. Of late an improvement has set in with regard to tin-plate in respect of quantity; prices remain about the same.

An explosion of gas occurred at the Park pit, Aberdare, on Tuesday, injuring three men, one severely. The cause was an escape of gas coming in contact with an open light. The colliers there work with an ordinary candle.

A testimonial is being got up for Mr. David Evans, Rhymney, and is being warmly supported.

A SHIP RAILWAY FOR CANADA.—There is a narrow neck of land between that portion of the Gulf of St. Lawrence which is south of Prince Edward Island and the Bay of Fundy; it is about 17 miles in width. A canal through this isthmus would save 600 miles of dangerous coast navigation in passing from the St. Lawrence to St. John, New Brunswick, Portland, and Boston. It is, however, said to have been proved that there is a difference in the tidal levels of the two bays of about 17ft., and that the Bay of Fundy water contains alluvial matter in such quantities that it would silt up any canal if made. A ship railway is now proposed. The question has received careful consideration, and in 1882 the Dominion Government of Canada agreed to give a subsidy of £30,000 annually for twenty-five years to the railway when completed. The scheme has been submitted to Mr. John Fowler, by whom the details of constructing and working the line have been considered and approved, and he has consented to act as engineer-in-chief. The railway will run through a practically level country, and will be laid with four lines of rails, over which the cradles in which the ships are placed will be conveyed. The steamers and sailing vessels to be transported will be limited to 1000 tons register, and they will be of the class which, having small draught of water, are adapted for lake and inland navigation. These are necessarily unsuited to the stormy weather and the navigation of the Atlantic—hence the advantage of the proposed mode of transit. Mr. Fowler says: "A ship railway, as here designed, is but a combination of a marine railway, or patent slip, on a large scale, with the hydraulic ship lift, both of which are in use in different parts of the world. The only novelty introduced in this instance is in the length of the marine railway, and the consequent adoption of locomotive power instead of the usual stationary engines, rollers, chains and inclined planes. The lifting of vessels with cargoes is now of common occurrence, even with double the tonnage contemplated to be lifted on your railway, without doing any injury or subjecting the vessels to any strain beyond what they were designed to withstand in the ocean. Looking to the large marine tonnage of Canada and the position of this railway, which will obviate the necessity of weathering Cape Canso and Cape Sable and the ocean coast of Nova Scotia, thereby saving 600 miles of difficult navigation to steamers and sailing vessels pursuing their course from the chief cities of Canada to St. John and the United States ports, I should think the commercial success of your undertaking to be unquestionable." Mr. Fowler adds that he has examined in detail the estimates of Messrs. James Perry and Co., and also of Sir W. G. Armstrong and Co., and is of opinion that the sum of £650,000 is quite ample to cover the entire cost of the line, with all the engineering, administration, interest and financing, as well as working capital, and believes that the contractors will carry out the works with credit to themselves and all concerned.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

*** *It has come to our notice that some applicants of the Patent-office Sales Department, for Patent Specifications, have caused much unnecessary trouble and annoyance, both to themselves and to the Patent-office Officials, by giving the number of the page of* THE ENGINEER *at which the Specification they require is referred to, instead of giving the proper number of the Specification. The mistake has been made by looking at* THE ENGINEER *Index, and giving the numbers there found, which only refer to the pages, in place of turning to those pages and finding the number of the Specification.*

Applications for Letters Patent.

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

3rd February, 1885.

