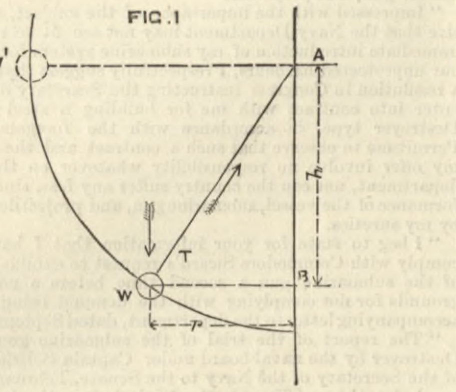
THE THEORY OF GOVERNORS.

By J. FOREST BRUNTON, A.M.I.C.E.

THE governor is one of the most important accessories of the steam engine, and by its invention and successful application Watt solved a most difficult problem, and at the same time rendered great service to the manufacturer and user of the steam engine. But, strange to say, important as the governor is in practice, and interesting as are its principles in theory, few, comparatively speaking, among the many who are brought into contact with it in their daily life understand these principles. The reason of this appears to me to lie in the fact that there are, as far as I know, no books which, having investigated the principles of the pendulum, follow them out in their practical application to the governor. And thus it is that many, seeing in text-books and elsewhere the theory of the pendulum expounded, lay down the book and betake themselves to their work, without the slightest idea how what they have just read can be turned to practical value, and be used to improve the governor they are designing in the drawing-office or erecting in the fitting shop.

My aim in this paper is to, first, inquire into the theory of the pendulum, and then to turn that theory to account by applying it to the governor, and analysing some of the types which are at present in use, and thus in a small degree making up the deficiency above pointed out. A revolving simple pendulum consists, in theory, of a small weight W, Fig. 1, suspended from a point A by a rod or

FIG. 1



cord $W A = l$, of insensible weight, and revolving in a circle about a vertical axis A B. Now, although to have a rod or cord of insensible weight is an impossibility, nevertheless, in practice, the ratio of the weight of the governor balls to the weight of the arms is so great that, without appreciable error, the weight of the arms may be neglected. In Fig. 1 the ball W is kept in equilibrium by three forces, viz., (1) The weight of the ball itself acting vertically through its centre of gravity; (2) the centrifugal tendency $= \frac{W V^2}{g r}$, where V denotes the velocity aud r the radius of revolution; (3) the tension upon the arm $A W = T$, which is the resultant of the two first-named forces.

Now, by the parallelogram of forces we can suppose the force W to be represented by $A B = h$, the force $\frac{W V^2}{g r}$ by $B W = r$, and the force $T = \frac{W}{\text{Cos. } \theta} = \frac{W V^2}{g r \sin. \theta}$, where θ denotes the $< W A B$. From this it follows that $\sin. \theta$ and $\cos. \theta$ never exceeding unity, T must, in all except two positions, exceed both W and $\frac{W V^2}{g r}$. The two exceptions are—first, when the weight W is upon the vertical axis A B, in which case $\cos. \theta = 1$ and $T = W$; secondly, when W occupies the position W_2 at right angles to the vertical axis A B, in which case $\sin. \theta = 1$ and $T = \frac{W V^2}{g r}$.

It also follows from what has gone before that the ratio

$$\frac{h}{r} = \frac{W}{\frac{W V^2}{g r}} = \frac{g r}{V^2} \quad . \; . \; . \; . \; . \; . \; . \; (1)$$

$$\text{Therefore } h = \frac{g r^2}{V^2} \quad . \; . \; . \; . \; . \; . \; . \; (2)$$

Now $V = 2 \pi r n$, where n denotes the number of revolutions per second.

$$\text{Therefore } h = \frac{g}{4 \pi^2 n^2} = \frac{\cdot 8154}{n^2} \text{ feet} \quad . \; . \; . \; . \; . \; (2_a)$$

$$= \frac{\cdot 8154 \times 12}{n^2} = \frac{9 \cdot 7848}{n^2} \text{ inches.}$$

$$\text{Also } \frac{1}{n} = \sqrt{\frac{h}{9 \cdot 7848}} \; \therefore \; n = \frac{3 \cdot 128}{\sqrt{h}} \quad . \; . \; . \; . \; (3)$$

From this we see that the number of revolutions vary inversely as the square root of the height of the pendulum, and when h = zero n is infinite, when h is infinite n = zero. We may also express h in terms of the angular velocity of the weight W. Let a denote the angular velocity; then $V = a r$; transpose in (2) then—

$$h = \frac{g r^2}{a^2 r^2} = \frac{g}{a^2} \quad . \; . \; . \; . \; . \; (4)$$

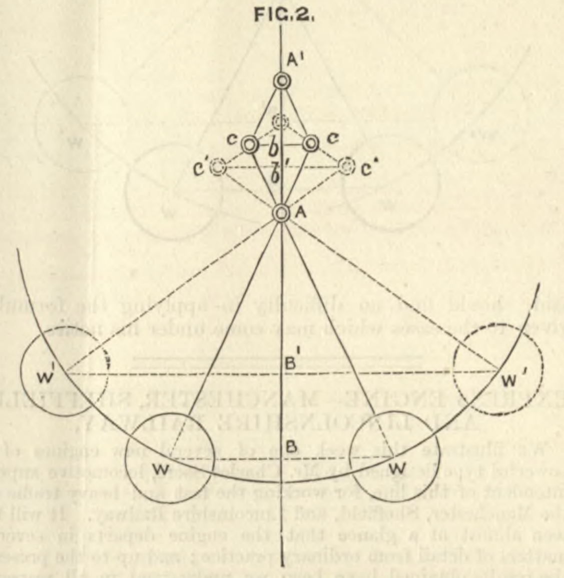
But $h = l \cos. \theta$ transpose in (4). Therefore $l \cos. \theta = \frac{g}{a^2} \therefore \cos. \theta = \frac{g}{l a^2}$. Thus, as a is increased $\cos. \theta$ is diminished, and consequently the angle is increased, which agrees with the equation $h = \frac{9 \cdot 7848}{n^2}$ for as h is diminished n is increased, and so also is the $< W A B = \theta$.

It may be well to state here that although a governor controls the action of a steam engine, and is invaluable for this purpose, it does not prevent variation in its speed, but only keeps these variations between certain limits; in fact, variation in the speed of the engine must precede any movement in the balls of the governor, for in each governor there is a certain radius of revolution constant for a given speed, and as long as the engine continues at a uniform velocity the balls remain at a radius proportionate to this velocity, and only when the alteration in the speed of the engine is imparted to the governor do the balls take up a new position, and by so doing either close or open the regulator.

In designing a governor, the object should be to keep the difference between the least and greatest speed of an engine as small as possible, so that, however the load may change, the velocity may remain nearly uniform.

I will now investigate an ordinary Watt governor, as shown in Fig. 2, and to ensure the results being of use to

FIG. 2.



all readers, I will assume dimensions for the different parts, and work them out in figures.

The length of $W A = l$ is assumed to be 22in; of A C, 6in.; diameter of balls, 7in.; and consequently = 47 lb.

The radius of revolution, r, when the balls are in their lowest position, is 6in.

$$\text{Therefore } A B = h = \sqrt{22^2 - 6^2} = 21 \cdot 166 \text{in.}$$

The number of revolutions corresponding to this height is, by equation (3)—

$$= \frac{3 \cdot 128}{\sqrt{21 \cdot 166}} \text{ per sec.,} = \cdot 680 \times 60 = 40 \cdot 8 \text{ per min.}$$

We will suppose the variation between the least and greatest speed is 5 per cent. Therefore the greatest speed $= \frac{105}{100} \times 40 \cdot 8 = 42 \cdot 84$; say, forty-three revolutions per minute.

The height corresponding to this number of revolutions per minute is, by $(2a)$—

$$h^1 = \frac{9 \cdot 7848 \times 60^2}{(n^1 \times 60)^2} = \frac{35{,}225}{43^2} = 19 \cdot 050 \text{in.}$$

Now $h - h^1 = 21 \cdot 166 - 19 \cdot 050 = 2 \cdot 116$in. If, as shown in Fig. 2, the points W A and C are in one straight line, so that the $< A^1 A C = < W A B$ the vertical motion of C varies as the ratio A C to A W, and it is easily seen that the vertical motion of A^1 is twice that of C, so that in the case under investigation the motion of C is $\frac{6}{22} \times 2 = \frac{6}{11}$in., and that of A^1 is $\frac{6}{11} \times 2 = 1\frac{1}{11}$in. This is evidently much too small for practical purposes, but the difficulty can be overcome by cranking the arm C A so that the $< A^1 A C$ may exceed the $< W A B$. Let ϕ denote any small increase in the angular position of C or W, and, as before, let θ denote the $< W A B = < A^1 A C$ if W A C are in one straight line. Then $b A = A C \cos. \theta$ and $b^1 A = A C \cos. (\theta + \phi)$, their difference being $b A - b^1 A = A C \left\{ \cos. \theta - \cos. (\theta + \phi) \right\}$. Now the difference between cosines of angles increases as the angle increases, therefore it is evident that if the $< A^1 A C$ be increased from θ to θ^1, $A C \left\{ \cos. \theta^1 - \cos. (\theta^1 + \phi) \right\}$

is greater than $A C \left\{ \cos. \theta - \cos. (\theta + \phi) \right\}$

and, therefore, by increasing the $< A^1 A C$ from θ to θ^1 we increase the difference between b A and b^1A by a quantity equal to

$$A C \left[\left\{ \cos. \theta^1 - \cos. (\theta^1 + \phi) \right\} + \left\{ \cos. (\theta + \phi) - \cos. \theta \right\} \right]$$

Also the radius r^1 for the new position W^1 of the balls is $\sqrt{(22)^2 - (19 \cdot 050)^2} = 10 \cdot 7$in. If it is found necessary to know the value of the force acting vertically downward through A^1, we proceed as follows:—The centrifugal tendency or force is $\frac{W V^2}{g r}$ acting horizontally at W. This may be resolved into two components, one acting vertically upwards at W, and the other acting in the straight line W A and in the opposite direction to the tension on the arm $= T = \frac{W}{\cos. \theta}$. When there is equilibrium these two forces are respectively equal and opposite to the two forces W and T. The former force is the only one we need consider at present. The centrifugal tendency $= \frac{W V^2}{g r} = Q$. The upward component of this force is $Q \cot. \theta = x$ suppose. Suppose the velocity of the balls is increased or diminished from V to $V \pm \lambda$. Then x is increased or diminished from

$$\left\{ \frac{W V^2}{g r} \text{ to } \frac{W (V \pm \lambda)^2}{g r} \right\} \cot. \theta.$$

And the available force over and above that sufficient to balance the weight of the ball W is—

$$\left\{ \frac{W V^2}{g r} - \frac{W (V \pm \lambda)^2}{g r} \right\} \cot. \theta = \pm \gamma.$$

Now, if λ be small λ^2 may be neglected, and γ becomes

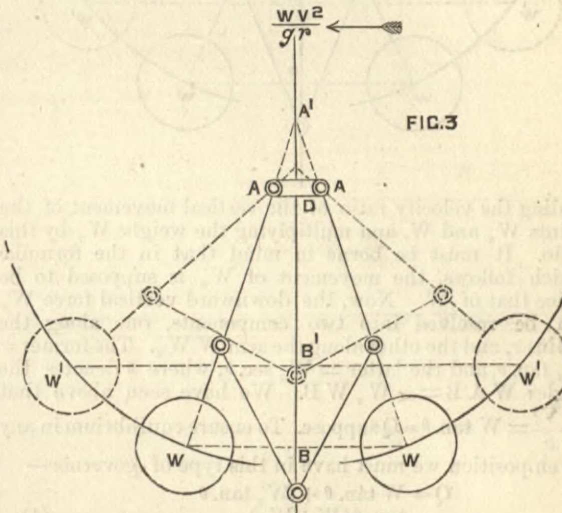
$$\pm \left\{ \frac{W V^2 \pm 2 W V \lambda}{g r} - \frac{W V^2}{g r} \right\} \cot. \theta =$$

$$\pm \frac{2 W V \lambda}{g r} \cot. \theta.$$

As the angle increases the cotangent decreases, from which it will be seen that the balls continue rising or falling until $\frac{W (V \pm \lambda)^2}{g r_2} \cot. \theta_2$ has again become equal to W, θ_2 being the new angle made by the arm with the vertical axis. The minus sign denotes a fall and the plus sign a rise in the position of the balls. The quantity γ is the force acting upward at W, and is, of course, not equal to the force acting at A_1, but is only a function of this force, and the latter may be either greater or less than the former, according to the design of the governor, though as usually designed it is greater. Having found the value of γ it is easy to find the force at A by the principles of the lever, and as it varies with every position of the balls it is not worth while going further into the subject in this paper.

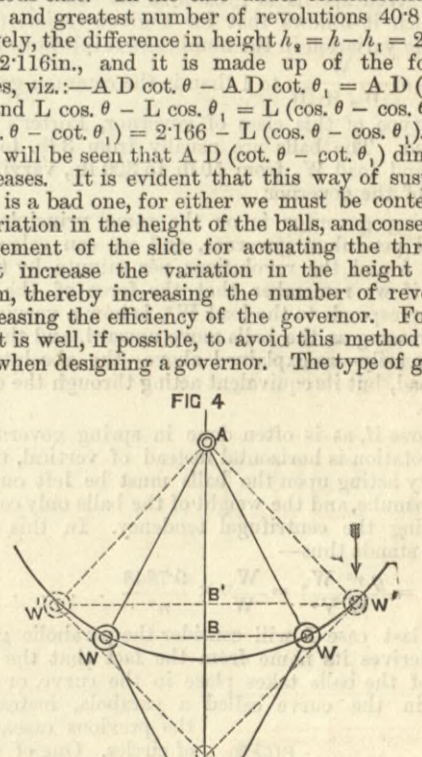
We will now see what difference it makes in the working of a governor by suspending the arms a small distance on either side of the vertical axis A B, as in Fig. 3.

FIG. 3



The height of the pendulum h is not in this case equal to A B, but to A^1 B, A^1 being the point where the straight line, passing through the centre of the ball and the point of suspension, cuts the vertical axis A^1 B. It will at once be seen that this is not a fixed point, but one that varies for each position of the balls. That we may the better compare the results, I will suppose the length of the arms, diameter of balls, number of revolutions, and consequently the height of the pendulum, to be the same as in the previous case. In the case under consideration, with the least and greatest number of revolutions 40·8 and 43 respectively, the difference in height $h_2 = h - h_1 = 21 \cdot 166 - 19 \cdot 05 = 2 \cdot 116$in., and it is made up of the following quantities, viz.:—$A D \cot. \theta - A D \cot. \theta_1 = A D (\cot. \theta - \cot. \theta_1)$ and $L \cos. \theta - L \cos. \theta_1 = L (\cos. \theta - \cos. \theta_1)$, also $A D (\cot. \theta - \cot. \theta_1) = 2 \cdot 166 - L (\cos. \theta - \cos. \theta_1)$. From which it will be seen that $A D (\cot. \theta - \cot. \theta_1)$ diminishes as θ increases. It is evident that this way of suspending the balls is a bad one, for either we must be content with a less variation in the height of the balls, and consequently less movement of the slide for actuating the throttle, or we must increase the variation in the height of the pendulum, thereby increasing the number of revolutions and decreasing the efficiency of the governor. For these reasons it is well, if possible, to avoid this method of suspension when designing a governor. The type of governor

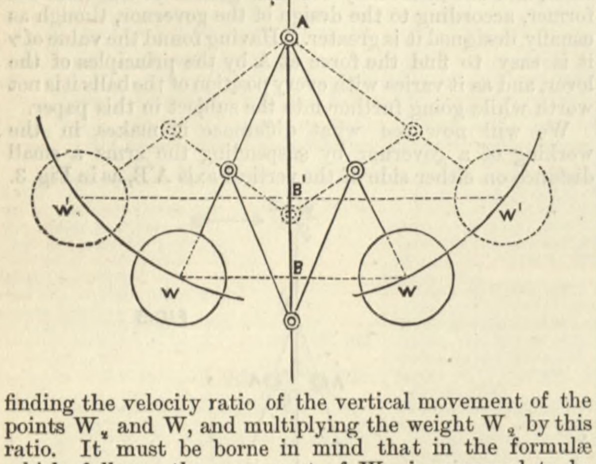
FIG. 4



shown in Fig. 4 is practically the same as in Fig. 1, the only difference being that the slide for actuating the throttle valve is below instead of being above the point of suspension, and therefore no further reference need be made to it.

I will now describe the weighted pendulum governor, a type which has met with considerable success, and which, no doubt, is a great improvement upon the old Watt governor. Upon a little consideration, it is evident that we cannot increase the sensitiveness of a governor by increasing the weight of the balls, as the centrifugal force is increased in the same proportion, and the height of the pendulum h, for a given number of revolutions, will remain the same whatever be the weight of the balls. To increase the height for any given number of revolutions we must apply a force, in the case under consideration in the form of a weight, acting vertically downward in such a manner that it does not add in any way to the centrifugal force exerted by the balls. This can only be done by suspending the body in such a way that its axis of rotation passes through its centre of gravity. This is shown in Fig. 5, where the spindle A B passes through the centre of gravity of the weight W_2, which in its turn is suspended by the links W W_2 to the balls W. If we suppose the links A W and W W_2 to be equal to each other, and to be connected with the weight W_2 in the manner shown in the diagram, the motion of W_2 will be twice that of W, and, consequently, equal to a load 2 W_2 acting on the balls direct, or to a load W_2 acting downward on each ball. If the weight is not hung as shown in Fig. 5, we can easily find what its equivalent at W would be by

FIG 5



finding the velocity ratio of the vertical movement of the points W_2 and W, and multiplying the weight W_2 by this ratio. It must be borne in mind that in the formulæ which follows, the movement of W_2 is supposed to be twice that of W. Now, the downward vertical force W_2 can be resolved into two components, one along the radius r, and the other along the arm W W_2. The former = W_2 tan. θ, and the latter = W_2 sec. θ, where θ denotes the angles W A B = < W_2 W B. We have seen above that $\frac{W V^2}{g r}$ = W tan. θ = Q suppose. To ensure equilibrium in any given position we must have in this type of governor—

$$Q = W \tan.\theta + W_2 \tan.\theta$$
$$= \tan.\theta (W + W_2) \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

We also have the ratio $\frac{h}{r} = \frac{g r (W + W_2)}{W V^2}$. Therefore,

$$h = \frac{g r^2 (W + W_2)}{W V^2} = \frac{9{\cdot}7848 \left(1 + \frac{W_2}{W}\right)}{n^2} \quad . \quad . \quad . \quad (2)$$

From this it follows that the height for a given speed is greater than in the ordinary governor, in the ratio of $\left(1 + \frac{W_2}{W}\right)$ to 1, and consequently the variation in height for two given speeds is greater in the same proportion; from which it follows that for a given variation in the height the variation in the number of revolutions is less in the ratio of $\frac{W}{W_2 + W}$ to 1 than in the common governor.

As a type of this class of governor, Porter's may be mentioned. The balls are usually from 3 lb. to 4 lb. in weight, and load W_2 from 50 lb. to 300 lb., varying with the size of the governor.

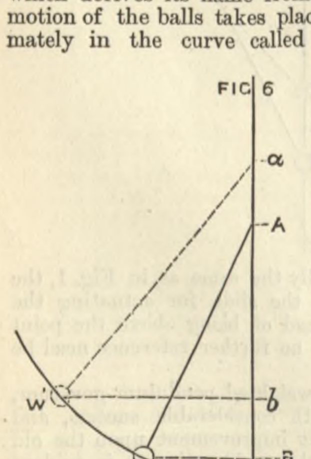
A spring governor is on the same principle as the weighted pendulum governor, and we can calculate the value of h and the revolutions per minute by the same formula if we remember that the force of the spring, which corresponds to the load W^2, is now a varying quantity, increasing as the balls move upward, and that W^2 is not necessarily—as explained above—the absolute weight of the load, but its equivalent acting through the centre of the balls.

Of course if, as is often done in spring governors, the axis of rotation is horizontal instead of vertical, the effect of gravity acting upon the balls must be left out of the above formulæ, and the weight of the balls only considered as effecting the centrifugal tendency. In this case the formulæ stands thus—

$$h = \frac{g r^2 W_2}{W V^2} = \frac{W_2}{W} \times \frac{9{\cdot}7848}{n^2} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

As a last case I will consider the parabolic governor, which derives its name from the fact that the vertical motion of the balls takes place in the curve, or approximately in the curve called a parabola, instead, as in the previous cases, in arcs of circles. One of the properties of a parabola is, that if we take any two points in the curve such as W W_1, Fig. 6, and from these draw W A, W_1 a perpendicular to the curve at these points, and cutting the axis in A a respectively, and if from the same points we draw perpendiculars to the axis, meeting it in B and b, then A B shall equal a b, and this is true for any point in the curve.

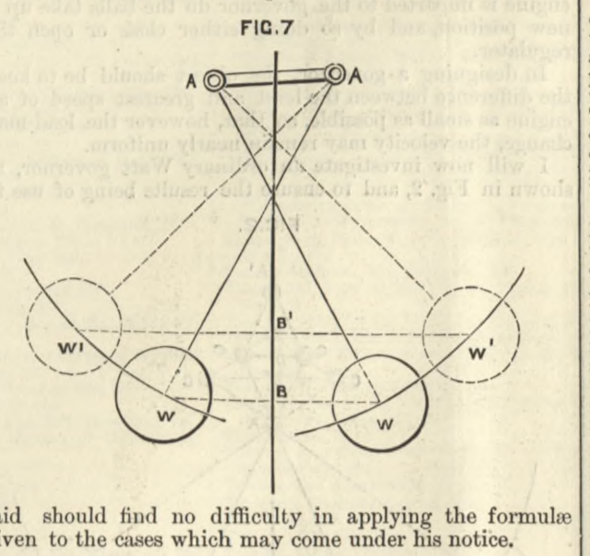
FIG 6



If now we can suspend the arms of the governor in such a position that the balls shall move in a parabola, it is evident, the height of the pendulum A B, a b, always being the same, the number of revolutions will remain constant for all positions of the balls, and any slight increase or decrease in the speed will send them from their lowest to their highest position, or *vice versâ*. This would of course be too sensitive for practical purposes, and to obviate this a spring is used to prevent the sudden rise or fall that would otherwise take place.

The above method of suspension necessitates that the arms should be crossed as in Fig. 7, and for this reason it is often called a "cross-armed governor." There are, of course, many centrifugal governors differing in detail from those here investigated, but I venture to think that anyone who will make himself acquainted with what has been

FIG. 7



said should find no difficulty in applying the formulæ given to the cases which may come under his notice.

EXPRESS ENGINE—MANCHESTER, SHEFFIELD, AND LINCOLNSHIRE RAILWAY.

WE illustrate this week one of several new engines of a powerful type designed by Mr. Charles Sacré, locomotive superintendent of this line, for working the fast and heavy traffic of the Manchester, Sheffield, and Lincolnshire Railway. It will be seen almost at a glance that the engine departs in several matters of detail from ordinary practice; and up to the present the results obtained have been, we understand, in all respects satisfactory. The arrangement of the wheel base is peculiar, the driving wheels being put further forward than usual. The dimensions of the engine are as follows:—

Boiler:			
Diameter outside			3ft. 11in.
Length of barrel			11ft. 6in.
Thickness of plates (Yorkshire iron)			½in.
Fire-box shell:			
Length			5ft. 6in.
Width between frames			4ft. 0½in.
Height (front)			6ft. 7⅝in.
Height (back)			7ft. 1⅝in.
Copper fire-box:			
Length inside			4ft. 10⅞in.
Width			3ft. 5½in.
Height (front)			4ft. 11¼in.
Height (back)			5ft. 5½in.
Tubes:			
Number			195
Diameter			1¾in.
Length over tube plates			12ft. 0in.
Water spaces			¾in.
Heating surface:			
Fire-box	87 sq. ft.		
Tubes	1057 sq. ft.		
	1144 sq. ft.	Total	1144 sq. ft.
Grate area			17 sq. ft.
Cylinders:			
Diameter			17½in.
Stroke			26in.
Ports			14½in. by 1⅝in.
Exhaust			14½in. by 3¼in.
Centres apart			6ft.
Inclination			1 in 12
Excentrics:			
Throw			3⅜in.
Diameter			1ft. 4in.
Rods:			
Connecting rod centres			5ft. 7⅜in.
Excentric ,,			5ft. 7⅜in.
Wheels:			
Leading diameter on tread of tire (steel)			3ft. 8in.
Trailing ,, ,, ,, ,,			3ft. 8in.
Driving ,, ,, ,, ,,			7ft. 6in.
Wheel base:			
Leading centres	7ft. 9in.		
Trailing ,,	8ft. 0in.		
	15ft. 9in.	Total	15ft. 9in.
Weights:	tons. cwt.		
Leading	11 3		
Driving	17 11		
Trailing	11 18		
	40 12	Total	40 tons 12 cwt.
Journals:			
Leading and trailing			Double-coned, 10in. long by 6¼in. and 5¼in. dia.
Driving			Straight, 8in. long, 9in. diameter.
Axles			Wrought iron.
Axle-boxes			Driving, brass; leading and trailing, cast iron; brass steps; all surfaces filled with Richards' patent metal.

TENDER.

Wheels:			
Diameter			3ft. 9in.
Centres (leading)	6ft. 3in.		
Centres (trailing)	6ft. 3in.		
	12ft. 6in.	Total	12ft. 6in.
Journals	Double-coned, 10in. long; diameter,		4½in. and 5¼in.
Capacity			3000 gallons.
Weight, empty			16 tons 13 cwt.

ERICSSON'S SUBMARINE GUN.

IN the U.S.A. Senate on Wednesday, December 10th, Mr. Blair submitted the following resolution:—"Resolved: That the Committee on Naval Affairs be instructed to investigate the system of naval defence for the seaports of the United States proposed by Captain John Ericsson, especially with a view to ascertaining the efficiency of his new submarine gun and projectile torpedo for that purpose; also to ascertain whether the same is about to be purchased for the exclusive use of any foreign Power, and whether or not the efficiency of the naval service and prudent provision for the national defence require the purchase and appropriation of this invention by the Government." Mr. Blair said furthermore: "I am informed and believe that the English Government is engaged in a negotiation for the appropriation of this invention. It is an American invention, made by the man who saved the commerce of the United States during the recent war, whose invention at that time effected a revolution in the system of naval warfare of the civilised world. I believe it probable that this new invention of his marks a like era; and it would be well for the Government of the United States to investigate this matter carefully, for it may be that other Powers will be very soon appropriating an invention which might be exclusively our own."

The following letter from the inventor was read:—

"New York, December 1st, 1884.

"Sir,—I am informed by my friend, Mr. G. H. Robinson, that you intend to introduce a resolution in Congress with reference to my new system of destroying hostile ironclad ships by means of submarine artillery, carried in small, cheaply-constructed vessels.

"The Secretary of War, in his report for 1883, said: 'Our seacoast, with its great cities and important harbours, is defenceless to-day against the attack of a modern ironclad, and it is humiliating even to imagine the mortification, loss of life, property, and prestige to which we would be subjected should war come suddenly upon us, as the history of nations shows may happen at any time.' That no means have yet been proposed by our Government capable of preventing the destruction of our great seaboard cities by an enemy's ironclad ships, will be seen by reference to the accompanying 'statement relating to the defence of the seaports of the United States.'

"Regarding the submarine gun, the principal feature of the Destroyer system, I have the honour briefly to call your attention to the fact that its explosive projectile, loaded with 300 lb. of gun-cotton, is capable of shattering the hull of any ironclad whatever, Admiral Porter, in a letter to the Secretary of the Navy, says with reference to the Destroyer system: 'My own opinion is that Mr. Ericsson has invented the most destructive principle known in naval warfare, and if there are objections to it, the objections are simply to mechanical details, which can be ascertained by careful trial. This Government is too poorly provided with means of defence against foreign aggression to allow it to treat lightly this invention of Mr. Ericsson'—see letter from the Secretary of the Navy to the Senate, February 20th, 1884. Since Admiral Porter's letter was written the Destroyer has been completed, as you will find by referring to the accompanying report: 'Trial of the Destroyer,' dated October 31st, 1883. No defects whatever having been discovered during this final trial of the system, I have offered to build a steel vessel of the Destroyer type, 132ft. long, 20ft. beam, 11½ft. deep, for the sum of 160,000 dols, including submarine gun, projectiles, and all appurtenances complete for actual service. I have also forwarded to the Navy Department complete working drawings and specification of the vessel, steam machinery, submarine gun, and projectile.

"Impressed with the importance of the subject, and apprehensive that the Navy Department may not see fit to recommend an immediate introduction of my submarine system for the defence of our unprotected harbours, I respectfully suggest that you introduce a resolution in Congress instructing the Secretary of the Navy to enter into contract with me for building a steel vessel of the Destroyer type, in accordance with the foregoing particulars. Permit me to observe that such a contract and the acceptance of my offer involve no responsibility whatever on the part of the department, nor can the country suffer any loss, since the due performance of the vessel, submarine gun, and projectile, is guaranteed by my sureties.

"I beg to state for your information that I have declined to comply with Commodore Sicard's request to exhibit the operation of the submarine gun a second time before a naval board, my grounds for not complying with the demand being stated in the accompanying letter to the department, dated September 29th, 1884.

"The report of the trial of the submarine gun on board the Destroyer by the naval board under Captain Selfridge—see letter of the Secretary of the Navy to the Senate, February 20th, 1884—concludes thus: 'Though the trials before the board have been very limited, sufficient has been shown to convince them that the Ericsson submarine torpedo is a projectile of the most formidable character within a limited range, and within that range whatever further experiments and improvements may prove such to be, it is superior to any known form of torpedo.' I respectfully submit that on the strength of this report and the facts contained in the accompanying printed document, apart from my offering sureties guaranteeing the successful performance of my invention—as was the case when I built the original Monitor, which was not fully paid for until after the action at Hampton Roads—Congress will do well to instruct the Navy Department to enter into a contract with me for the construction of a steel vessel of the Destroyer type armed with submarine artillery agreeably to the plans and specifications now in the possession of the Navy Department.

"I am, Sir, your obedient servant,

"J. ERICSSON."

"Hon. Henry W. Blair,

"United States Senator, Washington."

GLASGOW ENGINEERS' ASSOCIATION.

THE sixth meeting of this Association was held in their rooms, Bothwell-street, on the 11th ult., the president occupying the chair.

A paper was read by Mr. A. Hamilton Brown on cement testing, in which he brought before the Association the results of a number of his experiments, with reference more particularly to tensile strains, though at the same time touching upon tests by sifting, weight, compression, and torsion. The paper was well illustrated by means of drawings of the testing machines and briquettes used, and by tables giving the results of the different tests as well as the analyses of the cements. In speaking of testing by weight, reference was made by the author to the results of experiments by Mr. Grant, from which it was seen that although the heaviest cements are usually said to be the strongest, at the end of a year that weighing only 109 lb. to the bushel proved to be stronger than that weighing 112 lb.; but on the other hand, the cement weighing 123 lb. was greatly stronger than the former.

The briquettes used by Mr. Brown in his experiments were of the usual form, with a breaking section of one square inch. Before gauging the cement, the moulds were carefully greased, and laid on a piece of damp blotting-paper, which was placed on a block of gypsum, this expedient being adopted to hasten the setting of the cement.

According to the author's experiments, cement 7 days in water withstood a breaking strain of 396 lb.; 21 days, 420 lb.; 28 days, 465 lb.; 45 days, 520 lb.; 94 days, 590 lb.; 98 days,) 598 lb.; 117 days, 605 lb.; 138 days, 635 lb.

Neat cement eight weeks in water, weighing 112 lb. per bushel, bore on an average a tensile strain of 691 lb.

Briquettes of cement and sand in the following proportions (by weight), after being immersed 28 days in water, bore the following tensile strains—1 of cement to 1 of sand, 407 lb.; 1 of cement to 2 of sand, 281 lb.; 1 of cement to 3 of sand, 126 lb.

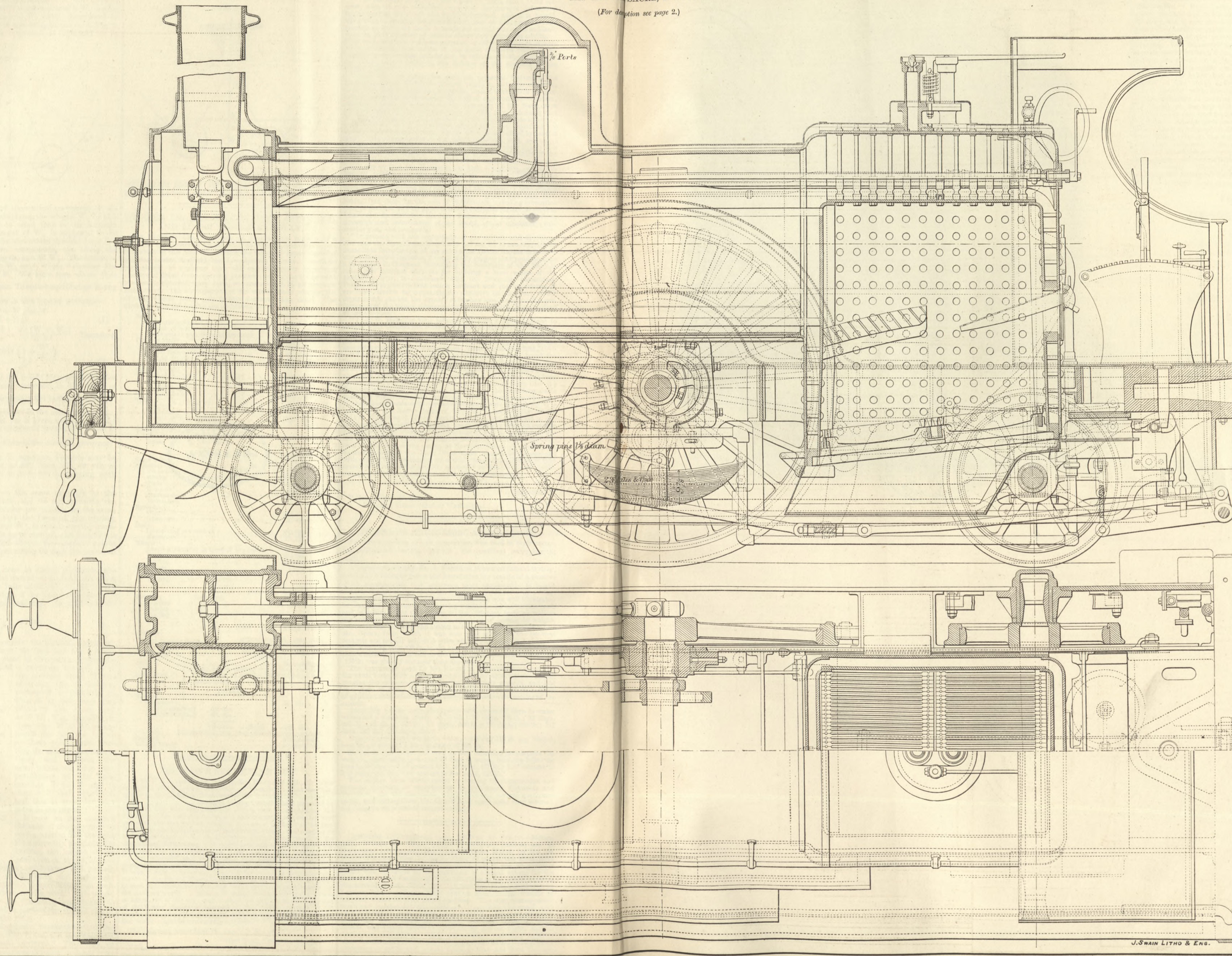
The author then briefly spoke of testing by compression and torsion, referring to experiments by Professors Reynolds and Thurston. In the discussion which followed several gentlemen spoke, and among these Mr. Alan Wilson made some very interesting remarks on practical cement testing.

CATCHING DYNAMITARDS AND THIEVES BY STEAM.—Messrs. Alex. Wilson and Co., Vauxhall Ironworks, London, are at the present moment completing a small steam launch for the use of the Thames Police to enable them to patrol the river more effectually than with the rowing boats now in use, an example which will no doubt be the precursor of several others for the same duty. The decision of the authorities to use steam launches was arrived at some little time ago, and the recent explosion at London Bridge will no doubt confirm them in the wisdom of adopting steam for river patrol purposes. The easy management, small and inexpensive consumption of fuel, and the speed such craft can attain, will greatly assist those in command to reconnoitre the river, guard the bridges, wharves, shipping, warehouses, and public buildings, whether by day or night, against dynamiters and thieves. They will increase waterside security, allay the anxieties of insurance companies, and afford more reliable protection to public and private property than has been the case previously.

