FLY-WHEELS.

By PROFESSOR R. H. SMITH.

THERE is no part of machinery the general object and effect of which is better understood than the fly-wheel. Its function is to steady the speed of the engine or other machine of which it forms a part, to prevent rapid variations of power exerted or of resistance offered resulting in rapid and large variations of speed. It is also almost universally understood and practically appreciated that the steadying effect of a fly-wheel is greater the greater its weight is. If two machines are in every respect alike, except that while one of them is required to maintain a certain average speed without any greater deviation than 5 per cent. of that speed up or down, the other is allowed under the same circumstances to vary 10 per cent. up or down, in speed, every, even the merest tyro, in engineering would feel sure of doing right in making the first fly-wheel double the weight of the second.

Beyond this point there is darkness and confusion reigning in the minds of, we venture to say, the majority of users and makers of machinery, and even among not a few of the designers of it. We believe this is largely due to the misapprehension that each driving engine, for instance, ought to be supplied with a certain size of fly-wheel that can, or ought to be, determined independently of the particular kind of work the engine is to be called on to do. If, again, the fly-wheel is to be put on a driven machine, as a pump or a dynamo-electric machine, there is a general idea that the proper size of fly-wheel should be capable of determination without reference to the particular kind of engine by which this machine is to be driven. No greater error could be fallen into, and it is probably due to this that the results of calculations based on different rules, taken from different manuals and treatises, give so wildly discordant results. So discordant are these results that this is a favourite subject over which those so-called "practical men" make merry and rejoice, who hate and despise all theory, because they are unable to discriminate between true and false, rational and irrational theories; the latter of which, we must admit, are unfortunately only too common, and the prevalence of which is to be regretted, not only because they are misleading—the opposite of useful—but also because they very naturally bring in their train discredit upon true theory founded upon facts, tested by experiment, and really useful in practical application.

A popular confusion, not shared, we are glad to believe, by anyone assuming the name of engineer, is that the fly-wheel absorbs power—the accidental or unavoidable excesses of power supplied above the useful work to be done—in the same way as friction, or the driven machine itself, might and does absorb power; that is, absorbs it so as to exhaust it or destroy it for practical uses, to make it disappear from the machine. But all the power absorbed by a fly-wheel it must and does give up again; it has no power of indefinitely absorbing power. It only absorbs power in consequence of its increase of velocity. It does not destroy, or hide away in any latent form, the power it absorbs, but retains it in the machine in the visible form of increased kinetic energy or energy of motion. It would be even physically impossible for it to go on indefinitely storing up power, and on account of the practical limits of allowable increase of velocity it can go only a little way in absorbing surplus energy unless opportunity be given for the discharge of the energy so stored, and this discharge can only take place by the slowing down of the speed of the engine or machine. Thus, if the average effort exerted by the driving engine be permanently in the least degree greater than the average resistance offered by the machinery it drives, no fly-wheel, however heavy, can prevent the engine running away. Its action is simply a temporary storing up of power during a temporary excess of driving effort, which power is given up again during the alternating deficiency of driving effort.

Since there is no permanent storing up of energy in the wheel, it follows that in the course of a complete cyclic period covering all the variations of effort and resistance, and which cycle of variations is exactly repeated over and over again, the work done in increasing the kinetic energy of the fly-wheel during the intervals of excess of power is exactly equal to the work done by the fly-wheel in slowing down during the intervals of deficiency.

The excess and the deficiency can only be obtained by comparing throughout the whole cyclic period the effort and the resistance of the driving and the driven machine. The proper size of fly-wheel, whether it be fastened on the driver or on the driven machine, can be determined only by considering the relation between the two at every instant of the cycle. It is impossible to do so by considering either or even both separately. This seems a very simple and easily comprehended proposition, but we have never seen any technical treatise that takes any notice of this obvious fact, unless we except Rankine's "Applied Mechanics," where the whole subject is treated in a somewhat offhand manner in a paragraph of a few lines. When rules are given for dimensioning the fly-wheel of a driving engine, it is most commonly taken for granted that the resistance is uniform!—charming assumption that clears the way for an imposing series of algebraic formulæ, but which leads to no result that will stand the test of practical application, simply because the rules deal with the variation in the driver alone, which is only one half of the condition which the machinery obstinately persists in obeying in spite of the disappointment of the mathematician! Again, to calculate the suitable size of a fly-wheel for a driven machine attention is paid only to the variation of resistance of the machine itself.

Since our machinery is chiefly rotative, and since the velocity that is to be kept nearly uniform is the angular velocity, it is most convenient in this connection to represent work done by the product of an angular motion (an angle moved through) by a force-moment (*i.e.* a force multiplied by a leverage). The angular motion must be measured in circular measure, or "radians," the unit being 57 deg. 18 min. For instance, the whole work done in one revolution of an engine is for our present purpose best calculated by plotting off a straight line to represent the complete circle (the length of which will be to some convenient scale $2\pi = 6{\cdot}28$); dividing it into say 48 equal parts; erecting at each division an ordinate to represent (to any other convenient scale) the corresponding turning moment exerted by the engine on the crank-pin; and finally drawing a curve through the tops of all these ordinates. Special care must be taken to calculate and plot off the moment at the points of cut-off, of release, and of compression, which will not in general agree with any of the equal divisions. At each of these points there is a sharp break or corner in the continuity of the curve of moments. The three diagrams, Figs. 1, 2, and 3, show such moment diagrams for three different kinds of engines with several different cuts-off in each case. In each case the effect of back-pressure and that of the obliquity of the connecting-rod are eliminated. The effect of considerable back-pressure modifies largely the shape of the diagram beyond the point of cut off. The obliquity of the connecting-rod has also a very appreciable effect in altering the shapes throughout the whole revolution from those shown in the diagrams. Fig. 1 corresponds to an engine with one cylinder, or to one with two cylinders working on cranks directly opposite each other. Fig. 2 corresponds to a two-cylinder engine with cranks at right angles; and Fig. 3 to a three-cylinder engine working on three cranks at 120 deg. from each other, or working all three on one crank with the cylinders ranged symmetrically round the crank shaft at 120 deg. apart, as in the Brotherhood engine. In each case separate diagrams are drawn for steam admitted full stroke and for steam cut off at three-fourths, five-eighths, one-half, three-eighths, one-fourth, one-eighth, and one-tenth of the stroke. A level line is drawn at a height equal to the mean moment for each of these cuts-off. The maximum moment exerted by each cylinder is taken as 100 in each case. These are simply given as examples of moment diagrams. They show the moments of the steam pressure in the cylinder. The curves of moments of actual pressure on the crank pin are often very different from these in shape, because of a considerable portion of the steam pressure being spent, near the beginning of the stroke, in accelerating the motion of the reciprocating parts coming between the cylinder and the crank pin. For the investigation of the proper size of fly-wheel, the moment curves of actual pressure on the crank pin should always be used, especially in rapid running engines.

Fig. 1.

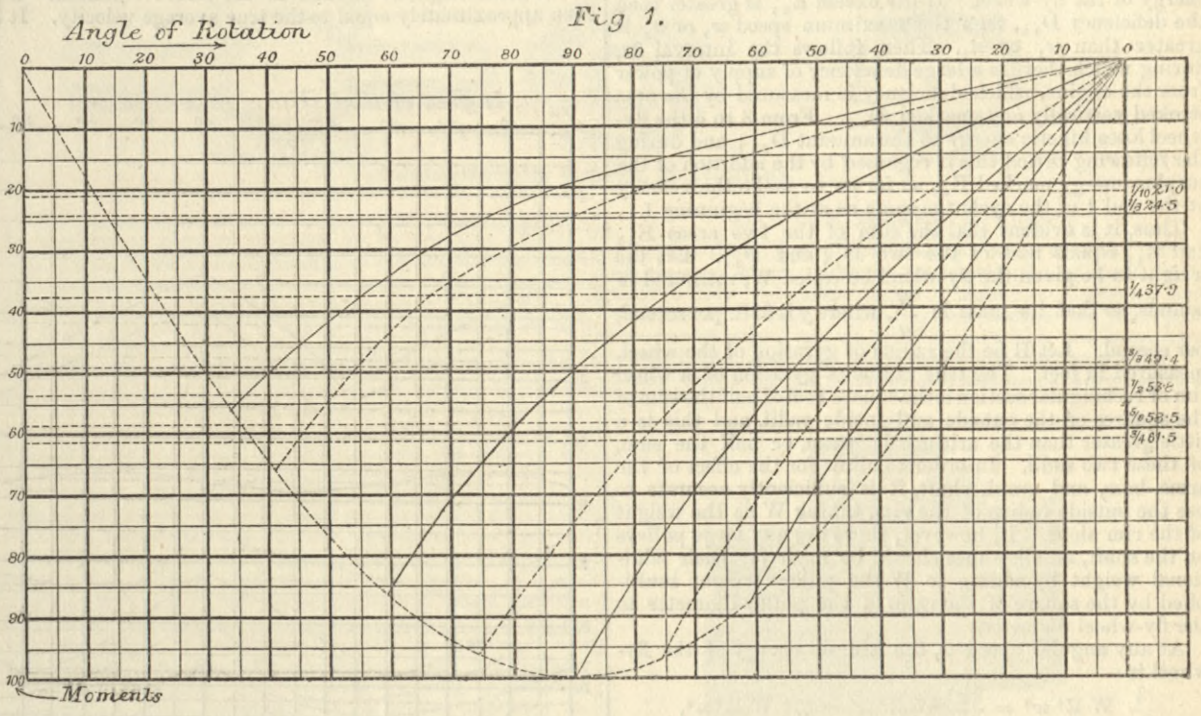
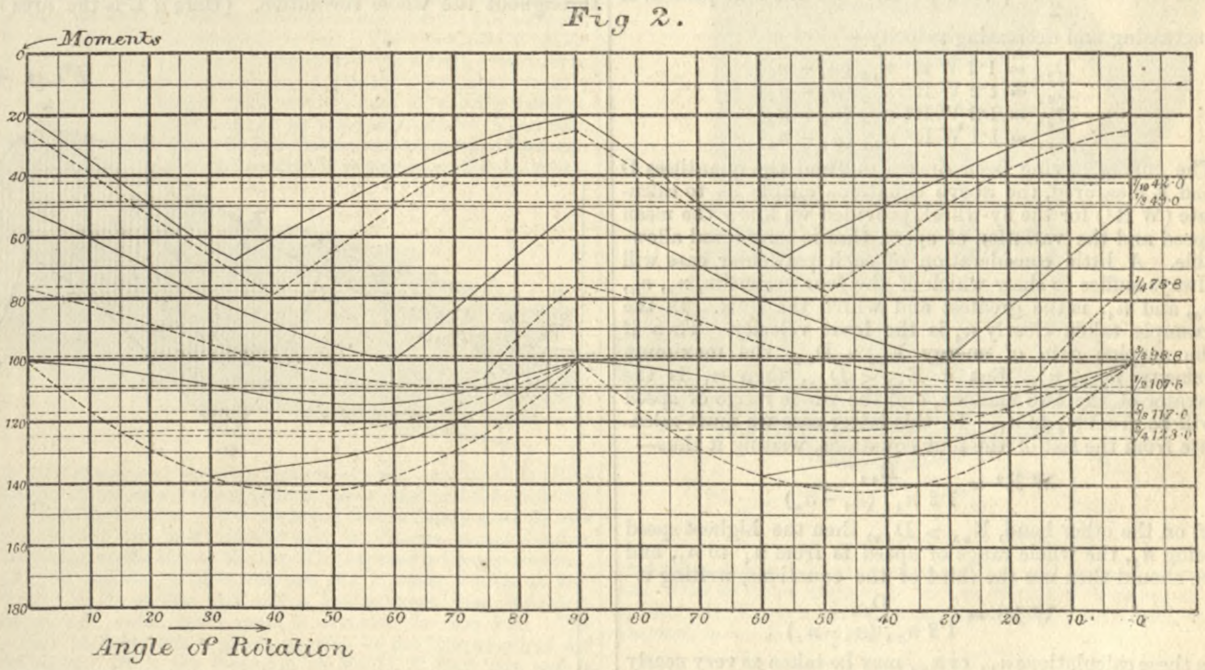


Fig. 2.



In passing, it is worth noticing that in two-cylinder engines with cranks at right angles the cut-off one-half gives very much more nearly uniform driving moment than any other cut-off. In any one of these diagrams the work done between any two instants of the revolution is measured by the area underneath the moment curve, and between the two vertical ordinates corresponding to these two instants.

In Fig. 4 let the curve *a a a* represent the variation of driving moment of the driving engine throughout a complete cycle. It must be particularly noticed that this cycle does not necessarily equal one revolution of the engine. If the driven machine goes through all its changes of resistance during exactly one revolution of the engine, then the cycle corresponds with this revolution; but if, for instance, five revolutions of the engine were made during a complete period of variation of resistance in the driven machine, then the cycle to be taken for our construction would be five engine revolutions. Let *b b b* be the curve showing the simultaneous variation of the resisting moment of the driven machine. We have started the diagram at a point at which the driving and resisting moments are equal, that is, where the two curves *a* and *b* intersect. Of course, they again intersect at the end of the diagram, because here begins again an exact repetition of the variations represented on the diagram. Besides intersecting at 1, they also intersect at the points 2, 3, and 4. Before 1 the driving moment is in excess of the resisting moment, so that up to the instant 1 the speed is continually increasing. It here reaches a maximum, because between 1 and 2 the resisting is greater than the driving moment, and, therefore, the speed is slowing down. At 2 a minimum speed is reached, and quickening of the pace goes on up to the instant corresponding to 3, because between 2 and 3 the driving exceeds the resisting moment. At 3 the speed is again at a maximum. Whether this second maximum speed is greater than the first is easily determined, as will be seen immediately. Then between 3 and 4 follows a longer interval of deficiency of supply of driving power, and at 4 a second minimum speed is reached. This minimum speed is lower than the first in our special example, because of the greater difference in height between the two curves *b* and *a*, and the longer continuance of the deficiency of the driving moment in the interval 3 to 4 than in that 1 to 2.