1458. SPINNING and DOUBLING MACHINES, G. Bernhardt, Manchester.
1459. PRESSURE in HYDRAULIC MAINS of RETORT HOUSES, F. Morris and J. L. Cloudsley, London.
1460. VENTILATING and SMOKE CONSUMING, J. W. Holden, Withington.
1461. BRICK-CUTTING TABLES, A. L. Lineff and W. Jones, London.
1462. PAPER-MAKING MACHINES, T. Rowland, Halifax.
1463. DRESSING, &c., METAL CASTINGS, M. Swain, Manchester.
1464. TENTERING MACHINES, H. Avison, Halifax.
1465. PUMPS for DRAWING BEER, &c., J. Merritt and C. Chambers, Birmingham.
1466. BOTTLES for BOTTLING BEER, &c., R. Mayall, jun., Liverpool.
1467. HAMMERLESS GUNS and RIFLES, J. W. Smallman, Nuneaton.
1468. DESKS for ART SCHOOLS, &c., F. W. Martin, Birmingham.
1469. PICTURE DOMINOES, T. L. Towler, Birmingham.
1470. BREECH-LOADING SMALL-ARMS, J. Cox, Birmingham.
1471. FILTER, W. Begg, Manchester.
1472. PROPULSION of VESSELS, W. Barber, Manchester.
1473. TANDEM VELOCIPEDES, S. Lee and W. McWilliam, London.
1474. DRIVING GEAR of TANDEM VELOCIPEDES, S. Lee and W. McWilliam, London.
1475. CUTTING FILES, &c., A. Shardlow, London.
1476. QUICK and EASY ACCESS to TALL CHIMNEYS, &c., W. Walton, Sunderland.
1477. EXPLORING the DEEP and LOOKING ROUND CORNERS, J. McGuirl and H. Currie, Maryport.
1478. IGNITING APPARATUS for GAS MOTOR ENGINES, T. M. Williamson, C. W. King, J. Malam, and W. A. Ireland, Southport.
1479. TUBES for CAP SPINNING, &c., MACHINES, H. Illingworth, J. Binns, and J. Kelly, London.
1480. AUTOMATICALLY STOPPING GILL, &c., DRAWING BOXES, H. Illingworth and J. Tarbotton, London.
1481. TRAWLING APPARATUS, S. Kemp, London.
1482. KEEPING COOL DYNAMO-ELECTRIC, &c., MACHINES, A. Lumley, London.
1483. SELF-ACTING TWENTY-FOUR HOUR DIAL, G. T. Forbes, Streatham.
1484. TROUSER SUSPENDERS, G. Walker.—(*W. Greenshields, New Zealand.*)
1485. FIXING CANDLE in CANDLESTICK by means of a STEEL SPRING, W. Henderson, Cumberland.
1486. UNIVERSAL SMOKE PREVENTER, H. Brown, London.
1487. HYGIENIC LAMP OIL, A. Wright, London.
1488. DOMESTIC and other FIRE-PLACES, J. Bennison, London.
1489. CAPILLARY FILTERS, J. C. Mewburn.—(*J. A. Tupper, United States.*)
1490. CINDER SIFTING APPARATUS for use with PAN CLOSET, J. Devey, London.
1491. VELOCIPEDES, J. Haukins, jun., Walsall.
1492. FUMIGATOR, F. Rosher, London.
1493. FIXING HANDLE KNOBS of DOORS to the LATCH SPINDLES, J. D. Morrison, jun., and A. Emley, London.
1494. ROTARY ENGINES, H. T. Liversedge, London.
1495. BOTTLES for BEER, &c., W. G. Moil, Liverpool.
1496. FOUNTAIN PENS, P. E. Wirt, London.
1497. SPREADING, &c., HEMP, &c., A. V. Newton.—(*J. Good, U.S.*)
1498. EDGE-SETTING and other CUTTING TOOLS for TRIMMING BOOTS and SHOES, S. Keats, London.
1499. INVERTED GAS-BURNER, D. W. Sugg, London.
1500. COMBINED CIGAR and MOUTHPIECE, L. A. Groth.—(*G. Kreglinger, Germany.*)
1501. WATER METER, L. A. Groth.—(*P. Tarda, Spain.*)
1502. HOLDING PRICE-LISTS, &c., L. A. Groth.—(*O. Dietze, Germany.*)
1503. ETCHING and its REPRODUCTION by PHOTOGRAPHY, L. A. Groth.—(*Dr. E. Albert, Germany.*)
1504. WINDOWS and WINDOW MECHANISMS, O. Flagstad, London.
1505. ELECTRIC BATTERIES, W. R. Lake.—(*H. L. Brevoort and I. L. Roberts, U.S.*)
1506. UNIONS or COUPLINGS for PIPES, N. Thompson, London.
1507. SCREENS for PURIFYING MACHINERY, H. Simon, London.
1508. HATS, J. Imray.—(*A. Crespin, France.*)
1509. GAS HEATERS, I. Spielmann, London.
1510. FILTERS, F. R. Lipscombe, London.
1511. MACHINE for HAULING NETS, A. Joss, R. Towns, A. Kynoch, and W. Reid, Glasgow.
1512. PADDLE WHEELS, A. Joss, R. Towns, A. Kynoch, and W. Reid, Glasgow.
1513. METAL TUBES, R. B. Evered, London.
1514. GAS LAMPS or BURNERS, F. H. Wenham, London.
1515. PRODUCING FACSIMILE COPIES of WRITINGS, &c., F. Friend, London,

4th February, 1885.