OUTSIDE CYLINDER EXPRESS ENGINE—MANCHESTER, SHEFFIELD, AND LINCOLNSHIRE RAILWAY.

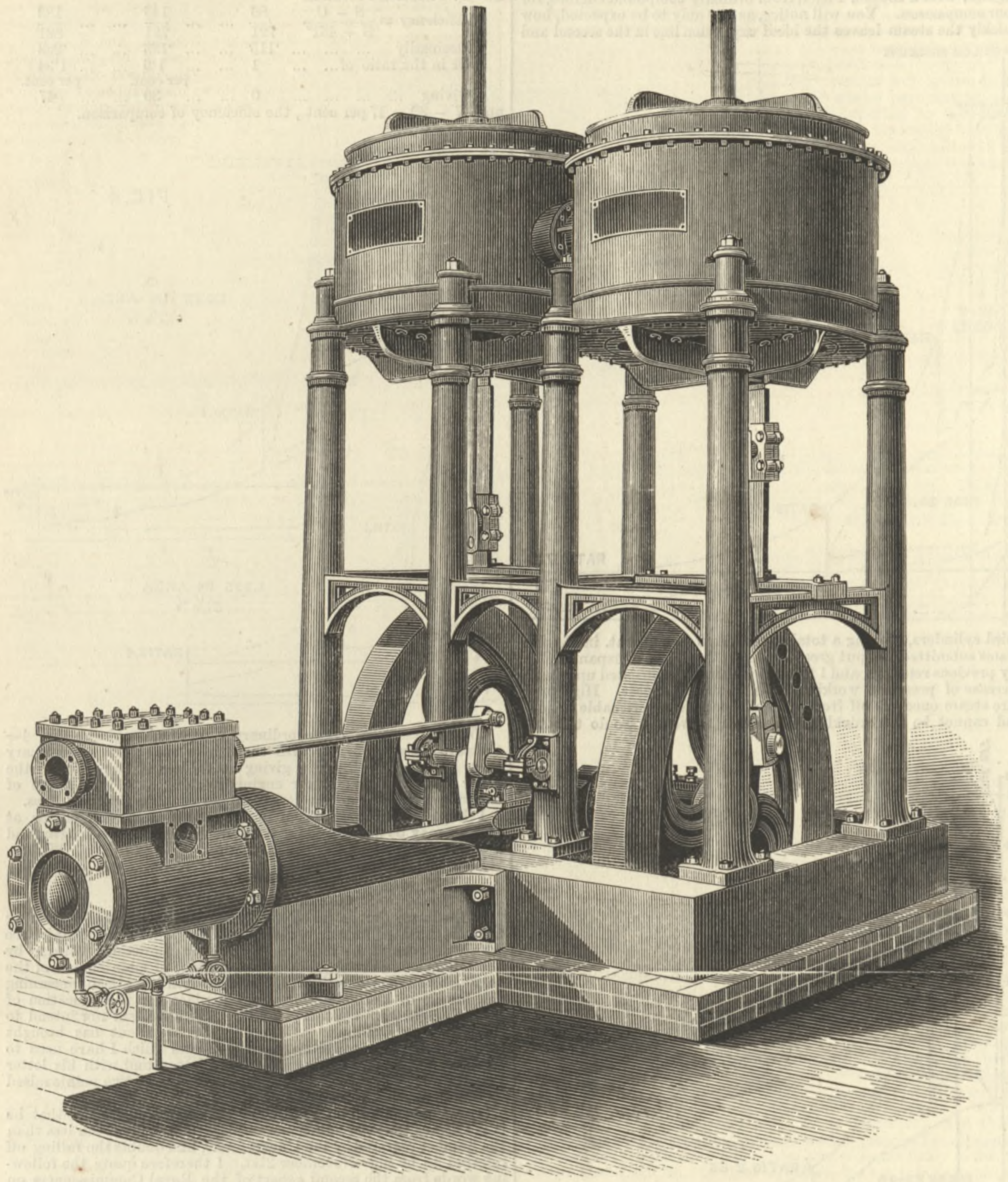
MR. CHARLES SACRÉ, ENGINEER.

(*For description see page 2.*)



J. SWAIN LITHO & ENG.

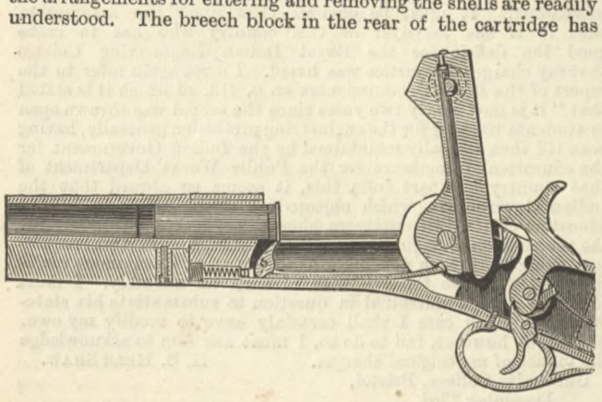
BLOWING ENGINES FOR CHARCOAL FURNACES.



THE engraving above represents the Weimer eight-column double-air cylinder blowing engine, with a crank shaft for a single steam cylinder. This style of engine is, according to the *American Manufacturer*, a great favourite with managers of charcoal furnaces, as well as with bloomary proprietors. These engines are fitted with patent all metal air valves. The engines are manufactured by Mr. P. L. Weimer, Lebanon, Pa.

BILLINGS' PATENT BREECH-LOADING SHOT GUN.

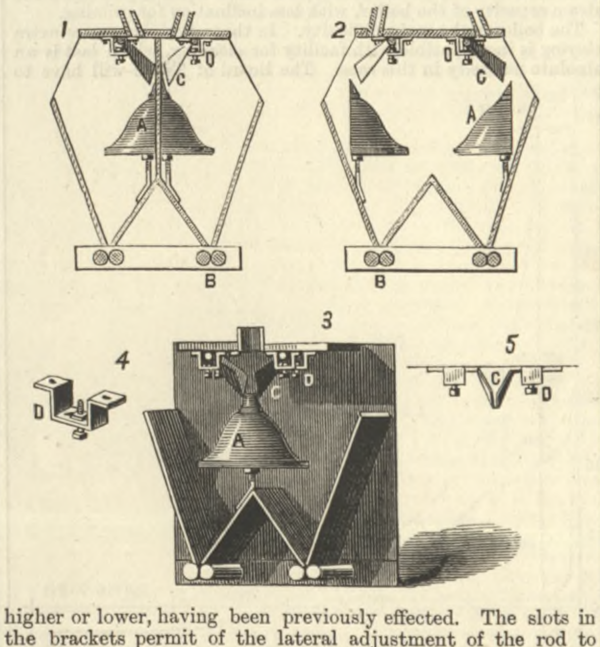
A NEW arrangement of a breech-loading, single-barrel shot gun is shown in the accompanying engraving, which possesses many desirable features not found in other arms of a corresponding price. The engraving shows a sectional view by which the arrangements for entering and removing the shells are readily understood. The breech block in the rear of the cartridge has



both a backward and upward movement. The cut shows it raised and the shell inserted in the barrel. After the shot has been made, by grasping the locking bolt at the farther end of the breech-block, and pulling it back, the block is unlocked and raised and the fire pin retracted, as shown in the engraving. The same motion, also automatically, loosens and starts the exploded shell out of the barrel, when it is quickly removed, and another put in its place. The letting down of the breech block forces the shell into position for the shot. This can all be done in an instant of time. These arms are finished in excellent style, and for strength, durability, lightness, and convenience, and ease in the arrangements of its working parts, it is claimed to be superior to any arm made. It is also provided with a close shooting detachable muzzle for contracting the shot, which can readily be removed when a scattering shot is desired.—*The Age of Steel.*

FEED MECHANISM FOR ROLLER MILLS.

THERE seems to be some difficulty in getting a uniform width of feed to roller mills. The accompanying engraving from the *Scientific American* illustrates a feeding device for roller mills, by Mr. Julius Busch, of Marine, Ill., which will deliver the material evenly to the rolls. The material is directed to the grinding rolls B by cant boards. Adjustably supported from the cant boards or the sides of the hopper by a threaded rod having an adjusting nut is a half-bell shaped distributor A, as shown in Figs. 1 and 2; or as shown in Fig. 3, two of these distributors may be combined. Fixed to a rod supported within slotted brackets D is an inclined spout C, the lower end of which is directly over, or nearly over, the apex of the distributor upon which the material is delivered. The rod is prevented from turning by the action of screws and nuts resting upon the bottom of the brackets, the inclination of the spout, to deliver the material



higher or lower, having been previously effected. The slots in the brackets permit of the lateral adjustment of the rod to admit of the lower end of the spout being located farther from or nearer to the distributor, according as the end of the spout is raised or lowered. A smaller distributor may be placed upon the apex of the large one when fine, soft material is being fed to the rolls; two of these may be united for use with the distributor A, Fig. 3. Material is fed to the hopper through delivery spouts. For coarse, sharp middlings the distributor A only will be needed. The middlings from the spout C, striking upon the curved face of the distributor, will be spread in a thin, even stream, which, falling upon the side of the hopper or the cant board, will be delivered in an even stream to the rolls. For fine, soft middlings the smaller distributor may be placed upon the apex of the other, and the spout so adjusted as to deliver near the upper apex

DR. OTTO GMELIN'S CUPOLA.

THE cupola shown in the annexed engraving was invented by Dr. Otto Gmelin, of Buda-Pesth, for smelting iron, copper, or other metals, and has during the last few years won ground in Austro-Hungary, and is now also being introduced in Germany. The illustration hardly requires any further explanation, considering the simplicity of the principle on which the furnace is constructed. Two concentric cylinders of boiler plates with two annular spaces between them, closed at the bottom, and open at the top, are placed on a foundation ring of brickwork. Cold water enters the annular space at the bottom, and the warmed water flows off below the upper edge of the cylinders. The interior of the inner boiler plate cylinder is made rough, and is covered with fire-clay. The circular space between the two cylinders is covered over by a cast iron plate which lies loosely on the top of the two cylinders. Two circular grooves in the cast iron top plate maintain the two cylinders at the correct distance from each other. The outlet of the metal and of the slag takes place through tubular boiler plate connections passing through the water space and attached to the inner and outer cylinders. The construction has lately been considerably simplified and strengthened by making the inner furnace cylinder of a welded tube, with tubes for air inlets welded on all in one piece. The novelty of the above construction consists chiefly in the cooling of the smelting furnace by water without using an air-tight water space. The inner cylinder can expand

FIG. 1.

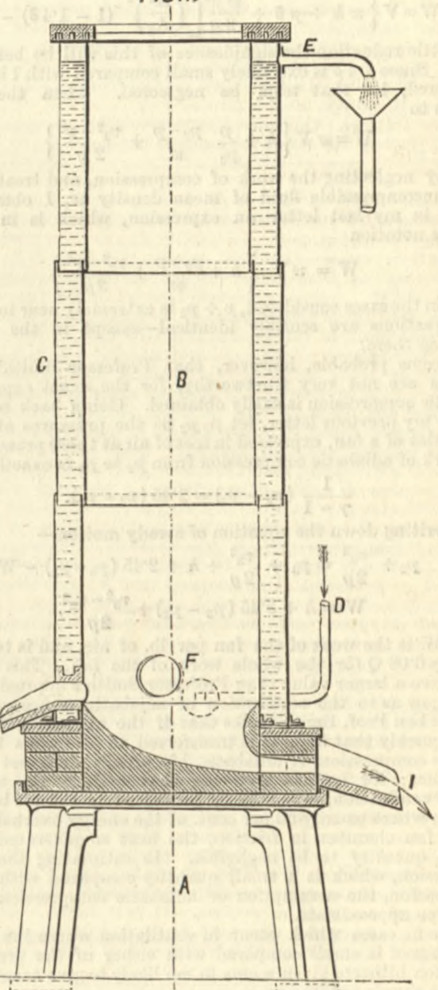
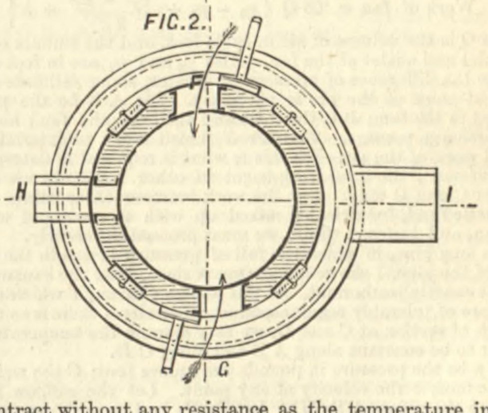


FIG. 2.



and contract without any resistance as the temperature in the furnace changes, and the consequence is that repairs are hardly ever required. The first furnace built upon this principle has now been at work daily for the last two and a-half years without ever having required any repairs to the boiler plates of the cylinders. The smelting operations can therefore also be kept up for any length of time without interruption. The energetic cooling of the inner smelting cylinder, which takes place with this system of furnace, is also stated to afford advantages as regards the saving of fuel—equal to 6 to 8 per cent.—and the decrease of burnt metal as well as the good and equal quality of the castings. The upper part of the furnace never gets hot, and the coke does not begin to burn until it arrives at the lower part of the furnace, where the smelting process takes place. The carbonic acid where formed escapes unchanged without being reduced to carbonic oxide as it passes through the upper charge of the furnace. The metal thrown in at the top of the furnace arrives completely unchanged into the smelting zone, where it is brought to the smelting point at once by a very strong blast. The furnace remains always round and smooth, which is also a very important feature with regard to economy of coke and good quality of the castings. It is likewise unaffected by chemical action, and the quality of the castings will therefore be considerably improved by the fact that this furnace admits of an addition of any quantity of basic substances without any risk of damage. This furnace offers special advantages in cases where scrap iron can be had cheaply, as on account of the small consumption of coal and silicium much more scrap iron than usual can be used along with the pig iron, without any fear of obtaining hard castings. The arrangement also offers advantages in cases where it is necessary to produce special qualities of castings—for example, hard castings—as the foreman can with much greater accuracy calculate the proportions of the materials to be put into the furnace to procure an even quality throughout, than he can with ordinary cupolas.

The firm of Ganz and Co., of Ofen, who have a very high reputation for their chilled rolls, is now altering all its furnaces to Dr. Gmelin's principle, and a number of other firms of high standing have also adopted Dr. Gmelin's furnace, namely, the machine factory of the Hungarian Government Railway, Buda-Pesth; the Ozterr Alpine Montangesellschaft, Vienna; the Austro-Hungarian Government Railway, Vienna; the Eisenhutte, Undine; Count Waldstein's Ironworks, Sedlec, Bohemia; and Howaldt Brothers, Kiel, Germany.—*Scientific American.*

LETTERS TO THE EDITOR.

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

THE EFFICIENCY OF FANS.

SIR,—In a letter in THE ENGINEER for December 19th Professor Smith tells Professor Herschel and myself that we are quite wrong, but that we may get right by going back to "plain and well-understood hydrodynamic and thermodynamic principles." It might perhaps have occurred to Professor Smith that in that well-gleaned field there was not much left to discover; but, at any rate, Professor Smith's new equation, whatever may be its value, involves no revolution.

By introducing two steps of approximation, Professor Smith obtains for the work of the fan the rather cumbrous expression—

$$W=V\left\{w\,h + p\,\delta + \frac{w\,v^2}{2\,g}\left[\left(\frac{A^1}{A_2}\right)^2 (1 - 1{\cdot}4\,\delta) - 1\right]\right.$$

By a little reduction the significance of this will be better understood. Since 1·4 δ is extremely small compared with 1 in the cases considered, let that term be neglected. Then the equation reduces to

$$W=w\,V\left\{h + \frac{p}{p_2}\;\frac{p_2-p}{w} + \frac{v_2^2-v^2}{2\,g}\right\}$$

Now, by neglecting the work of compression, and treating the air as an incompressible fluid of mean density w, I obtained very simply in my last letter an expression, which is in Professor Smith's notation

$$W = w\,V\left\{h + \frac{p_2-p}{w} + \frac{v_2^2-v^2}{2g}\right\}$$

Since, in the cases considered, $p \div p_2$ is extremely near to unity, the two equations are sensibly identical—except in the labour of obtaining them.

It seems probable, however, that Professor Smith's approximations are not very trustworthy, for the exact expression for adiabatic compression is easily obtained. Going back to the notation of my previous letter, let $p_2\,p_3$ be the pressures at the inlet and outlet of a fan, expressed in feet of air at those pressures; then the work of adiabatic compression from p_2 to p_3 is exactly—

$$\frac{1}{\gamma - 1}\,(p_3 - p_2) = 2{\cdot}45\,(p_3 - p_2).$$

Now, writing down the equation of steady motion—

$$p_2 + \frac{v_2^2}{2g} = p_3 + \frac{v_3^2}{2g} + h + 2{\cdot}45\,(p_3-p_2) - W,$$

$$W = h + 3{\cdot}45\,(p_3 - p_2) + \frac{v_3^2-v_2^2}{2g}.$$

where W is the work of the fan per lb. of air, and is to be multiplied by 0·08 Q for the whole work of the fan. This appears to me to give a larger value than Professor Smith's approximation.

But now as to the assumption of adiabatic compression in the fan. When Prof. Smith states that if the air passes through the fan so quickly that no heat is transferred to the walls by conduction the compression is adiabatic, his premis does not carry his conclusion; for he has forgotten that besides the transfer of heat by conduction, heat may be generated in the air by friction. In a fan where usually 50 per cent. of the energy exerted is wasted in the fan chamber in friction, the heat so generated is far too large a quantity to be negligible. In estimating the work of compression, which is a small quantity compared with others in the equation, the assumption of adiabatic compression does not seem even approximate.

Hence in cases which occur in ventilation where the difference of pressures is small compared with either of the pressures, no expression hitherto given seems to me likely to give exacter results than the simple expression—

$$\text{Work of fan} = {\cdot}08\,Q\left\{p_3 - p_2 + \frac{v_3^2 - v_2^2}{2\,g} + h\right\}$$

where Q is the volume of air in cubic feet, and the suffixes refer to the inlet and outlet of the fan. Also p_3 and p_2 are in feet of air. Where the difference of pressure is greater, some estimate of the internal work of the air is necessary. Let A B be the passage leading to the fan; B C the inlet and outlet of the fan; and C D the discharge passage. Then Prof. Smith seeks to determine the useful work of the fan—for this is what is required in determining its efficiency; the total work is got in other ways—by use of the data at C and D only. But the work between these points is, for an elastic fluid, inextricably mixed up with the waste of work in the fan, and hence, I think, we must proceed differently.

In a long pipe, in which the fall of pressure is due to the resistance of the pipe, I showed, some years since, that the expansion is almost exactly isothermal. If the passages through which the air flows are of tolerably regular section, especially if there is no abrupt change of section at C and D, we may assume the temperature of the air to be constant along A B and along C D.

Let p be the pressure in pounds per square foot; G the weight of a cubic foot; v the velocity at any point. Let the suffixes 1 2 3 4 apply to the points A B C D. Let F_a F_b be the work expended in friction per pound of air in A B and C D. Then for the length A B:

$$\frac{p_1}{G_1} = \frac{v_2^2}{2g} + \frac{p_2}{G_2} - \frac{p_1}{G_1}\log._\epsilon \frac{p_1}{p_2} + F_a$$

For the length C D—

$$\frac{p_3}{G_3} + \frac{v_3^2}{2g} = \frac{p_4}{G_4} + \frac{v_4^2}{2\,g} - \frac{p_3}{G_3}\log._\epsilon \frac{p_3}{p_4} + F_b$$

The whole useful work of the fan is the work in overcoming the friction in A B and C D, and in giving the energy of discharge. Consequently the work of the fan per pound of air is—

$$F^a + F_b + \frac{v_4^2}{2g} = \frac{v_3^2 - v_2^2}{2\,g} + \frac{p_1}{G_1}\log._\epsilon \frac{p_1}{p_2} + \frac{p_3}{G_3}\log._\epsilon \frac{p_3}{p_4}$$

If T_a T_b are the absolute temperatures of the air in A B and C D, this becomes—

Useful work per pound of air =

$$\frac{v_3^2 - v_2^2}{2g} + 53{\cdot}2\left(T_a \log._\epsilon \frac{p_1}{p_2} + T_b \log._\epsilon \frac{p_3}{p_4}\right)$$

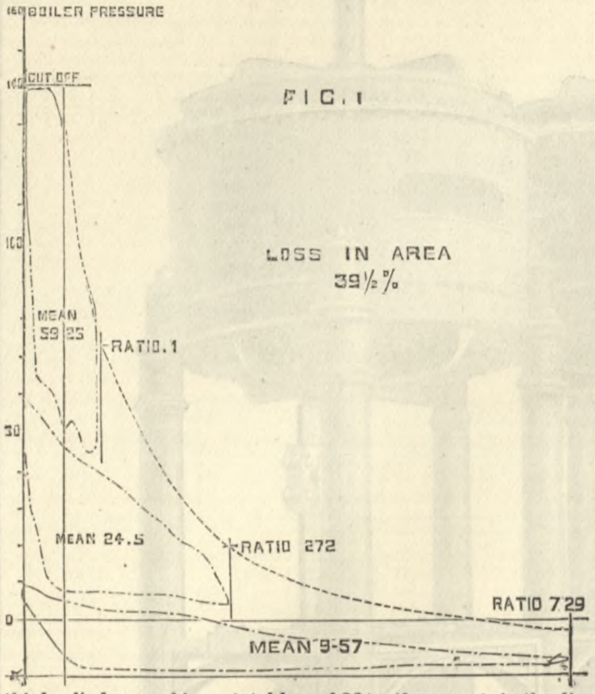
where the quantities are all such as can be observed. If the outlet is h feet above the inlet of the passages, h is to be added. For a fan taking air directly from, or discharging directly into the air, one of the terms in the bracket disappears. If the change of temperature in passing through the fan is small, as it usually will be, and if the air enters and leaves the ventilating system at atmospheric pressure, the formula becomes approximately—

$$\text{Work per lb.} = \frac{v_3^2 - v_2^2}{2\,g} + 53{\cdot}2\,T \log._\epsilon \frac{p_3}{p_2}.$$

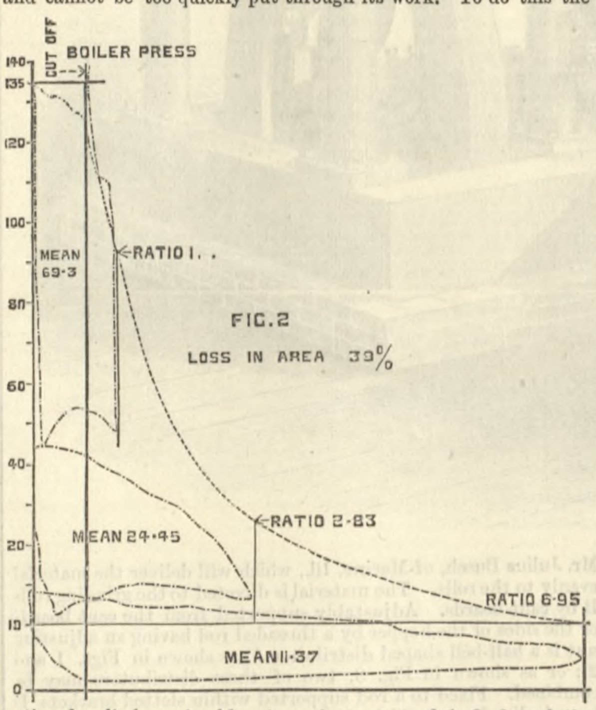
December 28th. W. C. UNWIN.

TRIPLE EXPANSION ENGINES.

SIR,—Not long ago you were good enough to insert a few remarks from me upon the superiority of the compound engine over the expansion in a single cylinder, and I concluded for similar reasons the triple expansion engine would in turn supersede the ordinary compound. Since then I have had many opportunities of seeing diagrams from engines of this class, and I take the liberty of enclosing a set of three, Figs. 1, 2, and 3, from different makers' engines, with a couple, Fig. 4, from ordinary compound engines, for your comparison. You will notice, as was only to be expected, how quickly the steam leaves the ideal expansion line in the second and

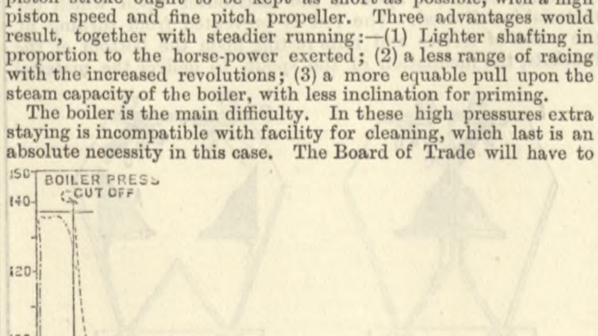


third cylinders, making a total loss of 36 to 40 per cent. in the diagrams submitted. I put great stress on "rapidity of expansion" in my previous remarks, and I think it is more to be insisted upon with increase of pressures working down to the condenser. High-pressure steam once cut off from the boiler is a very perishable article, and cannot be too quickly put through its work. To do this the



ratio of cylinders should not, perhaps, exceed 1, 3, 6, and the piston stroke ought to be kept as short as possible, with a high piston speed and fine pitch propeller. Three advantages would result, together with steadier running:—(1) Lighter shafting in proportion to the horse-power exerted; (2) a less range of racing with the increased revolutions; (3) a more equable pull upon the steam capacity of the boiler, with less inclination for priming.

The boiler is the main difficulty. In these high pressures extra staying is incompatible with facility for cleaning, which last is an absolute necessity in this case. The Board of Trade will have to



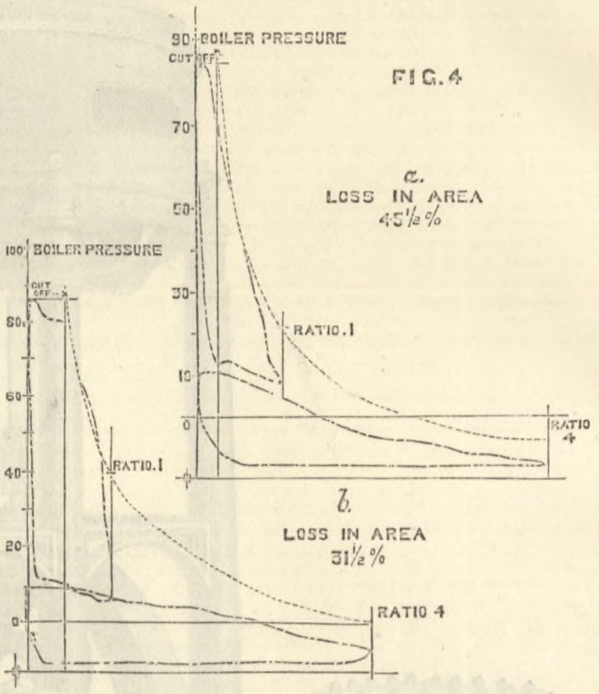
relax their hard-and-fast rules, or perhaps a new departure in special boilers may be taken, giving lightness and strength, easy accessibility and good circulation, saving in fuel and space occupied, all of which the present boiler is yet far short of.

We are told the saving in the triple over the ordinary compound comes to 28 per cent. This is hard of belief, especially looking at the diagrams enclosed. Theoretically it cannot be so much.

Theoretical efficiency of the three classes of engines, viz., old at 20 lb., compound at 75 lb., triple at 150 lb.

	lb.	lb.	lb.
Boiler pressures	20	75	150
Total pressures	35	90	165
Let condenser pressure be ...	7	7	7
	deg.	deg.	deg.
Temp. steam S	260	320	360
,, condenser C ...	177	177	177
Difference S – C ...	83	143	183
Sir W. Thomson's formula—			
Efficiency = $\frac{S - C}{S + 461^\circ}$	$\frac{83}{721}$	$\frac{143}{781}$	$\frac{183}{821}$
Decimally	·115	·183	·223
Or in the ratio of... ...	1	1·6	1·94
		per cent.	per cent.
Giving	0	30	47

and 47 – 30 = 17 per cent., the efficiency of comparison.



The diagrams from two ordinary compound engines—Fig. 4—compare very favourably with the others sent; one an ordinary cargo steamer in full steam, giving a total loss of 33 per cent.; the other from a much larger engine, working at a high grade of expansion, showing a total loss of 42 per cent. on the ideal lines.

I hope the interest taken in the triple expansion engine at present may be my excuse for troubling you at such a length, and I trust this may lead to some discussion. W. S.

Liverpool, December 29th.

COOPER'S HILL COLLEGE.

SIR,—In my first letter to you on the Royal Indian Engineering College, I stated that my object was to point out the injustice which appears to be inflicted upon other engineering colleges by the alteration in the regulations and scheme of maintenance of the establishment at Cooper's Hill. A discussion has arisen concerning the merits of the college itself as a place for the education of Indian engineers. On this point I neither have said nor intend to say anything whatever. Only one correspondent has brought forward any real answer to the arguments which I have used to establish the charges made in the above letter, and with his letter I shall directly deal. There are, however, one or two points raised by others which I must first notice.

(1) "Cooper's Hill on Furlough" says—December 5th—that he is not aware that the number of candidates has ever been less than the number required by the Government, and doubts the falling off referred to by me—November 21st. I therefore quote the following words from the second report of the Royal Commissioners on Technical Instruction, p. 414:—"Owing to the doubt which prevailed some years ago respecting the continuance of the school"—*i.e.*, Cooper's Hill College—"the numbers fell off considerably."

(2) It is due to Mr. Bower to say that the word "itself" in my letter, December 5th, should have been printed in italics, and then he would no doubt have understood my meaning, for I do not admit that at present Cooper's Hill does advertise *itself*. Again, with reference to the examinations, I carefully stated that no examination existed which was "entirely in the hands of the profession." This is the whole point of my argument, for of course Cooper's Hill College has a series of carefully marked examinations, and so has every other well-conducted college in the country; but this is a very different thing to that which I was referring to in my letter.

(3) I come now to what I believe to be the only serious answer to my arguments. I have all along plainly spoken of public money with the deliberate intention of conveying exactly the impression which your correspondent of last week characterises as misleading. It must be obvious that upon the assumption that it is the taxpayer of this country who has to make good the deficit for the Royal Indian Engineering College that my charge of injustice was based. I must again refer to the report of the Royal Commissioners on p. 413, of which it is stated that "it is now nearly two years since the school was thrown open to students training for the engineering profession generally, having been till then specially maintained by the Indian Government for the education of engineers for the Public Works' Department of that country." Apart from this, it seems so absurd that the Indian Government, which objected so strongly to pay for the education of its own engineers, should yet be content to pay for the preparation of engineers for other countries, that it will require something more than the mere assertion of an anonymous correspondent to prove the existence of such an anomaly. I must therefore ask the individual in question to substantiate his statements, in which case I shall certainly have to modify my own. Should he, however, fail to do so, I must ask him to acknowledge the justice of my original charges. H. S. HELE SHAW.

University College, Bristol,
December 23rd.

ELECTRIC CABLES.

SIR,—In his letter published in your number for the 19th inst., Mr. Johnstone avoids the point at issue, which is, whether pure sand—I have all along discredited the use of chemically-charged sand, as sand with lime would be—could in the presence of water act upon lead. Mr. Johnstone's statements clearly meant that galvanic action could take place between the lead and the metallic bases of the colouring impurities of the quartz by the dissolving action of water. This is the statement which I characterised as absurd, because, before such metallic bases could act on the lead, they would have to be dissociated from the quartz. This dissociation could be brought about by treatment with hydrofluoric acid, or by fusion in the blowpipe flame with sodic carbonate, but certainly not by the action of water, as Mr. Johnstone states. To my mind Mr. Johnstone clearly shows by this statement that he has no practical knowledge of the subject.

Mr. Johnstone in his letter takes certain words of mine, arranges them so as to convey a meaning which was never meant, calmly puts the statement so constructed within inverted commas, and fathers it upon me. This passes the bounds of fair and honest controversy. Nowhere have I said, "It is absurd to talk of the galvanic action set up by any natural process between the metallic bases of the quartz and the lead." Quartz has no such thing as a metallic base, though its colouring impurities have metallic bases. What I stated was that by no probable natural process could such metallic bases of the colouring impurities be separated from the quartz with which they are associated so as to act on the lead. This is a very different statement. I do not think that even Mr. Johnstone could characterise dissociation by means of hydrofluoric acid or by fusion as probable natural processes. My reason for asking Mr. Johnstone to explain the galvanic action which he stated took place, and to mention the electrolyte and give equations for the reaction, was simply because I had a shrewd suspicion that he did not understand what he was writing about. His letter confirms my suspicions.

As for his experiments on the explosion of gases, that matter is altogether irrelevant. I have no time to look into them. Are they like the experiments cited in his letter headed, "What is Electricity?" published in your issue of the 12th inst., and which "prove" that "electricity must be a kind of matter?" Mr. Johnstone is surprised that his experiments have not caused scientists to alter their views as to the nature of electricity. I am not.

If the sand to be obtained at Greenock was not sufficiently pure, and individual peculiarities of the case favoured the employment of peat, the engineers were right in using the latter. The decision could not have been left to abler hands. Peat, as I have all along said, is by no means a bad material, though I consider sand to be preferable in most cases because it does not retain water. Suggestions on the part of your readers of other materials which might be tried would be welcome, and some result of practical value might then arise from this correspondence. J. G. LORRAIN.
36 and 37, Brooke-street, Holborn, London, E.C.,
December 29th.

THE VICTORIA ELECTRIC LIGHTING INSTALLATION.

SIR,—With reference to your interesting account of the Victoria Electric Light Station, may we be allowed to point out that the small cut-outs and safety fuses by which the mains and branch wires are protected against excess of current and danger from fire were supplied by this company, and are on the principle invented by Mr. Killingworth Hedges? We feel sure that Messrs. Crompton and Co. will confirm our assertion, that a reliable safety fuse is one of the most important points in an electric light installation, and after careful experiments with the system introduced by Edison and others, we are convinced that Mr. Hedges' mica foils are the only kind which require no attention after being once properly fixed, and do not suffer any alteration in their melting point by the continual passage of the current.

P. WALTER D'ALTON, M.I.M.E., Manager,
For the Globe Electrical and Engineering Company.
20, Dartmouth-street, Westminster, S.W.,
December 29th.

WHAT IS ELECTRICITY?

SIR,—The letter of Mr. Davies in your previous number is all assumption and theory, without a single fact to support them, whereas my letters to you of May, 1882, and the 8th ult. were written for the purpose of drawing attention to electrical phenomena which demonstrate that electricity is a peculiar kind of matter. If Mr. Davies will repeat my experiments, and endeavour to prove that these electrical phenomena are not facts which demonstrate that electricity is a kind of matter, he would be doing some service to science. But until he or some one else has repeated my experiments, and has produced proof that the said electrical phenomena do not demonstrate that electricity is a kind of matter, I shall continue to maintain that the man who publicly asserts that electricity is merely energy and not a kind of matter, is propagating falsehood and not science.

8, Dalhousie-terrace, Edinburgh, JAMES JOHNSTONE.
December 22nd.

STEEL GUNS.

SIR,—Will you allow us to correct an important error you make in your article on "Whitworth Guns and the *Times*," as published in your issue of December 26th. You say: "If the gun of the present day differs from the original Armstrong in consisting wholly of steel, it differs from the original Whitworth gun in being built up. The metal doubtless we owe to our steel makers, the principle of construction is in a great measure that of Armstrong. So much so, that neither Krupp, nor Whitworth, would dare to employ one of their original *solid steel cast guns* for the work now demanded." The italics are ours.

We beg to inform you that we never have made a solid steel gun. Every naval gun we have made has been built up.

SIR JOSEPH WHITWORTH AND CO.
Ashton-road, Openshaw, Manchester,
December 31st.

THE ENGINEERING TRADES.

MESSRS. MATHESON AND GRANT, of Walbrook, in the half-yearly trades' report say:—

The year opens with dull and uncertain prospects for the staple trades of the country. During the past twelve months there has been a slow but continuous fall in values, and the depression in the iron trade which had become so serious in the autumn of 1883, and which has grown steadily worse ever since, is now more severely felt by the engineering trades than at the time of our last report. The leading firms in most branches have been fairly well employed up till now, the manufacturers who have suffered most being those who are dependent on the great industries of agriculture, sugar manufacture, iron-making and shipbuilding. The unprecedented cheapness of wheat and sugar which has pressed so severely upon the growers has, however, been of immense advantage to the working population, who have been able to tide over dull times with less loss and suffering than would under ordinary circumstances have occurred. Abroad the same dulness to trade exists without always the same ameliorations. In France, bounties and protective tariffs have so choked and burdened trade, and so effectually restricted export, that manufacturers and workmen are in a far worse condition than here; in the United States the falling off in trade is greater than in England, there is little export of manufactured goods, and the cheapness of food alone renders this depression endurable; in Germany reduced prices, unprofitable trade, and low wages also prevail, but the export of manufactured goods has been maintained, and in some directions increased.