We will call the angular velocities reached at the instants 1, 2, 3, and 4 by the symbols w_1, w_2, w_3, and w_4. At the end of the cycle 1 we get again the velocity w_1; w_1 and w_3 are maxima velocities, and w_2 and w_4 minima. In the example taken there are four intersections of the two moment curves, giving two maxima and two minima. Occasionally in practice we find only two crossings, but much more commonly there are four, six, or eight. The number, of course, must be even. It is simpler to some minds to deal with the angular velocities as expressed in revolutions per second rather than in radians. Let n_1, n_2, n_3, n_4 be the four critical speeds in revolutions; then $w_1 = 2\pi n_1$; $w_2 = 2\pi n_2$, *et cetera*, 2π being 6·28.

The area underneath the curve $b\,b\,b$ is the work done on the driven machine. During the complete cycle from 1 to 1 this exactly equals the work done by the driving engine, namely, the area under curve $a\,a\,a$, because there is no permanent absorption of energy by the fly-wheel. From 1 to 2 the work done by the engine is less than that done on the machine by the area between curve b and curve a from intersection 1 and 2. This is the work done by the fly-wheel during this interval; it loses kinetic energy to this amount. The area is lined over vertically and marked D_{12}, which symbol will be taken to represent the area or the energy which it measures. From 2 to 3 the area between the two curves—lined horizontally and marked E_{23}—is an excess of work done by the engine, which surplus work is spent in increasing the kinetic energy of the fly-wheel. If the excess E_{23} is greater than the deficiency D_{12}, then the maximum speed w_3 or n_3 is greater than w_1 or n_1. Then follows the interval 34, during which there is a large deficiency of supply of power from the engine, which deficiency is measured by the area stroked vertically and marked D_{34}. From 3 to 4 the fly-wheel loses kinetic energy to the amount D_{34}; and during the following period this is regained by the addition of the surplus energy marked E_{41} so far as to make the velocity at the end 1 of the cycle the same as at the beginning 1.

Thus, it is evident that the sum of the two areas E_{23} and E_{41} equals that of the two D_{12} and D_{34}. Let the weight to be given the fly-wheel be called W, measured in pounds, so that its mass is $\frac{W}{g}$, where g is 32ft. per second, per second. Let R be the radius of gyration of the wheel, measured in feet. The true radius of gyration of a wheel rim of rectangular section is the square root of half the sum of the squares of the outside and inside radii, and this is a little greater than the arithmetic mean, or half the sum, of these two radii. In order to allow for the effect of the arms, boss, and crank shaft, it is sufficiently accurate to use the outside radius of the rim, taking W as the weight of the rim alone. If, however, there are any large pulleys on the shaft, an allowance should be made for their additional weight by adding to W the pulley weight multiplied by the square of the ratio of the pulley diameter to the fly-wheel diameter.

At any angular speed w, the kinetic energy of the fly-wheel is—

$$\frac{1}{2g}\,W\,R^2\,w^2 = \frac{2\pi^2}{g}\,W\,R^2\,n^2 = \cdot 61\,W\,R^2\,n^2,$$

therefore the loss of kinetic energy from the instant 1 to the instant 2 in the above example is—

$$\cdot 31\,W\,R^2\,(n_1{}^2 - n_2{}^2) = \cdot 61\,W\,R^2\,\frac{n_1 + n_2}{2}\,(n_1 - n_2) \times 2$$
$$= 1\cdot 2\,W\,R^2\,\frac{n_1 + n_2}{2}\,(n_1 - n_2).$$

If we write n_{12} for the arithmetic mean between the maximum and minimum speeds n_1 and n_2, or $n_{12} = \frac{n_1 + n_2}{2}$, and similarly, $n_{23} = \frac{n_2 + n_3}{2}$; $n_{34} = \frac{n_3 + n_4}{2}$; and $n_{41} = \frac{n_4 + n_1}{2}$; then we have for the four periods of increasing and decreasing velocity—

$$D_{12} = 1\cdot 2\,W\,R^2\,n_{12}\,(n_1 - n_2)$$
$$E_{23} = 1\cdot 2\,W\,R^2\,n_{23}\,(n_3 - n_2)$$
$$D_{34} = 1\cdot 2\,W\,R^2\,n_{34}\,(n_3 - n_4)$$
$$E_{41} = 1\cdot 2\,W\,R^2\,n_{41}\,(n_1 - n_4)$$

The curves having been drawn out and the quantities D and E measured, the above equations enable us to calculate (W R²) for the fly-wheel, provided we know the mean speed and the variation of speed that is considered allowable. A little consideration of each particular case will always suffice to show which of the four velocities, n_1, n_2, n_3, and n_4, is the greatest and which the least. In the example taken clearly n_4 is the least velocity. Then if the surplus gain of energy $E_{23} > D_{12}$, the maximum velocity $n_3 > n_1$. But if $E_{23} < D_{12}$, then n_1 is the greater of the two maxima, and the whole range of speed will be from n_4 to n_1. In this latter case we must calculate from the last of the four equations, writing it thus—

$$W\,R^2 = \frac{E_{41}}{1\cdot 2\,n_{41}\,(n_1 - n_4)}$$

If, on the other hand, $E_{23} > D_{12}$, then the highest speed being n_3, the whole range of speed is from n_4 to n_3, and we should then use the third of the equations, writing it

$$W\,R^2 = \frac{D_{34}}{1\cdot 2\,n_{34}\,(n_3 - n_4)}$$

In these calculations n_{41} or n_{34} may be taken as very nearly equal to the average speed throughout the whole revolution, provided that the allowable variation of speed $(n_1 - n_4)$ or $(n_3 - n_4)$ is only a small percentage of the average speed, because then the average does not differ much from either the highest or the lowest speed, and differs still less from the half sum of the highest and lowest. It must not be supposed that the true average is accurately equal to this arithmetic mean between highest and lowest, but unless the range from highest to lowest speed be more than about 20 per cent. of the average speed, the above approximation is sufficient for practical purposes. It is justified by the fact that if, for instance, one found in the pattern loft a fly-wheel pattern two or three inches too large or too small in diameter, or a-quarter of an inch too deep or too shallow in the rim, one would never think of getting the pattern altered to the calculated dimensions.

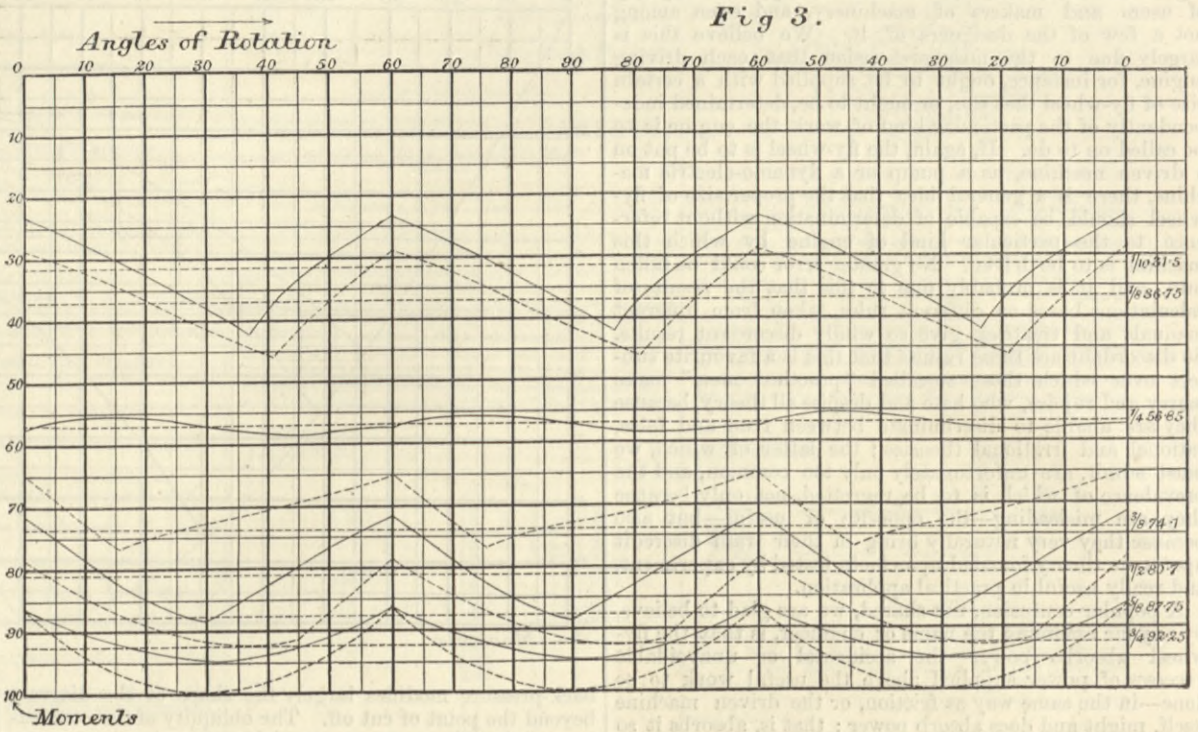
In the example taken, there being only four intersections of the curves a and b, the actual greatest and lowest velocities cannot be separated by more than a single interval of excess or of deficiency in the supply of energy. Where there are six or more crossings of the curves, however, they may be separated by three, five, or more intervals of excess and deficiency. The method of solving in such a case may be illustrated by reference to the above example, taking n_3 and n_1 as the highest and lowest velocities, and considering—instead of the simple interval 3 4 with its one deficiency area D_{34}—the period 4 1 2 3 covering the two excess intervals E_{41} and E_{23}, and the deficiency area D_{12}. We obtain the desired formula by adding the fourth and second, and subtracting the first of the four equations given above. Thus—

$$E_{41} - D_{12} + E_{23} = \cdot 61\,W\,R_2\,(n_3{}^2 - n_4{}^2)$$
$$= 1\cdot 2\,W\,R_2\,n_{34}\,(n_3 - n_4)$$

This is really the same thing as we had before, because the surplus supplies being equal to the deficiencies, $E_{23} + E_{41} = D_{12} + D_{34}$, and therefore $E_{41} - D_{12} + E_{23} = D_{34}$. But the last formula illustrates how one may work through several alternating periods of excess and deficiency from the lowest occurring speed to the highest.

If the range of velocity during the cycle is very large compared to the average, we cannot assume that the arithmetic mean between the highest and the lowest—which mean ought to be used in the above equations—is even approximately equal to the true average velocity. It is still practicable to solve the problem accurately, but only by a somewhat tedious process of graphic integration.

Fig 3.



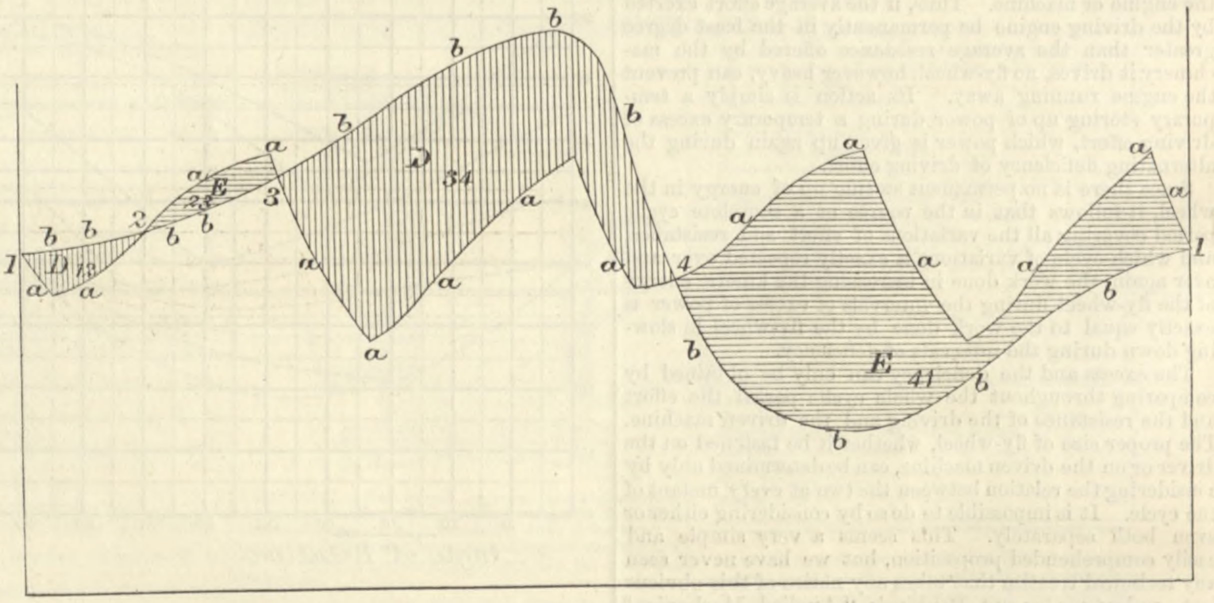
We begin by assuming any convenient value of W R², and a velocity as the minimum velocity as nearly equal to the true minimum as we can estimate. We then, by graphic integration from the equation—

$$d\,E = 1\cdot 2\,W\,R^2\,n\,.\,d\,n,$$

construct a curve showing the variation of velocity throughout the whole revolution. (Here $d\,E$ is the area of a small vertical parallel-sided strip of the area included between the curves $a\,a$ and $b\,b$, and $d\,n$ is the corresponding increase of velocity.) From the velocity curve so obtained we calculate again by graphic integration from the equation—

$$d\,t = \frac{1}{2\pi n}\,.\,d\,\theta,$$

Fig 4.



the whole time occupied by the complete cycle of angular movement. (Here $d\,t$ means the small time occupied by the small angular movement $d\,\theta$). This whole time of the cyclic period has thus been calculated from the *assumed* minimum velocity; and from this whole time we now calculate the *average velocity* corresponding to the same assumption. The difference between this average and the assumed minimum velocity is now compared (as an arithmetical fraction) with the range from minimum to maximum velocity found from the velocity curve that has been constructed. The ratio thus calculated is used as a multiplier of the actual range of velocity considered desirable to find the difference between the actual minimum speed and the known true average velocity. The real minimum velocity is thus calculated, and along with it may be found at once the actual maximum. Having thus found the actual maximum and minimum speeds, the above equations can then be directly applied to find W R².