1516. BOXING GLOVES, L. Jeyes, London.
1517. STEPS for ROAD CARRIAGES, J. G. Harrison, Birmingham.
1518. BUTTON FASTENERS, J. T. M. Burgess, Birmingham.
1519. MACHINES for WASHING WOOL, &c., J. and F. W. Petrie, Rochdale.
1520. FUNNELS or TUN DISHES, G. T. Neville, Birmingham.
1521. METALLIC or SPRING MATTRESSES, I. Chorlton and G. L. Scott, London.
1522. LAVATORY APPLIANCE, F. Cunliffe, Manchester.
1523. VERTICAL STEAM BOILERS, A. M. Brown, Ipswich.
1524. VIOLINS, I. Glazebrook, Birmingham.
1525. RAILWAY SLEEPER and SOLE PLATE, W. Scott, Newcastle-on-Tyne.
1526. CONFECTIONERY, R. Service, Dalry.
1527. RAILWAY FOG SIGNALS, M. Ingram, Manchester.
1528. DISTRIBUTING, &c., STAMPS, &c., H. B. Barlow, Manchester.
1529. FISH-PLATES or JOINT FASTENERS, W. Corteen, London.
1530. REGULATING the TENSION of a CONTINUOUS SHEET of PAPER in ROTARY MACHINES, &c., R. C. Annan, South Shields.
1531. ENABLING BOTH the OLD SYSTEM and the NEW SYSTEM of TIME to be INDICATED on the SAME DIAL, E. Obrecht, London.
1532. FEEDING CLOSE and OPEN FIREPLACES with FUEL, R. Canham, London.
1533. MERCURIAL PUMPS, W. F. Donkin, London.
1534. PRESERVING MEAT, C. Russell.—(*A. Losasso, Calcutta.*)
1535. INDICATING the POSITION of RAILWAY POINTS, T. Isherwood, London.
1536. HAT LEATHERS, C. Schofield, London.
1537. AUTOMATIC RE-OPENING of TORPEDO INDICATING LIGHTS, J. S. Comrie, London.
1538. STAYS for REGULATING, &c., the OPENING of CASEMENTS, &c., W. Brew, London.
1539. ATTACHING KNOBS to HANDLES, J. Walker and H. B. Worsey, London.
1540. CENTRIFUGAL MACHINES for DRYING SUGAR, &c., G. Fletcher and W. P. Abell, London.
1541. CENTRIFUGAL MACHINES, G. Fletcher, London.
1542. ROLLER MILLS, G. Fletcher, London.
1543. BUTTONS, &c., C. H. Newey, London.
1544. DRIVING GEAR for VELOCIPEDES, J. Ford, London.
1545. BOATS PROPELLED by MECHANISM OPERATED by the FEET, C. M. Linley and J. Biggs, London.
1546. LAMPS for VELOCIPEDES, J. S. Brown, London.
1547. SAFETY FASTENING for BROOCHES, H. M. Green, London.
1548. MATTRESSES, G. D. Peters, London.
1549. VESSELS for AERIAL NAVIGATION, W. R. Lake.—(*E. E. Falconnet, U.S.*)
1550. TREATING MEAT, P. Justice.—(*G. Holgate, United States.*)
1551. BARRELS, E. Lacemann, London.
1552. ATTACHING RUDDERS to BOATS, A. T. Frampton, East Molesey.
1553. PRODUCING, &c., CHLORINATED DIMETHYLPARAPHENYLENEDIAMINES, H. E. Newton.—(*R. Möhlau, Germany.*)
1554. COINING PRESSES, J. M. Napier, London.
1555. BENZOLINE LAMPS, T. Kerrigan London.
1556. MAKING CORRUGATED TUBES, S. Fox, London.
1557. SELF-ACTING STAY for HINGED LIDS, T. Monteath, London.
1558. CONSTRUCTING STANDARDS for WIRE FENCING, W. H. and F. Brooks, London.
1559. WATERPROOF GARMENTS, J. Bates, London.
1560. LAWN TENNIS, &c., BATS, G. H. Kenning, London.
1561. CANDLES, &c., J. S. Macintyre, Ashfield.
1562. EXPANSION GEAR, H. Kühne.—(*R. Proell, Germany.*)
1563. PROTECTING PROPERTY from THIEVES, F. M. Gowan, London.
1564. PROTECTING PLACES and PROPERTY from THIEVES, &c., F. M. Gowan, London.
1565. FILTER, A. M. Clark.—(*D. Biggs, United States.*)
1566. OSCILLATING STEAM ENGINES, A. M. Clark.—(*C. P. Waldron, United States.*)
1567. BOTTLING BEER, &c., E. R. Southby and W. T. Ramsden, London.
1568. SADDLES for BICYCLES, &c., J. A. Lamplugh, London.
1569. GALVANIC BATTERIES, W. J. S. Barber-Starkey, London.

5th February, 1885.