Iron.—There has been a considerable reduction in the consumption of pig iron, both for home use and export, but owing to a better understanding among makers than on former similar occasions of depression, the output has been proportionately reduced, and prices have not fallen to the worst level of 1879. The rolled iron trade is in an unprofitable condition, especially in the shipbuilding districts. In the North of England the weekly output of plates, which had grown from 6000 tons in 1880 to 9000 tons in 1883, has fallen to 7000 tons. The effect of this diminution on prices has been partly neutralised by the steady demand for structural ironwork, and a partial compensation is found also in the increasing use of steel.

Steel.—The combination between the English and continental rail makers to restrain excessive competition in the face of a falling demand has been fairly maintained, and prices have remained steady at the rates which were established last spring, namely, from £5 per ton for heavy sections to £6 for light sections, these rates being for considerable contracts, and not including accessories. But while this combination enables some of the less modern works to make rails without loss, it reduces the weekly output of the newer factories which with free competition would monopolise the trade. The output capacity of this country is about one and a-half million tons per annum, a total which much exceeds the demand. In the United States the capacity is even greater, there is no export trade to assist it, and the present prices of 27 dols. per ton are unremunerative to most of the factories. In England the basic process is hardly adopted at all, the low price of English and Spanish hematites giving the ordinary Bessemer process an advantage. In Germany the economical conditions appear more favourable than those in the North of England to the basic method, and about 4000 tons of steel per week are so produced. The trade in foreign steel-making ore—one of the most notable results of the Bessemer invention—has enormously developed during the last five years, the greatest supply coming from the well known Bilbao Mines in Spain, where at present large stocks have accumulated. Spanish, Elban and African ores are exported to the United States in large quantities, but the raising of the import duty to a fixed rate of 3s. per ton; coupled with the depression of the American steel trade, have reduced the amount sent westwards, and during the last six months mines in Cuba have been opened, from which non-phosphoric ore yielding 65 per cent. of iron has been obtained. The native ores available to the American steel makers are at present obtained principally from Lake Superior and Missouri, and the cost of railway carriage allows the foreign ores to compete at the steel works in the Eastern States. The proposed reciprocity treaty with Cuba, which would greatly reduce the import duty, is, therefore, keenly opposed by the owners of the American mines.

Steel for structures continues to approximate in price to iron, and for large sections is as cheap. Steel sheets are increasing in use for tin-plates, and steel hoops are likely to altogether supersede iron hoops for baling purposes.

The following table summarises the fluctuations in value during the last five years:—

	Per Ton.						
	January, 1880.	January, 1881.	January, 1882.	January, 1883.	January, 1884.	July, 1884.	January, 1885.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Steam coal, f.o.b. at Cardiff	0 8 9	0 9 6	0 10 9	0 11 0	0 12 0	0 11 6	0 10 9
West Hartley coal, f.o.b. at Newcastle	0 8 6	0 8 6	0 9 0	0 9 0	0 9 6	0 9 6	0 9 0
Pig iron at Glasgow, No. 3	3 6 6	2 12 6	2 11 0	2 9 0	2 3 6	2 1 6	2 2 6
Pig iron at Middlesbrough, No. 3	2 12 0	2 0 0	2 3 0	2 2 6	1 16 6	1 17 0	1 15 6
Iron ship plates at Middlesbrough	8 5 0	6 15 0	7 2 6	6 10 0	5 12 6	5 0 0	4 17 6
Iron bridge plates in South Yorkshire	9 0 0	7 5 0	7 15 0	8 0 0	7 5 0	6 15 0	6 12 6
Steel ship and bridge plates	14 0 0	12 0 0	10 10 0	10 0 0	8 10 0	7 15 0	7 0 0
Iron rails, f.o.b...	7 0 0	5 15 0	5 10 0	5 0 0	5 0 0	—	—
Steel rails, f.o.b...	8 5 0	6 10 0	6 10 0	5 5 0	4 10 0	5 0 0	5 0 0

Scrap iron and steel remain at low prices of the summer—namely, about 45s. for heavy scrap iron, f.o.b.; old spring steel, about 49s.; old iron rails, about 53s.; old steel rails, about 54s. Italy has lately been the best foreign customer; the export to the United States has nearly ceased, most of the few shipments thither having been to San Francisco.

Iron and steel shipbuilding having advanced each year from 1880 by increasing steps, culminated in 1883 with an unprecedented activity on the Clyde, the Tyne and the Tees. The accumulated tonnage has since exceeded the wants of the carrying trade, and as diminished exports intensified this superfluity the building of new steamers was almost entirely stopped. The worst seems to be past; there are fewer steamers out of employment, the losses at sea demand renewals, and the reduction in cost is again tempting capitalists to build. There is also the prospect of new war vessels being ordered from private yards. The advantages and experience of English shipbuilders are unequalled, and even those foreign nations which in other branches shut out imports by protective tariffs, cannot afford to do so in so vital a matter, but prefer to serve their own interests by purchasing here. The attempt to improve the shipbuilding trade in France by bounties has signally failed. Several new yards have been established, but as those previously existing sufficed for the need of the country, the new factories have only intensified the home competition and entirely neutralised the profit for which the bounty was given, while the quality of English steamers and the speed with which they can be built still brings French purchasers to this country. Improvements continue to be made in the design and construction of steamers. The use of steel boilers of improved form allows higher pressure of steam, and the compound principle is likely to be further developed with a corresponding economy in fuel.

Bridges, roofs, and structural ironwork have not been so cheap for many years as they are at present; from £12 to £15 per ton embracing most of the prices for structures of ordinary kind, anything dearer than these rates being for complicated or light structures. This cheapness is caused partly by the low cost of material, partly also by the economies in manufacture which modern machinery allows, and also by the pressure of competition. At home there is a constant and considerable flow of work from the railway companies for widenings and station extensions, the demands for these purposes going far to compensate for the absence of new railways. There is no branch of the engineering trade more dependent than this on export orders. India and Australia are the principal purchasers at present, and the demands from these countries are likely to increase rather than diminish. Several new factories are being established.

Mechanical engineers have, with few exceptions, been fairly well employed during the year, but during the last few months there has been a considerable falling off, and the immediate prospects are not favourable. Any general improvement in trade would, however, benefit manufacturing engineers immediately, as there is hardly any kind of new enterprise which does not need their services. As all branches of the sugar trade continue dull, those engineers who work for them share the depression. There is a growing demand for refrigerating and ventilating apparatus of all kinds. The exhibition just opened at New Orleans will bring together an unprecedented collection of machinery for the treatment and manufacture of cotton.

Ironfounders throughout the country are ill-employed, the competition is keener than ever, and prices are very low.

Locomotive builders continue busy, but the keen competition and low prices at which new contracts are taken indicate a want of faith in the prospects of the coming year. Very considerable orders have been given out and more are expected from India, Australia, and South America, but another large factory has been established in Scotland, railway workshops are increasing, and any reduction of the demand would produce the same depression which marked this branch of trade in 1877-9.

Agricultural engineers feel severely the continued depression of the farming interest, and, notwithstanding the abundant harvests, the low price of wheat affords no margin for outlay in the purchase of new machinery and implements. Not only at home but in the colonies and foreign countries which look to England for their machinery, a forced retrenchment has reduced greatly the usual demands. Those manufacturing firms suffer least who are not dependent entirely on agriculturists, but who make steam engines and machinery for contractors and other purposes. At the Smithfield Club Annual Cattle Show, just held in London, there was the usual display of machinery, but except trifling alterations in detail there are no novelties or improvements to record.

Railways and other public works on which the manufacturing trades so much depend are not at present very active in this country. No new railways of magnitude are projected, and there is a truce between the great companies whose rivalries have in the past given so much employment to engineers. The number of private bills deposited for the coming Session of Parliament is much less than that of last year, and the prospects of those who assist in the preliminary work of new lines are correspondingly dull. Most of the companies seek powers for extensions and widenings, and these with similar undertakings already sanctioned will afford much work for contractors. In London the old scheme of an underground line from Euston to Charing-cross is likely to be authorised, and further development of the Metropolitan system will probably be carried out during the next few years. The completion of the Inner Circle Railway and its connection by Whitechapel and the East London Railway through the Thames Tunnel opens out an important link with the Southern lines. The large new Barry Dock Works at Cardiff are going on; the improvements of the river Ribble at Preston are also commenced; the Tilbury Docks approach completion, and the promoters of the Manchester Ship Canal are determined to again seek powers for their great project.

Hydraulic transmission and distribution of power which has hitherto found its chief development at docks, railway stations, and steel works, has been extended in a notable manner during the past year. From one central pumping station in London, many miles of hydraulic main pipes have been laid under the paving of the principal streets of the City and Westminster. By means of the pumping engines and accumulators at the central station, a pressure equal to about 700 lb. to the inch is maintained in the pipes, this great force allowing cranes, elevators, and other machinery to be worked in warehouses, and factories with mechanism occupying little space, without the risk and trouble which steam or other motors involve. The high-pressure water can also be applied instantaneously in combination with the ordinary municipal supply to eject water for fire extinction with a force greater than that of a steam fire-engine. Compressed air, which is so useful in mines and for special purposes, is not adapted for cheap and general distribution, and schemes at present projected for so using it will probably fail.

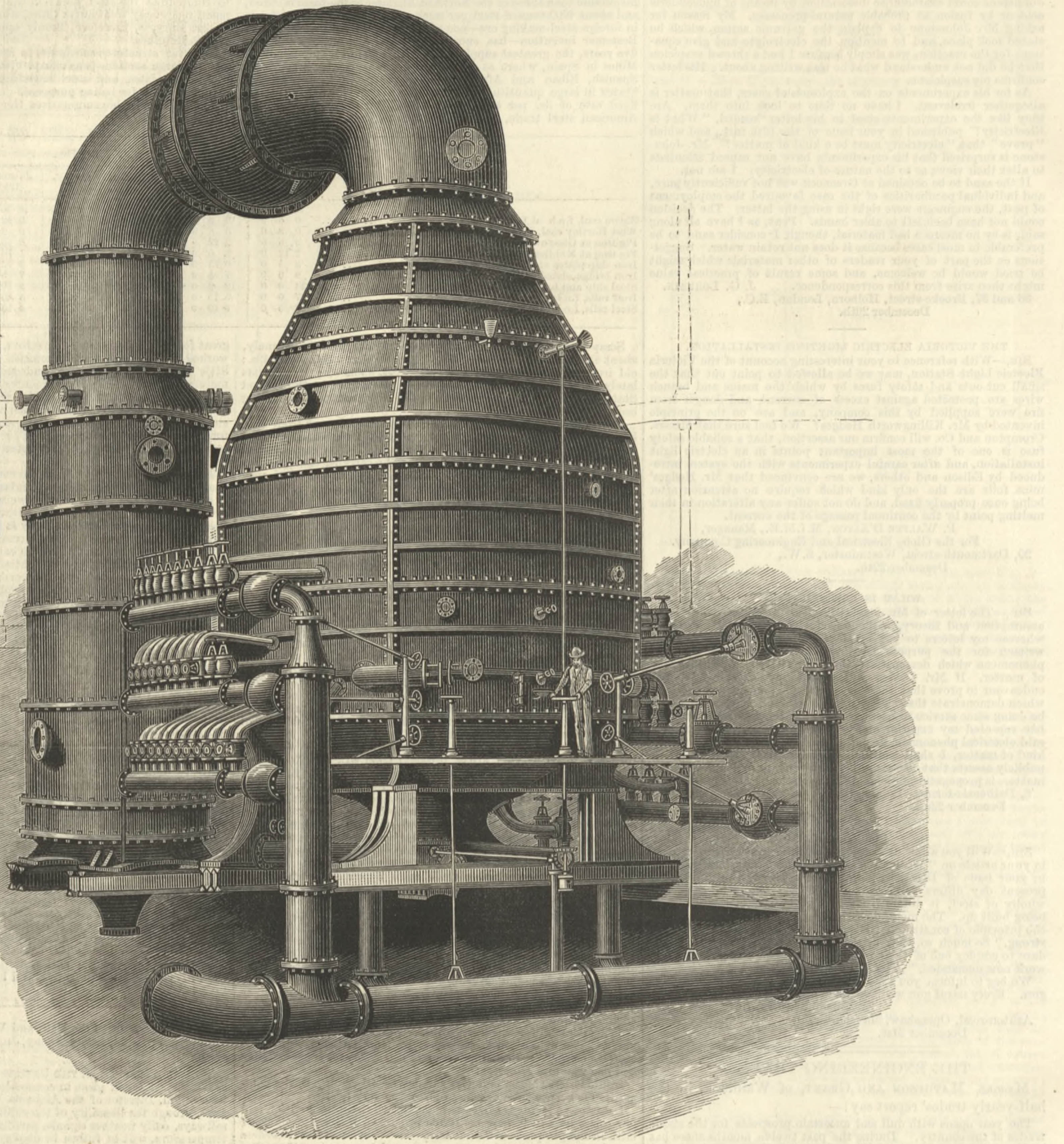
Though much of the trade of the country at present shows little profit, it is in other respects in a sound condition; there is an absence of speculation, and manufacturers were never better equipped than now for a revival when it comes. But with every revival in trade, the producing power of the country is increased, and greater therefore is the void when the next depression comes. While England is rapidly losing the custom of those countries which have manufacturing facilities of their own it is satisfactory to know that only in a few countries like Belgium and Germany is the loss due to direct competition, and that where the prohibition is due to protective tariffs, the latter entirely prevent competition with us in the non-manufacturing countries open to all. In these the field is vast enough for many years to come. Spain is about to grant us the most favoured nation tariff. In India the construction of stategical railways in the north-west, which has been going on for the last ten years, will be followed by extensions in other directions, and the aggregate mileage of the empire will for mere renewals afford much employment to makers of railway material here. In the Australian colonies large sums have been voted for public works, and the attempt to manufacture material instead of importing it rests at present on too unsubstantial a basis to cause much apprehension here. In Canada the approaching completion of the trans-continental line will develope subsidiary railways and other works on the Pacific Coast; in South Africa, when the present war troubles are settled, there are certain to be important extensions westward and northward, with outlet to the east coast at Delagoa Bay. In the Argentine Republic the success of the railways is inducing the investment of much additional capital, and the completion of the Trans-Andean line to Chili is likely to be accomplished. Brazil has need for railways beyond her present means, but the delay is only temporary; in Mexico the northern lines recently constructed have exhausted all the available credit, but progress will soon recommence, and as the attempts of the United States to obtain a preferential custom's tariff against this country have not succeeded, most of the railway material is likely to be made here. The Panama Canal, when finished, will revolutionise Central America in the interests of civilised progress. In China there are significant signs that the country is about to be opened to European improvements, and that the telegraphs already successfully established will be followed by railways ere long.

THE next meeting of the Bath and West of England Society will be held at Brighton, from Monday, June 8th, to Friday, June 12th, 1885.

WEATHER SIGNALS IN THE UNITED STATES.—A valuable extension has just taken place in connection with these signals. Professor Mell, Director of the Alabama Weather Service, announces that through the liberality of the chief signal officer and of several railways, daily weather signals, predicting changes of weather and temperature, will in future be displayed at upwards of 100 telegraph stations in that State. The predictions will be received by the director at an early hour every morning from the Signal Office in Washington, and then promptly distributed along the railways. On paying for the cost of the signal flags, about 6 dols., any town or telegraph station will receive free telegraphs warning of the daily weather changes. Only about five minutes are required to set the flags. A similar system has been for some time in operation in Ohio and in a portion of Pennsylvania, and will doubtless now have still further extension.

ACETATE OF SODA HEATERS.—For the last two years experiments have been making toward the warming of cars by means of a heat giving material, which continues for several hours to throw out heat with approximate regularity, for a time depending upon the original degree of heat imparted to the liquid. The cars of the De Kalb Avenue line, Brooklyn, seventy in number, have been heated by this system during the last winter to the satisfaction of the company, and presumably to that of the public. A large iron pipe containing the compound passes under each seat of the car; through the centre of the pipe runs a smaller pipe, through which steam is passed when it is desired to heat the compound. When heat is applied to the pipes from a steam boiler in the station, the crystals in the acetate of soda used are liquefied, and remain so until the temperature begins to fall perceptibly. Then the crystals begin to form, and the liquid throws out an increased heat. A thermometer taking the temperature of a pipe of the heated compound shows that during the first hour or two there is a slight fall in the temperature, then a sharp rise while crystallisation takes place, and then a gradual fall. A record of the temperature of one car kept during twenty days showed that after each run of sixteen miles, the temperature of the car was upon an average less than one degree lower when the car returned to the station than when it started out. The cost of heating cars by this system is said, by the company which controls the patents, to be not more than for stoves, while the heat is pleasanter and the atmosphere is free from gas and smoke. The compound in the pipes will last for an indefinite number of years, for all that is known to the contrary, being hermetically sealed. This company now proposed to introduce the same system as an improvement on heating by ordinary steam radiation. Steam coils often heat too violently in small rooms, and either give too little or too much heat. By using the steam to heat a reservoir of the compound liquid, the steam can be turned off when the room is sufficiently warm, and the reservoir will continue to throw out a constant amount of warmth for several hours. A small pipe full of the compound, 3ft. long and 4in. in diameter, is made for heating private carriages.

A GREAT VACUUM SUGAR PAN.



THE engraving above shows probably the largest vacuum pan ever built, recently constructed by Robert Deeley and Co., at their works, foot of West 32nd-street, New York city, for the California Sugar Refinery, San Francisco., Cal., Claus Spreckles, president. The body of the pan is of iron, 1⅛in. thick, there being four perpendicular sections, two dome-like sections at the top and one bottom section, all accurately and carefully fitted and bolted together. The inside diameter is 17ft., the height being 31ft. 7in., and the height to top of overflow 42ft. 6in. The capacity of this pan is about 1000 barrels, or over 100 tons of sugar at each "strike," the time required to make a "strike," or sufficiently exhaust the water from the juice before treatment by the centrifugal, being, under ordinary conditions, three hours.

The principle on which a vacuum pan is based is the fact that the boiling point of water, syrup, or any liquid, is in part dependent upon the pressure of the atmosphere, the temperature at which the liquid boils being higher or lower, according as the atmospheric pressure is increased or diminished. In practice with these pans the liquor is boiled at a temperature of 110 deg. to 120 deg. Fah., so there is no danger of burning the sugar, the inversion of sugar is reduced to a minimum, and the rapidity of the operation is greatly increased. A pan of this size must necessarily be of great strength in order to resist the atmospheric pressure, which increases according as the vacuum is more perfect. The arrangements for heating will be readily understood by reference to the illustration, the copper coils for this purpose presenting a surface of over 3000 square feet. There are eight of these separate coils, five being of 4in. diameter and three of 5in. diameter, affording sixty-nine inlets and outlets, and connected with eight steam trunks, two of 8in. and six of 12in. diameter, the steam being supplied by a 30in. main. Every facility is given for easy working, all the main valve stems being carried to convenient positions on the working platform, from which also the strike, or discharge valve at the bottom of the pan, is operated. This valve is 20in. diameter. The pan is charged with the liquor through two 6in. valves, controlled on the working platform, the atmospheric pressure readily forcing the liquor in. The cane juice, with which the pan is charged, usually gauges 25 deg. to 30 deg. Baume, or about 10 lb. to the gallon, and when discharged it is about the consistency of thick mortar. It is intended, in operation, that this pan will be filled with liquor only to a depth of 18ft., leaving 8ft. vapour space above within the pan itself, besides the room allowed in the great pipe leading from the top. There is a spray catcher or intercepter in the dome of the pan, and the vapour pipe leading up from its top is 6ft. in diameter. Situated in this vapour pipe, between pan and condenser, as shown on illustration, is a portion enlarged to 10ft. diameter forming a trap to catch any overflow, which can be returned to pan or tanks, as desired, and thence the 6ft. vapour pipes continue to condenser, which is 8ft. diameter and 28ft. high. The condenser has two 8in. perforated injection pipes and four scattering plates. The pumps which make and maintain the vacuum are connected with the condenser, forming what is termed a dry vacuum. The pan has two of what are styled lock proof-sticks, for removing and testing from time to time a small quantity of the syrup, but these proof-sticks are in reality tubes with nicely fitted valves and a piston for removing the syrup without destroying the vacuum. There are also eight eye-glasses arranged in different positions to enable the operator to keep a constant watch on the work going on inside the pan. A barometer and thermometer are also connected with the interior of the pan, by which the extent of the vacuum and the temperature of the contents are indicated at a glance. Formerly vacuum pans were built almost exclusively of copper, but of late years cast iron has been the choice, only the heating coils being of copper, the coils being so fixed as to prevent their vibrating during the boiling, and allowing for expansion and contraction without strain.

Besides the amount of fuel saved and the economy of conducting the sugar manufacture with a pan of such size as this, where the work can all be so easily overlooked and the process minutely regulated, probably the greatest advantage of all lies in the largely increased proportion of sugar thus gained, and the comparatively small quantity of molasses which each "strike" affords. By such improved pans the yield of sugar amounts to six or eight hogsheads to one of molasses, while by less improved means only two or three hogsheads of sugar are obtained to one of molasses.

The whole work was completed in four months at the Deeley Ironworks, the order having been received July 10th, while the pan was being taken down for shipment the second week in November.—*Scientific American.*

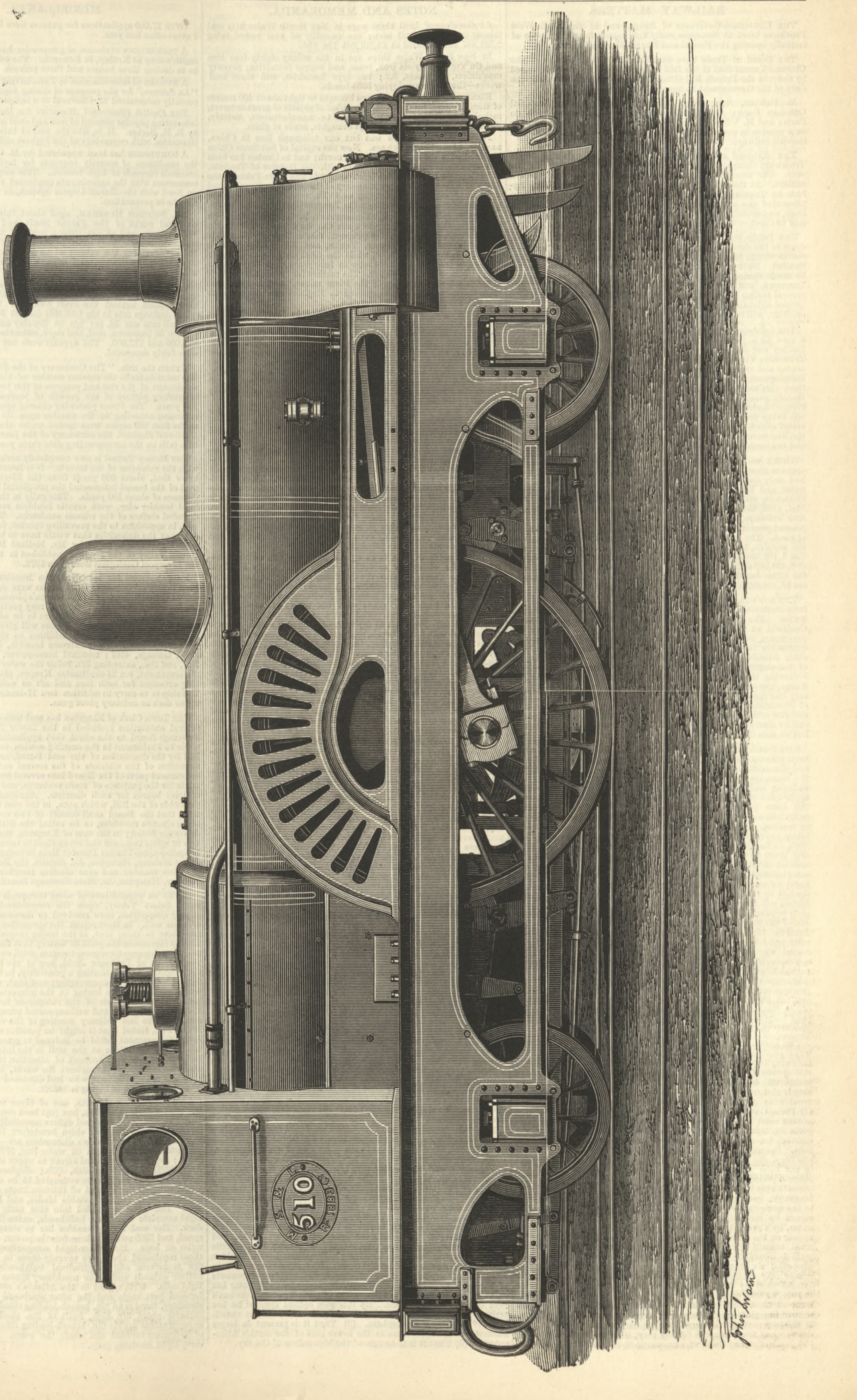
NEW TILBURY DOCKS.—An important arbitration, arising out of the original contract for the construction of the new Tilbury Docks, is proceeding before Sir F. J. Bramwell, F.R.S., with Mr. J. A. Radcliffe as legal assessor. Messrs. Kirk and Randall, contractors, are the plaintiffs, and the East and West India Dock Company the defendants. The amount claimed is over £600,000. Mr. Webster, Q.C., and Mr. C. A. Cripps are counsel for the plaintiffs, and Mr. Bradshaw Brown is retained as valuer; and Mr. E. H. Pollard and Mr. K. Digby represent the dock company, with Messrs. Fuller, Horsey, Sons, and Cassell, as valuers.—*Estates Gazette.*

THE FIRST SLEEPING CARS.—The Chicago *Inter-Ocean* gives the following as reprinted form the Baltimore *Chronicle* of October 31st, 1838:—"Beautiful railroad cars: The cars intended for night travelling between this city and Philadelphia, and which afford berths for twenty-four persons in each, have been placed on the road, and will be used for the first time to-night. One of these cars has been brought to this city, and may be inspected by the public to-day. It is one of the completest things of the kind we have ever seen, and is of beautiful construction. Night travelling on a railroad is, by the introduction of these cars, made as comfortable as that by day, and is relieved of all irksomeness. The enterprise which conceived and constructed the railroad between this city and Philadelphia cannot be too highly extolled, and the anxiety evinced by the officers who now have its control in watching over the comfort of the passengers, and the great expense incurred for that object, are worthy of praise, and deserve, and we are glad to find receive the approbation of the public. A ride to Philadelphia now, even in the depth of winter, may be made without inconvenience, discomfort, or suffering from the weather. You can get into the cars at the depôt in Pratt-street, where is a pleasant fire, and in six hours you are landed at the depôt in Philadelphia. If you travel in the night you go to rest in a pleasant berth, sleep as soundly as in your own bed at home, and on awakening next morning find yourselves at the end of your journey, and in time to take your passage to New York if you are bent there. Nothing now seems to be wanting to make railroad travelling perfect and complete in every convenience, except the introduction of dining cars, and these we are sure will soon be introduced.'

OUTSIDE CYLINDER EXPRESS ENGINE, MANCHESTER, SHEFFIELD, AND LINCOLNSHIRE RAILWAY.

MR CHARLES SACRÉ, ENGINEER, MANCHESTER.

(*For description see page 2*)



RAILWAY MATTERS.

THE Lieutenant-Governors of Bengal and of the North-West Provinces meet at Sonepore early this month for the purpose of formally opening the Bengal and North-Western Railway.

THE Board of Trade have intimated to the promoters of the Channel Tunnel that if the Bill which has been recently deposited by them in the Private Bill Office is persevered with, it will be the duty of the Government to oppose it in Parliament.

M. BERGER, representing the Paris branch of the Imperial Ottoman Bank; M. Denpert, of the Comptoir d'Escompte de Paris; and M. Vitalis, an engineer, have arrived in Constantinople on a mission in connection with the junction of the Turkish and Servian railways.

THE dividend earned by the Dudley and Stourbridge Steam Tramways Company has been at the rate of 6 per cent. for the year. The number of passengers carried has been nearly half a million. At the annual meeting of the company, held in Birmingham on Tuesday, the chairman, Mr. C. Cattell Greenway, complimented the shareholders upon the successful working of the lines, and added that the directors were not promoting any extension to Cleat or elsewhere.

THE Public Works Committee of Birmingham have, it is stated, come to the decision not to recommend any Bills for new tramway routes within the borough during the forthcoming session of Parliament. Such a decision will affect the applications that are to be made during the session by the promoters of the Edgbaston Tramway, and also of the Central Tramway Company. The general feeling is that these two schemes would constitute a much-desired extension of the tram system, and the committee, it is not unlikely, will be requested to reconsider the decision.

THE following manner of obtaining materials for litigation with a view to a judicial ruling upon a disputed point between the Dudley and Stourbridge Company and the Staffordshire Steam Tramways Company was adopted on Tuesday at Dudley. An engine and tramway car belonging to the South Staffordshire and Birmingham District Steam Tramways Company made its way from the top of the Tipton-road into the Market-place, Dudley, thereby passing on to the rails belonging to the Dudley and Stourbridge Steam Tramway Company. It was understood that this act was taken to try the legal rights of the Staffordshire Company to travel over that portion of the road indicated. The managers of the line were present. All passed quietly, the Staffordshire engine and car remaining only a few minutes.

THERE has been a rapid advance in the use of Pullman cars. It appears that in August, 1867, the Pullman Palace Car Company had only contracts with six railways, covering a mileage of 5000 miles, and the gross earnings for the first year of the company's existence, ending July 31st, 1868, were 258,000 dols. On July 31st, 1883, the company had contracts with no fewer than sixty-four railways, covering 62,270 miles; and on July 31st of the present year it held seventy-two contracts, embracing 69,144 miles of road. The gross earnings last year were 3,424,279 dols., and the surplus, being excess of revenue over ordinary disbursements, was 1,192,694 dols. The shops and plant at Pullman were valued at 6,434,828 dols., the cars and equipment at 11,326,337 dols., and the office building in Chicago at 649,252 dols. The total assets are 26,169,382 dols.

THE new extension of the London and North-Western Railway from Sutton Coldfield to Lichfield has been opened for passenger traffic. The first train left Birmingham at 7.10, calling at Sutton Coldfield at 7.30, and arriving at Lichfield 7.50. Among the passengers was Mr. Sutton, general traffic manager; Mr. Evans, contractor for the new line; Mr. Foxlee, resident engineer, and other friends and residents of Sutton Coldfield. A large number of passengers proceeded by the train at each of the stations. Following the passenger train was a light engine belonging to Mr. Evans, the contractor, and while doing some shunting on a temporary line laid for the convenience of making new roads at the back of Shenstone Church, William Field, a guard, was knocked down and run over by the light engine. Both legs were nearly taken off, and he died shortly afterwards. The unfortunate man had already lost an arm through getting entangled in some machinery.

THE Dutch Society for the Promotion of Local Rail and Tramways offers a prize of 300 guilders for the best means of reducing and diminishing the pull and strain upon the horses in bringing the tramcars into motion and to their normal speed, either by utilising and turning to account the force wasted by frequent application of the brakes, or by any other contrivance answering the same purpose. The apparatus must be so constructed as to allow of its being used in both directions, when the car is in motion. Clear and distinct duplicate drawings or models—the latter are preferred—must be sent in franco on or before July 1st, 1885, to the Secretary of the Society, Balistraat 2b, the Hague, and must be provided with a mark or symbol. The name and address of the sender must be enclosed in a sealed letter with the same indications on it for identification. The letters containing the name or names of the sender or senders of these plans will be opened by the directors of the Society, and the projector or projectors will be requested to produce at their own expense and cost their apparatus in such a manner as to allow of its being applied to one of the tramcars of the Amsterdam Omnibuses Company, before April 1st, 1886. After each apparatus has been in use and practically tried on such a car for one month, the jury will make its award, which must be published before August 1st, 1886. The apparatus will remain the property of the inventors, who are at perfect liberty, if they choose, to take out patents for them. The managers of the Society may come to an agreement with the inventor of the prize apparatus as to the compensation to be granted should the apparatus be used on the lines of members of the Society. The drawings and models to which no prizes have been awarded will be kept secret and forwarded to the addresses given by the senders.

THE Dutch Society for the Promotion of Local Rail and Tramways publishes the offer of a prize for the best answer to the following requirements:—A good system of control of the passenger conveyance by tram. In judging of the answers the following points will be taken into consideration. (1) The system must be simple and not too costly in practice. (2) It must cause as little trouble as possible to the passengers and a minimum of delay. (3) Frauds on the part of the public and on the part of the guards must be reduced to a minimum. (4) It must afford complete statistics as to the number of passengers conveyed and the distance travelled over by them. Existing systems may also compete. Specimens of the tickets and the other papers, &c., requisite for a due control must be sent in. The answers must be sent in not later than July 1st, 1885, free to the secretary of the above-mentioned Society, Balistraat, No. 2b, the Hague. The answers may be written in the Dutch, French, German, or English languages, sparing the half of each side of the leaf—folio—but not in the author's own handwriting. The contributions may not be signed by the author himself, but must be identified by another name, by a proverb or some other symbol. The same symbol must appear on the sealed letter accompanying the answer, which letter must contain the name and address of the competitor. If no prize is awarded, the above-mentioned letter will be destroyed unopened six months after the jury has made its award; the sender may demand the return of his answer on indicating the symbol used by him, and that within six months. The prize answer, as well as those not claimed within the above-mentioned limit of time, will remain the property of the Society. The answer accepted by the jury will receive a prize of 300 guilders. If the jury consider that none of the prizes submitted to them are deserving of the prize, the Society may, if it thinks fit, divide the 300 guilders among those who have sent in the best answers.

NOTES AND MEMORANDA.

AT the close of 1883 there were in New South Wales fifty coal mines, employing 5481 men; the quantity of coal raised being 2,521,457 tons, valued at £1,201,941 12s. 11d.

IN New South Wales there are in the colony eighty-four iron and tin works, fifty-six iron, brass, and copper foundries; seventy machinists, engineers, &c.; two type foundries, and three lead works—the whole employing 3335 hands.

RECENT excavations at Worms brought to light about 400 metres of Roman pavement and a large number of objects of great interest, including some which afford a hint to manufacturers, namely, pieces for playing a game such as draughts, made of glass.

FOUR years ago there was but one telegraph line in China, namely, Shanghai, to the sea. Now the capital of Southern China is joined with the metropolis in the north; and as Canton has been put in communication by telegraph with the frontier of Tonquin, the telegraph now stretches in an unbroken line from Pekin in the north to the most southern boundary of the Chinese Empire, and a message either from London or Pekin might reach the head-quarters of the Chinese forces on the Tonquin frontier in a few hours.

THE *Société de Géographie Commerciale*, in the last issue of its journal, contains a brief report upon the tin mines of Perak. In Lower Perak and Kinta, the principal mining districts are Olon-Kinta, Chandenong, Chemor, Yanka, and Khan-Baron, which exported last year 1038 tons, while the total tin exports of Perak have risen from 3054 to 5444 tons in four years, their total value being estimated at £4,500,000. The market for Siamese tin, which is much superior to that of the Siam mines, is at Penang, and from thence most of it is exported to England and her Colonies and the United States.

SOME idea of the progress of agriculture in New South Wales may be inferred from the fact that the quantity of land under cultivation at the close of 1883 was as follows:—Wheat, 289,757 acres; maize, 123,634 acres; barley, 5081 acres; oats, 17,810 acres; rye, 1140 acres; potatoes, 14,953 acres; tobacco, 1785 acres; sugar cane, 14,984 acres; grape vines, 4378 acres; oranges, 7268 acres; sown grasses, wheat, barley, and oats, for hay, 178,503 acres; same, for cattle, 107,993 acres. Gardens and orchards absorb 17,455 acres, the whole quantity of land under cultivation considerably exceeding three-quarter of a million acres.

PROF. TAIT recently exhibited a new form of apparatus for determining the compressibility of water. Formerly he measured the compression produced by a given pressure. In his new method he measures the pressure required to produce a given compression. His arrangement allows him to make any number of measurements in rapid succession at any one temperature. Then the temperature can be raised, and corresponding measurements made without once opening the compression-apparatus. Thus experiments which formerly would have taken weeks for their completion could now be accomplished in a single afternoon. Rude results only have been obtained as yet with the old very massive compression-apparatus. These seem to show that the diminution of compressibility at higher pressures becomes less at higher temperatures, and may possibly even become an increase for the first few hundred atmospheres pressure.