This latter process, however, is evidently too difficult and tedious for common practical use. The writer therefore recommends the following method to be followed when the variation of speed allowed is a relatively large one, the method being a safe and sure one, in the sense that it will make the machine run rather more steadily than is considered needful. Let N be the average desired speed of the fly-wheel in revolutions per second, and let n be the greatest difference considered allowable between the maximum and minimum velocities. Then the maximum cannot be less, it must be at least a little greater than the average; and the minimum cannot be less than $(N - n)$. Therefore the arithmetic mean between highest and lowest must be more than $\frac{N + N - n}{2} = N - \frac{1}{2}n$.

If we use this as a divisor in calculating W R² we are safe, because the smaller the divisor the larger is the size of fly-wheel calculated. If E represent the surplus or deficiency of work done between the instants of greatest and least velocities—for instance, in the examples already taken, E would stand for D_{41} or D_{34}, or $(E_{41} - D_{12} + E_{23})$—then we find W R² from the equation:—

$$W\,R^2 = \frac{E}{1\cdot 2\,(N - \frac{1}{2}n)\,n};$$

and it will be safe to use this formula in all cases, whether the permissible variation of velocity be great or small. Here E is to be measured in foot-pounds; N and n per second; W in pounds; and R in feet.

From W R² the dimensions of the fly-wheel can be calculated either by choosing the weight W and calculating therefrom the radius R, or by choosing any convenient radius R and from it calculating a rim section that will give the necessary weight W. The latter is the more ordinarily convenient process. It may assist this calculation if we write W R² in terms of the rim *section* for a cast iron fly-wheel. If this section measured in square inches be S, the circumference in feet being 2π R, we have $W = \cdot 26 \times 12 \times 2\pi\,R\,S = 19\cdot 6\,R\,S$, and

$$W\,R^2 = 19\cdot 6\,S\,R^3$$

We would then have—

$$S\,R^3 = \frac{E}{23\cdot 9\,(N - \frac{1}{2}n)\,n}$$

It must be remembered that in this formula S is in square inches, R in feet, E in foot-pounds, and N and n per second.

It is sometimes preferred to have a rule for the weight of fly-wheel in terms of the horse-power. The above can easily be changed into this form. If H.P. be the horse-power, the work done per second in foot-pounds is 550-H.P., and that done per revolution is, therefore, $\frac{550\text{-H.P.}}{N}$. Let the excess E be a certain fraction, say m, of the work done per revolution, that is, $E = m\,550\,\frac{\text{H.P.}}{N}$.

Then inserting this value of E in the last equation, and finding $\frac{550}{23\cdot 9} = 23$, we have

$$S\,R^3 = 23\,\frac{m\,\text{H.P.}}{N\,(N - \frac{1}{2}n)\,n}$$

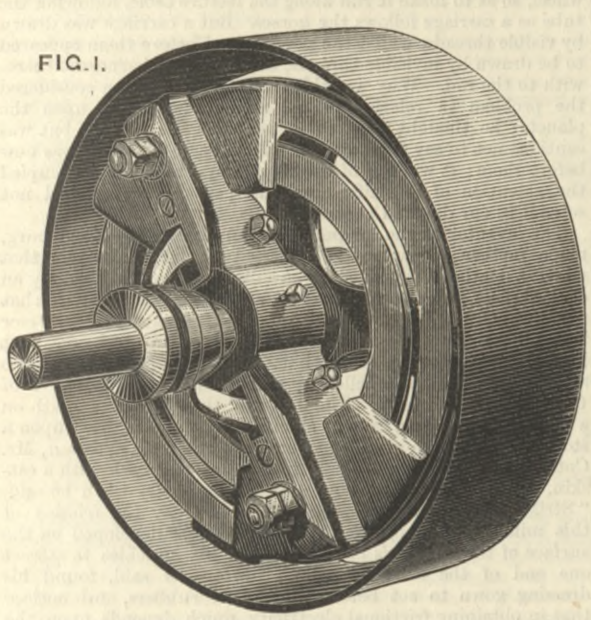
where again S is in square inches, R in feet, and N and n per second.

So long as m, H.P. N remain the same, if the dimensions of the rim be increased in the same proportion as the diameter of the wheel, the variation of speed n will be decreased nearly in inverse proportion to the fifth power of the diameter of the wheel, while the weight of the latter is increased in proportion to the third power of its diameter.

FRISBIE'S FRICTION CLUTCH.

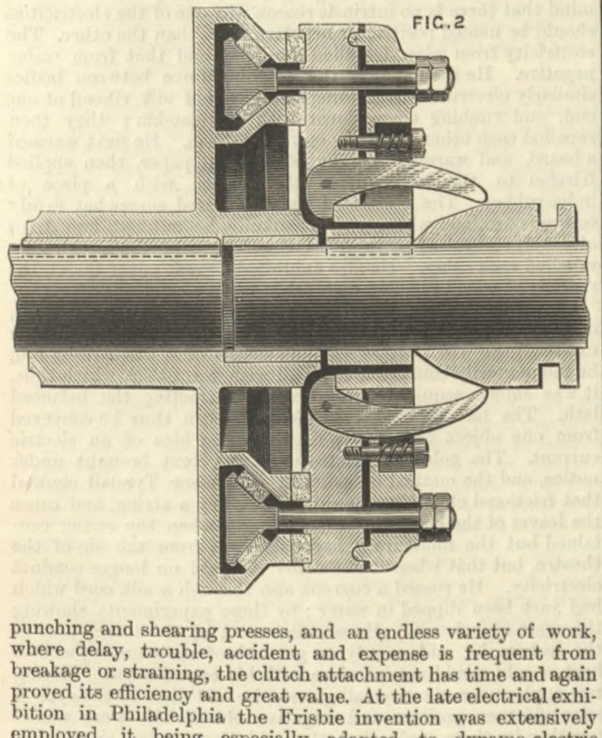
AMONG the new appliances for transmitting power, the friction clutch of Messrs. D. Frisbie and Co., North Fifth-street, Philadelphia, has, the *Electrical World* says, earned a well-deserved reputation, and been accorded prominent position. "The points of superiority which are claimed for it have been established by its successful employment for several years in many large establishments throughout the country. These advantages consist in its adaptability for every kind of work, however heavy or light, and for all grades of speed. It can be gauged to carry any weight or force, from a few pounds to tons, and works at the set limit under all circumstances, until a different adjustment is made, which can be easily effected while the machinery or machine is in motion, without the aid of tools, and by the most inexperienced employé. With this attachment

FIG. 1.



steam can be connected with water power without check or damage to shafting or machinery, as the connection is made gradually and the wheel and engine are made to work in perfect harmony without stoppage of either. The same control and guidance is exerted in starting and stopping all machines irregularly used, also in factories or mills where certain portions of the work demand more power and speed than others; all the delays and danger incident to such irregularities are entirely obviated by placing this clutch between the power or force and the machine or work. In hoisting machines, pile drivers, rubber and paper calendering rolls, brass and iron rolling mills, testing machines, wire-drawing, bolt-heading and nut machinery, heavy

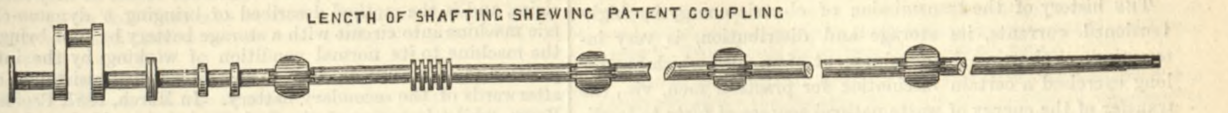
FIG. 2

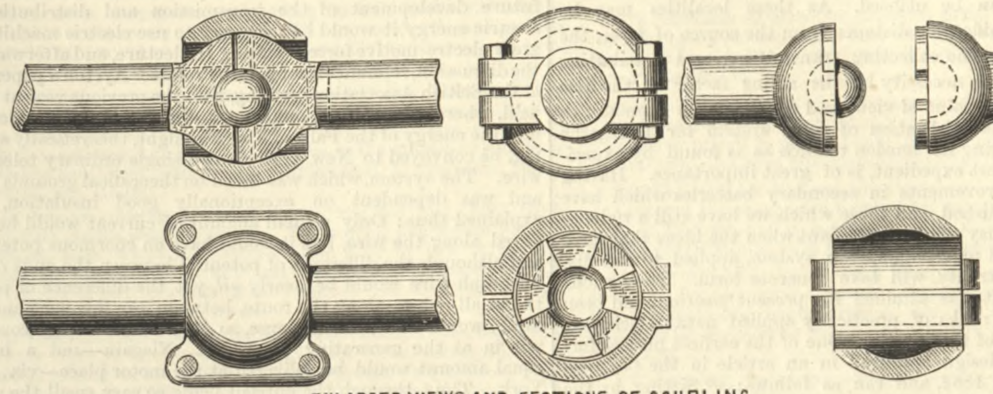


punching and shearing presses, and an endless variety of work, where delay, trouble, accident and expense is frequent from breakage or straining, the clutch attachment has time and again proved its efficiency and great value. At the late electrical exhibition in Philadelphia the Frisbie invention was extensively employed, it being especially adapted to dynamo-electric machines, permitting of the stopping or starting of any dynamo in the system without reference to any other. The durability of the attachment is well attested by three years' service in many places." We give two illustrations, Figs. 1 and 2, of the application of the friction clutch, which will be readily understood. The cone by being withdrawn along the shaft permits the two sections of the clutch to come apart, and so disconnect the driving and driven shaft.

JAMIESON'S SHAFT COUPLING.

LENGTH OF SHAFTING SHEWING PATENT COUPLING



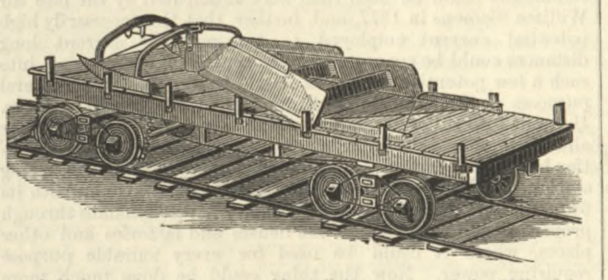


ENLARGED VIEWS AND SECTIONS OF COUPLING

WE illustrate above a line of screw propeller shafting adapted for ocean-going steamers, invented by Mr. Jamieson, Meadow Hall Works, Sheffield, and consisting of a ball-and-socket coupling allowing of a slight radial movement in every direction, so that the shaft may freely follow the constantly varying form of the ship's bottom, which is due to the many causes so well known to marine engineers. The principle of the coupling will be readily understood from the enlarged view shown above. Each extremity of the shaft is turned to a semisphere, the flat end being formed with four or more projections radiating to the centre, and these in turn fit into corresponding recesses in the flat end of the other shaft to which it couples, the whole of the power being transmitted through these projections after the manner of an ordinary clutch. Each of the ends where coupled together is hollowed out to a hemisphere, into which fits a small steel ball, and around this ball the coupling radiates; the ball also answers the purpose of keeping the two radial flanges at one common distance. The whole is held together by a steel casting machined to fit and bolted together in halves, provision being made for letting together if at any time found to require it. The casting, of course, revolves with the shafting. It is well known that propeller shafting is made considerably greater in diameter than what is actually required to withstand the torsional strain transmitted by the engine, and that the present excess of strength with rigid shafting is designed only with a view to overcome the severe strain thrown upon it by the working of the ship's bottom; and in the absence of these undue strains, Mr. Jamieson has no hesitation in saying that the shafts in present use, if made of the same diameter in good cast iron, would transmit with safety the whole of the power developed by the engines. The arrangement we illustrate seems very simple. The arrangement of coupling is for any purpose other than propeller shafting equally applicable where flexibility is required.

A NEW BALLAST UNLOADER.