1570. CLOCK-WATCH DIALS, F. L. Phillips, Birmingham.
1571. PUNCHING MACHINES, J. Walker and J. Austin, Leeds.
1572. BICYCLES, I. Briggs, F. Holloway, and H. D. Kendall, Birmingham.
1573. ALLOY for MERCURIAL GILDING, G. Lowe and H. Levetus, Birmingham.
1574. AXLE-BEARINGS of VELOCIPEDES, A. Burdess, London.
1575. LUBRICATING the BEARINGS of SPINDLES, &c., J. Marsh, Manchester.
1576. CUTTING ELLIPTICAL HOLES in METAL, R. K. Jones, Liverpool.
1577. ECONOMISING SPACE OCCUPIED by MORTICE DOOR LOCKS, &c., F. J. Commin, Exeter.
1578. PISTONS of MARINE COMPOUND STEAM ENGINES, J. Peacock and G. H. Harland, Hull.
1579. SAFETY RAILWAY CARRIAGE and TRUCK CONNECTOR, J. Aldous, H. J. Thomas, and E. Aldous, Colchester.
1580. PREVENTING WATER in RESERVOIRS and PIPES becoming STAGNANT, &c., A. B. Lorenz, Beverley.
1581. COMPOUND CARBON MOTOR, C. Kempster, jun., Great Ness.
1582. STEAM CYLINDERS, &c., W. J. Norris and T. Hosking, London.
1583. GENERATING, &c., ELECTRIC CURRENTS, W. P. Thompson.—(*A. G. Waterhouse, Canada.*)
1584. REFLECTORS for LAMPS, &c., A. R. Burman and A. S. Caine, Liverpool.
1585. RELEASING FISHING TACKLE from the BOUGHS of TREES, &c., C. Kempster, jun., Great Ness.
1586. PUMPS, F. Ball and W. Horton, Birmingham.
1587. CROCHET HOOK HANDLES, C. James, Redditch.
1588. BALL BEARINGS for BICYCLES, &c., W. and W. Stokes, Birmingham.
1589. DISTRIBUTING SAND and other MATERIAL, A. Roberts, London.
1590. NUT LOCKS, A. T. Allen and H. Cavill, London.
1591. WEAVING PILE DOUBLE, &c., J. Schofield and G. Jackson, London.
1592. ORANGE PEEL SLICING MACHINES, H. Faulder, London.
1593. STEERING GEAR, T. Archer, jun., London.
1594. CELLS or PREPARATIONS for the MICROSCOPE, M. H. Robson, London.
1595. MAKING MEATS of a COARSE NATURE, J. Milne, Glasgow.
1596. CHIMNEY-TOPS, R., G. S., W. H., and L. Wilson, Glasgow.
1597. CASH and PARCEL SYSTEMS for SHOP SERVICE, J. K. P. Nourse, C. Grant, jun., N. W. Stearns, and L. B. Holt, London.
1598. FIRE-LIGHTERS, P. M. Justice.—(*A. Riboulet, France.*)
1599. KNITTING MAHINES, T. Gadd and J. C. Moore, Leicester.—*27th January*, 1885.
1600. BICYCLE SAFETY CATCH, F. W. Marsh, London.
1601. WARM AIR STOVES, H. H. Bridgman and J. Russell, London.
1602. CONSTRUCTING FEED-WATER HEATERS, J. Russell, London.
1603. CONSTRUCTING HOT WATER AIR TAPS, J. Russell, London.
1604. RENDERING SUBSTANCES IMPERMEABLE to AIR, &c., T. J. Pearce and M. W. Beardsley, London.
1605. KNIFE CLEANING MACHINE, C. and C. W. Spong, London.
1606. PORTABLE CANDLE HOLDERS, J. H. Jenkinson, Manchester.
1607. TOBACCO PIPES, &c., C. Schramek and F. J. J. Bagley, London.
1608. RAILWAY PERMANENT WAY SAFETY KEYS, E. and C. G. Dumbrell, New Wimbledon.
1609. MEASURING INSTRUMENTS, A. J. Boult. —(*A. Schaere, France.*)
1610. MEDICINAL PREPARATION, A. J. Boult.—(*F. Vankeerberghen, Belgium.*)
1611. LIQUID for APPLICATION to the SCALP, A. J. Boult.—(*H. Rothe, France.*)
1612. PAPER or CARDBOARD BOXES, &c., A. J. Bird, London.
1613. VELOCIPEDES, T. H. Lambert, London.
1614. SEWING MACHINES, G. Sawyer.—(*The White Sewing Machine Company, United States.*)
1615. TREATING FISH for PRODUCING OIL, &c., P. Penn-Gaskell, London.
1616. TABLE DISH HEATER, P. Penn-Gaskell, London.
1617. ROLLER MOULDS for GRINDING, &c., PURPOSES, E. P. Alexander.—(*F. and A. G. Beyer, France.*)
1618. ADJUSTABLE WHEEL GEARING, P. Jensen.—(*F. Wegmann, Switzerland.*)
1619. SEWING MACHINES, P. Jensen.—(*G. W. von Nawrocki, Berlin.*)
1620. TELEPHONIC TRANSMITTING APPARATUS, J. L. Corbett, London.
1621. ELECTRIC ARC LAMPS, W. J. Mackenzie, London.
1622. MEASURING the VARIATIONS in the LEVEL of the SEA, &c., A. F. W. Paulsen, P. K. Prytz, and G. A. Kung, London.
1623. CHECKING TICKETS at THEATRES, &c., J. W. Longley, London.
1624. CLOCKS, WATCHES, and DIALS for same, W. C. Cooper, London.
1625. CUTTING PILE FABRICS, S. C. Lister and J. Reixach, Bradford.
1626. FLUSHING CISTERNS, R. B. Evered, London.
1627. RACK PULLEYS for WINDOW BLIND CORDS, R. B. Evered, London.
1628. WINNOWING MACHINES, G. F. Redfern.—(*Wirth and Co., Germany.*)

1629. EYELETTING MACHINES, A. Fougeadoire, London.
1630. COMBINED UMBRELLA and WALKING-STICK, A. Fougeadoire, London.
1631. CLIP for CLASSIFYING and BINDING LETTERS, A. Fougeadoire, London.
1632. TURNING OVER the LEAVES of MUSIC, A. Fougeadoire, London.
1633. GAS KILNS for BURNING GLASS, &c., G. W. Wilkinson, Birmingham.

6th February, 1885.