THE red oxide of iron is as agreeable to the eye as the blue-green oxide of copper or bronze, which is so much admired. There is no question about the durability and the permanency of iron oxide, in colour and texture, any more than of that of bronze or brass; the browned gun barrels of fowling-pieces are instances. Experiments have been made with the object of avoiding the dauby appearance of paint. The cast iron, after being pickled to remove the scale, was left to dry with the acid still on it. Then it was cleaned with a wire brush, and scraped with a coarse file. The result was a mottled surface, the lower portions being a grayish brown, the outer or upper portions bright. The surface was then swabbed with crude petroleum, and before it was dry was rubbed with a wire brush. Calvert's *Mechanics' Almanac* says:—"Such treatment insures an unchangeable surface, and gives an agreeable colour. Even without the petroleum the rust of the acid insures a very pleasing and permanent effect, but the petroleum prevents after stains, and mellows and blends the tints. In either way used it is an improvement on paint. Cast iron has a beauty of its own that is no more dependent on paint than that of brass or bronze."

A WORK lately published at Rome ("Censimento delgi Italiani all'estero") gives many interesting particulars concerning the number of Italians living in foreign countries at the end of 1881. At the head of the list stands France, which, with Algeria and the colonies, contains 274,825, of whom 21,577 are in Paris, 33,693 in Algeria, and 57,861 in Marseilles. The Argentine Republic, or La Plata, has 254,388, 103,595 of whom live in Buenos Ayres. Strange to say, the United States has in its immense population only 170,000, of whom 20,286 are found in New York. The number in Brazil is 82,196, of whom 17,570 fall to San Paulo. In Austria and Hungary there are 43,875, of whom Trieste has 16,202. In Switzerland there are 41,645, of whom 19,603 are in the canton of Ticino. In Uruguay, 40,000; in Turkey, 18,612; in Egypt, 16,302, most of whom live in Alexandria. Only 14,567 find a home in the British Isles and all the colonies, and of these only 7189 in Great Britain and Ireland. Tunis has 11,106, Peru about 10,000, Spain 8825, the German Empire 7096, of whom 1552 fall to Prussia (not including Hesse-Nassau, which has 496). Then come Mexico with 6103 Italians, Monaco with 3437, and at last the Russian Empire with only 2938.

AN examination of a series of water-marks set in 1750 all round the Swedish coasts, from the mouth of the Tornea to the Naze, in order to settle a dispute between the Swedish astronomer Celsius and some Germans, as to whether the level of the Baltic has been rising or sinking, shows that both parties were right. The gauges were renewed in 1851, and again this year, and have been inspected regularly at short intervals, the observations being carefully recorded. It appears, *Nature* says, that the Swedish coast has been steadily rising, while that on the southern fringe of the Baltic has been as steadily falling. The dividing line, along which no change is perceptible, passes from Sweden to the Schleswig-Holstein coast, over the Bornholm and Laland. The results have lately been published by the Swedish Academy of Sciences, and it appears from them that while during the period of 134 years the northern part of Sweden has risen about 7ft., the rate of elevation gradually declines as we go southwards, being only about 1ft. at the Naze, and nothing at Bornholm, which remains at the same level as in the middle of the last century. The general average result would be that the Swedish coast has risen about 56in. during the last 134 years.

MM. HAUTEFEUILLE and Chappuis have found that ozone is a blue gas, the colour appearing sky blue even when only so much ozone is present as is obtained in the ozonation of the oxygen contained in a tube a metre in length by the silent discharge. Furthermore, they found that under very great pressures the condensed gas becomes indigo blue. If the pressure is increased to 75 atmospheres and then suddenly relieved, a dense white cloud is formed, showing the beginning of liquefaction, while the same phenomenon does not take place with pure oxygen until a pressure of 300 atmospheres is attained. The ozone must be compressed slowly and with constant cooling, otherwise it will explode with evolution of heat and light. By mixing the ozone with carbon dioxide, and then submitting the mixture to great cold and pressure, Hautefeuille and Chappuis succeeded in obtaining a deep blue liquid, the blue colour being due to the liquefied ozone. The same observers have studied the absorption spectrum of ozone, and accurate measurements of the same have been made by W. N. Hartley. The latter has extended the research to the absorption of certain parts of the sun's rays by atmospheric oxone. By this new optical method he has arrived at the conclusions: (1) That ozone is a constant constituent of the upper atmosphere. (2) That it is present in larger amounts in the upper than in the lower part of the earth's atmosphere. (3) That it is the cause of the blue colour of the sky.

MISCELLANEA.

OVER 17,000 applications for patents were lodged in the English Patent-office last year.

A TREMENDOUS explosion of gunpowder has occurred at a gunsmith's shop at Kralup, in Bohemia. The concussion was so great as to destroy three houses and three persons.

A NUMBER of scientific men in Paris having founded a club called "La Science," for the purpose of dining together at stated times, recently entertained M. Chevreul at a banquet.

THE *English Illustrated Magazine* for last month contains an interesting popular account of iron and steel making in South Wales by B. H. Beeker. It is, like the rest of this excellent magazine, illustrated with engravings of the highest order.

A COMMISSION has been appointed by M. Cochery to determine the conditions of security requisite for laying electric cables to transmit currents of high tension. This step has been taken in connection with the experiments conducted at Criel and the Gare du Nord with the Marcel-Deprez system, as well as others which may be in preparation.

MR. SOLOMON HUFFHAM, aged about thirty, chief engineer at the steel works of the Patent Shaft and Axletree Company, Wednesbury, and at one time a pupil of the late Sir William Siemens, was suddenly killed in the midst of duty on Wednesday. He was directing the raising of an iron stack weighing over ten tons, when it fell over, and crushed him fearfully. He leaves a widow and an infant child.

ON Tuesday a joint Court of Arbitrators and Commissioners, under the Mines Drainage Acts, was held at Wolverhampton to hear appeals against the draft award of the arbitrators for a mines drainage rate in the Old Hill district for the ensuing year. The full rate was 3d. per ton on fire-clay and limestone, and 6d. per ton on ironstone, coal, and slack, estimated to produce between £11,000 and £12,000. The appeals were not numerous, but they were fairly successful.

UNDER the title, "The Centenary of the *Times*," Mr. W. Fraser Rae contributes to the current number of the *Nineteenth Century* an account of the rise and progress of this journal, which gives an interesting picture of the growth of journalism during the last 100 years. The *Times* yesterday entered upon its second century, reckoning according to the number upon its title page, although, as the first 939 copies were issued under the name of the *Daily Universal Register*. the centenary of the journal under its present title falls on the corresponding date three years hence.

THE Mersey Tunnel is now completely arched in under the river with the exception of the inverts. It is interesting to geologists to know that, about 300 yards from the Liverpool side, the upper part of the tunnel intersected the pre-glacial bed of the river for a distance of about 100 yards. This gully in the rock was filled with hard boulder clay, with erratic boulders resting upon the hard denuded surface of the triassic sandstone. This pre-glacial gully was, in opposition to the prevailing opinion, foreseen and predicted as one of the difficulties that would have to be encountered in the tunnel works in a paper by Mr. Mellard Reade, entitled "The Buried Valley of the Mersey," published in the "Proceedings" of the Liverpool Geological Society in 1872.

PREPARATIONS for launching the ironclad frigate which has been nearly seven years on the stocks were completed on Wednesday at Constantinople, and the Sultan's pleasure is now awaited for the launching of the ship. But it may pretty surely be predicted that his Majesty will not find leisure to be absent from the palace for this. The following particulars will give an idea of the size and description of the new addition to the Ottoman navy:—Length amidships, 292ft.; extreme breadth, 55ft.; depth of hold, 39ft.; tonnage, 4167; nominal horse-power, 800; armour, 6in., 7in., and 9in., extending 5ft. below the water-line and 15ft. above it; armament, ten 24-centimetre Krupps, placed in a central battery arranged for both fore and aft as well as broadside firing. The ship is to carry in addition two 17-centimetre Krupps on the upper deck as ordinary pivot guns.

THE Town Clerk of Kingston has sent notices to the clerks of the several authorities included in the Lower Thames Valley Main Sewerage Board to the effect that application is intended to be made to Parliament in the ensuing session for leave to bring in a Bill for the dissolution of the said Board, and to provide for the formation of the districts of the several authorities forming the constituent parts of the Board into several and distinct united districts for the purposes of main sewerage, and for the constitution of joint boards for such districts. Annexed to the notice is a preamble of the Bill, which asks, in the case of the Richmond district, that the Board shall consist of two *ex officio* members and seven elective members, to be called the Richmond District Main Sewerage Board; in the case of Kingston, the Board to consist of two *ex officio* members and seven elective members, to be called the Kingston-upon-Thames District Main Sewerage Board; in the case of the Molesey, Hampton, &c. district, the Board to consist of one *ex officio* member and nine elective members, to be called the Molesey, Hampton, &c. Main Sewerage Board.

AFTER an expenditure of some thousands of pounds, the Richmond Select Vestry, upon the recommendation of the Water Supply Committee, have resolved to discontinue the deep boring of their well. In their report the committee state that it is not now clear to them that, as the boring progresses, there is a satisfactory increase in the yield of water; that the difficulty of boring, and the consequent expense, increase with every foot bored; that the opinion of Professor Judd, one of the highest authorities in the kingdom, only indicating a possibility, but not a probability, of finding water, is not encouraging; and that, while the committee would gladly continue boring in the interests of science, they feel bound in the interests of the ratepayers not to continue unless there is a reasonable and well-supported prospect of ultimate success. At the last ordinary meeting of the vestry, the chairman, Major Full, stated that it might be possible some learned society or the Government would be induced to grant money to continue the boring operations at the well in the interests of science. It had attracted a vast amount of attention in the country and on the Continent, and throughout the world, but more particularly among French scientists, who had discussed it at their meetings. The present depth of boring is 1439ft.

THE steel cruiser Atlanta, one of three vessels authorised by the United States Congress, has just been completed by Messrs. J. Roach and Sons. The vessel differs essentially in appearance and equipment from the war ships heretofore built for the United States Navy. The Atlanta's dimensions are—length between perpendiculars, 270ft.; length on water-line, 276ft.; length over all, 283ft.; depth from garboard streak to upper side of superstructure deck, 34ft.; extreme breadth, 42ft.; displacement of water-line, 3000 tons. Her engines are estimated to be of 3500-horse power, which will give her a speed of thirteen knots an hour. Her screw is of steel, with four adjustable blades, and has a mean pitch of 20ft. The vessel is divided into nine main compartments with eight complete transverse bulkheads, extending up to the main deck. Her coal supply enables her to steam 2500 miles at full speed, and 5300 miles at three-fourths power, or at the rate of ten miles an hour. Her water-tight compartments, in addition to those mentioned above, are seventy-three in number, formed by the transverse and longitudinal bulkheads. An inner water bottom extends under the machinery spaces with twelve water-tight cells. With regard to the Atlanta's armament, outside the forward port angle and the after starboard angle of the superstructure, there is an 8in. breech-loading rified gun, mounted on a barbette about 3ft. high, built of 2in. steel plates; within the superstructure are six 6in. breech-loading rifled guns, with a train of 60 degrees forward and abaft the beam. The vessel will also carry eight revolving guns.

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S. W.—*The surfaces in your bearings are too small, and would cut to pieces. The invention is of no value.*

E. P. (Barnes).—(1) *We do not understand your sketch.* (2) *There is no such work of an elementary character.*

ICE.—*One pound of water at* 32 *deg. must part with* 142·6 *deg. of heat in order to become ice. In other words, the latent heat of fusion of one pound of ice at* 32 *deg. is* 142·6 *units.*

M. P. (Wexford).—*You can dissolve the rubber in bisulphide of carbon. The best arrangement would be to cover the rod with thin sheet vulcanised rubber secured with cement, which may be obtained at any india-rubber goods shop.*

ONE IN DOUBT.—*Beaufoy's experiments show that if a flat triangular board be drawn through the water by a cord attached to the middle of the length of one of the sides, the liquid resistance to motion will be less than if the traction cord was fixed to one of the angles. The solid of least resistance is very nearly a parabolic spindle.*

FOG—*If you are quite certain that the hole between the steam stop valve and the boiler is not partially stopped up, then either the indicator or the gauge is wrong. It sometimes happens that a lead jointing ring is used which swells inwards and partially stops up the pipe, or the pipe may not be in line with the hole in the boiler. We suspect, however, that you have made a mistake in the indicator spring. Write again when you have cleared matters up.*

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THE ENGINEER.

JANUARY 2, 1885.

1885.

THE year which has just passed away may, unfortunately, be characterised as one of almost unmitigated disaster, as far as the trade of Great Britain is concerned. It is difficult, indeed, to indicate a single branch of manufacture or production which has not suffered. It is poor comfort to be assured that our neighbours are as badly off as ourselves, and that the cause of their misery is identical with that of our own, which latter, perhaps, is doubtful. When they suffer, however, we suffer with them. Those who maintain that they are best qualified to judge assert that the prominent evil of the moment is over production. There are more iron and cotton goods, and ships, and railways in the world than its inhabitants can find any use for, and to produce more is little short of folly. We are not concerned just now to dispute the soundness of this proposition, or the accuracy of the deductions on which it is based, but we may be permitted to point out that England affords a spectacle which may suggest doubts as to the absolute wisdom of the utterances of the political economist. We have always been assured by him that the good of the consumer should be the first consideration, that of the producer being quite a secondary affair. Food, clothes, houses, railways, ships, transport, cannot, we are told, be cheap unless they are plentiful, and that country is best off which has most of such things. We have apparently reached the halcyon days of the political economist. Never before, perhaps, since money acquired its modern value have all the necessities, comforts, and luxuries of life been so cheap, and never has a more direful tale of starving men, women, and children, of failing trade and loss of capital, in all directions, been told. In vain do we look among any class or rank of life for that happiness and prosperity which cheapness ought, in theory, to give us. No longer can it be said that the prosperity of this country advances by "leaps and bounds." Our exports are falling off; our revenue is decreasing. In no single direction can we find any indication that trade is becoming better, or is likely to improve for many months to come. Surely in a country blessed with free-trade—the typical country of such men as Cobden—these things ought not to be. It is pointed out that protection has done France, Germany—in a word, Europe in general—no good, and it is urged that they are as badly off in the matter of trade as we ourselves. But when such statements are made it must be remembered that all the continental nations, without exception, have burthens of foreign debt to pay, from which we are practically exempt, and that they are laden with the weight of enormous military establishments, of which we know nothing. If, under the circumstances, they hold their own, it would seem that protection has for them less of the disastrous effects than it is proper to believe always appertain to it; and it is at least certain that, whether it has or has not done other nations good, it has done Great Britain harm, not only by preventing us from selling our wares, but by stimulating others to undertake manufacturing operations in direct competition with us. As regards over production and low prices, that has come to pass which was long ago foretold. Years ago it was pointed out in this journal that but one result could ensue from the determined efforts being made on all sides to cheapen production and augment output. If two tons of iron are made for the price that one ton formerly cost, the market value of iron must fall, and if improved mechanical appliances enable 100 tons to be made instead of 50 tons in a given time, a point must at last be reached when supply will outstrip demand; and it would really seem that a point has at last been reached below which we cannot well fall. Thus, for example, wheat has this year reached a lower price than has been touched at any time within a century. The lowest average for any week during that period was 35s. 6d., the price for the week ending October 11th, 1851. Large quantities of excellent wheat were sold toward the end of 1884 at the average of 30s. 5d. It appears that ruin is falling on the Western American farmer. It costs in Kansas, it is stated, about 40 cents a bushel to grow wheat, which has been selling recently at the average price of 27 cents. It must be kept in mind that the wheat cultivation of Western America, and the importation of wheat thence into this country, have been rendered possible solely by the labours of the engineer. The railways have enabled the farmers to get their corn to the Atlantic seaboard, and the much-despised and abused cargo steamer, the "coffin ship," the "ocean tramp," has rendered it practicable for the American to put his corn into our ports at a comparatively insignificant cost for freight. Corn has been grown largely in the United States with capital made in and lent by the Eastern States, but there is every reason to think that a limit has been reached, and that for the English agriculturist better times are in store; if not in the immediate future, at least within reasonable distance. In all the branches of trade and engineering nothing is possible but to wait, and to hope that as stocks will be absorbed, the balance of trade between supply and demand will be restored.

In pursuance of our usual custom we turn, in reviewing the past, and indicating, as far as may be done, the future of engineering, to that branch of the science which is most concerned with statics; in other words, to civil engineering.

There is, perhaps, a greater charm in a fine bridge structure than in any other of those upon which engineers are engaged. It sometimes combines beauty with a purpose as obvious as its utility, and there are not a few instances of the improvement of a piece of scenery by this form of artificial aid to the eye in its endeavour to comprehend by measure the beauty of a natural feature. Whether it is through custom or through real fitness, there is little doubt that the most generally pleasing form of bridge is the arch, whether it is of but slight elevation, and whether of the quaint beauty of the shaky Llanrwst Bridge of Inigo Jones, the Pont-y-tu-Prydd of William Edwards, the beautiful Ponte della Trinita of Ammanati at Florence, or the more severe beauty of one or two of Rennie's Thames and other bridges, or whether it be raised to graceful altitudes, with the beauty of an Aqueduc de Spollette, the Blea Moor, the Dent Head, or the Vale of Llangollen viaducts. There are, however, few who will not admit that there is much beauty in many an iron bridge and viaduct, such as the Britannia, the Menai, the Runcorn, the St. Louis steel bridge, the Pont de Douro, and many others in Germany and France.

The most stupendous bridge structure ever built is that now in course of construction over the Forth. The unprecedented magnitude of this bridge and its situation have made it necessary to depart from all preconceived ideas as to fitness or beauty in a bridge structure; and whether taste will ever be educated to such a pitch of appreciation of structural economics as to allow that beauty may reside in a structure which is reduced in its parts to a metallic representation of resultant stresses, is perhaps an open question. There is, nevertheless, a grandness in the bridge of Mr. B. Baker and Mr. Fowler which is unique. In proportions it is so far from having any equal that we are quite unable to convey any conception of its enormous size for want of any means of comparison. In the paper which we recently published by Mr. Baker * will be found the leading dimensions. These make it necessary to take, say, the height of Nelson's column as a submultiple of the height of the piers and furlongs to measure the length of the spans. Since this work was commenced the weather has been exceptionally favourable, last winter and so far this winter having done very little to stop the work, which has made very great progress. The enormous caissons, 70ft. in diameter, which form the lower part of the river piers, four to each pier, are finding their places in the hard boulder clay or on the bed rock, as at the historical Inchgarvie Island. Here the bed shelves so much that in the 70ft. diameter of the caissons there is a difference of level of 17ft., which has to be made up with a great bank of sand bags before the men imprisoned in the air-tight chamber can begin their work of cutting the rock down to a level and getting the caisson a bed upon which it and its great fill of concrete may rest.

Some idea of the progress of the work may be gathered from the fact that amongst the temporary works at South Queensferry, the coffer dam at No. 9 viaduct pier has been completed, and was pumped out early last month; the masonry of No. 8 viaduct pier and the south cantilever pier being above high-water level, the dams at these places have been removed. Staging for the erection of the viaduct girders has been erected for five spans. The plant for this bridge will cost about £100,000, and only recently eight additional radial drills, a second eight-spindle bedplate drilling machine, a second universal hole cutting tool, a third 7-ton travelling crane for the drill roads, a 60-horse power pair of engines for electric light, and several smaller tools have been added. One of the shops, also, has been considerably enlarged, and the other is in process of extension, whilst additional roads are being made for drilling both tubes and cross girders. At Inchgarvie, the staging which is to cover the space between the four piers is progressing, thirty-four columns and 622ft. of girders being now in position. The landing stage has also been extended.

Of the permanent works at South Queensferry, the masonry of viaduct pier No. 7 has been raised 15ft., and now remains at the level at which the girders are erected, viz., 27ft. above O.D. Viaduct pier No. 8 has been carried up 27ft., and is now at 17½ft. above O.D. At the south cantilever the masonry has been raised 20ft. and is now at coping level, some of the coping—of cutwater—being already set. A commencement has been made with the viaduct girders on the south side, and the lower booms of three spans have been rivetted up and a few of the diagonals erected.

At Inchgarvie the masonry of the north-east pier has been completed except a few of the capping stones; the caisson for the north-west pier having been successfully sealed to the rock by concrete and cement, was pumped out for the first time on the 23rd October, since when the benching of the rock and building of masonry has proceeded steadily, the tie rods securing the lower part of the caisson to the rock have been fixed, and the masonry at the deeper part of the foundation has been built up about 10ft., or two within 7ft. of low-water level. At North Queensferry the masonry of the south-west pier has been completed except a few of the capping stones; the lower bed plates of north-east and north-west piers have been rivetted up. The viaduct girders of one span, with cross girders, floor, handrail, &c., are all but completed, and those of a second span are more than half finished, while the lower booms for another are in hand.

About 202,000 cubic feet of granite have been delivered up to date, of which 142,000ft. are set; about 32,000 cubic yards of concrete and rubble masonry are in position, and about 8500 tons of cement have been used. The first of the large caissons for the Queensferry main piers has been sunk under air pressure through 45ft. of mud and clay to its final level, 62ft. below O.D.; progress through the last 20ft. of ground has been slower than was anticipated; owing to the very hard and tough nature of the boulder clay, one of the material locks has been removed, and the 18in. pipes and lock for passing concrete into the air chamber have been fixed, and the air chamber is being rapidly filled with concrete. The second caisson having been loaded with about 3600 tons of concrete, air pressure was applied on the 22nd ultimo, and excavation is being rapidly proceeded with by the ejector; the level of cutting edge of caisson is now 36ft. below O.D. The third caisson has been successfully launched, and is now secured to its permanent site by 3400 tons of concrete. The fourth caisson was successfully launched on the 3rd December, and the second course of plates above commencement of taper has been rivetted on. The erection and rivetting up of the first of the two deep water caissons for Inchgarvie has been commenced on the south shore, and the second will be built on the launching ways recently occupied by the fourth Queensferry caisson. In the shops about 5400 tons of plates, ties, and angles have been delivered, and about 1750 tons are now completed ready for erection. The whole of the bed-plates, four lower and four upper, for the Fife piers are now finished, and three lower plates for the Queensferry piers are in hand. Two Fife skewbacks are well advanced, and the third is being commenced. The vertical columns over the Fife piers are completed for a height of 80ft., and those of the Queensferry piers are in progress. The diagonal struts for the Fife piers are also in hand, and the third of the lattice girders connecting the skewbacks transversely to the centre line of the bridge. The number of workmen at present employed is about 1840. The men employed in the bottom of the caissons under the air pressure, which keeps out the water while the excavation is done, are all, or nearly all, Italians. They were previously employed on somewhat similar work in the Antwerp quay extensions, and are found to keep well to their work in spite of the state of the atmosphere in the often very small space in which they work. It is a noticeable fact that Italian workmen are finding a good deal of employment abroad on this and other kinds of constructive work.

All other bridges in construction seem small in size compared with that over the Forth. At home the new Tay Bridge, which, like the Forth, is being built by Messrs. Tancred, Arrol, and Co., is now making considerable progress. Its construction was commenced in March, 1883, and already about one-half of the pier cylinders have been sunk by means of the "quadruped" or pontoon platforms on legs, which we have described.*

* THE ENGINEER, vol. lviii., pp. 357, 388, 422.

* THE ENGINEER, vol. liv., p. 223.

We have so fully described the new bridge,* and the character of the design, which is to take the place of the unfortunate bridge of Sir Thomas Bouch, that it is unnecessary to do so here, as the only feature of note is its length, though the contractors' task is a difficult one. This, however, has been much reduced by the mechanical method adopted for placing and sinking the pier cylinders, which are 15ft., 17ft., and 25ft. diameter. The bridge will probably be finished by the end of next year.

Abroad there is a good deal of bridge work in progress. The style adopted for the Pont du Douro† has been copied at Garabut, and a bridge of considerable magnitude but no novelty, is to be constructed across the Danube, as now being described in our columns. The cantilever system of the Forth Bridge has been copied, and a small bridge completed over the Niagara upon this model and a very ugly bridge of the same order is to be erected over the Hooghly; while a remarkable bridge, though not of large dimensions, has been thrown across a chasm in South Africa on the Port Alfred and Grahamstown Railway, by Messrs. Handyside and Co., from designs by Mr. Max am Ende. These we shall illustrate in an early impression. The bridge contains some remarkable features, and the whole design shows the spirit of the leading bridge designers to be a departure from the beaten tracks and to initiate a school of design which shall be as fit for metallic structures as arches were for those of stone or brick. In bridges there is, except in these cases, little novelty in design; but in the methods of execution the adoption of special plant and powerful steam cranes has extended, and both cost and time reduced. A new bridge across the Thames at Tower Hill has at last been decided upon, and, except that Mr. Horace Jones, the City architect, has made an outline design for a form of bascule bridge,‡ the design has been placed in the hands of Mr. John Wolf Barry. There is probably no site in the world where a bridge is more wanted than here, and petty vested interests, which have for many years prevented its construction, have at last been overruled by the adoption of a low-level opening bridge, which will probably become a fixed bridge in a very few years.

A piece of railway engineering of as much interest as importance has been completed during the year, namely, the inner circle completion link of the Metropolitan and Metropolitan District Railways. This piece of line, extending from the Mansion House station of the latter railway to Moorgate-street station, was officially inspected on the 18th September, and opened on the 1st October without ceremony. By this line is completed what is, for convenience, called a circle which was commenced about twenty-four years ago, the first section of the line—from Bishop's-road, Paddington, to Farringdon-street, a length of four miles—being opened in January, 1863. This first part was made with the 7ft. gauge of the Great Western Railway, and the difficulties which were anticipated in ventilating the tunnel led to the attempt to use engines with condensers, and also to use a form of fireless engine, namely, an engine carrying a vessel filled with water heated to a high temperature, which was to evaporate as pressure fell, after the manner of the tramway engine now in use in France. The main features of the completing link and the work thereon have been described in our pages.§ The most remarkable part of the work was, perhaps, the heavy underpinning of the whole of Cannon-street, and building new cellarage and new foundations to the buildings of the whole street, while traffic and business were carried on as usual and without interruption. The Metropolitan and District Railways now connect the whole of the main lines except the South-Western, and by their aid the journey may now be made from east and west Richmond to Blackwall, and north and south from King's-cross to New-cross, trains passing through the Thames Tunnel. In New York it is proposed to adopt as something new the now forgotten 1844 plan for London of Mr. Williams—then Chief Commissioner for Metropolis Improvements. This was to make an underground railway by constructing a complete underground street, the sides being foot-walks, with the shops carried down to the new level and well lighted, and the centre of the street for the new railway. Though this could not, perhaps, have been done in Cannon-street and some other parts of the Inner Circle completing line, on account of the sewers and gas and water pipes, it is much to be regretted that the opportunity which this work afforded of making a permanent subway for these pipes was not utilised. The whole length of this completing link is but 1200 yards; yet it has altogether cost about £2,000,000, or an average of no less than £23 11s. 8d. per lineal inch. Some parts costs less, while that from Mansion House to King William-street cost over £30 per lineal inch.

There is still a very large area of London not served in any way by railway, namely, the whole of the district surrounding a line drawn north-west of Charing-cross. Over and over again proposals have been submitted to Parliament, and none have been more strongly supported than what was known last year as the Parks' Railway, which had semi-official Government support. This, however, like most other proposals, was rejected by Parliament, and those which gained sanction in 1864 and 1871 have fallen through from want of support. There is now before Parliament a scheme which proposes to do what was recommended in 1864 by a joint committee of the Lords and Commons, namely, construct a railway connecting the South-Eastern at Charing-cross and the London and North-Western at Euston. The proposed line would run close east of St. Martin's Church, and thence under the new street that is to be made from St. Martin's-lane to Tottenham Court-road. It would continue under the latter road, and then turn east at the south end of Hampstead-road, thence to Euston. This line would be a little under three miles in length, and the construction of the new street ought to afford the required opportunity for making a line which is really very much wanted. Paris has not yet made up its mind about the construction of an underground or other metropolitan railway, but amongst many projects brought forward, two have lately occupied a good deal of attention. The one is by M. Lesguillier, and the other by M. Haag—both engineers of *ponts et chaussées*. The former proposes an underground line, and the latter an over-head line, carried on a viaduct or a continuous series of arches, 46ft. wide, of ornate construction, and providing shops and other store places along its whole length, with streets on either side of 39ft. 4in. width. The whole width occupied would be but 130ft., but it is proposed to schedule 229ft. width, so as to be prepared for deviation and contingencies. It proposes to connect all the great lines; to have two special lines to connect the Gare St. Lazare and the Gare de Lyon, and to enclose an area bounded by the Trocadero and Grenelle on the west, Vincennes on the east, Parc Monceaux on the north, and by Sceaux on the south. It would be about three and a-half miles long, and is estimated to cost about £21,400,000. The project of M. Lesguillier connects the Gare de Lyon and Puteaux, uniting all the stations north of the Seine, but not passing south of the river at all. It is curious that in the objections to these schemes, several of those which have been overcome, or allowed to remain on our Metropolitan line, such as diversion of sewers, ventilation, want of speed, choice of motive power, are pressed against that of M. Lesguillier; but the high cost of that of M. Haag is the main ground of objection, while in his favour it is urged that his line would necessitate the removal of a large quantity of rookery, unhealthy property, open up a fine thoroughfare, and be thus of great hygienic service; while burrowing underground in the doubtful subsoil of Paris is apparently very much feared. If a metropolitan railway is ever made in Paris, it will probably be overhead.

* The Engineer, vol. lii., pp. 329, 350, 386.
† The Engineer, vol. l., pp. 175, 182, 365.
‡ The Engineer, vol. lviii., pp. 326, 353.
§ The Engineer, vol. lv., pp. 169, 184.

A big railway is likely soon to be put in hand in India, Government sanction having been given to a new company to construct a total of 580 miles of new lines on the 5ft. 6in. gauge, connecting the Great Indian Peninsula line with Gwalior and Cawnpore, thus providing direct communication between Bombay and the northern parts of India. The line is to be guaranteed to the extent of 3·5 per cent., and one-fourth of the profits above this is to be paid to the shareholders. The working of the railways in India has been so far satisfactory of late years that the Government consider the above guarantee sufficient, instead of the hitherto usual 5 per cent. There is little doubt that this new project will attract the necessary capital. Although the sanction has been given to a separate, instead of to the Great Indian Peninsula Company, by which it was sought, the proprietors in that company will no doubt be large subscribers. It will add materially to the demand for railway material, and 580 miles of new line will require the services of a good many engineers.

At home there are no great railway projects in hand, and one of the most remarkable abroad is Mr. Eads' ship railway to connect the Atlantic and Pacific by the Mexican Isthmus. This line is seriously proposed, and is supported by several engineers of very high repute in London, as well as by Sir E. J. Reed and others, though it does not seem to attract capitalists. It is urged that it could be constructed in half the time estimated for the Panama Canal and at one-fourth the cost. According to Mr. Eads' scheme the ship is to be elevated from the sea level to that of the railway by means of a large floating dock or pontoon, which may be described as a huge iron box. In practice, this pontoon would be about 450ft. long, 15ft. deep, and 75ft. wide. It is arranged to float or sink in a basin, in which its vertical movement is guided. On each side of the basin there will be twenty or thirty iron rods, arranged vertically, and secured to the bottom of the basin. These rods will be capable of holding the pontoon so as to prevent it rising above the level of the railway when the ship and cradle have been taken off it. The deck of the pontoon is laid with rails which will correspond exactly with those on the permanent land line when the pontoon is floated. When in this position a cradle on wheels, and capable of carrying the ship, is run on to the pontoon, which is then submerged by admitting water into it through sluice gates, which are regulated from the top of two quadrangular water-tight towers attached to the deck of the pontoon, and between which there is sufficient width for the cradle and the ship to pass. When the pontoon has been submerged to a sufficient depth for the bottom of the ship to clear the supports upon which it is intended she shall rest, the vessel is floated in from an adjacent basin, and secured over the top of the carriage or travelling cradle. The pontoon is then emptied out by means of a powerful pump, and its deck rises up to a given height above the water, its further progress being stopped by the heads of the vertical rods before alluded to. The rails on the deck of the pontoon now range precisely with those on the land, and while the pontoon is in this position locomotives are backed up and attached to the travelling cradle, and it is started on its journey across the isthmus. On reaching the end of the line the travelling cradle is run on to another pontoon, which is submerged, and the ship floated off into another basin on its way to its destination. The proposed line would be about 134 miles in length, and would not, it is said, need gradients of more than 1 in 100. Whether the probabilities of success incidental to "trucking" say a 3000-ton ship across the isthmus have been so far subjected to Hope's microscope as to convince others, as well as the projectors, that they are large, remains to be seen.

Another Alpine tunnel, namely, under the Simplon, has now passed from the stage of discussion by the engineers to discussion by bankers; while yet another is proposed under the Grand St. Bernard, and a third under Mont Blanc. The Simplon tunnel would be about 20,000 metres in length, the Mont Blanc 19,220 metres, and the Grand St. Bernard 9485 metres. The advocates of each have their commercial and political reasons for being confident of support. The latter affords a very direct route between Paris and Brindisi, and may be expected to receive French support; but political reasons will also make the Mont Blanc project a favourite. The difference in cost is all in favour of the St. Bernard, which will connect Martigny and Aoste; while the Mont Blanc route would encounter difficulties in crossing the glaciers. The temperature will also be, it is expected, very high in that Mount, namely, about 53 deg. Cent., and in the Simplon about 36 deg. Cent., while in the St. Bernard it is expected to be 22 deg. Cent. The ventilation problem is also supposed to be almost or quite insuperable in the two tunnels, both of which are so much longer than the Mont Cenis or the St. Gothard, which are respectively 12,240 and 14,920 metres. Though not in France, it is urged that from military considerations the St. Bernard northern entrance is better situated for France than the Mont Blanc entrance in Savoy. It will probably be a few years before another great tunnel will occupy engineers and Italian labourers under the Alps. On September the 20th of the year just closed the Arlberg tunnel, of which a full account has been given in our columns,* was opened by the Emperor of Austria. This tunnel with the Arlberg railway reduce the distance from Paris to Belgrade and the East by ninety miles. It places Austria and France in direct communication through Switzerland, and leaves them free of the German lines. The tunnel is 10,270 metres in length.

Strange things have been done during the year with the Hull and Barnsley Railway and Docks, and ugly things said about finances and financial operations. The works were continued as energetically as before from January to July, when, for monetary reasons, they were, for the most part, suspended, which suspension continued for four months. Meanwhile, the heaviest works which had been commenced, but not finished, such as the large swing bridges over the rivers Ouse and Hull, and the engine shed and shops near Hull, were carried on to completion, so that by the 29th August a train was run from end to end of the railway. Work has now been vigorously resumed, and upwards of 3000 men are employed, about one-half of whom are on the railway and the remainder on the dock. The railway work remaining to be completed consists of stations for passengers and goods at Hull, gravitation sorting sidings at Hull, exchange sidings with the Lancashire and Yorkshire Railway at Hensall, Great Northern Railway and Sheffield Companies at Hemsworth, the Midland Company at Cudworth, and the Sheffield Company at Stairfoot, near Barnsley, and a joint station with the Midland Company on its main line at Cudworth; also sidings and branch lines to four of the best collieries in the Barnsley coal seam. The whole of these works, including the dock, are, under contract with Messrs. Lucas and Aird, to be completed by the 1st July next. The Ouse Bridge, which was the last link on the main line, and the most important structure, having a moving span of 250ft. in length, and weighing about 700 tons, was turned by Mrs. Shelford, the wife of the engineer, on 29th August. The engine shed at Hull is built to contain thirty-two large engines, several of which are ready for delivery; the carriages are also ready.