THE ballast unloader, of which we give an illustration herewith, reproduced from the American *Railway Review*, differs in several points from devices heretofore employed for this purpose. It dispenses with centre guide or rail. There is a pair of guide runners or fenders pivotted to the nose of the plough, which serve to keep the plough in the centre of the car whether the train is on a curve or straight track, and on cars of varying heights. The plough is further steadied by the guides shown in its rear, which are held in place by the stakes on the sides of the car. It is claimed that with this method of construction the draught is

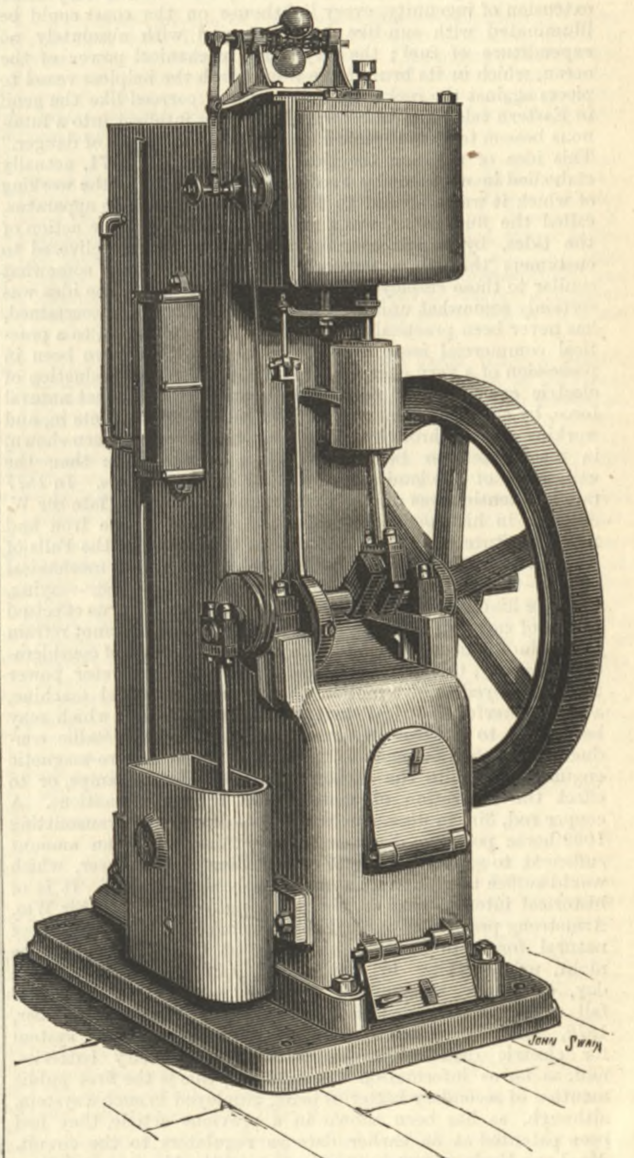


much lighter than where a guide rail is used; and the difficulties arising from gravel getting between the plough and the guide rail are entirely avoided. It is apparent that ordinary gondola cars can be used with this unloader with no change except shifting the brake to the side of the car. The expense is simply nominal; and the cars can be taken out and put in other service at any time. By dispensing with centre guides much dead weight is saved, and much more space is available for the load. The saving in first cost is great, as also in the time required for fitting up. It is the invention of Mr. H. M. Barnhart, and is made by the Marion Steam Shovel Company, of Marion, Ohio.

ECONOMICAL STEAMSHIPS.—We need not go, says Mr. N. W. Wheeler in the *Mechanical Engineer*, to the English or Scotch building yards for specimens of half-ounce per ton mile ships. We can find them running on our coasts and across the Pacific Ocean. We can even find a specimen or two in the back country—upon the great lakes. Take, for instance, the H. J. Jewett, which came out in 1882. She carries 2300 tons of 2000 lb. each. She runs in deep water fourteen statute miles per hour, which is almost exactly twelve nautical miles. Her course between Buffalo and Chicago covers long reaches of shallow water, which has the effect of reducing speed and increasing coal consumption per mile. She makes the round trip between Buffalo and Chicago with an average of 80 tons of Ohio coal—including the coal burned in port, steam being always kept on one of her two boilers. The shortest possible distance to be run on a round trip is 1800 statute miles, which is equal to 1564 nautical miles. Coal per mile equals 102·3 pounds, equal to ·0445 of a pound per ton, per mile making fuel cost per ton-mile ·71 of an ounce, at 12 knots per hour. Now the required powers for different speeds are as the squares of the speeds, so that the consumption at ten miles equals 100 ÷ 144 × ·71 ounce, which give us ·497 of an ounce of coal per ton, moved one mile in six minutes, saying nothing of shallow water resistance and coal burned in port. Upon the whole, it seems that our friends over the way have a faint prospect for selling to us their old one and two-ouncers, after we have built for ourselves half-ouncers, even away back upon the lakes.

DAVEY'S DOMESTIC MOTOR.

AT the Royal Agricultural Society's Show, held last year at Shrewsbury, Messrs. Hathorn, Davey, and Co., of Leeds, exhibited a new "domestic motor," which we illustrated and described at the time. Since July the machine has undergone some modifications, and we now illustrate it in the latest form which it has assumed. It consists of a cast iron boiler, in which steam is raised to atmospheric pressure, and worked in a



condensing engine. The air pump and hot well are seen at the side. One of these engines is in use driving a dynamo, and lighting Mr. Davey's residence at Headingley, near Leeds, as described in our last impression.

STEAMSHIP TRADE IN 1884.—Mr. C. Möller's steamship circular, dated January 1st, 1885, contains the following:—"Although the large number of steamers built during the three previous years was greatly in excess of the requirements, yet no less than 557 ships of an aggregate tonnage of 603,000 tons have been added to the number last year. The result has been disastrous both to owners and builders. The freights which were already low at the beginning of the year declined so rapidly that, when spring arrived, more than 100 steamers were laid up on the east coast, and that number has been more than doubled since. Of those which remained employed, very few have left any profit, whereas many have shown a heavy loss, and it is feared that when the annual accounts are made up there will be no dividends for the shareholders. The value of steamers has naturally suffered in proportion, and in several instances where sales were forced, extremely low prices had to be taken. This has caused several speculators to come forward, and a good deal of tonnage has changed hands; both new and good second-hand ships can still be placed, but only at much reduced prices, and as soon as freights improve these ships are expected to make profits, whilst the others have to lie idle. The large building establishments, especially those on the east coast, offer a melancholy sight, and the large number of hands which for a succession of years have been busily employed and well paid are now idle and in great distress. On the Clyde the state of things is not so bad, and most of the large firms have still work in hand which will keep them employed for some time. The losses have been very considerable during the year, and many of these resulted from collisions, which increase to an alarming extent."

FACTS NOT GENERALLY KNOWN CONCERNING ELECTRICAL INVENTION.

By J. S. Beeman, M.S.T.E.

The history of the transmission of electric energy by high-tensioned currents, its storage and distribution, is very interesting, as showing the development of an idea which has for long exercised a certain fascination for practical men, viz., the transfer of the energy of waste natural sources of force to localities where it can be utilised. As these localities may be situated at a considerable distance from the source of force, the capital invested in the collecting, transmitting, and distributing apparatus must of necessity be the ruling factor in the case from a commercial point of view, and therefore the economy to be effected by the application of some system for storing the energy and changing its tension to such as is found by experience to be the most expedient, is of great importance. Having in view the improvements in secondary batteries which have already been published, and those which we have still a right to expect, the day may not be far distant when the ideas that have been promulgated regarding such a system, applied to the distribution of electricity, will take concrete form. The various steps by which it has attained its present position, and been brought into the ranks of practically applied natural sciences, form the subject of this article. One of the earliest notices formulating such a design appeared in an article in the *Chemical News* in the year 1862, and ran as follows:—"Sitting by the seashore a few days since, we could not help noticing the vast reservoir of mechanical power existing in the ocean. We do not refer to the noisy dash of the waves as they break upon the beach, but to the infinitely mightier although silent and progressive energy exerted in the gradual rise and fall of the tides. By means of appropriate machinery connected with this tidal movement, any kind of work could be readily performed. Water could be pumped or air compressed to any desired extent, so as to accumulate power for future use, or for transport to distant stations. Light of surpassing splendour could be generated by means of magneto-electric machines; and with a very little extension of ingenuity, every lighthouse on the coast could be illuminated with sun-like brilliancy and with absolutely no expenditure of fuel; the very same mechanical power of the ocean, which in its brute force would dash the helpless vessel to pieces against the rocks, being bound and coerced like the genii in Eastern tales, and transformed by man's intellect into a luminous beacon to warn the mariner against the approach of danger." This idea of utilising the tidal power was, in 1871, actually embodied in a patent by Ferdinando Tommasi, for the working of which it was proposed to form a company. The apparatus, called the flux-motor, was a machine worked by the action of the tides, by which compressed air was to be delivered to customers through a network of pipes, on lines somewhat similar to those employed for the supply of gas. The idea was certainly somewhat unique, but, as far as can be ascertained, has never been practically tried; had it been carried to a practical commercial issue we should by this time have been in possession of a very cheap source of power for the production of electric energy. The possible application of this great natural force, by enclosing tidal waters just before the ebb sets in, and working motors through their release, has, however, been shown, in most cases, to be probably less remunerative than the utilisation of the land so enclosed for other purposes. In 1877 public attention was drawn to this question by the late Sir W. Siemens in his opening presidential address to the Iron and Steel Institute. He then stated that the energy of the Falls of Niagara might be made available by the then known mechanical means—though undoubtedly in a very wasteful manner—saying, to quote his own words, "Time will probably reveal to us effectual means of carrying power to great distances, but I cannot refrain from alluding to one which is, in my opinion, worthy of consideration—namely, the electrical conductor. Suppose water power to be employed to give motion to a dynamo-electrical machine, a very powerful electrical current will be the result, which may be carried to a great distance through a large metallic conductor, and then be made to impart motion to electro-magnetic engines, and ignite the carbon points of electric lamps, or to effect the separation of metals from their combinations. A copper rod, 3in. in diameter, would be capable of transmitting 1000-horse power a distance of, say, thirty miles; an amount sufficient to supply a quarter of a million candle-power, which would suffice to illuminate a moderately sized town." It is of historical interest that in the following year—1878—Sir Wm. Armstrong practically applied this method for the utilisation of natural forces in lighting his house at Craigside during the night, and working his lathe and saw bench during the day, by power transmitted through a wire from a waterfall nearly a mile distant from his mansion. In October, 1878, Mr. St. George Lane Fox patented his system for electric distribution by means of secondary batteries, and, as far as information is obtainable, this is the first public mention of secondary batteries being employed in such a system, although, as has been shown in a previous article, they had been patented at an earlier date as regulators to the circuit. Mr. Lane Fox's system is an extension of the idea of regulation, and it is worthy of passing note that at this period high-tensioned current dynamos, such as we are now accustomed to—the Brush, for instance—were practically unknown, the Brush patent not then having been published in this country. In November of the same year, a French engineer patented an invention, entitled "Improved means of Transmitting Electricity to Great Distances." Although his views and ideas were erroneous, the patent is interesting as showing that inventive talent was directed towards the subject of this paper, and because of the crude ideas contained in it as to the character of dynamic electricity. In December, 1878, Edison patented a system showing duplicate sets of batteries, one set being in the discharging circuit whilst the other could be in the charging circuit—there was practically no difference of tension in the two circuits. An interesting part in the patent was the apparatus whereby the sets of batteries, when fully charged, were cut out of the charging circuit; this was effected by utilising the gas given off to lift a diaphragm which actuated a switch or contact breaker. In May, 1879, Sir William Thomson gave evidence before the Select Committee of the House of Commons on lighting by electricity, saying, in reference to the utilisation of the energy of the Falls of Niagara for the purpose of generating electricity, and in answer to question No. 1799, "There is no limit to the application of it on a general scale. It might do all the work that can be done by steam engines;" he qualified this, and explained how it could be done in a later part of his evidence, by stating, in answer to question No. 1903, that the current sent along the wire would be used to turn electro-magneto machines, which current would be produced by magneto-electric machines. In October, 1879, Luke took out a patent for Houston and Thomson, wherein they showed means by which the tension of the discharging circuit might be raised far in excess of the tension of the current produced by the generator, this being accomplished by charging the batteries in sections and discharging them in series. The special feature of the patent bearing on one subject is contained in the twenty-second claim, and is the method described of bringing a dynamo-electric machine into circuit with a storage battery by first bringing the machine to its normal condition of working by the interposition in its circuit of, first, a normal working resistance, and afterwards of the secondary battery. In March, 1881, Professor Perry, whilst lecturing at the Society of Arts, said that for the future development of the transmission and distribution of electric energy it would be necessary to use electric machines of great electro-motive force. During the lecture, and afterwards in the discussion, reference was made to Professor Ayrton's paper read at the British Association meeting, held the previous year at Sheffield, wherein he pointed out, in a full and comprehensive way, how the energy of the Falls of Niagara might, theoretically speaking, be conveyed to New York along a single ordinary telegraph wire. The system, which was based on theoretical grounds only, and was dependent on exceptionally good insulation, was explained thus: Only a small amount of current would be conveyed along the wire, but it would have an enormous potential; and although the difference of potential between the ends of the telegraph wire would be nearly *nil*, yet the difference of potential at all points along the route, between the line wire and the earth, would be extremely large, so that much energy could be put in at the generating place—viz., Niagara—and a nearly equal amount would be delivered at the motor place—viz., New York. Thus, through the current being so very small the waste of energy in electric friction would be very slight. In April St. George Lane Fox, when lecturing before the Society of Telegraph Engineers, carried the system a step further by expounding a scheme whereby the energy transmitted under high potentials could be safely and usefully applied. He is reported to have used the following words:—"Electricity could be conveyed from a very great distance at an enormous electro-motive force, which electro-motive force could be reduced to any extent by means of a system of condensers, or of secondary batteries, and a suitable arrangement of commutators working automatically, so as to suit the requirements for distribution." Mr. Crompton, during the discussion, said: "As to the use of the secondary or reservoir batteries to act as a store of electrical energy, it is one of those things much talked of, but never yet practically carried out. M. de Meritens told me a few days since that a secondary battery had been recently brought out in France, which gave surprising results; five or six times as much energy can be stored in it as in the Planté battery." About May 16th appeared a letter in the *Times*, announcing the arrival of the above secondary battery, called, after its inventor, the Faure accumulator. On May 18th, Mr. Alexander Siemens lectured at the Society of Arts upon "Electric Railways and Transmission of Power by Electricity." He described a number of ways in which high potential currents could be utilised. He drew attention to large central stations fitted with powerful steam engines and dynamos supplying current to secondary batteries which would keep the electric energy stored until required for use. On June 6th appeared the celebrated letter of Sir William Thomson anent the Faure secondary battery, in which he stated that "the Faure accumulator always kept charged from the engine by the house supply wire, with a proper automatic stop to check the supply when the accumulator is full, will be always ready at any hour of the day or night to give whatever light is required." On the 9th he further wrote, when alluding to credit due to the late Sir William Siemens as the originator of the idea of utilising the Niagara Falls as the natural and proper chief motor for the whole of the North American Continent, "Under practically realisable conditions of intensity, a copper wire of $\frac{1}{2}$in. diameter would suffice to take 26,500-horse power from water-wheels driven by the Fall—losing only 20 per cent. on the way—to yield 21,000-horse power at a distance of 300 British statute miles; the prime cost of the copper amounting to £60,000, or less than £3 per horse-power actually yielded at the distant station." Early in September he, when delivering his opening address as president of the Physical Science Section of the British Association at the York meeting, went still further, and pointed out that through the introduction of accumulators much smaller conductors could be used than were anticipated by the late Sir William Siemens in 1877, and, further, that the necessarily high potential current employed to transmit the current long distances could be converted at its centre of distribution into such a low potential current as should be desired for the several purposes at the points of consumption of the electric energy. He went into fuller details regarding the contents of the letter alluded to above, stating that until he heard of Faure's invention he could only think of step-down dynamos at a main receiving station, to take the energy direct from the electric main with its 64,000 volts, and supply it by secondary 200 volt dynamos through proper distributing wires to the houses and factories and other places, where it could be used for every suitable purpose requiring power. Now the thing could be done much more economically and with much greater facility and regularity by keeping, say, 40,000 secondary battery cells always being charged direct from the supply main, and applying a methodical system of removing sets of 100, and placing them on the town supply circuits, while other sets of 100 were being regularly introduced into the great battery that is being charged. He further described and showed an automatic apparatus which he had designed and constructed to break and make the circuit between the battery and the dynamo. On the 24th of September, Duprez and Carpentier obtained a patent, wherein was described a system very similar, but, of course, giving more definite details of apparatus to be employed than did Sir William Thomson in the address referred to above. They referred to an automatic galvanometer which actuated a commutator or switch, thus causing the connection of the discharging circuit to be always in contact with a very constant supply of electricity. In November Professor Sylvanus Thompson, at a lecture at the Society of Arts, stated that we had in the tidal basin of the Avon enough energy to light Bristol, and in the channel of the Severn there was sufficient power—if only one-tenth were conserved in accumulators—to drive every loom spindle and axle in Great Britain. By this time the inventive public was thoroughly aroused, and the records of the Patent-office show that the details of the working out of the above system has received great attention. Nothing new has, however, been shown affecting the principle. Last month news reached this country that the Bell Telephone Company has two wires connected with the Niagara Falls, by means of which the Exchange at Buffalo has recently been operated. As an experiment, a generator was placed on the paper mills of Quimby and Co., at Niagara Falls, and the machinery connected with twenty miles of wire, the result being a success. The various attempts that have been made in this and other countries, notably France, with systems worked on the lines herein set forth, are practical evidence of the value of the foresighted idea of the late Sir William Siemens.