1634. SILOS, W. P. V. Collinson, Manchester.
1635. ROTARY SCREENS, W. W. Bullock, Ipswich.
1636. EVER-POINTED PENCIL CASES, J. Appleby, Birmingham.
1637. PLACING SLIDES in MAGIC LANTERNS, A. W. Smith, Rye.
1638. CATCHING FISH, F. Cordon and J. Scotland, Glasgow.
1639. INSULATING COVERED WIRE, J. Taylor and F. Whiteley, Liverpool.
1640. TANDEM BICYCLES and TRICYCLES, J. Hill, West Hartlepool.
1641. STEAM BOILERS, H. D. Child, Twickenham.
1642. RAILWAY CHAIRS, E. Hall, Grantham.
1643. COLOURING MATTERS, I. Levinstein, Manchester.
1644. KNURLING ATTACHMENTS to SCREW-CUTTING MACHINES, A. Anderson.—(*The Singer Manufacturing Company, United States.*)
1645. STEAM CRANES, G. Anderson, London.
1646. HEARING TRUMPETS, A. Young, London.
1647. BLOCK PRINTING, W. M. Melville, London.
1648. FASTENING IRON BANDS for BARREL-MAKING, &c., F. Andrew, Burnt Ash.
1649. EMBROIDERING TEXTILE FABRICS, &c., S. Wachter, London.
1650. MILLING, &c., ATTACHMENTS to LATHES, G. H. Villy, London.
1651. FIRE-GRATE, FUEL ECONOMISER, &c., J. Elam, Halifax.
1652. CRICKET BATS, &c., T. A. Ward and J. G. Heard, London.
1653. GLOVES for CRICKET and FIVES, J. G. Heard and T. A. Ward, London.
1654. MEDICINAL COMPOUND, J. Voller, Clapham Junction.
1655. TRICYCLES, &c., J. J. Brown, London.
1656. SELF-ACTING VENT PEG, G. F. Belling, Manor Park, Essex.
1657. BRUSHES, C. E. Gowan, London.
1658. THRASHING MACHINES, J. Marshall, London.
1659. TREATING SOLUTIONS of SULPHO-CYANIDES, C. W. Watts, Birmingham, and C. F. Claus, South Wimbledon.
1660. LUBRICATING STEAM ENGINES, &c., R. J. Bates and T. Leather, London.
1661. MOWING and REAPING MACHINES, P. Pierce, London.
1662. TAILOR-CUT PATTERN LINING for LADIES' DRESSES, J. Broadhead, London.
1663. CONVERTIBLE VELOCIPEDES, W. Smith and G. Hicking, London.
1664. CONVERTIBLE VELOCIPEDES, W. Smith and G. Hicking, London.
1665. CONSTRUCTING MOULDERS' CHAPLETS, G. Wilson, Glasgow.
1666. UNITING the ENDS of DRIVING BELTS, S. Rowbottom, London.
1667. GENERATING HEAT in STEAM BOILER FURNACES, T. C. Lewis.—(*F. Yates, Germany.*)
1668. HOOKS for CART HAMES, T. Marsh, London.
1669. METAL TUBES for BOILERS, &c., H. H. Lake.—(*J. P. Serve, France.*)
1670. PISTONS, PUMP BUCKETS, &c., W. Lockwood, London.—*19th December*, 1884.
1671. CUTTING HOLES, &c., in CLOTH, &c., A. Hentschel.—(*H. Rühl, Germany.*)
1672. AMMUNITION HOIST, A. Noble, London.
1673. FUSES for PROJECTILES, A. Noble, London.
1674. MOUNTING for a HOWITZER, A. Noble, London.
1675. LAMPS, W. Hardy, jun., London.
1676. GOVERNORS for CONTROLLING STEAM ENGINES, &c., P. W. Willans, London.
1677. STAND for EXPOSING GOODS for SALE, &c., J. H. Rosoman, London.
1678. HEATING BUILDINGS, A. Marriott, London.
1679. LASTS, C. E. Bird, London.
1680. BOOTS and SHOES, C. E. Bird, London.
1681. CLOCKS, G. F. Redfern.—(*A. Dardenne, Belgium.*)
1682. IMPARTING ROTARY MOTION to TOOLS, &c., T. Haxton, London.
1683. LATHING, A. M. Clark.—(*J. Morrison, jun., U.S.*)
1684. TOBACCO PIPE, &c., T. Haxton, London.
1685. SCHOOL BENCH, A. M. Clark.—(*L. G. Vogel, Germany.*)
1686. CONNECTING POSTAL and other CARDS, T. Haxton, London.
1687. ORNAMENTATION of TEXTILE FABRICS, &c., J. Whitley, Leeds.
1688. CLEANSING the BOTTOMS of IRON SHIPS, C. P. Ogilvie, London.
1689. MEASURING SEEDS, W. L. Corry, London.
1690. LIQUID METER, J. Bowie, W. Turner, and M. Hill, London.
1691. CLOCKS and TIMEPIECES, J. Kendal and M. Laval, London.
1692. METALLIC PACKINGS for PISTON RODS, &c., H. Parkin, London.
1693. SPIRIT or LIQUID LEVEL, G. P. Evelyn, London.

7th February, 1885.