During the year great progress has been made with the Mersey Railway, connecting Liverpool and Birkenhead. It will, when completed, be 4½ miles in length of double line. It runs from the central station at Liverpool to a junction with the joint railway at Birkenhead, and a branch is authorised to join the Wirrall Railway to New Brighton and Hoylake. With slight exceptions the railway will be in tunnel throughout. The tunnel under the river, which is just one mile in length from shaft to shaft, or 1300 yards from quay to quay, is now arched in complete, and will very shortly be ready for the permanent way. The land approaches are also in a very forward state, together with stations at Green-lane, Borough-road, and Hamilton-square, at Birkenhead, and James'-street in Liverpool, so that it is expected that traffic will commence about the month of June next. Hydraulic machinery, for use at the stations, fans, and other machinery for mechanical ventilation, and the locomotives and rolling stock for working the railway, are in course of manufacture. The contractors are Major Isaac and Messrs. John Waddell and Sons; the engineers, Messrs. James Brunlees and Charles Douglas Fox and Co. The cost per mile when completed is expected to be about half of that of the Metropolitan Railway. The central line across the river is straight. From the underground station, Hamilton-street, Birkenhead, the gradient is 1 in 30 to a point about one-third of the distance across the river; it then rises 1 in 900 to the centre of the river, then falls 1 in 900 to about two-thirds across, then rises 1 in 30 to James-street underground station, Liverpool. The least thickness of rock is 30ft. between the crown of the arch and bed of river. The section of the tunnel is as follows:—Width at springing of arch, 26ft.; height from invert to rails, 4ft.; from rails to crown of arch, 19ft.; radius of side walls, 25ft.; invert, 21ft. 6in.; arch, 13ft. The brickwork is all in best Portland cement, and is 2ft. 3in. thick. The drainage heading is 7ft. diameter, and rises 1 in 500 from the pumping shaft towards the centre of the river. There is a pumping shaft on each side of the river, and each shaft contains two 20in. lift pumps, two 30in. lift pumps, and one 40in. plunger pump; the latter, with a stroke of 15ft., raises 817 gallons each stroke, and can work up to six strokes a minute. If all the pumps on one side were to break down, which, of course, is most unlikely, the water could be easily dealt with on the other side. There will be three lifts at each of the underground stations, each capable of raising eighty people, and all working independently by hydraulic machinery. There will also be a subway to each of the underground stations to relieve the lifts. The ventilation will be effected by two fans—a 40ft. and a 30ft.—on each side of the river, exhausting the foul air from different points in the tunnel by means of driftways, &c. The most difficult tunnelling is that now proceeding in Birkenhead, where there is no rock, but beds of loam and sand, and a good deal of water. The ranging of the centre line across the river, and levels, was entirely done by Mr. A. H. Irvine, resident engineer for the company, and Messrs. D. A. Davidson and E. de Jaye, engineers for the contractors. There was no appreciable error in the lines when the two

* he Engineer, vol. liv. and lv., p. 384

sides met, and the levels checked to one-eighth of an inch.

The working of long tunnels and the working of tramway lines suggest a reference to the employment of other motive power than the ordinary locomotive. There are compressed air, hot water, and electric motors. Compressed air has not yet proved sufficiently attractive to tramway proprietors to secure adoption, although Colonel Beaumont is ready to show that with air compressed to 1000 lb. per square inch he can run tramway cars at a lower cost than it can be done by steam engines. A new system of working railways or tramways by compressed air is proposed in America by Mr. Pardy, or an old proposal has been brought forward and developed. It consists in using air compressed to a moderate pressure, say 100 lb., and transmitting this in pipes laid along the length of the tramway line. By simple means the driver of the car will be able, at stand pipes short distances apart, to renew or add to his supply of compressed air in the short time taken to take up or set down a passenger. The difficulties connected with the use of very high-pressure air will thus be avoided, and the details of the scheme ought to provide no great difficulties in working out. Compressed air at moderate pressures has advantages for tramway work over all other means of working motors except the cost of compression. Even this is greatly reduced by the system which can use comparatively low pressures. The hot water or fireless locomotive is making but slight headway, probably because the economy resulting from its use as compared with horses is not evident except when a complete plant of boilers to provide steam for heating the water and an extensive number of engines can be employed. Until this is done the advantages derivable from the system will not be obtained. Electric motors are also making very slow progress, although several small lines are worked by them. The Portrush line is not operated without some hitches, but it has shown the practicable character of electric motors. Mr. Volks' little line at Brighton has demonstrated the practical and profitable character of small lines worked by this means, and Mr. Holroyd Smith is about to construct a two mile tramway for the Blackpool Corporation. This line commences at the gate of Claremont Park and runs along the esplanade to the end of the south shore. The steepest gradient will be 1 in 59. The line will be single with fifteen passing places. During high tides and storms from the west about one-third of a mile is covered by the sea, and provision is made for cutting out this portion, and if the flood permits the cars to pass at all, they will be run through by horses or by accumulators. If the latter are used they will be employed on trucks that couple on as locomotives, and stands will be provided, so that whilst the truck is waiting for another car over this bit, its batteries can be strengthened from the main. Mr. Smith proposes to use two generators, each capable of giving a current of 160 ampères and 200 volts driven by engines of 100-horse power stationed near the centre of the line. The experience both of Mr. Volk at Brighton and of Mr. Holroyd Smith at Halifax, Manchester, and Blackpool, points to the probability that wet and damp will not practically affect the working of tramways by electricity. Of the Blackpool line we shall say more hereafter.

Opinions differ on the canal *versus* railway question, but there can be no doubt whatever as to the facts. In England and in America the inland canals have steadily declined in value as a means of transport and of profit wherever railways have provided an alternative route. That the quicker, though more costly, transit of the railway offers several advantages is proved by the persistence with which traders desert the canals. It is curious that quickness of transport should be of so much importance to senders and buyers of such merchandise as coal and minerals, but it nevertheless seems to be the fact. If it be so with these things, it is somewhat easy to understand that it must be so with most of the imported merchandise. In France the balance in favour of railways for the heavy transport seems not to exist. It may be that time is not so much an object as in this country, but this has probably much less influence on the results than the action of the railway companies in discouraging unremunerative heavy traffic. The canal system is more complete in France, and the railway companies have, in some ways, more freedom to adopt a line of action which is practically a refusal to take heavy transport. The results seem to be as much to the profit of the railways as to the canals. It may be asked whether, if our canals were improved so as to be worked on a more continuous system, they might not be made more attractive to senders of heavy freights, and whether the railway companies would not benefit by carrying less of the low-priced traffic, some of which they say is carried at a loss, that is made up by the higher tariffs charged on other freight. About 22 per cent. of the gross revenue of our railways is derived from minerals, and about 35 per cent. from goods. For this 22 per cent. more than double the tonnage is carried than for the 35 per cent. This apparent anomaly is not all explained by the greater bulk of the goods freights. Twenty years ago the average working expenses were much less—over ten per cent. —than now, and were it not for many improvements in locomotives, stock, and permanent way, the difference would be greater. It may then be a question whether some railways might not benefit if a part of the mineral traffic could be turned to the canals. The canals must, however, first be put in a position to deal with it. At the present time there is an average of 23·25 mineral wagons per mile of railway open in this country. The means of transport are nothing like this on the canals; and it might be asked whether an extension of the system of using a much larger number of smaller barges might not, for local and special trades, provide the means of more rapid transit on canals. Whether, in fact, trains of small barges would not afford greater facilities for loading and unloading—the whole barge might be lifted and tipped—and for different sorts of cargoes. The subject is one, however which we must leave for the present. It has occupied a great deal of attention, and though almost all experience seems in favour of railway transport, collection, and delivery, the time occupied in a reconsideration of the subject would not be thrown away.

With ship canals the case is different, or at least this is so when the ship canals join two oceans or seas, or provide a shorter route between these than previously existed. The Suez Canal is, of course, the most notable example of this class, and its success has compelled its proprietors to undertake to double its width, and thus to make its capacity about that which was intended when the concession was granted, but which was departed from when it became necessary to cut the width according to the money forthcoming. As a result of a visit of the Commission that went to Egypt to study on the spot the best means of improving the canal, the width is in general to be increased to 82 metres—say, 269ft. The Commission based its calculations on the Austral, the largest vessel which up to the present time has passed through the canal. Her breadth of beam is 14·6 metres. Supposing that two such vessels of, say, 15 metres—say, 49ft.—were to meet, it is calculated they could pass each other easily within the width of 82 metres. That would allow of 30 metres between the two ships, and 11 metres between the vessels and the sides of the channel of the canal. In the greater portion of the Suez Canal—that is to say, from Port Said to kilometre 130, situated at the further extremity of the Bitter Lakes—the current does not exceed one mile an hour; yet it is intended that throughout the whole of that portion of its course the canal should be made 82 metres wide at the top of the channel, and 70 at the bottom. From kilometre 130 to Suez—that is to say, in that part of the canal where the currents caused by the ebb and flow of the tide sometimes run two miles an hour—the safety of vessels passing one another is to be insured by making the channel 80 metres wide at the bottom. All the curves are to have a radius of at least 2000 metres. The channel at those places is also to be made 85 metres wide at the top. The proposal to make a second canal has, for the moment, been forgotten, and the widening and making a fresh water supply canal will probably occupy attention for some time.

The Panama Canal, which is also being made under M. Ferdinand de Lesseps, seems likely to have a chequered history. Reports have been drawn up and circulated as to the quantity of earth removed, and the number of men and machines employed. These have been supposed to give an indication of the progress made with this great project. It is, however, much to be feared that large as numbers showing the cubic metres of earth moved may have looked, they really represent what, in comparison with the vastness of the work of this sort involved, is only a mere scratching of the ground. The reports as to the work really done are somewhat conflicting, but if we take into consideration all the facts, we are bound to admit that the real progress made with the undertaking is very small. It is generally believed that not only is the death rate on the isthmus greater than has been admitted, but that there is great difficulty in obtaining experienced workmen and engineers. Recent trustworthy information from several visitors to the works shows that M. Lesseps did not over-estimate the constructive difficulties attending the Panama project, and the political difficulties have not been overcome. Negotiations have for some time been pending between France and the States on the subject, the United States Government interposing objections which would, at the least, cause trouble; but the last information is that France has practically abandoned the canal. A cable despatch says:—"According to the belief of Washington diplomatists, M. Grévy has informed M. Roustan—not by way of official instructions, but conveying his personal opinion—that the Panama and Nicaragua topics had better not be discussed with Mr. Frelinghuysen, French interests in the matter being very small, and M. de Lesseps' venture and the Rothschild loan being purely private enterprises. The knowledge that France holds entirely aloof in the matter will naturally largely influence the Senate regarding the pending Nicaragua Treaty."

The latter sets forth the terms on which the Republic of Nicaragua will give the United States the right to construct a ship canal across the Nicaraguan territory. If the treaty be accepted the canal is to be for the use of all nations, and to be constructed by the Engineer Corps of the United States Army. The last debate on the subject at Washington indicated that unless a large sum be voted for building war vessels the treaty would not be ratified, and this question has, it is said, shown the House the necessity for a navy.

At home the Manchester Ship Canal project holds the first place of interest. Plans have again been deposited in Parliament, certain modifications having been made by which the canal in the Mersey between Runcorn and Eastham is placed along the long southern shore bend, terminating in locks at the latter place. This, it is supposed, will remove the grounds of battle. A proposal to construct a straight channel from near Runcorn across the flat lands to Garston has not been adopted. The wisdom or otherwise of the policy of constructing a canal to Manchester need not be discussed here; it has already received attention in our columns. It is noteworthy that although the circumstances are somewhat different, the policy in other parts of the country is to provide dock room nearer and nearer to the mouths of the great rivers.

Considerable progress has been made with the Corinth Canal, and it is expected to be completed by the end of next year.

The Cronstadt Sea Canal to St. Petersburg was experimentally opened in October last. It is not yet completed, and docks have yet to be made at St. Petersburg. It will save about twenty miles for cargoes which have to be lightered up from Cronstadt, the port for St. Petersburg, for vessels drawing more than 9ft. of water. The canal is 26·5 versts, or seventeen miles in length, from 180ft. to 240ft. in width, 22ft. in depth, cost so far about ten and a-quarter million roubles, and was made by MM. Boreischa and Maximovitch, as contractors controlled by a Government committee.

During the year the old proposal to make Paris a seaport again cropped up; the Atlantic-Mediterranean Canal, cutting off the Iberian Peninsula, has been seriously discussed; the Forth and Clyde Canal project has also been trotted out, and the Jarrow Corporation have appointed a committee to investigate the feasibility of constructing a canal from Jarrow Quay to improve the permanent water-way.*

In referring to the civil engineering work of the past and of the coming year, we may not inappropriately mention that to-day—Friday, January 2nd—is the anniversary of the foundation of the Institution of Civil Engineers, which was established on the 2nd of January, 1818. From a new list of members just printed, it appears that there are now on the books 20 honorary members, 1447 members, 1889 associate members, 508 associates, and 804 students, together 4668, against a total at the same date last year of 4443. This number necessarily represents but a small portion of those for whom occupation must in some way be found, but a very considerable number of these engineers will be found abroad engaged in constructing the roads, railways, harbours, canals, and bridges of new countries which are in future, it may be hoped, to provide us with that increase in the engineering work which the remarkable growth of this, the representative Institution of English engineers, shows us to be necessary. Ten years ago the total number on the lists of the Institution was 2491. Between January, 1875, and January, 1885, the growth has therefore been over 58 per cent. The growth of the total numbers in the profession may from this be only imagined, and the increase in the engineering trade capacities has proceeded at an even faster rate.

In reviewing the facts relative to the sewage question a year ago, we remarked that but little light was then available for the purpose of showing whether the final settlement of this troublesome subject was near at hand. The Royal Commissioners appointed to investigate the effect of the metropolitan main drainage outfalls on the Thames were then preparing their first report, founded on the testimony of 126 witnesses, with 282 more ready to come forward. Early in the year the report appeared, and it was not difficult to see that although the Commissioners couched their conclusions in a mild and conciliatory tone, they were contemplating measures of a serious character. They had found that the effect of the drainage outfalls was hurtful, and they considered that the evils were likely to increase. Hence they decided to enter on the second branch of their inquiry, so that they might be in a position to recommend the proper remedial measures. This further step has since been taken, and London has now to face a series of proposals with regard to the main drainage question which will unquestionably occasion considerable excitement when the matter comes to be fully understood. It is demanded that there shall be a radical change in the manner of dealing with the sewage of the metropolis, and that this shall be effected with the least possible delay. Whatever may be the cost, something is to be done, and certain ways are shown whereby the work may be accomplished. No raw sewage is to go into the Thames anywhere. The suspended matters are to be precipitated by chemical treatment, and if the effluent is to enter the river near London it must be previously filtered through land. As an alternative, the sewage may be conveyed down to the estuary of the Thames, and there cast into the water without any further preparation than that of chemical precipitation. In the first instance, earth filtration means eight square miles of land in the vicinity of the metropolis. Evidently the Commissioners have no great confidence that such a project would be found practicable, and hence the alternative of removing the outfalls to the mouth of the river. But in the latter case there will be the cost of an immense sewer, many miles in length. The complete estimate is one of millions, and remembering that the coal tax will come to an end in 1889, the metropolitan ratepayers are not likely to be very well pleased with their prospective burdens. The final instalment of the main drainage loan of £4,200,000 has just been paid off, to which must be added £1,500,000 for relief lines and additional sewers. It was also intended, shortly before the appointment of the Royal Commission, to expend £160,000 in the improvement of the outfall works. With this outlay, supposing it to take place, it seemed as if the main drainage of London would be at last complete. But suddenly the objections which had long been urged against the outfalls at Barking and Crossness acquired additional force, and the whole question is now reopened, assuming a form which carries with it very wide issues. The Commissioners favour the idea that the drainage of the towns in the district of the Lower Thames Valley and in the valley of the Lea may be brought down to Crossness and Barking, there to join the metropolitan sewage, and thence to be conveyed to the estuary. The southern sewage is to be combined with the northern, the southern being carried under the Thames at Crossness to the northern shore. The scheme is a grand one, and if carried out in its entirety would deliver the towns above London of the difficulty in which they are now placed, and which is represented in the unfortunate history of the Lower Thames Valley Main Sewerage Board, which came into existence in 1877. In the past session of Parliament that body promoted a scheme for treating the entire sewage of the district by a chemical process, the precipitating works to be established at Mortlake. But the project excited a feeling of alarm, and although it had the support of the Local Government Board, it was rejected by a Select Committee of the House of Commons. Resolved to make one more effort, the Thames Valley Board have just adopted Sir Joseph Bazalgette's scheme for carrying the sewage of the district down to Crossness; while, on the other hand, several of the subsidiary authorities are trying to prove to the satisfaction of the Local Government Board that the best possible plan would be to dissolve the Thames Valley Board, and leave each locality to devise and execute its own scheme. For the investigation of this subject, one

* THE ENGINEER, vol. lviii., p. 470.

more long and costly official inquiry is now being added to the others that have gone before, and the result is awaited with much interest. Concerning the disposal of sewage where the sea is contiguous, a singular argument has been put forward within the last few days. Sir John B. Lawes submits that sewage which finds its way to the sea is not necessarily wasted, but serves to provide food for fishes. Hence, it is suggested, arises the fact that the quantity of fish caught on the east coast of Scotland and England, and on the south coast of England, is much larger than on the west coasts of England and Scotland, and on the entire coast of Ireland. In giving evidence before the Royal Commission, Sir J. B. Lawes stated it was quite possible that a larger pecuniary return is obtained by the nation from the sewage being discharged as at present into the Thames than could be obtained from it by any application to the land. The existing plan is easy and cheap; but during the recent hot summer it appears to have given very great annoyance. The Metropolitan Board resorted to chemical treatment, and in a very short time expended £30,000 in a partial deodorisation of the Thames and the sewage. The Royal Commissioners estimate that the cost of treating the entire sewage of London by a good and efficient chemical precipitation process would amount to not less than £200,000 a year. Among provincial towns the current expenses for chemical treatment were found to be rather more than a shilling per head per annum. On the plan of broad irrigation, the sewage of London would require an area of at least sixty-two square miles. Sir J. Bazalgette and Mr. Dibdin consider that by the methods which they have devised the sewage of London could be treated chemically at a much smaller cost than that estimated by the Royal Commissioners, and we may expect that during the coming summer they will give some proof to that effect. On the whole it may be said that the sewage question is entering on a more interesting phase than it has exhibited for some years past.

The water question continues to arrest attention in its financial aspect rather than in its sanitary or scientific bearing. The price of water rather than its quality seems to be uppermost in the public mind, and there is a very sore feeling on the part of the consumers in London and elsewhere on the subject of "annual value." The deficient rainfall of the past year, and the unusual heat of the summer, caused a great deficiency in the water supply in many parts of England, and great anxiety was felt as to the risk of a water famine in some of the large manufacturing towns. The effect has been to stimulate the authorities in several places to enlarge their storage reservoirs, and sundry schemes are on foot for this purpose. London was happily exempt from any troubles of this kind, but although the river supply and the deep wells in the chalk sufficed to meet the demand, the Thames gave evidence that the season was one of unusual drought. There was a marked decrease in the volume of water flowing over Teddington Weir, and objection was made in some quarters that the London water companies were seriously overtaxing the resources of the stream by the quantity which they drew off through their intakes. The condition of the Thames in the neighbourhood of Richmond is the source of continued complaint, so great an extent of the river bed being exposed on the ebb of the tide. The diminished flow of land water during the past summer made matters worse than ever, and the Richmond Select Vestry have prepared a memorial on the subject, addressed to the Home Secretary. The memorialists consider that the abstraction of water above Teddington Lock by the London water companies, "though it has its influence," is not the main cause of the present state of the river between Teddington and Isleworth. Enough water flows over the weir, but it is allowed to waste itself below. The actual reduction in the flow of the Thames for some months past is a remarkable fact. Of course, it is exceptional; otherwise it would have a somewhat direct bearing on the water question. Mr. John Taylor, C.E., in a letter to Sir Francis Bolton, shows that in September last the average daily quantity flowing over Teddington Weir was about 320 million gallons, and later on this fell as low as 250 million. As the water companies were taking more than 80 million gallons per day, it is evident that they abstracted a very sensible proportion of the entire volume. The companies are seeking to enlarge their resources by drawing on the subterranean waters. But, even when they bore into the chalk, it is found that they are not drawing upon an inexhaustible source. The Southwark and Vauxhall Company, by sinking a well on its own land at Streatham, has dried up more than a hundred springs and wells in the neighbourhood, some being at a considerable distance, and the inhabitants of the locality have suffered serious inconvenience in consequence. But subterranean waters are the property of anybody who likes to take them. The Solicitor-General, having been consulted on the subject, states that "at common law there is no right as to percolating water." He admits that the present case is a hard one, but it is practically beyond remedy, unless a clause should be inserted in a company's Bill imposing some restriction as to the underground operations. Still worse is the fact, lately made apparent by a decision in the Law Courts, that subterranean waters may be polluted with impunity, the law taking no cognisance of such an offence, although capable of protecting waters which flow above ground. The search for subterranean water by the Richmond Vestry has ended in finding no water at all, or not enough to be of service. Determined, if possible, to be independent of the Southwark and Vauxhall Water Company, the Richmond Vestry have expended many thousands of pounds in boring for water, and have gone down to a depth of 1439ft. In the interests of science it is desirable that they should keep on boring, but the interests of the ratepayers forbid that there should be any further expenditure on the enterprise. Accordingly the vestry have resolved to cease operations, and the well will be abandoned, unless the scientists can raise a fund to carry on the exploration. As an event in the history of the London water supply, we are bound to mention the admirable display made by the London water companies at the Health Exhibition. In connection with that Exhibition, Sir F. Bolton's hand-book on the "London Water Supply" was a valuable adjunct, destined to take its place as a standard work of reference. The supply of water to the metropolis will probably give rise to a discussion in Parliament in the coming session, the Metropolitan Board having resolved to re-introduce their Bill, by which they seek to be delivered from their present state of helplessness in this matter. As they are now situated, they are simply powerless, and cannot so much as even promote a Bill for a water scheme. Whether this disability is of any consequence is, perhaps, open to doubt. Mr. Torrens will also bring forward his Bill again, defining annual value to mean rateable value, as shown in the rate-books.

The gas companies exhibit no sign of collapse under the influence of the electric light. More than 2,000,000 tons of coal are now annually carbonised to supply gas to London, and the shareholders continue to receive handsome dividends. The possibility that the electric light will ultimately prove a dangerous rival to gas probably has some effect on the market value of gas shares, and may render local authorities less anxious to buy up the companies, or to become manufacturers of gas for their several jurisdictions. In London, the testing of gas is being carefully applied by the Metropolitan Board, though some further improvements in this respect remain to be carried out. A new gas-testing station has been opened, situated at St. John's Wood, and some months back the Gas Referees authorised the testing of gas on the premises of the Metropolitan Board at Spring-gardens. The portable photometer is also in use, although possessing no legal authority. An official return, showing the actual results obtained with this instrument, would doubtless be interesting. Now that gas-testing, as carried out at the authorised stations, possesses a commercial value, it is important in the interests of all parties that the mode of operation should be accurate. The sperm candle has been attacked as failing to afford a trustworthy standard of lighting power. As far back as 1879 the Board of Trade appointed a committee to inquire into the relative merits of the sperm candle method and certain other modes of ascertaining the illuminating quality of the gas supply. But the sperm candle remains as the only statutory standard, although the committee recognised its defects and recommended the pentane test devised by Mr. Vernon Harcourt. In other quarters the Methven standard is advocated. The Metropolitan Board have intimated that in their opinion the existing test is not satisfactory, and have asked the Board of Trade to legalise some better method. With a view to discover for themselves what would be the best apparatus for the purpose, the Metropolitan Board are having the matter experimentally investigated by their own chemist, Mr. W. J. Dibdin. A somewhat hot controversy is going on upon the subject, in which certain results are challenged and apparent facts are disputed. On a topic of a kindred character there has been a warm encounter between Professor Tyndall—himself one of the Gas Referees—and Mr. Chamberlain. The Professor is the champion of gas as a lighthouse illuminant, and is seriously at variance with the Elder Brethren of the Trinity House as to the relative merits of gas and the electric light. Professor Tyndall claims for the gas flame that, owing to its possession of a superabundance of rays belonging to the red series, it is better able to penetrate a fog than the electric light, the latter being characterised by rays of high refrangibility. Out of this scientific consideration there has arisen a very acute quarrel. The question is one of practical importance, as affecting the security of the navigation around the British coasts. There are not a few persons who consider, as a result of their personal observation, that the electric light is a failure in a fog, and that gas has then the advantage. In a clear atmosphere the case may be altogether different. Another gas controversy is that which has reference to the merits of Mr. Cooper's coal-liming process. By this method it is claimed that sulphur is more effectually and economically removed from gas than by any other means. The plan has been tried at the Tunbridge Wells Gasworks, and the results are said to have been most satisfactory. The manner of burning and applying gas, whatever may be the mode of its manufacture, is a subject of interest to the public, and excellent opportunities for becoming acquainted with improved gas burners and stoves were afforded by the Health Exhibition at South Kensington. Doubtless the Exhibition of Inventions, which follows on the same ground this year, will afford further illustrations of the same subject.

It was loudly asserted that a new patent law would work a revolution in mechanical engineering. Nothing of the kind has, however, taken place; indeed, although over 17,000 patents were applied for last year, we have failed to find that any one of these referred to a superlatively meritorious invention. It is not, indeed, too much to say that the result of the first year's operations of the new Patent Law has left mechanical engineering just where it found it; and has fully justified the prognostications of those who asserted that the cheapening of patents was not, in itself, likely to do much good. The great mass of the patents taken out are for trifles. Thus, since a little has been heard about the adoption of a twenty-four hours' system of hour grouping, no fewer than nineteen patents have been applied for, all referring more or less to the method of dividing dials. The work of the Patent-office may be taken as typical of mechanical engineering in general. During the past year nothing very remarkable has been done.

For years past every effort has been strained to effect economy in the use of fuel at sea. As much has not been attempted on our railways; but locomotive superintendents have not been idle, and there is every reason to believe that considerable reductions have been effected in the consumption of fuel. Thus, for example, the following tabular statement shows what has been done in ten years on the Midland Railway, on which there has been a slight decrease in the percentage of goods mileage compared with the passenger mileage during the above period, against which, however, must be set greatly increased speeds and loads. The figures, it must be understood, give the gross coal consumption and the gross mileage for all sorts of traffic—goods, passenger, and shunting, and they reflect much credit on Mr. Johnstone and his staff, who have to conduct some of the heaviest and fastest traffic in the world.

Year.	Train miles.	Increase.	Consumption of coal per mile. lbs.
1873	19,811,396 ...	— ...	57·18
1874	20,834,042 ...	1,022,646 ...	54·68
1875	22,515,234 ...	1,681,192 ...	53·40
1876	23,651,546 ...	1,136,312 ...	52·67
1877	24,738,317 ...	1,086,771 ...	50·76
1878	25,621,576 ...	883,259 ...	48·70
1879	27,097,735 ...	1,476,159 ...	49·17
1880	29,558,458 ...	2,460,723 ...	46·51
1881	31,583,760 ...	2,025,302 ...	47·39
1882	32,062,736 ...	478,976 ...	47·41
1883	33,087,255 ...	1,024,519 ...	49·00

The *Railway News* gives the following interesting table to illustrate the augmentation which has taken place in rolling stock during the last ten years:—

	Locomotive.	Carriages.	Brakes, &c.	Wagons.	Other Vehicles.	Total.
1873 ...	11,010	24,634	9,128	323,701	5,322	362,785
1874 ...	11,510	25,441	9,686	338,835	5,937	379,899
1875 ...	12,005	26,204	10,145	347,311	10,139	393,799
1876 ...	12,505	27,191	10,485	356,121	10,730	404,527
1877 ...	12,767	27,729	10,731	363,672	11,257	413,389
1878 ...	12,969	28,104	10,962	367,888	11,368	418,322
1879 ...	13,174	28,717	11,160	369,694	11,552	421,123
1880 ...	13,384	29,565	11,286	379,934	11,681	432,466
1881 ...	13,727	30,489	11,538	390,012	12,719	444,958
1882 ...	14,128	31,250	11,760	406,795	12,256	462,061
1883 ...	14,469	32,304	12,024	434,261	12,072	490,661

It would appear that a final point has been reached, beyond which it is impossible to go with the simple locomotive, and so resort has been had to the compound system. Abroad, in the first instance, more recently by Mr. Webb, of Crewe, and during the last year by Mr. Worsdell, locomotive superintendent of the Great Eastern Railway. The compounding of locomotives presents many interesting features, and we shall make no apology for considering it a little in detail here. In the case of the locomotive there are practically none of the objections to the use of very high pressure steam cut off early in the stroke that pertain to marine engines, because in any case, the pistons are small, and the momentum of the moving mass of engine and train is so great that the moments of rotational effort on the crank pin may vary very much without producing any evil consequences. All the advantages of large measures of expansion might therefore be had in the ordinary locomotive by simply augmenting the diameter of the cylinders—which has been deprived of all difficulty as far as space is concerned by Joy's valve gear. But it has always been found that if great cylinder capacity is given the drivers will use it, and the result is that they cannot keep up the boiler pressure. In other words, an engine with big cylinders in proportion to the boiler, means a small range of expansion and a low boiler pressure. This is not theory; this is practice; no economy, but the reverse, is secured. Now, let us suppose that the screw reversing gear was so arranged that steam must be cut off in the cylinders at, say, one-third of the stroke, as a maximum, and see what will happen. In such a case the boiler pressure would be kept up and economy would be effected; but the engine would be liable at any stop to get into such a position that it could not start again, because the ports would be blinded by the laps on the slide valves, both for going ahead and backwards. This fact has prevented railway engineers from putting it out of the power of their drivers to work save expansively, and it has rendered the compound system necessary, because with two compound cylinders it is impossible for the driver to work save with a good deal of expansion, and yet it is also impossible for the engine to get into such a position that it cannot take steam either to go ahead or backwards. The entire advantage gained by compounding is that the steam is always worked expansively, instead of only at times. This effects a reduction in the quantity of steam needed, which is again attended by subsidiary advantages. Thus, for example, the use of a relatively enormous blast nozzle becomes possible, with a corresponding reduction in back pressure; fewer sparks are thrown up the chimney, and the duration of the fire-box is prolonged. We shall proceed in a moment to describe Mr. Worsdell's compound locomotive, which we shall illustrate in an early impression. But before doing so we may stop to ask, Is compounding the only way in which drivers may be compelled to use steam expansively? We think the answer may be in the negative. Thus, for example, let us suppose that a locomotive is made, say, with a pair of 21in. cylinders, and a maximum slide-valve admission of 30 per cent. Now to prevent this engine from sticking on a dead point, it is only necessary to drill holes about ½in. diameter through each port face, one hole into each steam port, at such a distance apart that the slide-valve will just cover them both—so that both cannot be open at once—when the slide-valve is in the middle of its stroke. Matters being thus arranged, if the engine while in forward gear stops with all the ports blinded, one at least of the small holes to which we refer must be open, and when steam is turned on the cylinder will quickly have the boiler pressure in it, when the engine will move; and a very little will suffice, once motion is established, to put the cranks in such a position that one of the steam ports will be uncovered by the slide-valve. In this way all trouble may be got over, and the expedient may be applied to any locomotive with a good lap to prevent the necessity of reversing and backing, now practiced when the go-ahead steam port is blinded. The subsequent influence of a small hole of the kind named on the diagram when the engine is running at any sensible velocity would be imperceptible. We need scarcely add that there is no patent for the scheme, which commends itself, we think, by its extreme simplicity.

So much premised, we may now turn to Mr. Worsdell's engine, which is as simple as it is possible to be. It is unlike Mr. Webb's engine in that it has only two cylinders, while Mr. Webb's has, it will be remembered, three, one inside, actuating one pair of driving wheels, a pair of outside high-pressure cylinders actuating the trailing wheels, the driving and trailing wheels are not coupled save by the steam. In Mr. Worsdell's engine both cylinders are inside the frames, and are on the same centre lines as those of the ordinary 18in. cylinder engines. The left-hand cylinder is the high-pressure one, being 18in. diameter, and the right-hand is the low-pressure cylinder, 26in. diameter, both being 24in. stroke. The exhaust steam passes out of the high-pressure cylinder through an enlarged copper pipe carried round the upper part of the smoke-box, so as to act as a superheater for the steam before it enters the low-pressure steam chest; it terminates in this low-pressure steam chest, and the exhaust from the low-pressure cylinder is passed out through the chimney in the ordinary way. A 1½in. starting valve is connected to the superheating pipe just above the steam chest of the low-pressure cylinder. This pipe conveys steam direct from the boiler, and is controlled by a small regulator on the driver's side of the engine, this having a spring handle, so that it cannot be kept open; and a very slight opening is all that is necessary on this large piston to start the engine. To prevent this starting valve operating against the high-pressure piston, a special cut-off valve is arranged, which the driver pulls over, and which is thrown back by the exhaust steam from the high-pressure cylinder, so that there is no attention required to this. This part of the arrangement is most successful. To prevent getting too high a pressure in the low-pressure cylinder when steam is admitted from the boiler, a 1¼in. relief valve is fitted at each end, set to blow off at 80 lb. pressure per square inch.

We may now proceed to consider the results obtained. The engine has now been running for some little time, and Mr. Worsdell is satisfied with the results of its working. There was a little difficulty for the first few weeks in starting, but since the valve was put in for admitting steam to the low-pressure cylinder as just described, no trouble has been experienced, and heavier trains can be started with the compound engine than with any other passenger engine on the line. It has been running regularly, in its turn, the express trains between London and Ipswich, *viâ* Cambridge, and London and Yarmouth, *viâ* Norwich. These trains vary in composition, but the average does not fall below eleven vehicles, and on several occasions the compound engine has taken eighteen loaded coaches, and once or twice has taken twenty-three, stopping at Brentwood Station—the start from which is on an incline of 1 in 84—and has experienced no difficulty in getting away with such a heavy train at this point. The running of this engine seems to be freer, and consequently faster, than any of the engines of the same size and class that are not compounded. We refer to the standard four wheels coupled express engines with 7ft. wheels and 18in. by 24in. cylinders, the dimensions of the compound being exactly the same in every particular, with the exception of the cylinders. The steam is maintained more regularly and easily, the blast nozzle being as large as 5¾in. diameter, whereas in the other engines it is 4½in. to 4¾in. Mr. Worsdell has taken out the consumption of fuel during the month of November, and finds that the average of the engines of a similar type—non-compound—on the same service came to 31·6 lb. per mile. The compound engine under the same circumstances works at 26·8 lb. per mile, showing a gain in favour of the compound of 4·8 lb. per mile.

We would call our readers special attention to the fact that there is little difference between the construction of this engine and others, as it is in all essential points identical with the coupled express engines before mentioned, with the exception of the cylinders; and that instead of one pair of leading wheels working in a radial box, a bogie is used, so as to span the projection caused by the large cylinder on one side. Mr. Worsdell is about to build twenty new passenger engines, ten of which will be on the compound principle, exactly like the one we have just described, and if these confirm the results given by that now running, the whole twenty will probably be made the same.

In the United States few changes are in progress in the construction of locomotives, and it is not very probable that novelties will be produced during 1885 of any importance. The most noteworthy innovation is the extended smoke-box, which is being now very generally adopted. In America there are very stringent laws concerning the evolution of sparks, based, no doubt, on the conflagrations caused in the days of wood-burning engines. Hitherto the well-known conical chimney, with a wire gauze top or its equivalent, has been in use. It is now being superseded, the smoke-box being carried out as much as 3ft. further to the front than usual, the chimney still retaining its normal position. The result is said to be that the large smoke-box acts as a settling chamber, in which the sparks and cinders are deposited, instead of being ejected from the chimney. Extraordinary statements continue to reach us concerning locomotive performance in the States. Messrs. Baldwin have published a catalogue of their exhibits at the New Orleans Exhibition, in which we find it stated that an engine with 16in. cylinders, 24in. stroke, and 130 lb. boiler pressure, the driving wheels 5ft. in diameter, hauled a train, consisting of 105 cars, weighing, with their loads, 1778½ tons, on the Louisiana and Texas Railroad nineteen miles on a level. The weight of the engine and tender is only 47½ tons. Messrs. Baldwin give full particulars of the train, and add, "Assuming the frictional resistance to have been 7 lb. per ton, the performance indicates an actual effective pressure of 127 lb. per square inch developed against the pistons, as compared with a boiler pressure of 130 lb., and a development of tractive power equal to somewhat more than one-third the weight on the driving wheels." Furthermore, we are told that similar engines haul trains of eighty cars, weighing, we assume, 1400 tons, from Algiers to Lafayette, a distance of 144 miles, in about twelve hours. They have to surmount two inclines, one 3000ft. and the other 2000ft. long, rising at the rate of 1 in 251. These are simply astonishing statements. As it is quite impossible that the average cylinder pressure could have been equal to that in the boiler within 3 lb., and as it is to the last degree unlikely that a coefficient of over one-third could be had, it follows that the resistance of the train must have been very much less than 7 lb. per ton, and if that was the case we have much to learn in this country as to the making and working of railways.