THE ROYAL INSTITUTION.

PROFESSOR TYNDALL ON THE SOURCES OF ELECTRICITY.

On Saturday, December 27th, Professor Tyndall delivered the first of a course of Christmas lectures adapted to a juvenile auditory on "The Sources of Electricity," to a body of listeners which filled the theatre of the Royal Institution.

The speaker stated that nine years ago he had lectured there on the subject of frictional electricity, but on the present occasion he intended to give a connected story of the whole subject, to show how the knowledge of electrical science grew up. No doubt all present were aware that the word "electricity" was derived from the Greek word "*electron*," meaning "amber," for the Greeks knew that amber when rubbed would attract light particles, such as small fragments of paper. Amber is found in Europe on the seashore of the Baltic, particularly after storms, and the people gather it among the seaweed; there are also fossil trees which once yielded amber; in fact just as gum oozes out of the cherry tree at the present day, so did gum in those early times ooze from the amber tree. The two mouthpieces of pipes stuck together, which he held in his hand, had been in the Royal Institution he did not know how long, and when he rubbed them on a cat-skin, they saw that the amber attracted light particles of bran. The mind of man was never contented with mere facts, so the real question was "Why does the amber attract the bran?" A great philosopher of those early days, Thales by name, supposed amber to possess a soul, and because of its soul it attracted bodies, and for the next two thousand years nothing more was known about electricity. In the year 1600, Dr. Gilbert, who lived in the time of Queen Elizabeth, remarked that amber was nothing but gum because it contained insects, so that other bodies might possess the same electrical power; he discovered many such, including glass.

The lecturer then balanced a lath, perhaps about four feet long by two inches wide, upon a pivot; he said that a watch-glass would do as well, and that if a boy could not afford a watch-glass, he could balance it on an egg in an egg cup. He then showed that a rubbed glass rod would attract one end of the lath, and would also attract a small broad-rimmed paper wheel, so as to make it run along the lecture table, following the tube as a carriage follows the horses. But a carriage was drawn by visible threads, whilst the paper wheel before them appeared to be drawn by invisible threads, as if it were harnessed therewith to the rod. Why was this? Sir Isaac Newton considered the problem in relation to the action of the sun upon the planets; he thought that there was something there, but was cautious not to say what it was. That same question was now before them; it was one of the most important which occupied the attention of scientific men, and perhaps they would not solve it in our day and generation.

The inventor of the air pump, a Burgomaster of Magdeburg, made further discoveries in electricity. He found out that when a feather suspended by a silk fibre was touched by an excited glass rod, the feather was afterwards repelled by that rod, but attracted by a rubbed rod of gutta-percha. Professor Tyndall no doubt meant sealing-wax, as gutta-percha was not known in Europe at that time. Other rubbed resins also attracted the feather repelled by glass; hence arose the idea of two kinds of electricity. The lecturer then balanced a lath on a stem insulated by a cake of shellac, and placed himself upon a stool insulated with glass legs; he next asked his assistant, Mr. Cottrell, to strike him several times upon the back with a cat-skin, which amused the boys present, especially when he said, "Strike me again, if you please, Cottrell." By the friction of this mild flagellation, enough electricity was developed on the surface of the lecturer's body to enable his knuckles to attract one end of the balanced lath. Newton, he said, found his dressing gown to act better than other rubbers, and noticed that in obtaining frictional electricity, much depends upon the character of the rubber. Professor Tyndall then suspended a stick of excited sealing-wax by its centre to a silk string, and showed that it was repelled by another excited stick of wax; two rods of gutta-percha similarly repelled each other, and he said that the same effect could be produced by means of two paraffine candles. He excited an ebonite comb by drawing it several times through his hair, and showed that it would then repel a suspended comb; it was necessary that the hair should be dry. Resinous bodies, he added, repel each other electrically, but attract vitreous bodies; the conclusion, therefore, was that similar electricities repel each other, and opposite electricities attract each other. These electricities were once called "resinous" and "vitreous," but now "positive" and "negative," but they must bear in mind that there is no intrinsic reason why one of the electricities should be named positive or negative more than the other. The electricity from glass is called positive, and that from resins negative. He then showed the repelling force between bodies similarly electrified, by holding two pieces of silk riband at one end, and rubbing them down with the catskin; they then repelled each other, standing out in Λ-form. He next warmed a board, and warmed a sheet of foolscap paper, then applied friction to the latter upon the former with a piece of india-rubber. The electrified paper adhered somewhat firmly to the board, and when, with a penknife, he cut out two strips of paper, and raised them from the surface of the board, they repelled each other. He also exhibited a great paper tassel, the ribands of which repelled each other when electrified.

On two long, dry, narrow glasses he placed two brass balls, one on each glass, then electrified one of the balls with an excited glass rod; afterwards, by means of a discharging-rod, he momentarily connected one ball with the other, which thus, it was shown, acquired the power of attracting the balanced lath. The fact, he said, that electricity can thus be conveyed from one object to another, first gave the idea of an electric current. The gold-leaf electroscope was next brought under notice, and the method of using it. Professor Tyndall showed that frictional electricity would travel along a string, and cause the leaves of the electroscope to diverge, when the string contained but the moisture it had taken up from the air of the theatre, but that when it was dried it could no longer conduct electricity. He passed a current also through a silk cord which had just been dipped in water; by these experiments showing the effect of moisture. He warmed most of the things used in the lecture, he said, merely to get rid of moisture, otherwise heat or cold would not interfere with his experiments. Placing two apples upon the two tall glasses, he said that in the eyes of scientific men positive and negative electricities were mixed together in those apples, but that this speculation should not fetter the minds of the listeners; nevertheless, it enabled experimentalists to predict results before they were obtained. He then held an excited glass tube near one of the two apples, which were touching each other, saying that the tube was supposed to attract the one electricity and to repel the other; he next separated the apples, and by the electroscope showed that one was charged with positive and the other with negative electricity.

RAILWAY MATTERS.

A SCHEME is on foot for a new railway to connect St. Helens with Liverpool, and this, by means of the Mersey Tunnel, with Cheshire and North Wales.

THE number of passengers who travelled to and from various stations on the Metropolitan Railway on Boxing Day, December 26th, was 234,830, being an increase of 7684 on the previous Boxing Day.

THE Wigtownshire Railway, 20½ miles in length, is to be acquired by the London and North-Western, Midland, Caledonian, and Glasgow and South-Western Companies, under the arrangement for a joint ownership of the Portpatrick line. The capital of the Wigtownshire Company is upwards of £156,000, and the traffic receipts for the year 1883 were £7584. The Portpatrick Railway is 62 miles in length, the capital £611,000, and the traffic revenue for last year was £37,581.

THE reconstruction in iron of the massive viaduct which carries the Caledonian line of railway to Aberdeen over the Glen of Ury is now nearing completion. The *Aberdeen Free Press* says the execution of this contract was entrusted to a local firm, Messrs. Blaikie Brothers, Footdee Ironworks, who have been entrusted by the Great North of Scotland Railway Company with the construction of the extensive viaduct over the Spey at Garmouth, in connection with the Buckie extension. The centre girder of this viaduct has a clear span of 350ft.

A CORRESPONDENT, "R. B. P.," referring to the paragraph on sleeping cars on page 6 of our last issue, calls attention to the regulations of the Grand Junction Railway published in "Osborne's Guide to the Grand Junction," Birmingham, 1838, the preface of which is dated July of that year. It is there stated that "The first-class trains consist of coaches carrying six inside, and of mails carrying four inside, one compartment of which is convertible into a bed carriage if required." The fare from Birmingham to Liverpool or Manchester in a sleeping carriage was £2.

ON Wednesday a coroner's inquest on three people killed on the Manchester and Sheffield line by an accident caused, it is supposed, by the breaking of a wagon axle, resulted in a verdict of "Accidental Death." Conflicting evidence was given as to the character and quality of the axle. Penistone has been twice in a few months the scene of very bad accidents, the second of which could not, however, have been avoided as the first might with good brakes. Since the above-mentioned accident another wagon axle has broken on the same railway, near Sheffield, and fouled the line, but no other train was passing.

THE Great Southern and Western Railway Company, Ireland, has accepted the tender of Mr. Robert Worthington, of Dame-street, Dublin, for the construction of its extension from Baltinglass to Tullow, 10½ miles. Mr. Worthington is at present constructing the Sallins and Baltinglass Railway, 24½ miles, for the same company, and the Ballywilliam and New Ross Railway, 7 miles, for the Wicklow and Wexford Company. We understand the tender of the same contractor was recently accepted by Sir Arthur Guinness, Sons, and Co., Brewers, Dublin, for the construction of a new malt store, at a cost of over £40,000.

ON the 5th inst. the Scotch mail train on the London and North-Western Railway ran into a goods train between Wolverhampton and Bushbury Junction. The brake van of the goods train was wrecked, and the engine of the express was much damaged. The driver and fireman of the goods train, which had been brought to a standstill, jumped off the engine, and the brakesman had a narrow escape. The driver and stoker of the mail, when they saw that a collision was inevitable, also sprang off, though, it is said, not until they had applied the brakes. They had time for this. A really good brake could have been applied throughout the train in less time, done good work, passengers less injured, and the men saved the risk of jumping from their engine.

THE first railway locomotive which was introduced into Australia has, says an exchange, just been consigned to a resting-place in the Technological Museum at Sydney, where it will remain to remind the colonists of early days. The locomotive arrived in Australia on the 13th January, 1855, or not quite thirty years ago, and since then it has covered an enormous mileage. The engine was built by the well-known firm of Stephenson and Sons, of Newcastle-on-Tyne. It is one of four with 16in. by 24in. cylinders, and four coupled wheels 5ft. 6in. diameter, coupled forward. It is believed in some quarters, the really first engine introduced was No. 5. This was a contractor's locomotive, built by Hawthorne, of Newcastle, with 14in. by 22in. cylinders, and 4ft. 6in. forward coupled wheels.