1694. KNITTING MACHINES, J. J. Gilbert, London.
1695. DIRECTION LABEL and ENVELOPE, T. Parker, Leeds.
1696. SUNSHADES for PERAMBULATORS, E. R. Pearce, Birmingham.
1697. TWO-WHEELED ROAD VEHICLES, W. Kermeen, Liverpool.
1698. FENDERS, C. Meason, Birmingham.
1699. UMBRELLA STANDS, C. Meason, Birmingham.
1700. GAS MOTOR ENGINES, C. W. King, Southport.
1701. DYNAMO-ELECTRIC MACHINES, M. H. Smith, Halifax.
1702. LIDS of SANITARY TUBS, B. Shaw, Halifax.
1703. HEAT MOTOR ENGINES, J. Wright, London, and T. Charlton, Hammersmith.
1704. COMBINED COAT and VEST, M. Kersh, Manchester.
1705. TICKET HOLDERS, J. H. Bailey, Barnsley.
1706. CLOSING TUBS, W. F. Schumacher, Paris.
1707. PIANOFORTE MUSIC CABINET and TRIPLE DESK, J. Manger, London.
1708. BRAKES, W. Rixom, Barnes.
1709. MOISTENING POSTAGE STAMPS, A. B. Calder, Glasgow.
1710. COMB, W. Cooke.—(*G. Koblinsky, Germany.*)
1711. LAYING, &c., ELECTRIC TELEGRAPH WIRES, J. C. Sellars, London.—*29th October*, 1884.
1712. EAR-RINGS, G. Tabberner, London.
1713. TAKING-UP the SLACK in WIRES OPERATING RAILWAY SIGNALS, &c., J. Coleman and I. Henson, London.
1714. ELECTRICAL MEASURING INSTRUMENTS, J. R. Pratt, Upper Norwood.
1715. PACKING and PRESERVING FRESH MEAT, &c., J. Wallace, London.
1716. COATING and DRYING PLATES for USE in PHOTOGRAPHY, A. Coventry, Manchester.
1717. FILTERING MEDIUM for WATER, &c., J. Robey, Lewisham.
1718. KEY RINGS and BRACELETS, H. Trussell, London.
1719. LOCOMOTIVES, T. C. Craven, London.
1720. CONNECTING TAPES or BELTS, G. Williamson and I. Jackson, Glossop.
1721. TEACHING the RUDIMENTS of MUSIC, F. Ballin, Brentford.
1722. VALVE-GEAR for STEAM or other ENGINES, T. Swan, London.
1723. BICHROMATE of SODA, W. H. Higgin, Little Lever, near Bolton.
1724. ROOF LAMPS, J. Rea, Birmingham.
1725. DIGGING MACHINES, J. D. Morrison, jun., and A. Emley, London.
1726. FORME CYLINDERS and FORMES for WEB PRINTING, J., F., and J. Y. Foster, London.
1727. MAKING LACE, R. Toone and T. Cooper, London.
1728. TREATING LEATHER HIDES, H. McL. Caldwell, London.
1729. APPARATUS for SCREW PROPULSION, W. Steel, London.
1730. CONSTANT PRESERVATION of MUSTARD, C. Wells, London.
1731. TORPEDOES, C. Wells, London.
1732. INDICATOR for DETECTING PRESENCE of HEAT, C. Wells, London.
1733. APPARATUS for CLEANING SHIPS' BOTTOMS, C. Wells, London.
1734. COWL, E. B. Bushell, London.
1735. SYPHONS, E. Edwards.—(*M. Delavallade, France.*)
1736. BRAKE for PERAMBULATORS, H. Loog, London.
1737. MAKING METAL TUBES, &c., F. Elmore, London.
1738. CORSETS, W. Pretty, jun., London.
1739. HAND SWEEPING MACHINE, A. M. Clark.—(*J. Gombert and M. Kunze, France.*)
1740. BRAKES, F. Barnett, London.
1741. RAILWAYS, J. Howard and E. T. Bousfield, London.
1742. EXAMINATION of BORINGS in EARTH, H. H. Lake.—(*Wirth and Co., Germany.*)
1743. YARN or THREAD, S. Hollins, London.
1744. AUTOMATIC FLOATING VALVE, P. A. Maignen, London.
1745. ELEVATOR, C. E Hall, London.

9th February, 1885.

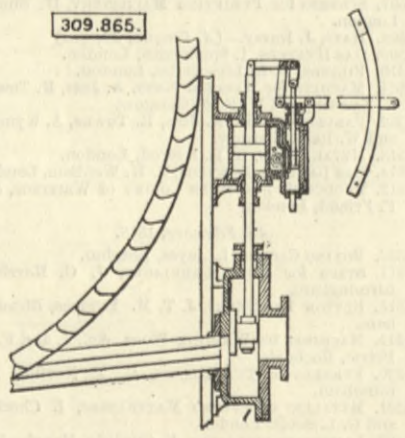
1746. GRIDS for FIXING in OUTLETS to ROOF GUTTERS, J. Blacka, Todmorden.
1747. SURFACES of GRINDSTONES, &c., T. H. Perrott, Cork.
1748. DISINFECTANT, A. J. Shilton, Birmingham.
1749. WATER or LIQUOR METERS, H. Stockman, Hampton.
1750. PRINTING, &c., TEXTILE FABRICS, J. Birtwistle and E. Ogden, Manchester.
1751. MUSICAL CABINETS, F. A. Abraham.—(*E. E. Dorman, United States.*)
1752. FOOT-STEPS of MULE TWINERS, &c., G. Pickford and E. Jagger, London.
1753. SHIFTING, &c., the DECKLE FRAMES of PAPER MAKING MACHINES, W. Archibald and J. Purdie, Glasgow.
1754. INDIA-RUBBER TIRES to CARRIAGE WHEELS, T. Coward, London.
1755. DAMPERS for PIANOFORTES, F. Hudson, London.
1756. COUPLING TWO or more BICYCLES, E. H. W. and L. W. Winnall, London.
1757. WATCH CASE, C. Dinichert, London.
1758. BOTTLE OPENER, E. Cornelis, London.
1759. STEAM LUBRICATORS, E. Tate, London.
1760. SHEARING PILE FABRICS, T. Salt, London.
1761. FILLING, &c., AERATED, &c., BOTTLES, H. M. Thomas, London.
1762. SELF-CLEANSING LOW-PRESSURE FILTERS, W. C. Dickenson and E. Harrison, London.
1763. RIVETTED JOINTS, J. A. Rowe, London.
1764. SECONDARY BATTERIES, J. S. Sellon, London.
1765. SAFETY STIRRUP, J. Scott, London.
1766. EVAPORATING SEA SALT, P. and J. T. Smith, Anerley.
1767. CELLULOSE, &c., from WOOD, A. Behr, London.
1768. FASTENER for WEARING APPAREL, H. O. Bayfield, London.
1769. FANCY BOXES for HANDKERCHIEFS, E. A. Gribbon and F. Rothwell, London.
1770. POCKET KNIVES and SCISSORS, F. Neuhaus, London.
1771. CAN-OPENER, H. J. Allison.—(*H. A. Herbert and L. Seldner, U.S.*)
1772. FOLDING CENTRE-BOARDS for VESSELS, A. W. L. Reddie.—(*W. Childs and W. J. Root, U.S.*)
1773. COPYING-PRESS, A. J. Hurtu, London.
1774. FURNITURE, T. Sennett, London.
1775. WEIGHING, &c., GRAIN, D. J. R. Duncan.—(*D. R. Cameron and J. Martin, India.*)
1776. CALCULATING MACHINES, J. McCarthy, London.
1777. DOOR LOCKS, G. H. Chubb and G. G. Exton, London.
1778. CEMENT, J. Thomlinson, London.
1779. FOOTSTEP BEARINGS, A. Sheldon, London.
1780. DYEING HAIR, J. Graham, London.
1781. CLEANING GRAIN, L. Gathmann, London.
1784. SENSITIVE PLATES, B. A. Slade, London.
1783. GUN CARRIAGES, C. D. Abel.—(*F. C. Glaser, Germany.*)
1784. SUBMARINE CABLE GRAPNELS, Sir J. Anderson and A. E. Kennelly, London.
1785. LIGHTING RAILWAY CARRIAGES by ELECTRICITY, A. M. Clark.—(*The Maschinenfabrik Esslingen and the Electrotechnische Fabrik, Cannstatt, Germany.*)
1786. APPLIANCE for PROLAPSUS UTERI, F. C. Child, Wellingborough.