An accident on the Manchester, Sheffield, and Lincolnshire Railway last July turned attention once more to the well-worn dispute concerning the merits and demerits of outside and inside cylinder engines respectively. The fact brought out most prominently was that very little is really known, generally, concerning the comparative liability of crank and straight axles to break, and it is much to be desired that the data bearing on this point, which exist in abundance, should be collected, put into shape, and brought before the world in the form of a paper to be read before the Institution of Civil Engineers or the Institution of Mechanical Engineers. The information which we have collected on the subject goes to show that straight axles are just as likely to break as crank axles unless special precautions are taken in designing them. If this is done then they are more durable than crank axles. We illustrate fully this week what may be regarded as the very latest type of outside cylinder engine. This locomotive has been built from the designs of Mr. Charles Sacré, locomotive superintendent of the Manchester, Sheffield, and Lincolnshire Railway. This particular class of engine is employed principally in running the fast trains between Manchester and Liverpool, and the standard load is about 100 tons exclusive of passengers; but in busy times the load is doubled, as many as twenty coaches being put on, excellent time being still kept. The 4½ hour and 4¼ express from Manchester to London are worked by these engines between Manchester and Grantham.

Among shipowners and engineers there is no subject attracting more attention than the possibility of effecting further economies in fuel, or, more accurately, in the cost of working steamships. No fewer than fourteen firms are now making triple expansion engines, and the forced draught system is undergoing at Mr. Howden's hands a somewhat exhaustive investigation, in a boat belonging to Messrs. Scrutton and Co. Opinion is much divided concerning the value of the triple expansion principle, and while we find the north-east coast adopting it extensively, neither in Liverpool nor on the Clyde has as yet met with extended favour. It is no doubt very difficult to arrive at anything like accuracy, but the result of very careful inquiries which we have made is to the effect that the best triple-cylinder engines, working with a boiler pressure of 140 lb., are more economical than the ordinary compound, working with 60 lb. to 80 lb. pressure, by about 15 per cent. In a few cases pressures of 150 lb. and 160 lb. have been used, and it is stated that about 20 per cent. is saved in fuel. It must be remembered, however, that the triple expansion engines are, for the most part, quite new, and their performance is compared with that of engines not quite so new and probably not quite so steam tight, and a very moderate amount of leakage, will represent a considerable difference in economy. Before going on to speak in detail of what is actually being done, and is certain to be done, during 1885, it may be worth while to say a few words concerning the theory involved. The triple expansion engine would be no better than the ordinary engine if the pressures were not different; and the whole advantage derived from expanding steam three times instead of twice is due to the additional range of expansion which high-pressure steam permits us to use. In the ordinary compound engine, with cylinders in the proportion of four to one, it will be found that the true ratio of expansion is about seven-fold, after allowance has been made for clearance, which is usually very large in proportion to the size of the cylinder, in marine engines. In the three-cylinder engine the ratio is probably about twelve-fold. The relative theoretical values of expansion are expressed by the hyp. logs. of the ratios and 1. Thus for a seven-fold expansion we have $1·94+1=2·94$, and for a twelve-fold expansion we have $2·48+1=3·48$, and the consumption of steam will be in the inverse ratio of these numbers. In other words, 29 tons of coal ought to do as much in the one case as 34 tons in the other, or, in round numbers, the saving effected ought to be about one-seventh, or say 15 per cent., and so far theory appears to be fairly consistent with practice. But in the three-cylinder engine condensation appears to be enormous, and any device which would even mitigate this condensation would prove of very great value, provided it was not accompanied by any serious counteracting disadvantages. In another page will be found a letter on the triple expansion engine, which we commend to our readers. For the moment, however, the question is quite beyond the pale of theoretical speculation. It is asserted alike by shipowners and engineers that by doubling boiler pressures from 15 to 20 per cent. can be saved in fuel, and the evidence on this point is at present so strong that we are compelled to accept it. If such statements are not based on facts, then the truth may be trusted to make itself felt ere long. So far, however, there is nothing inconsistent between theory and practice.

The recent history of the triple expansion system is brief and simple. Probably it was first used at sea by the late John Elder. It first took any sound tangible form in the hands of Mr. Alexander Kirk, while engineer to Messrs. John Elder and Co. The s.s. Propontis had triple expansive engines, designed by Mr. Kirk, fitted to her in 1873. She made more than one successful voyage, but her water-tube boiler was a failure, and ordinary compound engines and cylindrical boilers took the place of her original machinery. It was felt, however, that Mr. Kirk was on the right path. The difficulty in the way of following it was purely a question of boilers. Mr. Taylor, of Newcastle-on-Tyne, subsequently designed the engines of the steam yacht Isa, which have given complete satisfaction, the small size of the boiler permitting a pressure of 120 lb. to be used without trouble. Several small engines of this kind were built, such as those of the Millicent, which have been illustrated in our columns. With the introduction of trustworthy steel plates and Fox's corrugated furnaces, the boiler question was revolutionised, and it is now as easy to build boilers to carry 150 lb. as it was in the days of iron to make them to sustain 75 lb. Credit where credit is due, and we think it must be awarded to Mr. Kirk and Mr. Fox in large measure.

The first really powerful triple expansive engines were fitted to the steamship Aberdeen, by Messrs. G. Thompson and Co., in 1881. The success of these engines has been complete. She carries 125 lb. pressure, and so far as can be ascertained from the coal bills—the best possible test—she is burning 15 per cent. less fuel than the best double cylinder engines doing the same work, and we may add that not one sixpence has yet been spent on caulking or repairing the boilers in any way. Last year we gave particulars of certain large Mexican boats fitted with three-cylinder engines. The results obtained with these have not been satisfactory. We refer to this at all only because erroneous statements are in circulation on the subject. The failure of the boilers—it is the boilers which have suffered—was due to causes which have nothing whatever to do with the pressures carried, or the three-cylinder system.

It is very much the custom with some people to denounce the cargo steamer as a disgrace to civilisation. As a matter of fact, however, such vessels deserve to rank among the most remarkable achievements of the day. Nothing in the history of the world has been met with to compare with them in power of transporting merchandise cheaply. The modern cargo steamer is a triumph of science, which has resulted from keen competition among the talented heads of firms, each anxious to beat his neighbours on their own ground. The power required to move vessels through the water at slow speeds is excessively small, and the slow speeds are sufficiently rapid for the required purpose. We may cite a few examples. We shall not, however, give names, lest it should be thought for even a moment that we drew invidious comparisons. A cargo steamer, 258·6ft. long, 34·8ft. beam, and 19·5 deep, immersed midship section 604 square feet, 2345 tons displacement on 18·5ft. draught, burns 9·5 tons of Welsh coal in twenty-four hours steaming at 9 knots. She carries 150 lb. pressure, and has triple expansion engines indicating 609-horse power. The cylinders are 19in., 35in., and 53in. diameter by 2ft. 9in. stroke. Steam is supplied by one double-ended boiler 12ft. 3in. diameter and 16ft. long. It will be seen that in this ship the cost of moving a ton of cargo a mile is almost infinitesimal as far as fuel is concerned. Six sets of nearly similar engines are at sea and all doing well. The owner of the vessel claims a saving of 33 per cent. as compared with the consumption of a sister ship. In another case we find a speed of 8·5 knots per hour—this is her regular working speed—given to a hull 260ft. by 36ft. by 19·6ft., with a total displacement of 3970 tons, by a triple engine with cylinders 20in., 33in., and 54in. diameter, 3ft. stroke. The pressure is 160 lb. This vessel has a sister with ordinary compound engines; the cylinders 32in. and 60in., with a stroke of 3ft. 3in. She makes eight knots, with 13 tons per twenty-four hours, as against 8·5 tons for the triple-cylinder engines. We are disposed to think that the double-cylinder engines and their boilers are not in superlatively good order. One of the great advantages claimed for the triple engine is that much space is saved for cargo. The great object in the Eastern trade is to run from port to port on a small consumption. Thus, the ship we have named can run from Aden to Singapore without coaling, and yet not encroach in any way on cargo space. Perhaps the most remarkable example of the favour which the triple system now enjoys is supplied by four steam colliers, engined by Messrs. Alexander Stephens and Co., of Glasgow. These ships ply between London and the North; each run occupies about thirty hours. They make about fifty trips a year, and probably save two tons of coal per trip by the use of three instead of two cylinders. Inasmuch as colliers use a very cheap coal indeed, it would seem that in this case the game can hardly be worth the candle. Among the principal firms now building triple expansion engines we may mention Messrs. Blair, Palmer, Richardson, the Wallsend Slipway Company, Wigham, Richardson, and Co., Dickinson, Earle's Shipbuilding Company, and the North-Eastern Engineering Company, while Mr. Kirk has designed and Messrs. Napier are constructing two sets of triple engines, each to indicate 8000-horse power, for a Russian man-of-war being built, it is understood, on the Black Sea.

Not content with three cylinders, two firms have adopted four cylinders. The Arowa, built by Messrs. Denny, of Dumbarton, has four cylinders. In this case we have practically an ordinary three-cylinder compound engine—which must not be confounded with a triple expansion engine—with a 61in. cylinder exhausting into two 71in. cylinders, to which has been added a 37in. cylinder. The stroke is 5ft., and the pressure 160 lb. The Barrow Shipbuilding Company has built a vessel in which the steam is expanded four times, her cylinders being respectively 20in., 28·5in., 40in., and 57in. in diameter, with a stroke of 3ft. 6in., and a pressure of 164 lb. The vessel has recently sailed for New Orleans.

As to work actually in hand, Messrs. Denny have four sets. Messrs. Caird have one pair for a P. and O. boat—a sister of the Chusan, for the Australian trade. She is 400ft. by 45ft. by 29ft. deep. The Chusan has two cylinders, 52in. and 96in., by 5ft. 6in. stroke. The new boat will have three cylinders, 35in., 56in., and 89in., with a 5ft. 6in. stroke, and will carry 145 lb. pressure.

We now come to the second departure, as it may be termed, in marine engineering, namely, the use of forced draught. It will be remembered that in the course of a paper on marine engineering, read at the Newcastle meeting of the Institution of Mechanical Engineers in 1881 by Mr. Marshall, reference was made at considerable length to this subject. Hitherto forced draught has been only used in torpedo boats, and in some men-of-war, as, for example, the

Riachuello and the Polyphemus. At the last meeting of the Institution of Naval Architects Mr. Howden read a paper on the same subject, and was severely criticised for the vagueness of his statements. Imbued with the courage of his opinions, he has fitted a ship, the property of Messrs. Scrutton and Co., on his system. She is now away at sea, and is expected to arrive in London about the end of January, and the result of the experiment will be regarded with much interest. She has just half the grate surface usually employed. It may be added that so far the results obtained have been satisfactory. The ship in question is the New York City, one of the Direct West India Line boats. She is 260ft. by 34ft. 5in. by 22ft. 5in. deep, and 1724 tons gross. She was built at Stockton-on-Tees about five years since, and was originally fitted with one double-ended boiler, with four furnaces 3ft. 5in. diameter and 75 square feet of grate area. Her engines have two cylinders 36in. and 61in. diameter, with a stroke of 2ft. 9in. The Howden boiler is single-ended, with three furnaces, each 3ft. 4in. diameter, and only 36 square feet of grate. The saving of one stokehole, and in the length of the boiler, gives 120 tons extra cargo space. The air is supplied by a 36in. Gunther fan driven by a small engine exhausting into the condenser. She made her trial trip in the beginning of last October with great success. She works with a closed stokehole. It is not quite clear to what the gain to be obtained is supposed to be due, but it is probable that it will lie in the possibility of using much smaller boilers than those which are employed under normal conditions, and so weight and space will be saved. The system lends itself to higher pressures. It is well known that the strength of the modern boiler is limited by that of the furnaces, and one of the first results of the use of Fox's corrugated furnaces has been the adoption of larger furnaces than were previously possible. Thus we have now boilers with two furnaces only, over 4ft. in diameter, each furnace provided with two fire-doors. If extreme pressures are to be used, then three furnaces of smaller diameter will give a much better boiler, but it would cost more. The almost invariable practice now is to use tubes 6ft. long and 3½in. diameter. With forced draught there would be better combustion, less smoke, and tubes 2½in. diameter might be used without fear of choking up with soot or a falling off in draught. It is impossible at present to say much either for or against the forced draught system. We can only wait for the development of events.

It may be mentioned that Messrs. Palmer, of Jarrow, and a number of other east coast firms, including Bolckow, Vaughan, and Co., are rearranging their furnaces and plant to roll steel for shipbuilding purposes on the basic system. This is important for the east coast.

A notice of the progress of engineering which did not allude to Joy's valve gear would be incomplete. The advance of this gear in favour is steady and continuous. It has found its way from the locomotive to the marine engine. It is used in the great war ships of the Italian Navy; and its success in the engines of H.M.S. Amphion, recently illustrated in our pages, augurs well for its general adoption in the British Navy. As an example of its success in locomotive work, we may state that the Joy gear fitted by Mr. Webb to a goods engine in 1880 has run 126,892 miles, and the phosphor bronze quadrant blocks are not yet worn out.

Mr. Kircaldy, of West India Dock-road, has devised a simple arrangement for supplying boilers with hot water when they are being filled up afresh after cleaning, &c. A simple feed-water heater is fitted into the feed pipe, and supplied with live steam from the donkey boiler. The apparatus has been applied to several ships; among others to the Somerset, of the Great Western Steamship line. The engineer of the ship states that "the heater worked well on the homeward and outward run, and neither in Montreal nor in Avonmouth was there any boiler-work to do—the first time for five voyages." It appears also that there is a saving of coal effected—in one case amounting to about 9 per cent. The water is sent into the boiler at about 182 deg. Among other matters of detail we may mention that Outridge's balance slide valves seem to be more favoured than balance valves have been. Peyton's balanced valve, made by Messrs. A. Wilson and Co., of Vauxhall, is also extending in favour.

In considering the whole aspect of marine engineering at present, it can hardly fail to strike those conversant with the subject that had the Board of Trade been the only body supervising the construction of marine engines and boilers recent improvements could not possibly have taken place. It is to the strenuous exertions and liberal policy of Lloyd's that so much is due. Lloyd's influence has always been brought to bear to influence the Government body to work in the right direction. We make every allowance for the difficulties under which all Government servants have to labour in dealing with scientific questions, but it is none the less to be regretted that the action taken by the marine department of the Board of Trade has been extremely obstructive. Its policy has no doubt been safe, but something more than this is needed. There has been manifested too a lack of frankness, which is to be deprecated. Thus, for example, when it became obvious that the hard-and-fast rules of the department concerning pressures and strengths could no longer be enforced, the Board, instead of admitting that change was necessary, increased the tenacity of the material, stipulating for steel shell plates with a tenacity of 28 to 32 tons, instead of 26 to 30 tons. Now it is well known that tenacity is simply a question of carbon, and it is also known that the more carbon a steel plate has in it the worse it is. Therefore what we may term Board of Trade steel is a worse boiler material than it need be. To the mildness of steel has been due the whole of its popularity as a constructive material, but a 32-ton steel is certainly not so mild as a 30-ton metal.

In gas engines it is by no means unlikely that a good deal will be done during the year 1885. The great success which has attended Messrs. Crossley's operations has stimulated invention, and new forms of engines are being made or patented either here or in the United States. The original Lenoir type in a very improved form is again being heard of, and some of the new engines are extremely ingenious. Thus in one the gas and air are first carefully mixed with each other, and then sent into the working cylinder. The mixture passes on its way through a short ring, so to speak, of tubing kept at a very high temperature. This ignites the explosive mixture; but the arrangements are so well carried out that the diagram obtained is more like that from a high-pressure steam engine than anything hitherto had with gas. In another type of gas engine, economy of gas is effected by making the governor control, so to speak, the explosion. Thus, although the mixture enters the ante-chamber of the cylinder, it is not suffered to explode unless the governor determines that an explosion is required to maintain the velocity. In hot air engines, pure and simple, we hear of nothing new. The Bailey engine and the Buckett engine seem to have supplied all the existing demand. Mr. Henry Davey, Sun Foundry, Leeds, produced at the Shrewsbury Show last summer a noticeable novelty in the shape of a domestic motor. This is a condensing steam engine working with a pressure about that of the atmosphere. This little machine is perfectly successful, and has very recently undergone certain improvements in form which we shall illustrate. Mr. Davey has employed one of 2-horse power to light his residence at Headingley. It drives a small dynamo, and can keep twenty incandescent lamps brilliantly lighted. A self-acting hopper has been fitted to the boiler, and this being filled up with coke, the engine once started requires no further attention for several hours. Several years have now elapsed since we pointed out in the pages of this journal that if a high-speed steam engine was to be made a success it must be single. The hint was taken, many high-speed single-acting engines soon found their way into the market, and more are being produced. Among those likely to be heard of in the future we may name one being made by Messrs. Burrell and Co., of Thetford, which we have seen at work, although it is not yet before the public. All or nearly all the recent innovations in this type of engine have been illustrated from time to time in our pages.

The distribution of power attracts attention in large towns. Hydraulic pressure mains are being laid down in London for this purpose, and we shall have more to say on the subject. In Birmingham a company has been incorporated under the title of the Birmingham Compressed Air Power Company, which proposes to supply compressed air to work existing steam engines. The theory on which the scheme is based is that it is possible to put up a large plant of engines, pumps, and boilers, which can be worked much more economically than the small engines now distributed all over the town. It is stated in the prospectus of the company, that an enquiry carried out by Mr. Piercy for the Public Works Committee showed that the present rate of consumption amounts to as much as 11·68 lb. of coal per horse per hour for 25-horse power engines nominal, and the company proposes to work its engines for about 1½ lb. per horse per hour; so that allowing 50 per cent. for losses, a large margin would remain for profit. We fear that the scheme can never realise in practice what is anticipated, but it is not improbable that it may get a fair trial this year. We may say that it has been in use for many years at Portsmouth Dockyard, and with great success, cranes and capstans being driven from a central station, while small engines for revolving turrets, &c., are tested in place by leading a hose on board ship from one of the mains with which the yard is traversed in various directions. Popp's pneumatic system of clocks has been at work in Paris and Brussels for several years, with great success. In Paris alone over 8000 clocks and dials are worked in this way, and at Eastbourne the mains needed for Schone's pneumatic drainage system have been down four years in the streets, and have given no trouble. Sir F. Bramwell, who has been employed by the company, concludes his report as follows:—"I believe the Corporation might acquiesce in the laying-on of power by means of compressed air without risk of loss or damage, and by doing so they would be offering the inhabitants of Birmingham, and especially the industries requiring small power or intermittent power, facilities which they do not now possess, and which it would be advantageous for them to have."

The Birmingham Company obtained an Act of Parliament last session—with the support of the Corporation—to supply compressed air to an area of about two and a-half square miles of the town, in which are embraced a vast number of motors now being worked by steam power. Under the Act the company is bound to supply air at a pressure of not less than 43 lb. to the square inch above atmosphere. The capital of the company is £300,000. Before proceeding with the works, the company convened a public meeting on the 17th of December to confer with the manufacturers, whose co-operation as consumers was sought. Mr. Arthur Chamberlain presided, and a large number of the leading merchants were present, who passed a unanimous resolution to support the scheme, which assurance, it was stated, alone was wanted to enable the undertaking at once to be proceeded with. The company proposes to charge for the air power at an average of 5d. per 1000ft., and the consumer will only pay for the amount actually used, which will be measured by a meter constructed to register both volume and pressure. We shall refer to this project more fully in another impression.

The battle of the brakes has raged during the year, and is even not yet terminated, but there is reason to conclude that we are near the end, and that on the principle of the survival of the fittest, the Westinghouse brake will supersede all its rivals. For a long period the railway companies held out against automatic action in brakes, but their resistance has been overcome. At the end of 1880 there were about the same number of vehicles in England fitted with automatic and non-automatic brakes, but at this moment the automatic brakes exceed the non-automatic by nearly three to one in England; the number of Westinghouse brakes being 13,000 at the end of 1883, that of the vacuum brake was about 6000. In France the Westinghouse brake grows in favour. Thus, on the Chemin de Fer de l'Ouest, between the 14th March, 1878, and the 1st of January, 1882, there were fitted with this brake 275 engines, 1802 carriages, 320 vans. Between the 1st of January, 1882, and the 1st September, 1884, there were fitted 178 engines, 734 carriages, and 216 vans, bringing the totals up to 453 engines, 2536 coaches, and 536 vans. It is interesting to note that not fewer than twenty-seven accidents, many of which must have been very disastrous, have been clearly prevented from taking place on this line alone by the prompt action of the Westinghouse brake.

It may interest some of our readers to learn that the difficult problem of cutting epicycloidal and hypocycloidal teeth has been solved by Mr. W. Tighe Hamilton, of Dublin, but as the apparatus has not been patented, we are not as yet able to explain its principles as we hope to do at a future time. It is a following out of the same inventor's bevel gear machines, as to which the doubt was so great in America that an eminent firm wrote that the man must be mad who could suppose it possible to cut a bevel wheel at a single passage of a rotary cutter. The evidence that it is quite possible is seen in the several machines already sent out. Some of these are now at work in the English and Malta dockyards, as well as at Spezzia and in India. In order to carry out in these machines the form of tooth recommended by Professor Willis, which is considered sufficiently true for all purposes in wheels of a moderate size, we can notice the device of shaping the cutters by means of a cone now patented. No doubt this new invention, which we understood originated in the preceding cone cutter, will open a new field for watch and mill gearing, as it is applicable to all sizes, whether small or great. We hold that in mechanics all things are possible, where the idea is lifted out of the old grooves and applied with intelligence to what is required of it. It is only thus that invention has progressed hitherto, and will progress in future, provided experienced men do not allow themselves to be too much hampered by their experiences. In connection with Mr. Hamilton's bevel gear machine, which we explained and illustrated some time ago, we may now notice the remarkable instruments of precision supplied by the same inventor. They are executed in gun-metal by the machinery of an accomplished optician. One is an angle gauge, to give for a lathe the proper back and front angles of blanks for every pitch; the same result as this is now attained by a special machine of a large size supplied to Portsmouth Dockyard. The second instrument adjusts the bevel gear machine to cut the proper taper between the teeth of bevel wheels. The remaining instrument gives all depths of teeth, as well as their widths and those of the spaces within which they act; it also shows for every case the excess of the outer over the pitch diameter. These instruments are either set or the measures taken by the compass, according to the figures engraved upon them.

According to the opinions of those best able to judge, the year 1884 will probably be a turning point in the history of the electric light enterprise, and as, at the present moment, as well as for two or three years past, this application of electricity has been more prominent than any other in the minds of the public, it will perhaps be best to consider it first. It is a thrice-told tale that the hasty promotion and subscription of a large capital in the early days of electric lighting was a mistake. What was really required before so large a capital was embarked in the enterprise was greater experience. This experience has now been obtained to a considerable extent, but at the cost of grumbling shareholders. Even now we are only at the commencement of what may be termed the period of electric lighting, and the machines with which we have to deal and the apparatus which we have to use is far from being perfect. Great strides have been made, and are being made, both in improving the electrical generators and the apparatus which uses the electricity generated—that is to say, the dynamo machines give a far greater output now than formerly, and the lamps, both arc and incandescent, are more economical in using the current. The concensus of opinions from all quarters is that future prospects are far more satisfactory than they have been at any previous period in the history of electric lighting. There should be no wonder at this, for the many proofs we have that the electric light is far superior to any other illuminant in certain places and under certain conditions are so overwhelming that the surprise is rather that its progress is so slow. In proof of this we may point to the fact that arc lighting, although not so extensively utilised on this side as on the other side of the Atlantic, is becoming very common in mills and factories, in engineering operations, in docks, stations, &c., while the incandescent lamp is making its way slowly and steadily to illumine theatres and other large buildings. Taking an example of the spread of incandescent lighting, we may refer to the work of the Edison Company of Berlin. The greater part of this work has been done during the past year, during which time some 22,000 incandescent lamps have been installed, supplied by 169 dynamos of different sizes, and these driven by steam engines having collectively some 2500-horse power. Several of these installations use over a thousand lamps; thus Strasburg station has 1960 supplied from eight machines. The theatre at Stuttgart has 1060 supplied by five machines; the factory of Messrs. Hartmann and Sons, at Munster, has 1000 lamps supplied by three machines. In Berlin 1800 lamps are supplied from the central station in the Friederich Strasse. The theatres at Munich have 2500 lamps supplied by six dynamos. Besides these the light has been applied to mills, hotels, factories, and private houses. The French Edison Company has during its operations put down more than 400 installations, and has about 100 more in hand. Among other work done is the lighting of the Grand Opera, Hotel de Ville, Messrs. Hachette and Co.'s, the well-known publishers, the powder magazines at St. Chamaz, the theatres at Prague and Brunn, in Austria: in Spain, the arsenals at Carthagena and La Carraca: in Roumania the work of lighting up the theatre at Bucharest is almost complete. In Denmark the Royal Palace at Copenhagen has been lighted, and similar installations have been carried out in Italy and Russia. Wherever we look we meet with a fair promise of activity, for in almost every case the opinion expressed is that the orders coming to hand are now largely in excess of what they have been previously. Coming nearer home, the largest and most complete installation outside of exhibitions is that at Victoria station, recently fully described in our columns. Work of similar magnitude is being carried out by the Telegraph Construction Company at the Paddington station of the Great Western Railway, while installations in mills, factories, theatres, and private residences are becoming very numerous. It is interesting here to put on record one case in which electricity and gas have been fairly tried in antagonism, and in which electricity has won the most unmistakeable victory. We refer to the lighting of the Palsgrave, the well-known restaurant, opposite the New Law Courts. Provision was made when building this huge structure for heating, cooking, and supplying the engines for actuating the lifts and the dynamo machines, &c., by means of steam, but on getting into full working order it was found that the supply was hardly so large as was required, and it was thought a considerable saving might be effected by getting rid of a large part of the electric light, introducing gas in its place. After a fair trial it has been determined to resume the electric light.

We have referred to the improvements in dynamo machines, the most important of which have been carried out by Messrs. Crompton and Co., of Chelmsford, and the Anglo-American Brush Company in the Belvedere-road. The basis of Messrs. Crompton's machine was the Gramme; the basis of the Victoria machine was that of Schukert; but each of these manufacturers is quite confident that, with their improvements, a 1000-light machine will be a size of very ordinary make in the immediate future. The Victoria claims that while the well-known 1000-lighting Edison machine weighs, say, twenty tons, its weight is only about one-tenth as much. The improvement in lamps is neither so marked nor so satisfactory as we could wish. Indeed, the complaints are frequent that the mechanical part of the manufacture, instead of becoming better, is degenerating, and that sufficient care is not exercised, in sending out parcels of lamps, to have the lamps similar in every respect. On this account breakages are more frequent, inasmuch as the electro-motive force of, say, 60 volts is not suitable for the lamp which requires only 45 volts. Under these conditions, the lamp soon breaks down, while, on the contrary, a lamp requiring 60 volts is only raised to redness with an electro-motive force of 45 volts. The makers of arc lamps, on the contrary, have made considerable improvements in economy, in steadiness, and in simplicity, and we have no doubt that in many instances where arc lighting is practicable it will soon be introduced. In the question of secondary batteries no great progress has been made during the year, but what has been done has tended to greater durability of the plates, and therefore brings us nearer to the time when these very necessary accessories to incandescent lighting will be quite general. We are glad to see that the more proper estimation of the usefulness of this accessory is becoming common; the idea of storage is no doubt very taking, but it is preferable to consider the secondary battery more as a regulator, and as something which can be called upon to act upon emergency.

One application of electric lighting should not be overlooked, viz., to the lighting of trains. Early in the year Mr. Massey lighted up a shuttle train on the District Railway by means of a miniature plant carried in a van. This method has commended itself to some of the railway authorities, and Messrs. Crompton and Co., have supplied several complete installations to the Great Eastern Railway Company, for use on suburban trains. In these installations one of Heenan and Froude's direct-acting engines is used to drive the dynamo, so that the apparatus is complete in itself, and so far has given great satisfaction.

Perhaps the electric light has more than in any other direction proved its suitability for ship lighting. Scores of ships—we might say hundreds—have already been lighted; many others are to be lighted, and hardly a new vessel is built but it is fitted with the necessary electrical apparatus for such light. So much has been said on this subject that there is little new to be suggested. Sufficient consideration, however, has not been paid to the fittings, or to the best form of lamps, or to the best form of filament in the lamps to be used on shipboard. An incandescent lamp filament is a fragile article, unable to withstand concussion. The more economical the lamp—economy at present consists in a longer, finer, and therefore more fragile filament—the worse is it adapted for the rough usage on board ship, unless every precaution be taken to absorb concussive effect before it reaches the filament.

Two applications of electricity seem to require notice; not that much has been done in this direction, but because much may be done in this direction. We refer to the transmission of power, and the use of the current for heating purposes. Telpherage as yet is in the embryo stage; whether it will successfully emerge the future will solve, but it has been stated that the system is well adapted for use in sugar and similar plantations. The future of the electrical transmission of power, however, is only part of the problem, how best to utilise the great natural forces, now almost entirely wasted, in the shape of winds, streams, waves, and tides. If electricity is to be used, the minor questions of insulation and personal safety must be settled, for at present economy demands very high potentials.

With regard to heating by electricity still less has been done, yet experiments both in England and France show that this application is by no means unimportant. The writers and speakers who complain about London soot have the fixed idea that coal or coke must be burned in grates or stoves in order to obtain the necessary warmth in our houses. Theoretically there are grounds for believing that heat could thus be distributed by means of electricity, but, of course, experiments are required to show how far practice and theory agree.

Turning our attention to telegraphy, there is nothing to chronicle except the usual extensions. The three great cable factories have each done a fair amount of work during the year. The Telegraph Construction and Maintenance Company has manufactured a large quantity of cable for the Eastern and Eastern Extension Company, which has been laid in connecting all the islands of the Grecian Archipelago and in the trans-Indian waters. Much work has also been done for the Direct Spanish and the Brazilian Submarine Companies. Messrs. Siemens have made and laid two Atlantic cables, known as the Bennett-Mackay cables, while the Silvertown Company has done good work in Spanish and South American waters. During the year two new ships—the Magneta and the Electra—have been added to the cable fleet—the former belonging to the Eastern Extension, the latter to the Eastern Company. These vessels are each of about 1000 tons, and have been built by Messrs. Napier and Son, Glasgow, to the designs of Mr. Joseph Burnie. The cable gear has been made by Messrs. Johnson and Phillips, the electrical apparatus by Messrs. Elliott Brothers. The ships are fitted with every modern appliance and improvement, and may be expected to do good work. The one is intended for the Singapore station, the other for the Mediterranean. On land, wires are added to wires, and preparation is made for sixpenny telegrams; but little is known of improvements in instruments, if any, outside of the department.

Similarly the progress in telephony has been more of a commercial than of a scientific nature. Overhead wires are still tolerated, though the time must come when London, at whatever cost, will have to be provided with subways, and then many evils which we now grumble at will pass away. The Van Rysselburgh system has been adopted in Belgium. This system permits the use of the ordinary telegraph wires for telephone purposes. We understand that Messrs. Woodhouse and Rawson are about to introduce the Brown and Saunders system on a practical scale, which enables a number of instruments to be placed on one wire. The use of such a system should tend to reduce the cost to the subscribers. For ordinary telephony a trunk line has been carried through from London to Brighton.

THE INSTITUTION OF CIVIL ENGINEERS.

In conformity with the by-laws, the annual general meeting was held on the 23rd of December, "being the Tuesday previous to Christmas Eve," the president, Sir J. W. Bazalgette, C.B., in the chair.

In the report of the Council it was remarked that it might be convenient to take, as a starting point, the condition of the Institution when the present by-laws were enacted, on the 2nd of December, 1878. Then the strength consisted, irrespective of the students, of 2815 of all other classes; now that number was 3782, or an increase of 34 per cent. in six years. During the past session there had been 279 elections, while the deductions from deaths, resignations, and erasures were 85, leaving a net effective increase of 194, or 5½ per cent. in the twelve months. Out of the elections 100 candidates were resident beyond the sea—a proof that engineers in the colonies were well satisfied with the way in which the affairs of the Institution were conducted and administered.

The death of Mr. Charles Manby, who was for seventeen years the secretary, and had since 1856 been the honorary secretary, had removed from the books one who had taken for many years a leading part in the conduct of the affairs of the Institution. By his tact and energy at an early and critical period of its history, he had managed to secure the co-operation of the principal members of the profession, and of scientific men generally, and thus laid the foundation for its present reputation and success.

The changes in the class of students had been very numerous; for, although there were 170 admissions, exactly the same number had disappeared from the list, of whom seventy-one had become associate members. The total remained the same, 722, as at the close of last year. Of the 1964 students admitted since the creation of the class seventeen years ago, forty-eight were members, 545 associate members, and six associates. As greater activity had of late been displayed by the students, the council had sanctioned, as an experiment, the announcement of twelve meetings for students only for the session 1884-85, three before Christmas and nine afterwards, at fortnightly intervals. No paper would, after the current session, be received from a student, in competition for the Miller Scholarship and the Miller Prizes, when he was qualified by age—viz., 25 years—for election into the corporation.

As there seemed to be a strong desire among many non-resident members that the day for holding the annual general meeting should be altered, the out-going Council expressed the hope that its successor would see fit to convene a special general meeting, at an early and convenient date, for the purpose of considering the propriety, and, if approved, of making the necessary alteration in the by-laws to effect the change.

The statement of receipts and payments for the year ended the 30th of November showed that the income proper had amounted to £14,292 17s. 3d., of which £1769 17s. 5d. arose from dividends on Institution investments, aggregating £48,000, and mainly placed in debenture stocks of British railway companies. There had also been received £3495 9s. from life compositions and the admission fees of new members, which were treated as capital, and £432 11s. 2d. from dividends on trust investments, the total of which was represented by £14,642 13s. 10d., almost entirely standing in Government stocks. On the other side of the account, the general expenditure had been £12,476 18s. 5d., of which £6193 15s. 5d. had been applied in the production of the publications, about twenty-five thousand volumes in all, which were delivered free of charge to all members wherever resident. The capital investments during the year had amounted to £5322 3s. 8d., and the premiums under trust had absorbed £516 11s. 11d.

The Council were directed to arrange for the publication of the papers read at the ordinary meetings, and of such other documents as might be calculated to advance professional knowledge, in aid of the public and scientific objects for which the society was founded. In pursuance of this obligation, it was satisfactory to refer to the four volumes of "Minutes of Proceedings," as they must necessarily afford the main evidence to distant members of the work of the Institution. These volumes had included, in addition to the papers read and discussed at the ordinary meetings, forty "other selected papers," of which five were by students, besides "Abstracts of Papers on Foreign Transactions and Periodicals," a section of the volumes much appreciated by members in the colonies, as well as by others. There had likewise been issued to every member the series of six lectures on "The Practical Applications of Electricity"—the first lectures ever delivered at the Institution—and this series would be speedily followed by those given last session on "Heat in its Mechanical Applications." Arrangements had been made for the delivery during this session of six lectures on "The Theory and Practice of Hydromechanics."

For papers read at the ordinary meetings, the Council had had pleasure in awarding a Watt medal and a Telford premium to Mr. S. W. Barnaby, Telford medals and Telford premiums to Mr. S. B. Boulton and Mr. W. Foster, Telford premiums to Mr. W. T. Douglass, Mr. J. A. Longridge, and Mr. W. Hackney, and the Manby premium to Mr. G. H. Stayton. For papers printed in the "Proceedings" without being discussed, Telford medals and Telford premiums had been awarded to Mr. T. Andrews and Mr. F. Collingwood, and Telford premiums to Mr. J. H. Apjohn, Mr. T. Gillott, Mr. J. W. Wyatt, and Mr. W. S. Crimp. For papers read at the supplemental meetings of students, the awards had included the Miller scholarship to Mr. A. R. Sennett, and Miller prizes to Messrs. P. C. Cowan, W. O. Rooper, R. Moreland (*tertius*), E. W. Cowan, and J. Fawcus.

Referring to the list of subjects for papers which had lately been circulated, it was stated that it was not to be regarded as limiting in the least degree the range of inquiry, nor to be taken in any sense as supplanting previous lists, but only as supplementing them, in the same way as it would in turn be altered, amended, and enlarged. One direction in which it was thought members might materially enrich the "Proceedings" was by furnishing detailed particulars of a technical character, respecting the engineering resources of newly-developed countries, embracing observations on preliminary exploration or pioneer work on the materials used, and on the tools and appliances available.

This brief statement would, it was trusted, be taken as evidence that the Council had zealously endeavoured to adopt every possible means for the advancement of the Institution, and so to transact its business as to confer the greatest benefits on the greatest number of members.

After the reading of the report, the President presented the premiums and prizes to the several recipients. The adoption of the report having been duly moved and seconded, was declared to be carried, and ordered to be printed in the "Minutes of Proceedings" in the usual manner. Hearty votes of thanks were then passed to the president, the vice-presidents, and other members of Council, to the lecturers, the auditors, the secretary, and the scrutineers for the services they had rendered to the Institution.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, December 19th.