A REPORT by Major Marindin on an accident which occurred on the 25th August at Shields Junction, on the Glasgow and Paisley Joint Railway, concludes:—"There is always a certain risk of such an occurrence when home signals are placed far back from facing points, and, where this is unavoidable, it is better either to provide a splitting signal at the points, in addition to the home signal, or to introduce a second locking bar between the home signal and the points. The speed of the train in this case was probably at least thirty miles an hour, and, as it was brought to a stand with comparatively little damage in a distance of only 93 yards after the engine finally left the rails, it is evident that the continuous brake with which the engine, tender, and twelve out of the eighteen vehicles in the train were fitted, and which was promptly applied, did excellent service."

PLANS and estimates of cost of the Mount Gambier and Narracoorte Railway have been laid before the South Australian Assembly. The figures are as follow:—Length, 63 miles 60 chains; land and compensation, £5800; permanent way, £106,162 17s. 4d.; works, £46,540 10s. 11d.; buildings, £15,947; rolling stock, £28,475; machinery, plant, &c., £3967; provision of water and fuel, £4180; general expenses, £11,267 10s. 1d.; maintenance for one year, £5023 2s. 8d.; contingencies, 10 per cent., £22,736 6s. 2d.; total estimate, £250,099 8s.; average cost per mile, £3969 16s. 8d. The *Colonies and India* notes that the following memorandum was attached:—"Since this estimate was made last April the line has been deviated by Kalangadoo, increasing the length by one mile and a-half, the cost of which deviation, excluding the land, will be £3650. The land has also been carefully valued at £7500. Cost as estimated in April last, £250,100. Cost as now estimated for 64¾ miles will be £255,450."

THE Sukkur Bridge, India, contract has been let to Messrs. Westwood and Bailie, Isle of Dogs. It will be remembered that about a year ago this bridge was offered for tender, with the extraordinary condition that the immense cantilevers were to be erected for inspection at the works of the maker in England. Few makers were able to tender in this way; but some of the more enterprising offered to take the responsibility of the work going together properly in India by erecting it at the site. The business was postponed till now, pending communication with India. The authorities there prefer to erect the bridge themselves. If, therefore, the original plan of erecting at the factory be carried out, the cantilevers will present a somewhat startling spectacle on the banks of the Thames. It will be interesting to note if Mr. Rendel will carry out the design as it was described last year. It is, however, almost impossible that such a hideous thing will pass into actuality without important modifications; but in any case the Sukkur bridge, even as far as it has yet gone, is an illustration of the way England is officially committed to the greatest barbarisms of design when design is thrust upon officials as a matter of routine, instead of being solicited from those who have special talent in the work to be done. Moreover, if it becomes necessary to erect all the new bridges in the factory yard, bridge builders will have to buy a county for erecting room, to say nothing of the enormous extra cost and waste of money. Perhaps, however, the designers will learn to predicate the capability of their bridges to stand without erecting them twice.

NOTES AND MEMORANDA.

M. LAZARE WEILLER has shown that the phosphide of tin, drawn into wires, possesses a higher electric conductivity than platinum or iron.

IN 1883 there were nine woollen mills in New South Wales, in eight of which there were produced during the year 202,000 yards of cloth and tweed.

THE number of steam and water mills for dressing grain in New South Wales is 154, representing 2847-horse power, the number of hands employed being 685.

IN London, during the week ending 20th December, 2631 births and 1595 deaths were registered. The annual death rate per 1000 from all causes, which had been 22·9 and 21·3 in the two preceding weeks, declined to 20·7.

THE deaths registered during the week ending January 3rd, in twenty-eight great towns of England and Wales, corresponded to an annual rate of 25·0 per 1000 of their aggregate population, which is estimated at 8,762,354 persons in the middle of this year. The five healthiest places were Huddersfield, Portsmouth, Derby, Bristol, and Halifax.

IN London, during the week ending the 3rd inst., 3283 births and 1918 deaths were registered. The annual death-rate per 1000 from all causes, which had declined from 22·9 to 18·6 in the four preceding weeks, rose to 24·9 last week. This increase, as also the excess of births, was in great measure due to arrears of registration from the previous week.

THE deaths registered during the week ending December 20th in twenty-eight great towns of England and Wales correspond to an annual rate of 21·6 per 1000 of their aggregate population, which is estimated at 8,762,354 persons in the middle of this year. The five healthiest places were Brighton, Wolverhampton, Birmingham, Huddersfield and Portsmouth.

THE wax plant, indigenous in Carolina and Pennsylvania, is now being cultivated in Algeria. The fruit, enclosed in a bag of coarse cloth, is plunged into boiling water, and in a few seconds the liquid wax floats on the surface. This is skimmed off and dried, and forms a good substitute for beeswax for foundry and other purposes, as it has the same chemical composition.

DR. F. WAGNER concludes that the heat conductivity of a soil is greater the more densely its particles are packed together. The difference thus occasioned is the more considerable the higher the proportion of water. In a dry soil the heat conduction rises with an increase in the size of the particles of the soil. Water increases the conductivity of the soil considerably, other circumstances being equal.

AS a result of a series of experiments made on some samples of vulcanised Para india-rubber, M. Jenatzy, of Brussels, found that, under uniformly increasing loads, a band of caoutchouc takes increasing elongations until it becomes twice as long as it was originally, after which the successive elongations decrease, and he also finds that the weight necessary to quadruple the length is three times that under which the length has become doubled.

M. JABLOCHKOFF announces another battery of great scientific interest. A small rod of sodium weighing about 8 grammes is squeezed into contact with an amalgamated copper wire and flattened. It is wrapped in tissue paper and then damped with three wooden pegs against a plate of very porous carbon. This completes the element. The moisture of the air settles on the oxidised surface of the sodium. It works without any other liquid. The E.M.F. is 2·5 volts, but the resistance is as great as 25 ohms.

THERE was recently exhibited at the Franklin Institute an Edison lamp in which the copper, with which the juncture of the wires with the carbon filament is electro-plated, had been volatilised by the heat of the lamp. The metal had been deposited very uniformly on the interior surface of the globe, forming a continuous copper coating of superb metallic lustre when viewed by reflected light, but so excessively thin as to be quite transparent by transmitted light, the transmitted colour being green, or the complementary colour to the first named. Similar effects have often been observed with other Edison lamps, but the specimen shown was remarkable for its beauty.

DURING the week ending December 6th, in thirty cities of the United States, having an aggregate population of 7,289,300, there were 3122 deaths, which is equivalent to an annual death-rate of 22·3 per 1000. Of the deaths 1161, or 37·1 per cent., was under five years of age. The death-rate in the North Atlantic cities was 22·8, in the Eastern 24·3, in the Lake 18·4, in the River 19·7, and in the Southern cities, for the whites, 19·7, and for the coloured, 26·3 per 1000. During the following week, in twenty-nine cities, with an aggregate population of 6,988,300, there were 2857 deaths, which is equal to an annual death-rate of 20·9 per 1000. Of the decedents, 374 were children under five years of age. The rate in the North Atlantic cities was 20·3, in the Eastern 23·1, in the Lake 17·6, in the River 19·2, and in the Southern cities 21·9 for the whites, and 33·8 for the coloured.

THE history of glass-making in France is bound up with the company called the "Société de St. Gobain, Chauny et Cirey." This company received its letters patent—the first in its particular walk—from Louis XIV. in 1665, on the recommendation of the Minister Colbert. In 1691 De Néhore invented the process of casting glass, and set up the making of it in the Château of St. Gobain. In 1702 the St. Gobain Company was re-modelled on fresh lines, and in 1830 became a joint stock undertaking, and was finally modified in 1855, under its present title, on amalgamation with the Compagnie de St. Quirin. At this last date the company owned four glass-making works—at St. Gobain, at Chauny, at Cirey, and at Mannheim, in the Grand Dukedom of Baden. In 1863, the *Plumber and Decorator* remarks, the Société bought the Stolberg glass works near Aix-la-Chapelle, and finally, in 1868, rounded its possessions by becoming the owner of the Montlucon works.

IN a paper by Mr. J. P. Kimball in the "Transactions," American Society of Mining Engineers, the author says the fact that in some instances, coralline masses have become bodily indurated and crystallised into marble, while in others they have disappeared by dissolution and their place has been taken by specular oxide of iron, is to be explained by a difference in local circumstances, of which at least the following are easily conceived:—(1) A mass of coralline limestone situated at an elevation so that drainage would be away from it, would not be subject to the solvent effect of carbonated or other acidulated waters, except upon its surfaces. Such is the topographical situation of all the marble deposits known to me in the region. (2) The period of the crystallisation of the calcareous or coralline material has doubtless in some cases governed the matter in question. If originally crystallised as one of the immediate effects of igneous contact, it would be in a state to resist solvent action of circulating waters except at its surfaces. The alteration of limestone into the crystalline form of marble is a common effect of vulcanism, whether of trap-dikes or other larger injections. (3) The condition of the coralline limestone when overflowed, whether emerged and therefore to some degree consolidated, or whether still of the nature of coral-reef, is a question of some moment in its bearing on the difference to be observed among the several developments of limestone, and of the iron ores. In other words, some of the points of difference suggest the probability that, in some cases, the coralline masses involved were at least under water and parts of them still of the character of reef, when involved in the igneous flood. The presence of organic life is indicated by the pyritous ore possessing the structure of corallum at the "north shaft"—pit—of East mine, which is near the contact of one of the great ore-bodies with the syenite. The limestone, so far as is at present known, is completely obliterated in the case of the development of large ore-bodies.

MISCELLANEA.

THE streets of Chester were on the 1st instant gay with bunting, on the occasion of the freeing of the Dee bridges from tolls, and the removal of the gates.

IN the reference in our annual article last week to the Institution of Civil Engineers we gave its growth in ten years as "over 58 per cent." This should have been "over 85 per cent."

MR. J. B. EVERARD, Assoc. Mem. Inst. C.E., of Leicester, has been appointed the engineer to advise on a scheme of drainage for the Humberstone and Evington suburbs of Leicester.

THE American *Mechanical Engineer* says: "Recipes for restoring burnt steel abound; the best one we ever found was to throw the burnt steel in the scrap heap, get a new piece, and use more care in working it."

IN commemoration of the services to astronomy rendered by the French observers of the transit of Venus in 1874, the French Government have placed in the National Library of Paris a large monumental vase, designed and manufactured at Sèvres.

THE Philadelphia Natural Gas Company—Westinghouse—which has entered Pittsburg with its big 10in. gas pipe line, has fixed the price at 15 cents, and it is stated that in consequence thereof it is almost overwhelmed with orders from householders and others.

ON the 4th inst. more water than was wanted found its way into and flooded many shops in Glasgow, and got mixed up with the furniture and other articles, and the congregations of the churches in the vicinity had to go without music. Water mains had burst.

AN alarming machinery accident occurred at Bradford on the 2nd inst., when a large engine fly-wheel in Riley's mill, weighing from 20 to 30 tons, broke into pieces whilst in revolution. One huge piece ascended through the engine house and carried away the gable end of the mill. The engine house itself was demolished, but fortunately there was no loss of life.

ON the 30th ult. a new twin screw hopper dredger, of 500 tons and 450-horse power, was launched by Messrs. W. Simons and Co., Renfrew. It is named Surprise, and has been designed and constructed for France. It will dredge from 6in. to 25ft. depth, and carry 400 tons of its own spoil at a speed of eight miles an hour. Its place will be re-occupied by another new hopper dredger, twice the size, for the Clyde.

AT a recent meeting of the North of England Institute of Mining and Mechanical Engineers, a paper "On the Endless Chain in Spain," by Mr. George Lee, was read. The author, who has had extended experience in the transport of mineral and underground haulage, gave a practical description of the system and its peculiar advantages—saving in first cost and the greater economy attending its regular working.

AT the recent Agricultural Exhibition of the Imperial Agricultural Society of South Russia, engines and machines were exhibited by Messrs. Ransomes, Sims, and Jeffries, Messrs. Clayton and Shuttleworth, and Messrs. Burrell and Co. Messieurs T. Malachoffski and N. V. Yakounin were appointed expert judges of these exhibits, and awarded equal honour to all. The committee gave unequal awards, and Messrs. Malachoffski and Yakounin publish an indignant protest in the *New Russian Telegraph* against what they consider an unfair action, injurious to the Society.

AT the meeting of the Southend-on-Sea Local Board of Health on Tuesday last, Mr. W. Lloyd-Wise drew attention to the recent report of the Royal Commission on Metropolitan Sewage Discharge, and moved, "That this Board will strenuously oppose any scheme for sewage disposal involving the treatment or discharge of sewage or sewage liquids from London and its neighbourhood in the Thames, whether at Hole Haven or elsewhere, near or so as to be calculated to injure Southend." The resolution having been seconded and carried, a committee was appointed to give effect to it.

THE Committee of the North German Cotton Manufacturers' Association have addressed a memorial to the Reichstag, in which they urge the speedy adoption of the Mail Steamer Subvention Bill. The members of the committee say that the majority of their number have lived long enough in England and in countries beyond the seas to know the extreme importance to trade of regular mail lines of steamers for carrying correspondence, passengers, and goods, and the influence which such principal lines, supported by the State, will have on the development of German shipping, trade, and industry in general. They declare that the want of such German mail steamers has long been felt by all Germans who do business with countries beyond the seas to be a serious drawback, and that the advantages of their establishment will very soon become apparent.