SELECTED AMERICAN PATENTS.

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

309,865. HYDRAULIC GATE and VALVE, *Joseph Moore, San Francisco, Cal.—Filed February 18th*, 1884.

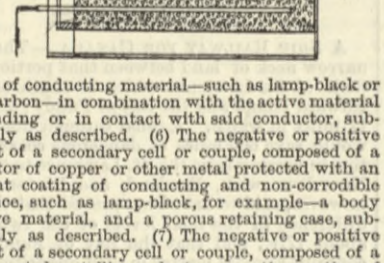
Claim.—The combination of a hydraulic motor having a hand operated differential valve gear, as herein



described, and a hydraulic valve or gate connected therewith, substantially as and for the purpose set forth.

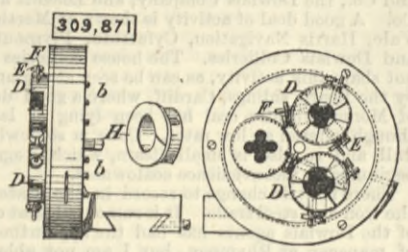
309,838. POLARISATION BATTERY or ELECTRIC ACCUMULATOR, *Camille A. Faure, Paris, France.—Filed August 10th*, 1882.

Claim.—(1) In a polarisation battery or electric accumulator, an electrode having a conducting support provided with receptacles therein, and active material in the form of leaf lead or foil packed in said receptacles, substantially as described. (2) An electrode comprising a conducting support combined with active material in the form of pieces of metal—leaf lead or foil, for example—applied to said conducting support and corroded on their surfaces prior to immersion in the battery liquid, substantially as described. (3) An electrode having metal foil, rolled, crumpled, or in other suitable form, applied to a conducting support, substantially as described. (4) An electrode comprising corroded metal foil, combined with a conducting plate or support, substantially as described. (5) An electrode comprising a conducting support provided with receptacles extending through the support, so as to open on both sides of said support, active material packed in said receptacles and applied on both faces of the support, and a porous or permeable retaining medium outside of said active material. (6) An electrode comprising a conducting support provided with receptacles extending through the support, active material in the form of leaf lead or metal foil corroded, crumpled, and packed in said receptacles, and applied also on the surface of the conducting support, and a porous retaining medium, substantially as described.



309,871. LATHE TOOL, *John M. Palmer, Chicago, Ill.—Filed March 6th*, 1884.

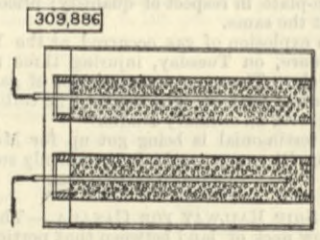
Claim.—In an attachment to an engine lathe, the combination of a slotted tubular cutter holder D,



slotted bushing H, cutters E E, adjusting screws F F, and binding screws *b b*, substantially as shown, and for the purpose specified.

309,886. SECONDARY BATTERY, *William A. Shaw, Pittsburg, Pa.—Filed June 25th*, 1883.

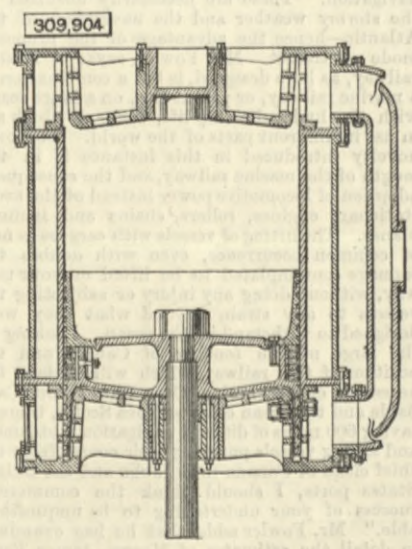
Claim.—(1) In a secondary cell or couple, and in combination with porous, granular, or pulverulent active material of an element thereof, a retaining case of perforate or porous fabric stretched on a frame of wood or similar material for holding the said active material, substantially as described. (2) The positive or negative element of a secondary couple or cell, composed of a retaining case of perforate or porous fabric stretched upon a frame of wood or similar material, active material in a porous, granular, or pulverulent condition within said case, and a conductor embodded in said active material, substantially as described. (3) In the element of a secondary couple or cell, an active portion of lead shot or other small particles of solid metal mixed with active material in a porous or pulverulent condition, substantially as described. (4) The positive or negative element of a secondary cell or couple, composed of an active portion of small metal particles surrounded by porous or pulverulent active material, a conductor, and a porous retaining case, substantially as described. (5) In the negative or positive element of a secondary cell or couple, a conductor of metal protected with an adherent protective