A VIGOROUS effort is to be made to induce the anthracite coal-producing companies of Eastern Pennsylvania to reduce costs of coal and rates of freight, so as to effect a reduction in the cost of pig iron 1 dol. per ton, to offset the cheaper Alabama and Virginia iron. The two finest grades of American iron were reduced this week from 18 dols. to 16 dols. at furnace, and it is probable that other grades will be shaded. Forge ranges from 15 dols. to 16·50 dols.; foundry, 16 dols. to 17·50 dols. delivered. At present 171 anthracite and bituminous furnaces are making 67,000 tons of iron per week. Bessemer and Scotch are selling sluggishly. The unrest is keeping buyers, large and small, out of the market, and, in fact, negotiations on the point of terminating a few days ago have been discontinued until after the holidays. The Pennsylvania makers are able and determined to keep out all, except in poorish Alabama iron, as the steamship lines cannot deliver it at less than 4 dols. to 4·50 dols., and the railroad lines at 5 dols. per ton, while home iron pays 1 dol. to 2·50 dols., according to distance hauled. Steel rail contracts this week cover 15,000 tons. A buyer has sailed for Liverpool to place contracts for 100 miles of road in Mexico. The entire line will be 2000 miles long, and will be built rapidly. Several large requirements are in sight. January demand will be active. No upward tendency is probable. Lead and copper are declining, and production is being restricted. A great deal of rolling capacity is shutting down for the holidays. Prices throughout are weak. Within six months eighteen anthracite furnaces have blown out and five bituminous furnaces. The anthracite coal trade, which has maintained a monopoly over the production of coal for ten years, is encountering serious opposition from manufacturers, who demand reduction in cost of coal, and from bituminous coal operators, who are crowding their coal into Eastern markets. Thus far, nearly one million tons have been sold over the volume sold last year, and that in spite of a general restriction of manufacturing. Old rails are wanted here at 16 dols., Bessemer pig at 18 dols., Spiegel at 25 dols.; but these figures are too low to find sellers. A moderate demand exists for Scotch pig, tin-plate, steel wire rods, and steel forgings. The iron trade will not present any encouraging features until after the railroad builders, ship and car builders, and engine and locomotive builders shall have completed their requirements for the next six months.

Railroad returns are not satisfactory. Several changes in management are probable. The Pennsylvania and Reading Companies are scaling down expenses still further, and are avoiding all unnecessary purchases, repairing where possible, and holding operating expenses down to minimum limits. The Baltimore and Ohio will expend its ten million dollar loan in betterments in the mineral regions of Western Pennyslvania and West Virginia. The reduction of wages continues, and no serious opposition is made. The general liquidation of values when completed will make general improvement probable. There are about three weeks' pig iron stocks in the country, and a depletion in all lines of staple products is rapidly progressing. Strong efforts are being made to secure very Conservative legislation at Washington. Opposition is developed in western cities to the Lowell Bankruptcy Bill, and the adoption of all the essential features of the English bankruptcy laws are strongly urged.

Capital is abundant, and rates of interest continue nominal. This year's bankruptcies will foot up ten thousand, and this year's fires in the States and Canada 112,000,000 dols. Trade prospects are expected to improve in wholesale and manufacturing circles early in the year. Ten thousand carpet weavers and shoemakers are on strike in Philadelphia. *Bradstreet's* has appeared with complete industrial returns from all the leading manufacturing centres, showing a decline of 25 per cent. in the volume of business as compared to last year, a reduction of 10 to 20 per cent. in rate of wages, and a general decline in the profits on investments.

The total imports of merchandise at this port for past week foots up 8,133,943, and for year 406,291,218 dols, The exports of specie for the year are 15,694,818 dols. against 15,317,586 dols. for same time last year. Copper production for the first ten months in Lake Superior region was 32,000 tons. Trouble is threatened in the copper combination, and the heretofore autocratic authority of the Calumet and Hecla has been resisted. Lake copper is steadily declining, and no opposition is likely to check the downward tendency. The volume of business last week as against the same week last year shows a decline of 20 per cent. according to clearing house returns. The general business of the country is stagnant. No early improvement is probable. The iron trade is greatly depressed throughout the States. Lower quotations fail to draw out orders, and suspensions of production are taking place on a large scale. Rails are held at 28 dols. in small lots at mill. An effort has been made to cheapen cost of production by a reduction of freight rates and coal prices. A large coal-producing area in central Pennsylvania has been recently developed. Special interest is taken in the Spanish treaty. Manufacturing and commercial interests are divided; ironmen oppose it, coal companies favour it, tobacco interests are bringing strong influence against it. The Pennsylvania iron producers have organised an association for protection. The recent reduction in pig iron has practically shut out Southern iron, as good Lehigh is sold at 18 dols. for No. 1 foundry, and 16 dols. for forge. The bar, plate, sheet, and pipe mills are doing less work than usual, but an improvement is expected to grow out of the requirements which are usually presented during the first thirty or sixty days of the year.

The New Orleans Exposition is attracting great attention, and the traffic southward will be unprecedentedly large. Southern cotton mills are resuming with abundant orders at improving prices. The distribution of textile goods in Eastern markets is improving, and manufacturing activity is likely to result.

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

(*From our own Correspondent.*)

THE new year is opening tamely in the West Midland iron and coal trades. A small number of the mills and forges resumed work after the holidays this week. Such concerns were, however, generally those where orders are on the books which call for early delivery. At many works the fires will not be re-lighted till next week, masters being generally glad of the opportunity afforded by the holidays to delay manufacturing operations.

Those firms who have most orders on their books with which to begin the new year are the thin sheet and tin-plate makers. Certain of these were very busy during the closing three months of last year, and they were the first to resume this week. Orders are on the books for the United States, Germany, Australia, and other distant markets, and already encouraging new inquiries are to hand on home account. The outturn of these descriptions of iron last year must have been very considerable, and the probabilities favour a large outturn during 1885. Prices of thin sheets range from £11 to £13 per ton.

Makers of merchant and galvanised sheets have done but very little work this week. The difficulty lately observable of getting in specifications under old contracts continues. Yet some of the galvanised sheet makers report themselves this week with a fair number of orders in hand and with good prospects. The demand is finding expression mainly on account of Australia, South America, and the Cape. Business with the Argentine Republic is expected to be improved this year by the removal of the import tariff upon galvanised sheets—a step which it is understood the Argentine Government contemplate taking with the opening of 1885. Certainly shipments to that part of the world have of late been held back in anticipation of such reduction in tariff.

An improvement in prices is greatly desired by the galvanised sheet makers. Ordinary qualities of 24 gauge bundled, delivered Liverpool, may be had at something between £11 10s. and £12 per ton. Black sheets, singles, are £6 10s. to £7, and doubles are £7 5s. to £7 10s.

Good bar makers are anticipating the receipt at the end of February or early in March of orders from the Australian Colonies —markets which are of much importance to South Staffordshire. A rather better demand on home account was experienced for best bars during the latter portion of last year; and although at present inquiries are very quiet, yet it is hoped that home consumers will before long again enter the market. Marked bars remain at £7 10s.; other excellent bars are £7; second-class bars, £6 10s.; ordinary, £6; and common, £5 10s. as a minimum.

The chairman of the Iron Trade, Mr. Benjamin Hingley, who is the head of one of the principal bar-making firms in South Staffordshire, gives it as his opinion this week that prospects are not bright for the new year, since wherever we look, whether at home or abroad, there seems, in his view, to exist few circumstances which are likely to occasion any revival in the demand. The slackness of orders for finished iron from the Australian colonies, South Africa, India, South America, and other foreign markets, is due in the judgment of this authority largely to the low prices which prevail for native produce in the countries mentioned, whether wool, grain, sugar, tea, or what be indicated. These low prices deprive consumers of their average purchasing power, and they are compelled to be satisfied with hand-to-mouth buying.

Strips and hoops and other descriptions of light merchant iron are in actual business easier this week. Hoops are £6 to £6 5s. at works, and gas strip £5 15s. per ton upwards.

New business in all branches is generally postponed until the quarterly meetings, which are fixed for Wednesday and Thursday next, in Wolverhampton and Birmingham respectively. Standard prices will in all probability be re-declared without alteration.

The ironworkers, numbering some 250, were on Wednesday paid off at both works of the Chillington Iron Company in Wolverhampton and Bilston, under the notice recently given by the company to terminate contracts. No intimation has been given to the managers or the operatives as to when their services will again be required. This—Thursday—morning the shareholders received circulars calling an early meeting of the company.

The pig iron trade does not show much life this week. Still a few sales of pigs made out of this district have been made in lots of 1000 tons and 500 tons. Derbyshire brands have changed hands in this fashion upon the quotation basis of 42s. 6d. per ton. Tredegar hematites are quoted at 55s., with but little business. Native pigs are 80s. for cold blast all-mines; 60s. down to 55s. for hot blast; 45s. down to 42s. for part-mines; and 37s. 6d. down to 35s. for cinder pigs.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—The year has closed with both the coal and the iron trades of this district in a generally unsatisfactory condition, and with an absence of any hopeful feeling with regard to the future. Although there has undoubtedly been a considerable weight of business done during the past twelve months, it has never been sufficiently large to overtake the enormous means of production, and the result has been that excessive supplies have constantly borne down prices. From the beginning to the end of the year there has been a practically unchecked downward movement in both pig and finished iron, which, during the twelve months, has resulted in a fall of about 4s. to 5s. per ton in the price of local and district brands of pig iron, and of 10s. to 11s. per ton in the price of finished iron. Hematites, which have met with only a very depressed demand all through the year, have probably never touched much lower prices than those which have been taken during the past twelve months. In the coal trade a dull inanimate demand, with plentiful supplies in the market, has been the prevailing feature all through the year, and this has been accompanied by an almost continual downward movement in prices, which received only a very partial check with the commencement of the present winter season, and the year closes with best coals 1s. to 1s. 6d., and the commoner classes of round coal 6d. to 9d. per ton lower than they were at the end of 1883. With regard to the large contracts that are usually placed out during the year, the railway companies were to a large extent able to cover their requirements for good qualities of locomotive fuel at about 5s. 6d. per ton at the pit mouth, whilst gas coal contracts were accepted at a trifle under last season's rates, but not for quite such long periods of delivery to which colliery proprietors during the previous couple of years were willing to commit themselves.

In the engineering trades the year opened with a fair amount of activity in nearly all branches, except those directly connected with shipbuilding, and even marine engineers had a tolerable weight of work in hand which they were finishing, but as this was not replaced as it ran out, they have since been only indifferently employed. Locomotive builders have had their shops full of work all through the year, and although the weight of new orders has of late been gradually falling off, they have, with the close of the year, still sufficient in hand to keep them fully employed. The machine tool making trade has also had a very fair run of activity all through the year, which, notwithstanding a tendency to taper down during the last few months, is still tolerably well maintained, and there are very few of the leading firms who will commence the new year with any real slackness of orders in the shops. Cotton machinists have had a considerable weight of work coming into their hands, both in connection with the fitting up of new mills in Lancashire and for export. Small stationary engine and millwright work has been somewhat fluctuating, but the builders of heavy engines have been kept well employed, and apart from the depression resulting from the collapse of shipbuilding, the engineering trades of Lancashire have during the past year well held their own. So far as the men are concerned, although employment is not so good as it was at the commencement of the year, there has been no really serious falling off in the demand for labour, and except in the shipbuilding centres, wages have been maintained at the advanced rates which were conceded when trade showed indications of improvement last year.

The closing iron market of the year at Manchester on Tuesday brought together a moderately good attendance, but there was only a very dull tone generally, and little or no attempt was made at business either in pig or finished iron. Nominally prices, which, however, were scarcely tested, remained without change, Lancashire pig iron delivered equal to Manchester being quoted at 41s. to 41s. 6d., less $2\frac{1}{2}$, with about the same figures representing the average basis for good district brands, although there were forge qualities of Lincolnshire to be bought readily at 40s. per ton, less $2\frac{1}{2}$, delivered here. A few inquiries for long forward delivery into next year were reported, but these were of no great weight, buyers, as a rule, preferring to hold over the consideration of further contracts for the next two or three weeks, until business has again resumed its ordinary course, and some more settled idea with regard to prices has been obtained through the medium of the quarterly meetings. In the finished iron trade prices remain on the basis of £5 10s. to £5 11s. 3d. for bars, £6 for local made hoops, and about £7 for local made sheets delivered into the Manchester district.

Messrs. W. H. Bailey and Co., of Salford, are constructing for the Technical School of the City Guild Institute, London, a number of testers for tensile and torsional strains in metals, cements, concrete, and other materials of construction, and apparatus for testing oil and other lubricants. All the above apparatus is being produced from new special designs, and I may add that Messrs. Bailey, who have paid considerable attention to the improvement and perfecting of all description of testing appliances, have just issued a pamphlet descriptive of the various testers manufactured by them. Amongst their most recent improvements is a deadweight wire and cloth tester, in which a very simple mode of operations is introduced for testing elasticity and tensile strength. Shot is poured into a can at the end of a lever until fracture takes place, when the shot is taken out, weighed, and the weight being multiplied by fifty, an accurate result is obtained. The elastic strain and tensional stretching are taken up by means of a worm and wheel, and recorded in ten-tenths of an inch on a dial plate at the foot of the machine. Another new machine is a ster-hydraulic crushing tester for cement, concrete, stone, or brick, which can be used on an office table with facility, and has been specially designed to meet the requirements of architects and civil engineers who want something cheaper than the expensive hydraulic press for the above purpose.

Messrs. Frank Pearn and Co., of Manchester, have in hand several specialities in pumps and hydraulic plant. They are constructing for Sir Arthur Guinness and Co, of Dublin, a pair of vertical pumping engines with 22in. cylinders, 16in. rams, with 18in. stroke, which are specially designed for pumping from a well, the engines being above ground and the pumps in the well. The engines are arranged to work expansively, with an automatic cut off which is regulated by one of Hartnell's governors. These pumps are constructed to raise 1000 gallons per hour 200ft. high. A pair of large pumps have just been completed for the Bridgewater trustees; these have two double-acting 7in. rams and 26in. high pressure and 40in. low-pressure cylinders with 24in. stroke; the engines are also condensing, and the pumps have to force 18,000 gallons per hour against a head of 870ft. The firm are also engaged on hydraulic plant for pumping against 3000 lb. to the square inch.

In the coal trade, with the exception that there has been a little extra push of orders during the past week from buyers anxious to get in supplies prior to the New Year holiday stoppages of the pits, which in many cases will extend over pretty near a week, there is no actual improvement in the demand. Generally a very dull tone is reported for the time of the year, and prices are not more than maintained at the late low rates. At the pit's mouth best coal only in very exceptional cases averages more than 9s. per ton; seconds, 7s. 6d.; common house fire coals, 6s. 6d.; steam and forge coals, 6s.; burgy, 4s. 6d. to 5s.; best slack, 4s. to 4s. 3d.; and common sorts, 2s. 9d. to 3s. per ton.

For shipment there has been a moderate demand during the past week, with good steam coal delivered at the high level, Liverpool, or the Garston Docks, fetching about 7s. 6d. per ton.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

WORK was resumed after the Christmas holidays in several of the large establishments on Monday, but there will be little done this week, as the Sheffield artisan regards new year as holiday time as well as Christmas.

At Swaithe Main Colliery, the scene of the great explosion a few years ago, four men were engaged on Monday morning in a level, lowering the floor of the mine. Suddenly, without any warning, a large stone, 15ft. long by 8ft. wide, and nearly 2ft. thick, fell from the roof. One labourer was killed on the spot, another injured, while the others escaped.

On Monday morning at two o'clock, a goods train from Grimsby to Manchester was wrecked at Crowden Station, just beyond the Woodhead Tunnel. The train consisted of twenty-five wagons, eighteen of which were thrown off the line, five being overturned, and three smashed. The main line was blocked for four hours, when the up-line was cleared for traffic, but it was twelve hours before both lines could be used as usual. Among several wagons picked up at Kiveton Park Station was a salt truck, which was returning to Cheshire laden with coals. The axle of this truck gave way, and the sudden jerk snapped the couplings, thus causing the accident which, though destructive to rolling stock and part of the permanent way, was unaccompanied by personal injury.

Mr. Philip Ashberry, an employé of Messrs. Ward and Payne's, the well-known edge tool makers, has invented a machine to make chisels, by which work which formerly cost 5s. 6d. a dozen can be done for 2s. a dozen. The firm have rewarded the inventor with £100, and he also receives a share of the profits on the chisels thus produced.

The Denaby Main Collieries are now the scene of a gigantic strike, the hands—between 1100 and 1200—having brought out their tools on the last day of the year, being determined to resist the proposed revision of prices.

Hematite iron—Nos. 1, 2, and 3—was 55s. per ton in December, 1883. In June, 1884, it fell to 53s. 6d., and the price now ruling is 53s. If anything, the hematite iron market is rather firmer just at present. Six weeks ago hematites were sold at 52s. to 52s. 6d., but makers will not accept these figures now. At the end of October last prices of this class of iron fell as low as was ever known, excepting only when, in 1879, they dropped to the same figure—52s.

Some interesting figures of Sheffield trade with the United States—information about which is now excessively difficult to get—have been supplied to me. From 1870 to 1883 there was a value of £12,517,133 exported to the United States. The highest point was touched in 1872, when the value was £1,734,626, and the lowest in 1878, when the year's business was represented by £429,016. In 1881 there was a "boom," and the value again mounted to £1,287,401, falling in 1883 to £793,675. To three quarters of 1884 the total value is £446,481. The amount for the fourth quarter of 1884 has not yet been ascertained, but it will be considerably smaller than for 1883. A better business is expected with the United States next year, when there is no presidential contest; besides, stocks must be excessively low.

The efficiency and usefulness of the Telephone Exchange in Sheffield has been fully confirmed by the enormous increase of the calls during the past week, which were 14,236, or 4200 in excess of the corresponding week of last year. The largest number of calls registered in one day was on Thursday, when the number amounted to 2840. Messrs. Tasker, Sons, and Co., of Sheffield, who direct the Exchange, have been appointed telephone engineers to her Majesty in recognition of the way in which they have completed telephone work at Balmoral, Abergeldie, Ballater, and Windsor.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THE Cleveland iron market, held at Middlesbrough on Tuesday last, was but thinly attended, and no business of importance was transacted. Merchants continue to offer No. 3 g.m.b. for prompt delivery at 35s. 6d. per ton, and for delivery to the end of June, 1885, at 6d. per ton more. Most makers have orders which will last till February commences, and in the meanwhile they show no disposition to reduce their prices. For immediate delivery they quote 36s. to 36s. 3d. per ton, and 3d. to 6d. per ton more for deferred contracts. As the finished ironworks are more or less closed for stocktaking, the consumption of forge iron has fallen off considerably, and the price is proportionately easier. The usual quotation is 34s. per ton, but certain makers still ask 34s. 6d.

The quarterly meeting of the Cleveland Iron Trade will be held at Middlesbrough on January 6th.

Messrs. Connal and Co.'s stock of pig iron at Middlesbrough decreased 100 tons last week, the quantity held on Monday being 52,419 tons. In their Glasgow store the stock on the same day was 579,358 tons.

Shipments of pig iron from the Tees, taken from December 1st up to Monday last, reached 62,019 tons, of which 37,485 tons were sent to Scotland. During the corresponding period of November 74,654 tons were exported.

There is a fair demand for finished iron, for purposes other than shipbuilding, and it is expected that orders will be given out more freely when the holidays are over. Prices are unaltered, plates of shipbuilding quality being worth about £5 per ton; angles, £4 15s.; and common bars, £5 2s. 6d., free on trucks at makers' works. Messrs. Jones Brothers started their plate mills again on Monday last, to work off a few orders which have accumulated.

The demand for steel rails has not improved. The quoted price for heavy sections is still £4 15s. per ton. The North-Eastern Steel Company's works at Middlesbrough, and Messrs. Bolckow, Vaughan, and Co.'s works at Eston, are closed this week for repairs and stocktaking.

A meeting of employers and workmen connected with the North of England shipbuilding yards is intended to be held at Newcastle this week, in order to discuss the wages question, and, if possible, to settle the existing dispute amicably. The employers demand a reduction of wages of $7\frac{1}{2}$ per cent., and to this the men are strongly opposed.

The leading engine building firms carrying on business on the banks of the Tyne have, it is said, decided to claim from their men a further reduction of wages, owing to continued depression in trade.

The following shows the gross tonnage of vessels launched during 1884 at North of England ports:—On the Tyne, 124,221 tons; on the Wear, 99,597 tons; at Hartlepool, 30,963 tons; on the Tees, 30,336 tons; at Whitby, 6803 tons; and at Blyth, 5067 tons; total, 296,987 tons. This is less than half what was launched in 1883 at the same ports, the total tonnage for that year being 597,277 tons.

It appears that the Spanish Government has intimated its intention to increase the export duty on iron ore, and that to a serious extent. Hitherto the duty has been $2\frac{1}{2}$d. per ton, now it is about to be increased to 10d. This will affect seriously the cost of production of hematite pig iron in this country, and the value of steel in every form will be proportionately increased. The only exception will be that which is made by the basic process, as in that case no hematite pig iron is used. When it is remembered that two tons of hematite ore are required to make one ton of pig iron, and $1\frac{1}{4}$ tons of pig iron to make a ton of ingots, and $1\frac{1}{10}$ tons of ingots —approximately—to make a ton of rails, it will be manifest at a glance that nearly two shillings per ton will be added to the cost of rails by the increase of export duty. This will be a clear advantage to those who manufacture by the basic process. For inasmuch as they are too few as yet to supply the entire current demand, low though it be, they will be able to obtain the full benefit of the rise which those who make from Spanish hematite will have to demand to avoid loss. The advantage will equally be gained by those connected with the production of hematite pig from English ores. The smelters will get the benefit to the extent of their current ore contracts, for these will now be more valuable. When they expire the lessees of the mines will get the benefit, until their leases terminate. After that it will come entirely to the royalty owners. For it is obvious that Spanish mineowners, who alone are able to compete with them, will now be handicapped to the extent named. All this is on the understanding, of course, that the Spanish Government carries out its present intention, and continues to maintain the same policy.

The advantage pointed out as likely to accrue to those who manufacture rails by the basic process will eventually stimulate competition among them. More and more rails will come to be so made from inferior pig iron, and fewer in proportion from, at all events Spanish, hematite, for supposing manufacture from the two kinds of pig iron to have been hitherto equally profitable, it is clear that the basic method will now become the more profitable of the two.

When sufficient time has elapsed for the steel rail trade to have adapted itself to its new circumstances, then will the Spaniards discover the true effect of their change of policy. They will then perhaps find the bulk of the steel manufactured in England derived from English ore, instead of, as at present, from Spanish ore. They will then, perhaps, also find their revenue from export duty on this article to have dwindled into insignificance. It is not merely a question of trade economics operating in the way above pointed out. There is also the perhaps still more important question of breach of, or shock to, confidence, as between seller and buyer. Extensive works have been erected and an immense trade has been established in several parts of this country, in the faith that raw material could always be obtained from Spain without impediment of a political character. Certainly timid persons have at times pointed out that there was always a risk of the trade being imperilled should the Spanish Government raise the export duty in order to obtain money to meet pressing necessities. But such forebodings have usually been silenced by the reply, that the Spaniards too well knew the folly of mal-treating the goose which furnished them so plentifully with golden eggs. The hour of mal-treatment appears to have arrived notwithstanding. It will be surprising if the goose, as represented by British users of Spanish hematite ore, does not feel a considerable diminution of confidence in the wisdom and fair dealing of the Spanish Government. The cry will be raised that if this increase of taxation be quietly borne, others will from time to time follow; so that sooner or later there will be nothing but Spanish mercy between the British steel trade and ruin. This will never do. Every available influence ought immediately to be brought to bear on the Spanish Government to induce it to abandon the suicidal policy it menaces. It should also be respectfully urged to give adequate assurance that it will not raise the question again in the near future. If a satisfactory reply cannot be obtained, then the sooner the use of Spanish ore by English smelters is abandoned the better. It would be the height of folly to continue thereafter to found and develope mighty industries in this country in the hope that the Spaniards will some day recover their wisdom, and sell their ores untaxed.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE Christmas holidays have necessarily tended to limit business in the iron trade. There was no pig iron market from Wednesday of last week till Monday, and this week the meetings have, for the most part, been little else than formal. It is much to be regretted that, owing to a want of cordial feeling between the ironmasters, they have not been able to issue their annual report of the production and stocks for the past year. All the firms, except four, representing five ironworks, sent in returns, these amounting to 75 per cent. of the whole, but the ironmasters resolved that they would not estimate the remaining 25 per cent., and decided, as they could not yet frame returns, to issue no report at all. It is necessary to make this explanation in order that the reader may understand that, as regards the production and stocks of makers' pig iron, the official returns this year are a pure estimate. No doubt they are carefully prepared, as carefully as they possibly could be in the circumstances, and are probably not in any particular very wide of the mark. The report is as follows:—

Production, Consumption, Exports, and Stocks of Scotch Pig Iron from December 25th, 1883, to December 25th, 1884, published by authority of the Committee of the Glasgow Association of Iron Merchants and Brokers.

	1884.	1883.	1884. Increase.	1884. Decrease.
	Tons.	Tons.		
Production	988,000	1,129,000	—	141,000
Consumption:				
In foundries	237,000	235,000	—	—
In malleable and steel works..	231,000	248,000	—	—
Quantity of malleable iron and steel made: — 1884, 387,000; 1883, 427,000	463,000	483,000	—	15,000
Exports:				
Foreign, 316,603—less English iron transhipped (estimated), 3400	319,463	415,612	—	—
Coastwise	197,251	204,045	—	—
Railway to England.. ..	17,286	27,343	—	—
	534,000	647,000	—	113,000
Stocks:				
In Connal's stores	579,423	584,138	—	—
Quantity in makers' hands ..	241,577	250,862	—	—
	821,000	835,009	—	14,000

	1884.		1883.
Average price M/n warrants ..	42/1½	..	46/9
Average number of furnaces in blast	95	..	110
Number of furnaces in blast on December 25th	93	..	103
Imports of English iron by rail and water .. .. Tons	369,000	..	432,000
Lowest price touched, June 4th..	40/10	..	43/6
Highest price paid, January 21st	44/7½	..	49/3½

The shipments of pig iron in the past week were only 5815 tons, as compared with 6091 tons in the preceding week, and 7221 in the corresponding week of 1883.

In the malleable department there is a fair amount of business, but no sign of an improvement in prices. A few shipbuilding orders have been placed, but the iron and steel required for them will scarcely have much effect upon the trade generally. The iron and steel goods, exclusive of pig iron, shipped from Glasgow in the past week, are valued at fully £60,000. They included eleven locomotives, worth £18,715, five of these being for Adelaide, and six for Bombay. Steel barge work, weighing 41 tons, and valued at £750, was sent off to Calcutta, to which considerable quantities of steel rails were also despatched, and Melbourne took £1576 worth of tramway rails, besides pipes and castings.

The coal trade has been in an active state during the week, shippers being anxious to get their orders implemented before the New Year holidays. At Glasgow 24,000 tons were shipped; Greenock, 108; Irvine, 1304; Troon, 5538; Ayr, 7118; Leith, 3262; Burntisland, 15,775; Bo'ness, 824; and Grangemouth, 9605 tons. The aggregate shipments for the twelve months are about 200,000 tons less than they were last year. There has been a considerable drop in the prices in 1884, and just now the prospect of an improvement is not encouraging.

Last August attention was called in this correspondence to a resolution of the directors of the Glasgow and South-Western Railway Company to exercise their running powers over a part of the North British system, with the object of affording direct communication with the Lanarkshire collieries and the Ayrshire ports. The company introduced a reduced tariff and did all it could to foster the trade, but it appears it has not been successful. Only 10,000 tons of coals have been carried in four months from Lanarkshire to the ports of Ayr, Irvine, Ardrossan, and Troon. This is not more than is frequently shipped in three days at Glasgow harbour, and it is therefore not surprising that the railway directors have intimated that they will discontinue this traffic after the 31st January. Of course the Ayrshire coalmasters will not regret the resolution, or that the competition with them in the shipping department of the coal trade is for the present a failure.

The Clyde shipbuilders have intimated a general reduction of ½d. per hour in workmen's pay, to take effect in the course of a few weeks.

WALES & ADJOINING COUNTIES.

(*From our own Correspondent.*)

OUR industries have scarcely rallied from the holidays, and hence export totals of coal and iron figure very feebly from all the ports. Cardiff only sent away 82,000 tons during the past week, or two-thirds of its late averages, and one-half only of former averages. The steam coal trade is decidedly quiet, and the colliers generally have had rather a poor Christmas in consequence. Taking the last quarter into account, a good deal of time has been lost. Rhondda collieries especially have suffered, and docks and railways in ratio. Last week a number of horses had to be withdrawn from the Bute Docks, there being an insufficiency of work. The fact is a trifling one, but suggestive, showing, too, the extreme vigilance exercised in minute details. One is reminded by contrast of incidents of the old *régime* of collieries and ironworks, when managers had small farms of their own, and agents realised handsome incomes by commission on all materials bought, and "dead men" invariably figured on pay sheets. I have heard of a custom in one district of placing a substantial *douceur* in the fire-box of every new locomotive sent into Wales, and of heartburnings when the gift got into wrong hands.

House coal is quieter at this time of year than it usually is, and coalowners are somewhat perplexed to know the reason. Prices are easy both for steam and house. Small steam is going off better, and prices are stiffer than they have been ef late.

Pitwood is firmer in price on account of lessened quantities coming to hand, and ruling quotations are at 18s.

Patent fuel maintains its vitality, makers' books are well supplied, and prices remain unchanged.

It is always a significant sign when one of the vigorous rulers in the coal world transfers his responsibilities to a company. Although remaining a member of the company, with greater interest than any, still the individual character is gone, the reign practically over. I see that Mr. Davies, M.P., owner of the Ocean Collieries, has seceded in this manner. He has floated the company I referred to last week, with a capital of £400,000 in £100 shares, and henceforth will be associated in his collieries with London and other capitalists. I think his tenure as a coal owner has been about fifteen years, and his success is established by the fact of his being a millionaire.

Cyfarthfa sent down its first train of coal to Cardiff this week over the new line of the Rhymney and Great Western. This has been an expeditiously formed line, and Messrs. Meakin and Dean deserve strong commendation for the energy shown. For the present the connection with the Great Western will be worked by the Cyfarthfa branch, as a couple of months' work remain to make the regular link. A clever bit of work is to be seen at Glyndyrus, where a new bridge has been substituted without interfering with the traffic, which is always considerable.

Preparations are going on steadily for the start of steel works at Cyfarthfa, and there are hopes of colonial orders coming to the neighbourhood, of which they may have a share. Dowlais is now working Canadian ores.

At present orders are few and trade generally slack. I fear that before any substantial good can arise a few of the weak must go to the wall. It seems a case of the "survival of the fittest," as in human affairs. Here, however, the works are fairly equal, and with ample coalfields, which by a turn of the wheel may become remunerative again.

I regret to see that the Willow Wire Works at Merthyr are closed, but am informed that it is only temporary, and that it is not likely the fine plant will long be left idle.

Bar iron is a little better in favour of inquiry, though business is not brisk. Tin-plate works have not rallied sufficiently from the Christmas stoppages to enable one to form an opinion as to the probable state of trade.

At Swansea business is hopeful for New York. America and Holland are coming in fairly well with orders.

The gross export of coal foreign and coastwise from Cardiff during the year 1884 is estimated by good authorities to be slightly over nine million tons.

Next week I shall be in a position to go more into details.

An improvement in ship business is noted at Swansea, and tonnage is coming in better. Imports, too, are good.

It is rumoured that another important tin-plate works is going into the steel bar trade.

The management at Penrhiwcerber Colliery is to be changed.

Efforts are being made for a further development of the Bristol coal field. It is officially stated that the coal is almost identical in quality with the best seams of South Wales, and that it has been tested by several leading companies, whose report is most favourable. I can scarcely think, however, that Bristol, with its proverbial astuteness, would have allowed a coal equal to that of South Wales to remain undeveloped.

THE number of printing establishments in New South Wales is sixty-five, employing 1804 hands, exclusive of newspaper printing offices.

MADAGASCAR.—Madagascar consists of a central plateau or highland rising from 4000ft. to 5000ft. above the lowlands of the coast, and from this plateau rise occasional volcanic cones, the highest, Ankaratra, being 8950ft. above the sea. These volcanoes extend from the northern extremity of the island to the 20th parallel of south latitude. South of this appear granitic rocks, at least as far as 22 deg. south latitude. At higher latitudes than this the rocks of the interior are practically unknown to Europeans. According to a recent paper by Mr. F. W. Rudler, F.G.S., several crater lakes and mineral springs abound; and to the north of the volcanic district of Ankaratra there is a tract of country containing silver, lead, zinc, and copper ores. As regards building stones, besides the granite which is so general, there are vast beds of sandstone and slate between the district of Ankaratra and the fossil regions in the south-west of the central plateau. These fossils, according to M. Grandidier, the recent French traveller in the interior, are referable to the Jurassic system, and comprise remains of hippopotami, gigantic tortoises, and an extinct bird of the ostrich species. The coasts of the country are rich in timber, and it would also appear that the interior is a good mineral field.

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 numbers of the Specification.*

Applications for Letters Patent.

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

19th December, 1884.

16,650. CUTTERS and CUTTER-HOLDERS, W. F. Smith and A. Coventry, London.
16,651. DEPOSITING MAGNESIUM and its ALLOYS, F. W. Gerhard, Wolverhampton, and J. Smith, Stoke-upon-Trent.
16,652. DEPOSITING CALCIUM and its ALLOYS, F. W. Gerhard, Wolverhampton, and J. Smith, Stoke-upon-Trent.
16,653. DEPOSITING ALUMINIUM and its ALLOYS, F. W. Gerhard, Wolverhampton, and J. Smith, Stoke-upon-Trent.
16,654. SUSPENDING SPRING STIRRUP, T. Temple, Leamington.
16,655. CONNECTIONS for ELECTRIC LEADS, &c., W. B. Sayers and G. Hookham, Birmingham.
16,656. ELECTRICAL SWITCHES, W. B. Sayers and G. Hookham, Birmingham.
16,657. EXCLUDING AIR from CASKS, &c., W. J. Cooper, Burton-on-Trent.
16,658. CARDING ENGINES, T. Garside and T. and J. Taylor, Manchester.
16,659. PENCIL and CRAYON CASES, M. Turnor, Birmingham.
16,660. PRESERVATION of MARE'S MILK, the Hon. F. A. Wellesley.—(*G. L. Carrick, St. Petersburg.*)
16,661. STEAM BOILERS, J. H. Leetham, Kingston-upon-Hull.
16,662. PERPETUAL AUTOMATIC CALENDAR, W. P. Thompson.—(*M. C. Mégnin, Saint-Imier.*)
16,663. BLEACHING FABRICS, &c., W. Mather, Manchester.
16,664. WEAVING of CORDS, J. E. Newton and J. E. Harrison, Manchester.
16,665. AUTOMATON BIRD, &c., TARGETS for RIFLE PRACTICE, A. Slocombe, Birmingham.
16,666. FASTENING STAYS, &c., E. L. C. Dubois, London.
16,667. STEAM CONVERTER, J. Gullery, Belfast.
16,668. CLOSING UP WINDOWS, J. Robertson, Sunderland.
16,669. WORKING RAILWAY BRAKES, J. C. Jones, Rhymney.
16,670. SCREW COLLAR JOINT for DRAIN PIPES, J. C. Webb and F. D. Smith, London.
16,671. COVERS, &c., for CLOSE ANNEALING METALS, E. S. and S. T. Thompson.
16,672. CHIMNEY COWL and VENTILATOR, E. G. Wright, Landport.
16,673. RAISING SUNKEN VESSELS, &c., S. Garau, London.
16,674. IMPARTING ROTARY MOTION to BORING DRILLS, &c., T. Haxton, London.
16,675. CONVERTIBLE BROADCAST SOWER, &c., T. Haxton, London.
16,676. STANDARDS for WIRE FENCES, T. Haxton, London.
16,677. KNITTED WARP FABRICS, H. B. Payne, London.
16,678. MOTIVE POWER ENGINES, J. Elliott, London.
16,679. SASH FASTENER, G. Collings, London.
16,680. KNITTING MACHINES, J. Foster, O. P. Laue, and E. T. Timæus, London.
16,681. UMBRELLAS, &c., E. A. Thomson, London.
16,682. BRUSHES, E. G. Thomson, London.
16,683. MULES for SPINNING, W. Griffiths, J. Rushworth, and R. Ratcliffe, London.
16,684. DOUBLE-CORD ACTION for BLIND, &c., ROLLERS, E. and J. M. Verity and B. Banks, London.
16,685. GARDEN SPADES, J. Lee, Birmingham.
16,686. APPLYING LOCAL HEAT to the BODY, J. Simmonds, London.
16,687. SHARPENING EDGE TOOLS, H. G. Bridge, London.
16,688. RAIL and PERMANENT WAY for RAILWAYS, J. Wallace, London.
16,689. WROUGHT IRON and STEEL TUBES, T. Jones and J. Smith, London.
16,690. ENGINES, W. Lockwood, London.
16,691. WATER CIRCULATING FIRE-BARS, &c., D. Riley and W. Lee, London.
16,692. RECEPTACLES for USEFUL ARTICLES, M. Boyd, London.
16,693. SORTING TABLE for LETTERS, &c., W. Dickson, London.
16,694. PLATES or SURFACES for PHOTO-MECHANICAL PRINTING, E. Falk, London.
16,695. WASHING MACHINES, H. St. G. Voules and R. H. Lowe, London.
16,696. FIREGRATES, &c., F. H. Moore, London.
16,697. AUTOMATIC DIAL GONG TICKET PUNCH, R. W. Thomas and P. C. Smith, London.
16,698. GAS MOTOR ENGINES, G. Turner, London.
16,699. DAMPENING MACHINES, T. S. Wiles and M. E. Wendell, United States.
16,700. MEAT POWDER, M. Bauer, London.
16,701. PRESERVED MEATS, &c., M. Bauer, London.
16,702. TRUSSES, E. de Tomanzie, London.
16,703. FLY-TRAP, E. de Tomanzie, London.
16,704. LOW-WATER ALARM and WATER GAUGE, H. J. Haddan.—(*E. Roynette, Sotteville-les-Rouen.*)
16,705. PURIFYING or SOFTENING WATER, A. Howatson, London.
16,706. SEPARATING IMPURITIES from LIQUIDS, A. Howatson, London.
16,707. SECURING TROUSERS at their LOWER ENDS, S. and J. Chandler, London.
16,708. LOOMS, M. Corrigan, London.
16,709. CHIMNEY COWLS and VENTILATORS, J. White, London.
16,710. BEDSTEADS, J. Martin and J. C. Mineard, London.
16,711. BEATERS for THRASHING MACHINES, C. Woolnough, London.
16,712. FLOORING CLAMPS, H. H. Lake.—(*T. A. Southwick and Major C. Alexander, United States.*)
16,713. FOOT-POWER APPARATUS for DRIVING MACHINERY, H. H. Lake.—(*E. Maynz, United States.*)

20th December, 1884.