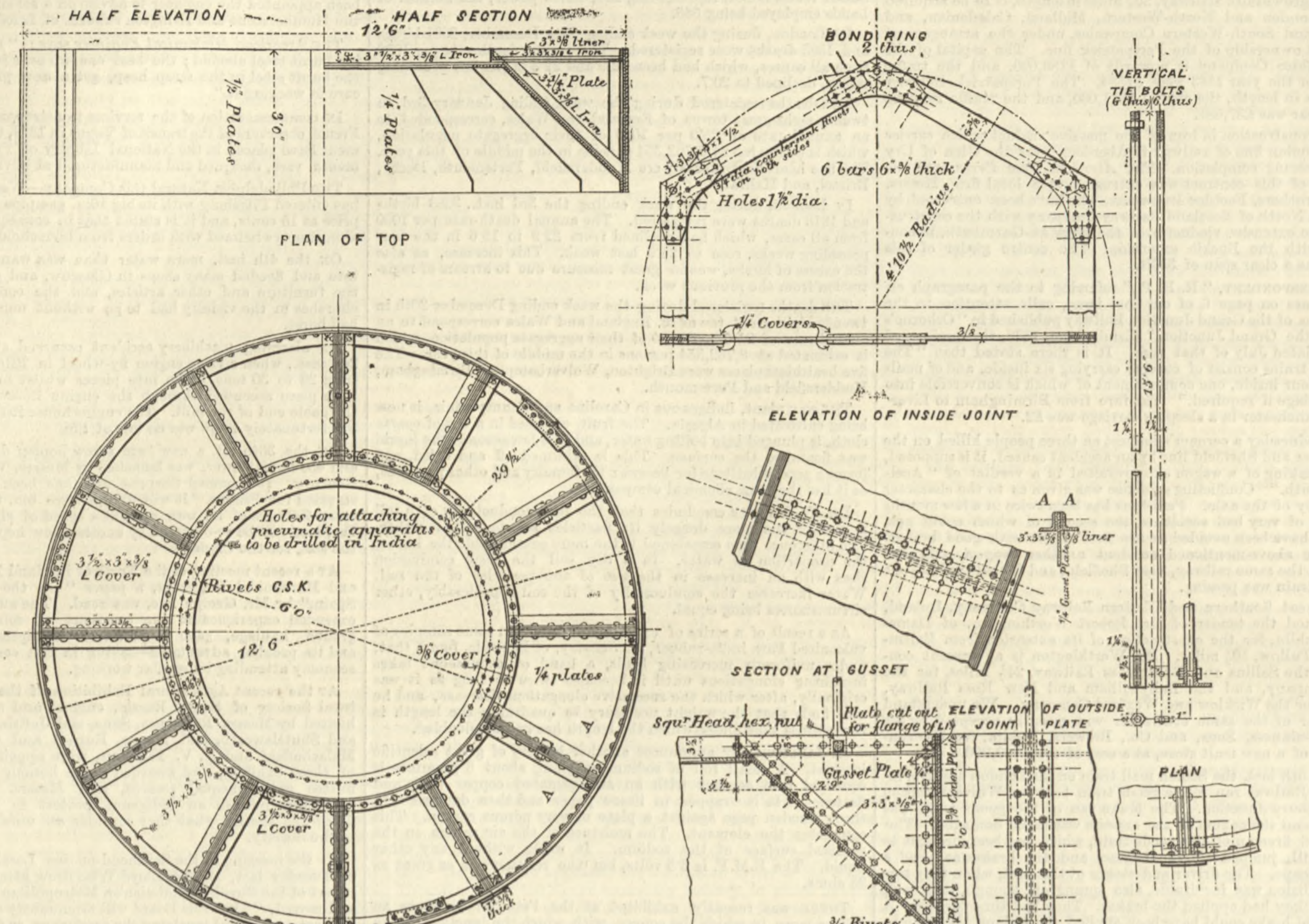
A TRIAL of a smoke rocket for testing drains is thus described by Mr. Cosmo Jones in the "Journal" of the Society of Arts:—The one fixed upon is 10in. long, 2¼in. in diameter, and with the composition "charged rather hard," so as to burn for ten minutes. This gives the engineer time to light the fuse, insert the rocket in the drain, insert a plug behind it, and walk through the house to see if the smoke escapes into it at any point, finishing on the roof, where he finds the smoke issuing in volumes from the ventilating pipes. The house experimented upon on Saturday had three ventilating pipes, and the smoke issued in dense masses from each of them, but did not escape anywhere into the house, showing that the pipes were sound. If the engineer wishes to increase the severity of the test, he throws a wet cloth over the top of the ventilating pipe, and so gets a slight pressure of smoke inside it. The smoke rocket is not protected by any patent, and is made by Mr. James Pain, 1, St. Mary Axe, E.C.

AN agricultural implement called the Mallee roller is occupying attention in South Australia. Some correspondence has recently taken place as to its first use in the Wimmera district. The honour of priority has been claimed by one and another, until it has transpired that ten years ago a mallee roller was used by Mr. J. Affleck, a sheep farmer at Lorquon. The *Colonies and India* says: It matters little who first introduced the roller so long as it can be shown that work can be done effectively and cheaply in the mallee country, and to this end trials of mallee rollers, stump jumpers, or mullenisers may well be encouraged. The attempt to cultivate the mallee country now being made at Yarrock is being watched with interest, and lessees of mallee fringe allotments in other parts of the Wimmera are making inquiries and trials, with a view to following in the steps of those South Australians who have been successful in their attempts to cultivate similar country.

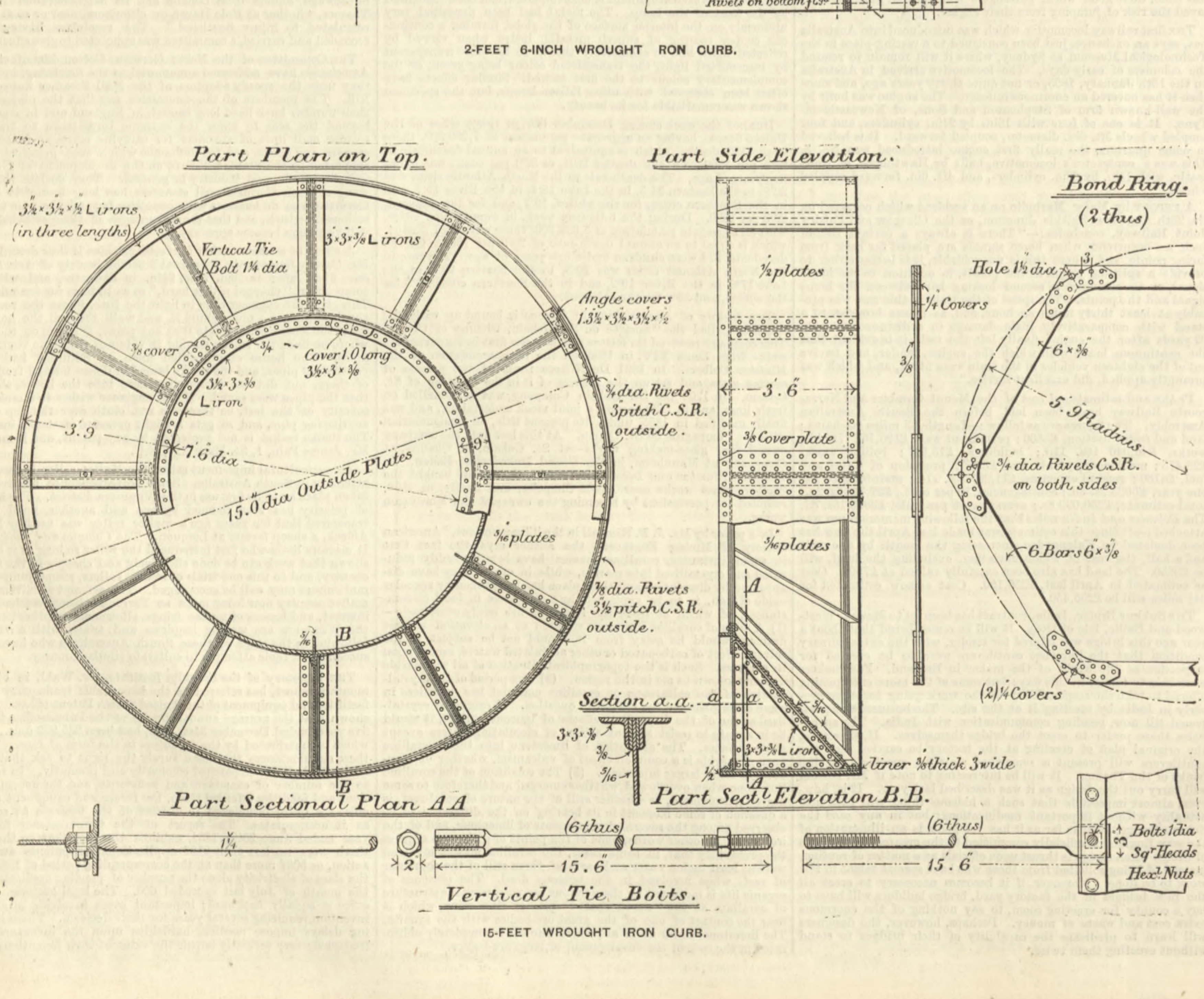
THE secretary of the Franklin Institute, Dr. Wahl, in his last monthly report, has referred to the lamentable inadequacy of the facilities and equipment of the United States Patent-office. It was shown that the average annual surplus of the Patent-office for the five years ended December 31st, 1883, had been 285,992 dols., all of which is contributed by the inventors in the form of fees. Under these circumstances they have surely the right to ask that their business shall be despatched efficiently and promptly. In respect to the number of examiners and assistants, and the accommodations and facilities afforded them, the forces and equipment of the office are quite insufficient to dispose of the business as rapidly as it accumulates. The report of the Commissioner for the year ended June 30th, 1884, exhibits the fact that on that day there were no less than 9186 applications for patents awaiting action, or 5087 more than at the corresponding period of 1883. In the class of electricity alone the number of pending applications in the month of July last exceeded 600. The legal business of the office is equally backward; important cases involving priority of invention requiring several years for their decision. These harassing delays impose needless hardships upon the inventors, and frequently very seriously impair the value of their inventions.

CONTRACTS OPEN—WELL CURBS, INDIAN STATE RAILWAYS.

For specification see page 26.)



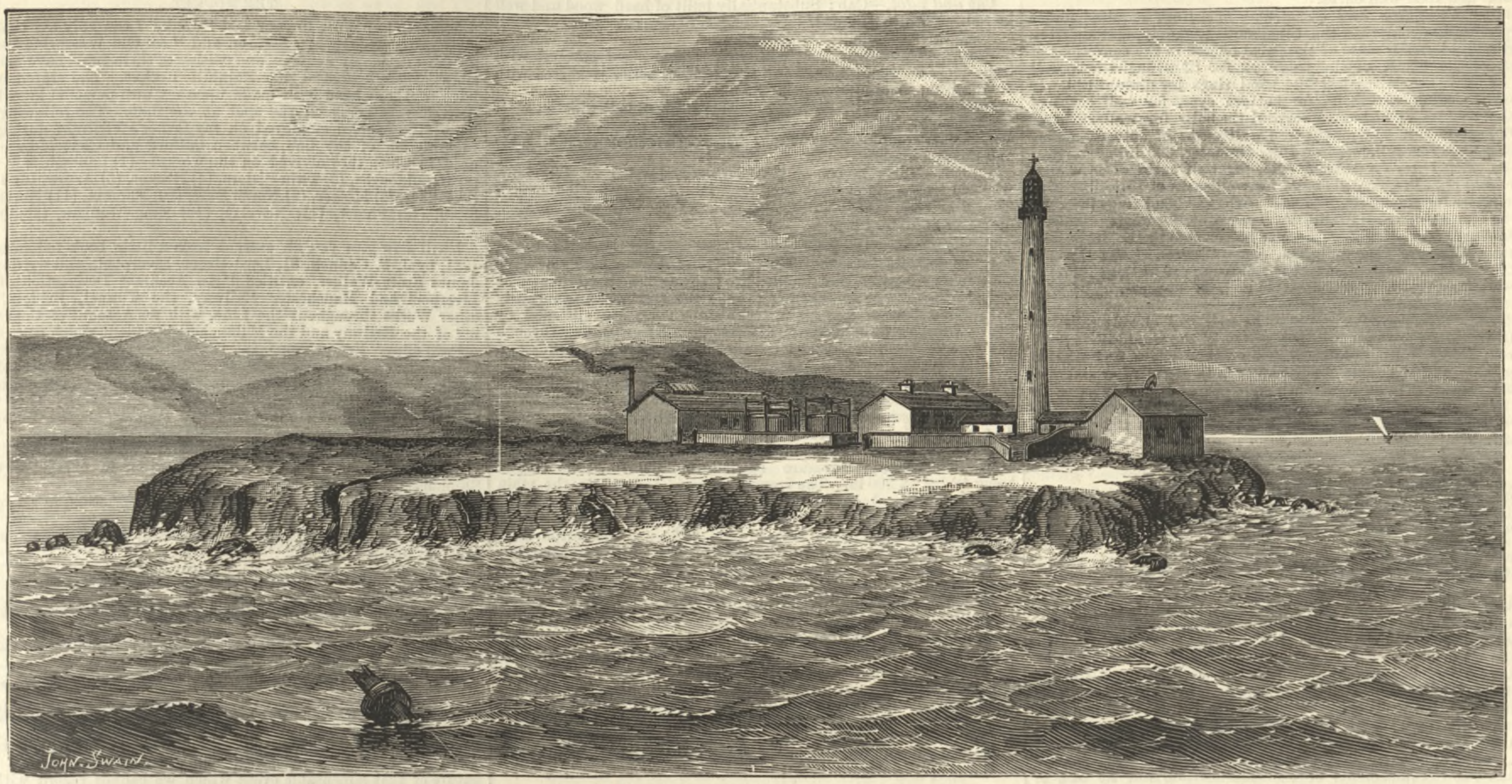
2-FEET 6-INCH WROUGHT IRON CURB.