coating of conducting material—such as lamp-black or other carbon—in combination with the active material surrounding or in contact with said conductor, substantially as described. (6) The negative or positive element of a secondary cell or couple, composed of a conductor of copper or other metal protected with an adherent coating of conducting and non-corrodible substance, such as lamp-black, for example—a body of active material, and a porous retaining case, substantially as described. (7) The negative or positive element of a secondary cell or couple, composed of a carbon-coated metallic conductor, an active portion of metallic particles—such as shot or beads of lead—coated, incrusted, enveloped, or mixed with porous or pulverulent material—such as red lead or its specified substitute—and a retaining case of porous or perforate fabric stretched upon a frame of wood or like material, substantially as described.

309,904. BLOWING ENGINE, *Peter L. Weimer, Lebanon, Pa.—Filed November 16th*, 1883.

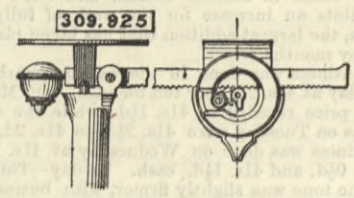
Claim.—(1) In a blowing engine, the combination, with a cylinder provided at its ends with annular heads for a surrounding water jacket, of cylinder heads, each provided with an annular air space, the inner wall of which is furnished with independent discharge valves, the central portion of the cylinder head extending inwardly and provided with independent air inlet valves, and a pipe connecting the annular air chambers at the opposite ends of the cylinder, substantially as set forth. (2) In a blowing engine, the combination, with a cylinder provided at



its ends with annular heads for a surrounding water jacket, of cylinder heads, each provided with two inwardly projecting flanges that fit on the annular heads of the cylinder and form an annular air chamber or space, the inner flange of the head being provided with independent valves, and the outer flange perforated and provided with a removable ring, substantially as set forth. (3) In a blowing engine, the combination, with a cylinder and a cylinder head provided with a converging annular space in line with the interior of the cylinder, independent inlet valves located in the inner wall of said space, and independent outlet valves located in the outer wall of said space, of a piston constructed with tapering extensions adapted to enter the converging annular spaces, substantially as set forth. (4) In a blowing engine, the combination, with a piston-rod and nut for retaining the piston in place, of a cylinder head constructed with a central opening, a box fitted within said opening and made flush with the interior surface of the head, said box constructed to receive the nut and to be rotated to turn the nut, substantially as set forth.

309,925. POISE FOR SCALE BEAMS, *Charles D. Carter, Detroit, Mich.—Filed February 13th*, 1884.

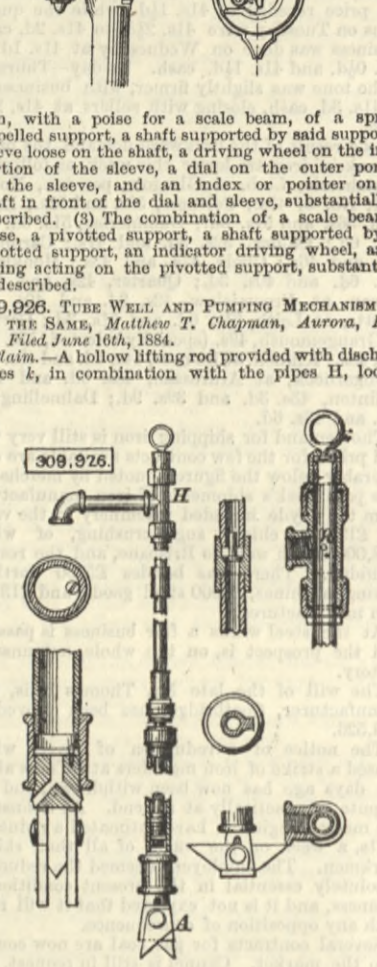
Claim.—(1) The combination, with a poise for a scale beam, of a pivotted swinging support, an axis carrying a driving wheel and supported by said swinging support, and a spring acting on the support to hold the driving wheel in yielding engagement with the beam, substantially as described. (2) The combina-



tion, with a poise for a scale beam, of a spring-impelled support, a shaft supported by said support, a sleeve loose on the shaft, a driving wheel on the inner portion of the sleeve, a dial on the outer portion of the sleeve, and an index or pointer on the shaft in front of the dial and sleeve, substantially as described. (3) The combination of a scale beam, a poise, a pivotted support, a shaft supported by the pivotted support, an indicator driving wheel, and a spring acting on the pivotted support, substantially as described.

309,926. TUBE WELL and PUMPING MECHANISM for the SAME, *Matthew T. Chapman, Aurora, Ill.—Filed June 16th*, 1884.

Claim.—A hollow lifting rod provided with discharge holes *k*, in combination with the pipes H, loosely



placed upon the lifting rod, and having its interior communicating with the holes *k*, for rotating the lifting rod without rotating the discharge tube, substantially as and for the purposes specified.

CONTENTS.

THE ENGINEER, February 13th, 1885. PAGE