16,714. CANS or CHURNS for CARRYING MILK, C. Stroud, Wolverhampton.
16,715. PURIFYING SULPHURIC ACID, J. Donald, Glasgow.
16,716. WIRE TONGS, W. T. Smith, Birmingham.
16,717. TREATING CALCIUM CHLORIDE, W. S. Richardson and W. J. Grey, Gateshead-on-Tyne.
16,718. DOUBLE-ACTING HIGH-PRESSURE SLUICE VALVES, T. Blakeborough, Brighouse.
16,719. SLEEVE and CUFF LINKS, W. C. Alldridge and D. Blakley, Birmingham.
16,720. OIL CAP for CARRIAGES, A. Barnfather, Carlisle.
16,721. NUTCRACKERS, P. and A. Crawford, Paisley.
16,722. GIRDER, T. Dykes, Glasgow.
16,723. SHUTTLES and BOBBINS, T. and C. L. Tweedale, Manchester.
16,724. MECHANISM for the DIVISION of TIME, R. Crowe, jun., Liverpool.
16,725. WEIGHING APPARATUS, A. E. Ragg, Liverpool.
16,726. PERAMBULATORS, L. L'Hollier, Birmingham.
16,727. DOUBLE DARK SLIDES for USE in CAMERAS, I. Todd, Halifax.
16,728. ELECTRICAL SELF-ADJUSTING PENDULUM INDICATORS, F. King and W. P. Mendham, Halifax.—*17th November*, 1884.
16,729. ELECTRIC ARC LAMPS, G. A. Nussbaum, London.
16,730. RAISING and SUPPLYING FUEL to the HOPPERS of MECHANICAL STOKERS, W. Senior, Halifax.
16,731. ELECTRICAL SWITCH for PREVENTING SPARKING, J. A. Kingdon, London.
16,732. CHECKING RACING in MARINE ENGINES, J. H. Hamilton, London.
16,733. ELASTIC BOOTS, W. Pearson, London.
16,734. WRITING TABLETS, J. Willoughby and J. A. Eaton, London.
16,735. COMMUNICATING by ELECTRICITY between MOVING TRAINS and FIXED STATIONS, H. J. Allison.—(*L. J. Phelps, United States.*)
16,736. WORKING, &c., GUNS, A. Sauvée.—(*J. B. G. A. Canet, Paris.*)
16,737. CIGARETTES and CIGARS, C. Ricketts, Folkestone, and G. de Chassiron, Dover.
16,738. RACKS for STACKING RIFLES, W. Dickson, London.
16,739. VISIBLE-FEED LUBRICATORS, T. Rrabson, London.
16,740. JOINTING EARTHENWARE PIPES, J. C. Bloomfield, London.
16,741. OBTAINING COLD DRY AIR, F. W. Scott, London.
16,742. CARRIAGE BRAKE BLOCKS, H. Downie, London.
16,743. EFFECTING the SUBSIDENCE of SOLID MATTERS in SUSPENSION in LIQUIDS, E. Perrett, London.
16,744. SAFETY POCKET RECEPTACLE for LADIES', &c., WATCHES, C. Hammond and D. A. J. McFarlane, London.
16,745. LOCKS, C. F. Veit, London.
16,746. COAL VASES, &c., R. H. Bishop and W. Down, London.
16,747. MEANS of GIVING INFORMATION to PASSENGERS, &c., G. E. Welsman and W. R. Oswald, London.
16,748. ADVERTISING, W. R. Oswald and G. E. Welsman, London.
16,749. TRACTION ENGINES, T. R. Harding, London.
16,750. EFFECTING TIGHT CLOSURE of GAS RETORTS, H. Green, London.
16,751. OBTAINING IMPROVED DECOCTIONS or INFUSIONS of TEA, &c., G. C. and A. G. Thompson, London.
16,752. OBTAINING MUSICAL SOUNDS on REED INSTRUMENTS, J. Beare.—(*E. Hamma, Stuttgart.*)
16,753. BICYCLES, J. K. Starley, London.
16,754. DEVICE for INDICATING whether the BOLT upon WATERCLOSET, &c., DOORS is or is not FASTENED, A. A. King, London.
16,755. FIRE LIGHTERS, A. Hubbard and H. C. Connew, London.
16,756. PORTABLE HOT-WATER APPARATUS, &c., for BATHS, &c., G. A. Harvey, London.
16,757. DIALS or FACES of WATCHES, &c., W. H. H. Muir, London.
16,758. DENOTING TIME on the DIALS or FACES of WATCHES, &c., W. H. H. Muir, London.
16,759. HYDROGEN, R. Lehmann.—(*J. Oettli, Cossonay.*)
16,760. SAFETY BANDS for CHILDREN on PERAMBULATORS, &c., F. Koopman, London.
16,761. COMPOSITION for IMPARTING BRILLIANCY to HATS, W. R. Lake.—(*Simon Coste, Paris.*)
16,762. CONTROLLING the MOVEMENTS of GUNS, J. Vavasseur, London.
16,763. BLEACHING POWDER, J. Burnett, London.
16,764. DYNAMO-ELECTRIC MACHINE, S. Z. de Ferranti London.
16,765. FENDERS, C. A. McEvoy, London.
16,766. CONTROLLING the PRESSURE, &c., of FLUIDS, W. T. Layton, London.
16,767. STEERING, &c., ELECTRICAL ENERGY, J. H. Johnson.—(*L. H. Rogers, U.S.*)
16,768. STEAM TRAPS, &c., for SEPARATING WATER, &c., from VAPOURS, &c., I. S. and J. T. McDougall and T. Sugden, London.
16,769. HYDRATES of BARYTA and STRONTIA, W. G. Strype, London.
16,770. PORTABLE ELECTRIC LAMP, A. V. and G. F. Rose, London.

December 22nd, 1884.

16,771. SASH FASTENER, T. and J. Broomhall, Birmingham.
16,772. BOX SLIDES for DOOR CHAINS, J. Walker, Birmingham.
16,773. INDEX MACHINES, &c., in LOOMS for WEAVING, J. E. Wadsworth, Manchester.
16,774. LAVATORY BASINS, &c., Hr Sutcliffe, Halifax.
16,775. FIRE-PROOF PASSAGES, H. Smith, Birmingham.
16,776. STEAM SIGNAL WHISTLES, G. Gill, Durham.
16,777. TROUSERS' TREES and PRESSES, A. T. Saxelby, Birmingham.
16,778. VAN-LOCK, H. Roberts, Carnarvon.
16,779. BAR ATTACHMENT for CHAINS, A. J. Pettit, Birmingham.
16,780. LANDAU, &c., HEAD LIFTS, G. Simmons, Liverpool.
16,781. WINDOW SASH FASTENERS, J. Walker, Birmingham.
16,782. LOOMS for WEAVING, J. Gregson, Preston.
16,783. ADVERTISING and POSTAL PACKET, R. Shaw and J. Lyon, Glasgow.
16,784. PROTECTOR for the FEET from WET, R. Hill, Glasgow.
16,785. ARRESTERS, &c., for DESICCATING MACHINES, &c., W. A. Dyer, London.
16,786. REGISTERING PAPER, &c., upon the FEED TABLES of PRINTING, &c., MACHINES, F. Hoyer, London.
16,787. FIXING, &c., SPRING APPARATUS of TOOTHED LAMP SLIDES, J. H. Stone, London.
16,788. ATTACHING PILLOW SHAMS to BEDSTEADS, &c., H. L. Goodwin, New York.
16,789. PRODUCTION of CAUSTIC SODA, &c., W. G. Strype, London.
16,790. WINDOW SASH FASTENER, H. A. Williams, Stratford.
16,791. CUTTING, &c., WOOD, P. R. Shill, London.
16,792. LAYING, &c., SLATES, G. Ross, London.
16,793. UNCAPPING and CAPPING LENSES, F. W. Branson, London.
16,794. UNCAPPING and CAPPING LENSES, F. W. Branson, London.
16,795. ARC LAMPS, E. J. Paterson and J. Foxcroft, London.
16,796. TRACING WHEELS, J. Simmonds, London.
16,797. ADVERTISING SIGNS, J. Simmonds, London.
16,798. COUPLINGS for RAILWAY CARRIAGES, J. H. Cohrs, London.
16,799. TELEPHONES, W. J. Bethell, London.
16,800. FOUNTAIN PENHOLDERS, H. J. Haddan.—(*B. Köllisch, Nürnberg.*)
16,801. GIG MILLS, C. E. Moser, Halifax.
16,802. PROMOTING CIRCULATION of WATER in STEAM BOILERS, J. Keiller, London.
16,803. APPARATUS for FILLING and SYRUPING ARTIFICIAL, &c., BEVERAGES, J. H. and W. Galloway, London.
16,804. OSCILLATING GUN CARRIAGES, L. K. Scott, London.
16,805. PRODUCING CARBONISABLE MATERIAL for the MANUFACTURE of CARBONS for ELECTRIC LAMPS, F. Wynne and L. S. Powell, London.
16,806. MANUFACTURE of HUMAN EXCREMENT in DRY and VALUABLE CONDITION, C. Lehofer, London.
16,807. RECLINING CHAIR, W. F. Endall and F. W. Hassan, London.
16,808. SEWING and QUILTING FABRICS, A. W. L. Reddie.—(*F. L. Palmer, United States.*)
16,809. BUTTONS or DRESS FASTENERS, A. Morrison. (*G. Feigl, Gablonz.*)
16,810. CHECKING EVAPORATION from the ROOTS of PLANTS, R. S. Moseley, London.
16,811. GAS-COOKING STOVES, J. Russell, London.
16,812. VENTILATING MINES, J. L. Lobley, London.
16,813. FLEXIBLE or FOLDING BUCKETS, W. R. Lake.—(*A. F. Moriceau, Paris.*)
16,814. TUBULAR SURFACE CONDENSERS and HEATERS, J. Kirkaldy, London.
16,815. BILLIARD MARKERS, &c., O. W. Hill, London.

16,816. MAKING SCREW STOPPERS for BOTTLES, H. Codd, London.
16,817. OPENING and CLOSING FANLIGHTS, &c., R. Adams, London.
16,818. EFFECTING the AUTOMATIC CLOSING of DOORS, M. P. Ismay, London.
16,819. VALVES for AIR PUMPS, &c., J. Allan, London.

23rd December, 1884.

16,820. HEAT REGULATORS for FIREPLACES, N. Poulson, Paris.
16,821. SASH BAR CRAMPS, &c., J. H. Hubert and T. Colley, Wolverhampton.
16,822. AUTOMATIC OPENING and CLOSING POCKET RECEPTACLE for CHALK, J. Jackson, Birmingham.
16,823. STONE BREAKING and CRUSHING MACHINES, W. H. Baxter, Halifax.
16,824. REEDS for WEAVING LOOMS, &c., E. Haydock, Halifax.
16,825. TELEPHONE EXCHANGE CALL INDICATORS, S. Williams, Newport.
16,826. SADDLE STIRRUP BARS, W. Woolley, Birmingham.
16,827. LAMPS for BURNING HYDRO-CARBON OILS, &c., G. R. Postlethwaite, Birmingham.
16,828. SPRINGS, S. E. Howell, London.
16,829. FIRE-LIGHTERS, C. G. Satterthwaite, London.
16,830. MECHANICAL STOKERS, J. Hodgkinson, London.
16,831. WATER GAUGES, W. P. Thompson.—(*H. Ochwadt, Germany.*)
16,832. HORSESHOES, W. Stewart, Glasgow.
16,833. FENCING WIRE, F. W. Brampton, Birmingham.
16,834. SLOW COMBUSTION SMOKELESS GAS FURNACE, J. Somerville and W. H. Y. Webber, London.
16,835. STEAM ENGINES, &c., G. Westinghouse, jun., London.
16,836. EXTINGUISHING FIRE, W. B. Dick, London.
16,837. LOOSE PULLEYS for SHAFTS, H. J. Haddan.—(*J. McCaffrey and C. H. Smith, U.S*)
16,838. DOUBLE-LOOPED BANDS, W. K. Blackburn, London.
16,839. GRINDING, &c., LITHOGRAPHIC STONES, &c., W. Greaves, Halifax.
16,840. TELEPHONE RECEIVERS, J. E. Fuller, London.
16,841. BOOTJACKS, R. P. Dawson, London.
16,842. VENTILATION of MINES, &c., W. Teague, jun., London.
16,843. TRIMMING and STITCHING FABRICS, J. W. Dewees and E. B. Moore, London.
16,844. CRUSHING MILLS, &c., A. G. Brookes.—(*E. M. Villeroy, Schramberg.*)
16,845. MILITARY WATER BOTTLE, W. J. Boyes, Bishop's Stortford.
16,846. COVERING INSULATED WIRES with LEAD, A. D. Wilson, London.
16,847. CLEANSING COMPOUND, F. J. Harrison, London.
16,848. MECHANICAL CALCULATOR, R. Gough, London.
16,849. SHIELDS for MACHINE GUNS, &c., L. K. Scott, London.
16,850. EXCHANGING MAILS between TWO TRAINS in MOTION, E. C. E. Gallois, London.
16,851. COOKING RANGES, A. Emley, London.
16,852. FURNACES for CLOSE ANNEALING METALS, J. Page, London.
16,853. REDUCING HARD SUBSTANCES, W. W. Beaumont, London.
16,854. FASTENINGS for CUFFS, &c., W. E. Patterson and G. Slater, London.
16,855. PLATING SILVER with GOLD, J. Banks, London.
16,856. CUTTING and FACING the SIDES of SCREW NUTS, W. Fairweather.—(*G. Skrziwan, Berlin.*)
16,857. ROTARY ENGINES, G. Persson, Sweden.
16,858. DIRECT-ACTING ENGINES, H. E. Newton.—(*C. C. Worthington, United States.*)
16,859. WASHING MACHINES, J. Hunt, London.—1*st November*, 1884.
16,860. SELF-ACTING WATER-CLOSETS, H. N. Marks, Stoke-upon-Trent.
16,861. RAILWAY CROSSINGS, R. Price-Williams, London.
16,862. LAVATORIES, &c., G. Pepper, London.
16,863. EXHIBITING the SIMPLE MULTIPLICATION and DIVISION TABLES, J. A. Dingle, London.
16,864. REPRODUCING DRAWINGS, &c., W. S. Simpson and J. F. Sutton, London.

24th December, 1884.

16,865. RIDING SADDLES, A. Perkin, Water Orton, near Birmingham.
16,866. CRANES or HOISTS, J. Craven, Leeds.
16,867. VALVES, R. Whitehead, Manchester.
16,868. CHARGING LIQUIDS with GASES, &c., I. Levinstein, London.
16,869. VALVE GEAR for STEAM ENGINES, G. H. Daglish, Liverpool.
16,870. DIFFERENTIAL PULLEY BLOCKS, H. Pullar, Glasgow.
16,871. SECURING BROOM HANDLES, G. T. Moorwood and T. A. Knowles, Sheffield.
16,872. SANITARY SLOP-STONE, T. Lythgoe, Manchester.
16,873. COMPOSITION for IMITATIONS of CARVED WOOD-WORK, J. Smith, Birmingham.
16,874. CLEARING TRAMWAYS of SNOW, &c., J. and E. Townsend, London.
16,875. NIGHT SIGNALLING, J. Wall, London.
16,876. COOKING RANGES, G. G. Brodie and J. D. Prior, Birmingham.
16,877. PATENT ANCHORS, J. B. Storey and J. T. Penman, Gateshead.
16,878. DRIVING GEAR and GUARDS, B. Hindle and J. S. Harvey, Halifax.
16,879. WASTE-PREVENTING and RESPIRATING HORSES' NOSE-BAGS, H. Cable, Clerkenwell.
16,880. SECURING SKULL-CAPS in HATS, J. W. Walker, Halifax.
16,881. SECURING ANIMALS, H. J. Allison.—(*A. and C. Milinaire, Paris.*)
16,882. FURNACES for HEATING POTTERY, &c., H. Hassall, London.
16,883. COMBINED DOOR SPRING and LOCK, J. Gullery, Belfast.
16,884. PREPARING PRINTING SURFACES on ZINC or STONE, W. Dickes, London.
16,885. OPENING PATENT GLASS BOTTLES, G. S. W. Tappen, Shenfield.
16,886. DIRECT-ACTING STEAM ENGINE, G. E. Dow, London.
16,887. CONTINUOUS BRAKES, H. R. Haigh, London.
16,888. STEAM PUMPING ENGINES, S. G. Browne and W. Boby, London.
16,889. PAINTING WALL, &c., SURFACES, H. Britten, London.
16,890. ELECTRO GAS ENGINES, D. S. Regan, San Francisco, California.
16,891. PAPER, LEATHER-BOARD, and MILL-BOARD, S. H. Hodges, London.
16,892. WATERPROOF CLOTHING, W. L. Wise.—(*J. A. Thiery-Delattre, Rheims.*)
16,893. BRICKS and INTERNAL WALLS of FURNACES, J. Gillespie, London.
16,894. BRICKS and EXPOSED WALLS of GARDENS, &c., J. Gillespie, London.
16,895. TRICYCLES, R. S. Crawford, London.
16,896. EXACT AIMING GUNS and SHOOTING, J. Livtchak, Wilna, Russia.
16,897. GOVERNING MARINE ENGINES, F. A. Willett, London.
16,898. LEVER WATCH MECHANISM, J. Fellheimer, London.
16,899. ROLLER-BLIND FURNITURE, G. F. Whitehouse, and W. Bendall, London.
16,900. WIRE FENCES, D. Rowell, London.
16,901. COLLECTING, &c., the FARES of PASSENGERS in PUBLIC VEHICLES, W. M. Ward, London.
16,902. TAKING UP SLACK CHAINS, &c., of CRANES, J. W. Styles, London.
16,903. COMPOUND MOTIVE POWER ENGINE, S. O. Ferry, London.
16,904. HORSESHOES, T. E. Newton.—(*K. T. Rennerfelt, Urfors.*)
16,905. FUEL ECONOMISERS, A. Lowcock and T. Sykes, Manchester.
16,906. FILE or BINDER for LETTERS, &c., A. M. Clark.—(*L. A. E. Hébert, Paris.*)
16,907. LIFTING and FORCING LIQUIDS, R. Paulson, Nottingham.
16,908. SIGHTING GUNS and ORDNANCE, C. A. McEvoy.—(*J. Simpson, Paris.*)
16,909. LIFTING WATER and other LIQUIDS, C. T. Burgess, London.
16,910. DISTRIBUTION of ELECTRICITY, S. Pitt.—(*T. B. E. Turrettini, Geneva.*)
16,911. CANDLE BRACKET for TOILET MIRRORS, J. H. Bessell, London.
16,912. SELF-FEEDING EYELET MACHINES, W. Douglas, London.
16,913. RAISING and LOWERING RAILWAY CARRIAGE and other WINDOWS, E. F. J. Callaghan, London.
16,914. BAGASSE DRIERS, H. H. Lake.—(*R. H. Yale, U.S.*)
16,915. SUBMARINE BOATS or VESSELS, A. Campbell and J. Ash, London.
16,916. MULTIPOLAR ELECTRIC MACHINES, J. D. F. Andrews, London.
16,917. MAINTAINING the HEAT of STEAM, C. J. Galloway and J. H. Beckwith, London.
16,918. GRIPES and RINGS for COFFIN HANDLES, J. Gordon, Birmingham.

27th December, 1884.

16,919. STEERING APPARATUS for TRICYCLES, J. Carver, London.
16,920. GALVANIC BATTERIES, J. Rapieff, London.
16,921. REGISTERING DISTANCES, H. N. Harris and A. J. Helyear, London.
16,922. DRESSING STONE, P. Corcoran, Manchester.
16,923. SELF-LOCKING WINCH, S. Allcock, Redditch.
16,924. BAG for VELOCIPEDES, T. Farrington, London.
16,925. FOLDING PAPER, G. A. Wilson, Liverpool.
16,926. REGISTERING any POINT or PART in NATURE with GEOMETRIC ACCURACY, J. A. Grimshaw, Leeds.
16,927. BOOT, DRESS, GLOVE, and other FASTENINGS, H. Rongier, Birmingham.
16,928. WATCHES, A. H. Read, Birmingham.
16,929. VALVE MOTIONS of ENGINES, W. N. Dack, Manchester.
16,930. BREECH-LOADING SMALL-ARMS, J. Bullough and G. P. Appleyard, Halifax.
16,931. CLOCKS and WATCHES, J. Weir, Glasgow.
16,932. LIFE-SAVING JACKETS, W. McNab J. and McNab, Dundee.
16,933. LIGHTING BUILDINGS, J. Roylance and J. Hoyle, Manchester.
16,934. FINISHING STAY-BUSK FASTENINGS, J. Cadbury, Birmingham.
16,935. SCREW STOCKS, J. Bentley, Birmingham.
16,936. WARP-SIZING MACHINES, J. S. Sutcliffe and J. S. Smith, Manchester.
16,937. CUFF FASTENERS or SUSPENDERS, W. Routledge, jun., Carlisle.
16,938. AUTOMATIC CUT-OFF VALVE GEAR, A. Lamberton, Glasgow.
16,939. HYDRAULIC CRANES for SHIPS, A. B. Brown, Glasgow.
16,940. UNIVERSAL CALORIMETER, T. J. Baker, Birmingham.
16,941. SHADES or GLOBE HOLDERS for GAS LAMPS, &c., F. E. Allen, Birmingham.
16,942. TABLE NAPKIN SUSPENDER, C. Arnold, London.
16,943. SECURING the MEETING BAR of SASH FASTENERS, S. Willett, Herne Hill.
16,944. TRANSMITTING and VARYING ROTARY MOTION, F. G. M. Stoney, Glasgow.
16,945. FEEDER ARRANGEMENT for MINERAL OIL BURNERS, W. P., G. E., and C. E. Cherry, Kingston-upon-Hull.
16,946. ADAPTING EXISTING WATCHES, &c., to the TWENTY-FOUR O'CLOCK SYSTEM of TIME, E. Powell, Chester.
16,947. GAS MOTOR for TRAM-CAR, J. Imray.—(*B. Barnes and J. Danks, Victoria.*)
16,948. MARTINI FIRE-ARMS, A. Francotte, London.
16,949. FIRE-ARMS, J. Schulhof, Vienna.
16,950. PORTLAND CEMENT, W. Smith, Dublin.
16,951. PLANING WOOD, S. S. Hazeland, Cornwall.
16,952. GENERATING and EJECTING FUMES, &c., J. Watts, London.
16,953. PROTECTING ENSILAGE from the WEATHER, J. Hunt, London.
16,954. ELECTRIC TELEPHONIC APPARATUS, A. A. Campbell-Swinton, London.
16,955. MECHANICAL MUSICAL INSTRUMENTS, F. E. P. Ehrlich, London.
16,956. BOOTS and SHOES, W. Barlow, London.
16,957. SAFETY VALVES, W. N. Nicholson and A. T. Allcock, London.
16,958. PISTON-RINGS, J. Riley, London.
16,959. FINISHING HAT BRIMS, J. and O. Oldham, London.
16,960. LADIES' BOOTS, W. Haywood and J. Dyche Birmingham.
16,961. GUIDING the WIRE CLOTH of PAPERMAKING MACHINES, R. M. Thomson, London.
16,962. VALVES for MOTIVE POWER ENGINES, A. Cunningham, London.
16,963. SWEEPING CHIMNEYS, J. M. Ross, London.
16,964. TELEPHONIC SWITCHING APPARATUS A. R. Bennett, London.
16,965. FORGING HORSESHOE NAILS, R. Dott—(*J. Mills, United States.*)
16,966. SHAPING CLAY-WARE, F. Grosvenor, London.
16,967. LOCOMOTIVE ENGINES, W. H. Nisbet, London.
16,968. WROUGHT IRON WINDOW FRAMES, J. Griffin, London.
16,969. STOPPERING BOTTLES, D. P. P. de la Sala, London.
16,970. PHOTOGRAPHIC CAMERA, &c., STANDS, H. H. Lake.—(*A. Stegemann, Berlin.*)
16,971. CUSHIONING PISTONS, H. H. Lake.—(*Piguet and Co., Lyon.*)

29th December, 1884.

16,972. PIANOFORTES, E. G. Camp, Bristol.
16,973. DRYING MOULDS and CORES, J. Askham, London.
16,974. SYRUPING, &c., AERATED BEVERAGES, J. McEwen, London.
16,975. CLOCKS and WATCHES, G. W. Baskett, Colchester.
16,976. RECORDING DURATION of SUNSHINE, J. B. Jordan, Staines.
16,977. MAKING COILS of WIRE, E. S. Bond and S. W. Johnson, Aston.
16,978. DYNAMO-ELECTRIC MACHINES, J. H. Greenhill, Belfast.—11*th November*, 1884.
16,979. PRODUCING PHOTOGRAPHIC PRINTS, T. Schenkenhofer, Hamburg.
16,980. BOOT and SHOE APPLIANCES, W. Beverley, Glasgow.
16,981. SEWING MACHINE TREADLES, F. L. E. Coulvier, London.
16,982. INSTRUMENT for CUTTING EGGS, L. P. Othon, London.
16,983. ELECTRIC ARC VACUUM LAMP, G. W. Bayley, Walsall.
16,984. CHRISTMAS, &c., CARDS, I. A. Spackman, Lee.
16,985. WHEELS, W. Eyre, London.
16,986. PHOTOGRAPHIC LENS MOUNT, A. M. Clark, London.
16,987. PURIFYING TIN, T Bowen, London.
16,988. ARTIFICIAL FUEL, J. Robbins, London.
16,989. MAKING HYDRATES of BARIUM, &c., H. L. Pattinson, jun., London.
16,990. PREPARING FLAX, &c., for SPINNING, J. C. Mewburn.—(*J. Cardon, Lille.*)
16,991. HORSE MILLS, R. H. Radford.—(*H. Edlemann, Perleberg.*)
16,992. HOT AIR ENGINES, R. H. Radford.—(*H. Martini, Chemnitz.*)
16,993. PANTOGRAPHS, E de Pass.—(*J. Conte, Paris.*)
16,994. ARRANGING the DRIVING STRAP of THRASHING MACHINES, G. Downing.—(*C. A. Klinger, Alstadt Stolpen.*)
16,995. DAMPING BRUSH, G. Downing.—(*S. Goldmann, Dresden.*)
16,996. CHECKING VICIOUS HORSES from RUNNING AWAY, &c., G. S. Orchard, London.
16,997. DRIVING DYNAMO-ELECTRIC MACHINERY, W. Mather, Manchester.
16,998. TANDEM VELOCIPEDES, W. J. Lloyd and W. Priest, London.
16,999. LOCKS, T. R. Shillito.—(*L. Bender, Karlsruhe.*)
17,000. MATCH-BOXES, G. Arehn, Stockholm.
17,001. CARTRIDGES, C. A. Day.—(*L. G. Bachmann, Brüssels.*)
17,002. PHOTOGRAPHIC APPARATUS, A. M. Clark.—(*H. Correja, United States.*)
17,003. PRODUCING DESIGNS in ENAMELLED METAL WORK, W. F. and E. H. Simpson, London.
17,004. PROTECTING VESSELS from TORPEDOES, H. E. Newton.—(*J. Ericsson, United States.*)
17,005. LOCKING NUTS on SCREW BOLTS, E. Brasier, London.
17,006. GOVERNORS for STEAM ENGINES, &c., P. W. Willans, London.
17,007. ORDNANCE, G. Quick, London.
17,008. ELECTRIC ARC LAMPS, J. G. Statter, London.
17,009. KNITTING MACHINERY, W. R. Lake.—(*A. Bonamy, St. Just-en-Chaussée.*)
17,010. CAST METAL CHAINS, W. R. Lake.—(*A. Léger, Lyons.*)
17,011. VENTILATING and DRAINING CONDUITS, J. B. Pash.—(*T. R. James, Victoria.*)
17,012. DISINFECTING BALES of RAGS, &c., A. M. Clark.—(*C. E. O'Hara, United States.*)

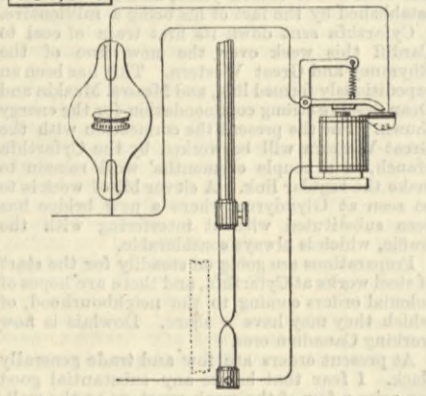
SELECTED AMERICAN PATENTS.

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

307,818. AUTOMATIC CUT-OUT FOR ELECTRIC APPARATUS, *E. Thomson, Lynn, Mass.—Filed April 12th*, 1884.

Claim.—(1) In combination with an electric lamp or other electric apparatus, a short-circuiting or shunting appliance consisting, essentially, of electrodes placed very near one another, and connected, respectively, to opposite sides of the lamp, and switch devices controlled by the current leaping from one electrode to the other to switch or shunt the lamp. (2) In combination with an electric lamp or other electric apparatus, a circuit changer or shunting switch, and an electro-responsive device controlling the same, placed in a circuit in which current may flow by being forced from

307,818

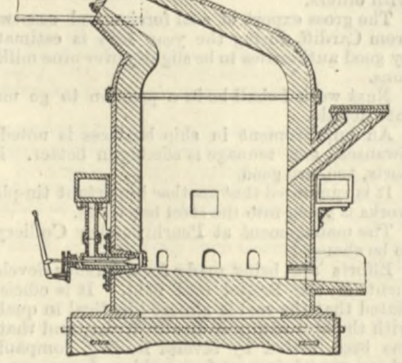


terminal to terminal through a small partially vacuous space, as and for the purpose described. (3) The combination, with an electric arc lamp or other electric apparatus in a circuit, of a vacuous receptacle for opposed electrodes, connected to opposite sides of that portion of the apparatus wherein an abnormally high resistance may occur, as and for the purpose described.

307,874. BESSEMER CONVERTER, *Hermann Schulze-Berge, Rochester.—Filed January* 14*th*, 1884.

Claim.—(1) A fixed converter or similar vessel for treating molten metal having tuyeres extending laterally through its sides, provided with downwardly-projecting close hoods or shields over the mouths of the tuyeres, substantially as and for the purposes described. (2) In a fixed converter or similar vessel

307,874

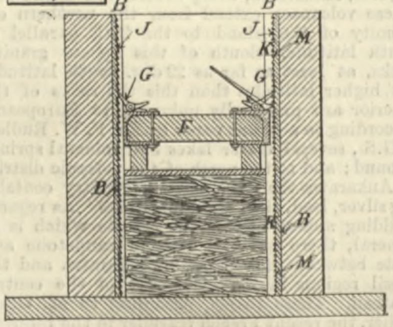


for treating molten metals, tuyeres extending laterally through the sides of the converter, and provided with internal stoppers, in combination with downwardly-projecting shields or hoods extending over the mouths of the same, substantially as and for the purposes described.

307,953. SILO PRESS, *Chas. W. Jefferson, Rugby, Tenn.—Filed August 27th*, 1884.

Claim.—(1) A silo press having its press beams F provided with pawls G G at each end, which work in racks J J of plates B, fixed to the silo wall, and said plates B having ways K between the racks J J to receive tongues L on the press beams, and also having

307,953

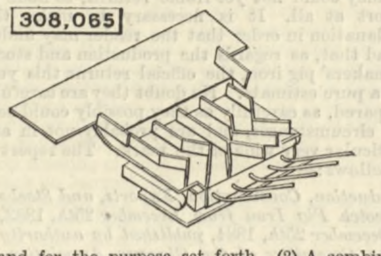


racks M, to be engaged by a lever or pinch bar, all substantially as shown and described. (2) In silo presses, the wall plate B, made with central way or groove K, and a rack M, at the back-face of the groove, and also with the racks J J, one at each side of the groove K, substantially as shown and described. In silo presses, the wall plate B, made with central groove or way K, having a rack M, and with racks J J, one at each side of the groove K, and with flanges N N, projecting beyond the face of the plate, in combination with the press beams F, having tongues L, entering the grooves K, and shoulders O O, contacting only with the flanges N N, substantially as shown and described. (4) The combination, with the walls of a silo press, of rack plates secured to said walls, and of press beams carrying pawls fitted for engagement with said rack plate, substantially as shown and described.

308,065. COMBINED THRASHER AND SEPARATOR, *Jas. Davis, Quaker Springs, N.Y.—Filed June 20th*, 1884.

Claim.—(1) In a combined thrasher and separator, the combination, with a thrashing cylinder having zigzag peripheral ribs, of a concave formed with transverse bent ribs arranged to converge from the receiving edge toward the middle of the concave and to diverge from the middle to the rear edge, substantially

308,065

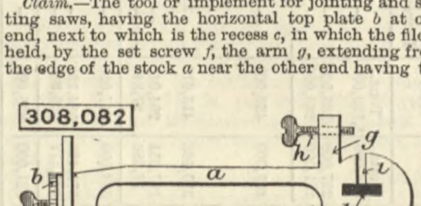


as and for the purpose set forth. (2) A combined thrasher and separator comprising a thrashing cylinder formed with zigzag peripheral ribs, a concave formed with transverse bent ribs, first converging and then diverging, as described, and a dust conveyor and fan, substantially as and for the purpose specified.

308,082. DEVICE FOR SETTING AND JOINTING SAW TEETH, *David Logan, Hartstown, Pa.—Filed March 5th*, 1884.

Claim.—The tool or implement for jointing and setting saws, having the horizontal top plate *b* at one end, next to which is the recess *c*, in which the file is held, by the set screw *f*, the arm *g*, extending from the edge of the stock *a* near the other end having the

308,082



set screw *h* passed through it in the direction of the stock, with the point of said screw *h* toward the end of the stock nearest said arm *g*, and the transverse recess *i* near the arm *g*, said recess *i* being provided at its inner end with a rubber cushion *k*, as shown and described.

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A COMMISSION appointed by the French Government to consider the best method of developing the mineral wealth of Annam and Tonquin has just issued its report. It lays down a programme for a mining mission, which it has been decided to send out there, and suggests the appointment of two separate missions. The duty of the first of these would be to ascertain whether the metalliferous deposits stated by Annamite documents to exist in two north-western provinces of Tonquin do actually exist there, and how far it would be possible to work them profitably. The second should investigate the copper deposits of the delta, and subsequently extend its labours into Annam.