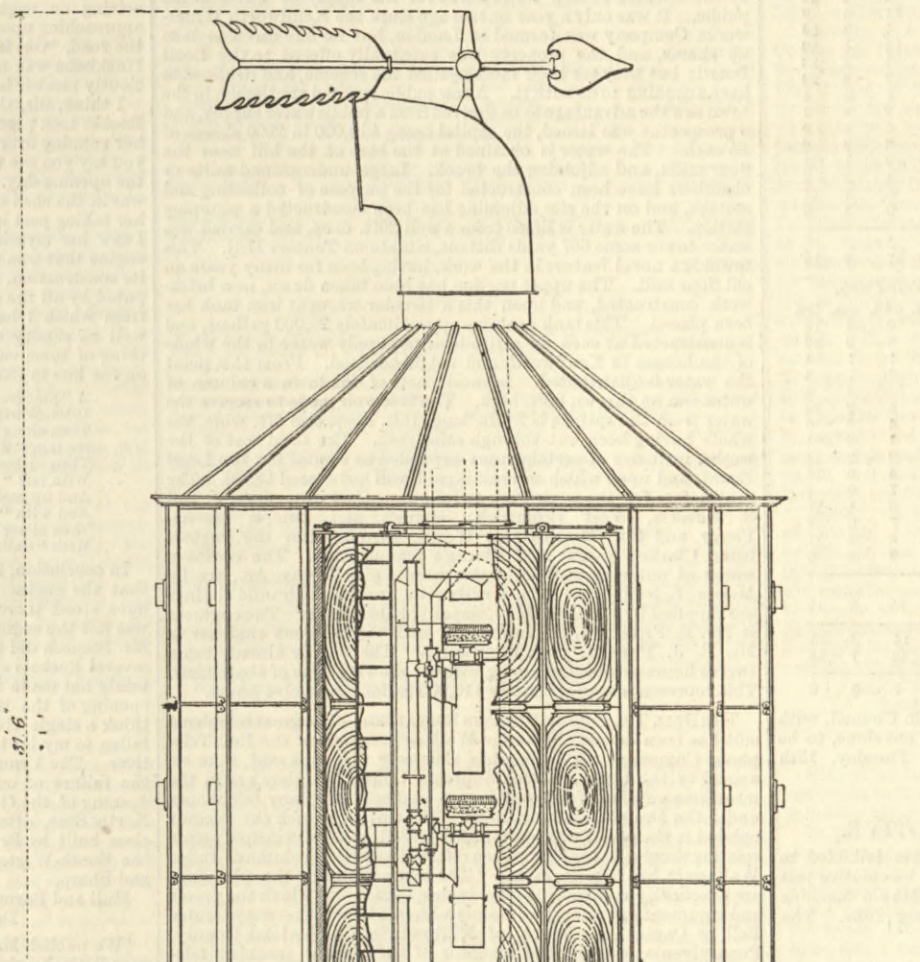
15-FEET WROUGHT IRON CURB.

MEW ISLAND LIGHTHOUSE, BELFAST LOUGH.

MR. W. DOUGLASS, M.I.C.E., ENGINEER.



A GOOD deal of discussion has recently taken place concerning, among other lighthouses illuminated by gas, that at Mew Island, situated at the entrance to Belfast Lough. We now illustrate this lighthouse, which supersedes the old lighthouse on Copeland Island. The tower and adjoining buildings were erected by Messrs. Dixon and Son, of Belfast, and the gasworks, lantern, dioptric apparatus, lighting apparatus, sirens, engines, and receivers were supplied and fitted up by Messrs. Edmundson and Co., of London and Dublin. A Committee of the Commissioners of Irish Lights, who are the lighthouse authorities in Ireland, recently formally lighted this lighthouse for the first time. The committee consisted of Captain Hady, R.N., Captain Riall, R.N., Mr. William Watson, and Mr. Ed. H. Kinahan. They proceeded to Mew Island in the steamer Princess Alexandra, commanded by Captain A. Knox Galway, and were accompanied by Mr. W. Douglass, engineer-in-chief to the Commissioners of Irish Lights, Captain Boxer, R.N., their Inspector of Lights, and Mr. John R. Wigham, of the firm of Edmundson and Co., the designer and patentee of the light, which is made from gas produced on the island, and is called a triform group flashing light. The groups of flashes are exhibited every minute, and each group consists of four brilliant flashes of several seconds duration. The deep darkness between each flash, which is the characteristic feature of this lighthouse, is caused by the extinction of the gas, which by a simple automatic arrangement is again relighted to form each of the flashes. There are thirty-two jets in the burner which produces the light used for ordinary clear weather, so that the consumption of gas for such weather is but trifling, but when the weather becomes thick or foggy no less than 324 jets can be employed, forming the largest lighthouse light in the world, the power of which is equal to more than 2½ million standard sperm candles, and which, if the lighthouse were sufficiently elevated, could be seen for sixty miles. The gas which produces this light is also used as the motive-power for actuating the fog signals at this station. Gas-sounded fog signals possess this advantage over all others, viz., they can be put into action at a moment's notice, whereas steam engines and hot-air engines take some time in preparation. The thanks of the seafaring community are due to the Commissioners of Irish Lights for thus placing for their benefit on a most dangerous part of the cost a light of such transcendent power.



The blocking or lightroom, as it is sometimes called, of which we give a detailed illustration, consists of sixteen cast iron plates, each with a large ventilator, by which air is admitted through lateral openings at the level of the bottom, and passes into the lantern by brass hit-and-miss ventilators inside the blocking. The blocking is lined with polished mahogany, which gives a warm, sightly finish to the interior, and is supported upon cast iron hollow boxes carrying a balustrade and hand rail, as shown, and supported by strong cast iron cantilevers built into the masonry.

The clockwork by which the lenses are rotated is contained in a cast iron pedestal, glazed with plate-glass; an endless chain being attached to the rotating machine, passes through the floor and is carried sideways to the tower, where a trough constructed in the masonry is prepared for the weight. The weight is enclosed in this trough by cast iron framing and doors, so as to admit of easy access to it. There are twenty-four large annular lenses about 4ft. square in three tiers of six each, strongly bound together with gun-metal framing, and supported on cast iron brackets secured to the live ring on which the hexagonal superstructure of lenses revolves. There are three large gas-burners—Wigham's patent superposed—each placed in the focus of each tier of lenses. There are 108 jets of gas in each of these burners, but each flame is one solid mass measuring about 12in. in diameter and about 8in. in height. These burners are so constructed as to be absolutely smokeless and to require no glass chimneys, which in lighthouses are so objectionable, as causing loss of light and expenditure from breakage.

Attached to the rotating apparatus is an arrangement of cog wheels and cams by which the gas is continually turned off and turned on, and it is this arrangement which causes the peculiar distinctive characteristic of the lighthouse. The revolution of the lenses transmits to the observer a beam of light every minute, but this beam is broken up, by the extinction and reignition of the gas, into four flashes as the lens passes the eye of the observer, so that every minute he sees four brilliant flashes occupying about fifteen seconds. The power of the light is such that the mariner has also the advantage of never losing sight of the light even in the intervals between each group of flashes, and this is an advantage of no small moment, when it is remembered how many lights there are now to be found near our great harbours, such as Belfast Lough, where this lighthouse is situated; fishing boats anchored at their nets, lights on shore, anchor lights of ships in the roadsteads all of them at a close distance as bright as a lighthouse at a long range, and therefore frequently puzzling to the sailor. In the presence of Mew Island lighthouse, with its continual characteristic intensified beam, there can be no confusion in his mind.

The lantern, which, with all the apparatus, burners, &c., was constructed by Messrs. Edmundson and Co., of Great George-street, Westminster, London, and Dublin, is formed of wrought iron upright bars with malleable iron cross astragals. The roof and crown are made of copper fixed to wrought iron T-bars; the gutter also is copper, and the down pipes for carrying off the rain water.

Although we have said the gas is continually being extinguished, yet it is not really so, but is reduced to a small invisible point of blue flame, and there are brass connecting pipes by which a very small and invisible flame is kept continually at the point of combustion in case any of the gas-burners should be blown out by any current of air.

It is right to mention that as yet only two of the tiers of lenses have been erected; the third tier is at the South Foreland Lighthouse, where the lenses which comprise it are being used in the experiments which the Trinity House are conducting there with Mr. Wigham's burners.

SOCIETY OF ARTS.—The ordinary Wednesday evening meetings of the Society of Arts will recommence, after the Christmas recess, on January 14th, when Mr. R. H. Tweddell will read a paper on "The Employment of Hydraulic Machinery in Engineering Workshops." The following are the papers arranged for subsequent evenings:—January 21st, "Labour and Wages in the United States," by D. Pidgeon. On this occasion the Hon. J. Russell Lowell, the American Minister, will take the chair. January 28th, "The Influence of Civilisation upon Eyesight," by R. Brudenell Carter, F.R.C.S. "The History and Manufacture of Playing Cards," by George Clulow; "The Musical Scales of Various Nations," by A. J. Ellis, F.R.S.; "A Marine Laboratory as a means of Improving Sea Fisheries," by Prof. E. Ray Lankester, F.R.S.; "Recent Improvements in Coast Signals," by Sir J. N. Douglass; "The Evolution of Machines," by Prof. H. S. Hele Shaw; "Education in Industrial Art," by Charles E. Leyland; "The American Oil and Gas Fields," by Prof. James Dewar, F.R.S.; "Past and Present Methods of Supplying Steam Boilers with Water,' W. D. Scott Moncrieff,

CONTRACTS OPEN.

WELL CURBS—INDIAN STATE RAILWAYS.

THE Indian State Railways ask for tenders for the ironwork of 12ft. 6in. and 15ft. well curbs.

General description and quantity.—The work required under this specification comprises the construction, supply, and delivery in England, at one or more of the ports named in the conditions of tender, of the whole of the ironwork for 52 wrought iron well curbs of 12ft. 6in. diameter, 104 bond rings for ditto, 312 lower vertical tie bolts, with bolts for bottom eyes, for well curbs of 12ft. 6in. diameter; 312 upper vertical tie bolts for well curbs of 12ft. 6in. diameter; 50 wrought iron well curbs of 15ft. diameter, 100 bond rings for well curbs of 15ft. diameter, 300 lower vertical tie bolts, with bolts for bottom eyes, for well curbs of 15ft. diameter; 300 upper vertical tie bolts for well curbs of 15ft. diameter; all the rivets for completing the well curbs and bond rings in India, with, in each case, an allowance of 30 per cent. for waste. Service bolts and ordinary platers' washers to be selected by the Inspector-General of Railway Stores, for use in the erection of the work in India, are also to be supplied in the following proportions:—With each well curb, ½ cwt. of bolts and ¼ cwt. of washers. The well curbs are illustrated on page 24.

Material.—The wrought iron is to be well and cleanly rolled to the full sections shown on the drawings or in the specification, and free from scales, blisters, laminations, cracked edges, and defects of every sort, and the name of the maker is to be rolled or stamped on every piece. It must be of such strength and quality as to be equal to the following tensional strains, and to indicate the following percentages of contraction of the tested area at the point of fracture:—

	A Tons.	B
Round and square bars, and flat bars under 6in. wide	24	20
Angle and T-bars, and flat bars 6in. wide and upwards	22	15
Plates	21	10
Plates across grain	18	5

A, tensional strains per square inch. B, percentages of contraction of fractured area.

Sample pieces of angle iron are also to be tested, each with one hole, of a diameter proportioned to the rivets to be used in the well curbs punched in the centre of the area to be tested. The iron intended to be used for the rivets must, whilst cold, be capable of being bent double without showing signs of failure. The tests are to be conducted at the works of the contractor, or elsewhere, or both, as may be determined by the Inspector-General. The expense of the tests is to be borne as provided for in the conditions of contract. No material is to be used which, in the opinion of the Inspector-General, falls short of the tests and other requirements of the specification, and no iron of foreign manufacture is to be used throughout the contract.

Supposed Quantities in one Well Curb of 12ft. 6in. diameter.

	Tons.	cwt.	qrs.	lb.
Outside plates..	1	1	0	4
Cover plates for ditto	0	1	1	18
Inner plates	0	11	0	9
Gusset plates	0	4	0	20
Gusset angle irons..	0	12	1	20
Liners	0	1	3	23
Outer angle iron ring	0	2	2	22
Inner ditto, ditto	0	1	2	4
Top plate ring..	0	2	0	1
Covers for ditto	0	0	0	9
Bond rings and covers	0	6	2	2
Covers for angle iron rings	0	0	1	21
Rivet heads and spare rivets, say 7 per cent.	0	4	2	8
Vertical tie bolts and short bolts for ditto ..	0	6	3	17
Service bolts and washers	0	0	3	0
Total weight of one well curb complete, with spare rivets, service bolts, &c. ..	3	17	2	10

Supposed Quantities in one 15ft. diameter Well Curb.

	Tons.	cwt.	qrs.	lbs.
Outside plates..	1	9	1	16
Covered plates for ditto	0	8	0	22
Inner plates	1	1	1	4
Gusset plates	0	8	1	3
Gusset angle irons..	0	15	3	0
Liners	0	6	2	22
Outer angle iron ring	0	4	2	5
Inner ditto ditto	0	1	2	24
Top plate ring..	0	2	2	12
Covers for ditto	0	0	0	15
Bond rings and covers..	0	7	0	4
Covers for angle irons	0	0	1	27
Rivet heads and spare rivets, say 7 per cent.	0	7	0	8
Vertical tie bolts and short bolts for ditto ..	0	6	3	17
Service bolts and washers	0	0	3	0
Total weight of one well curb complete, with spare rivets, bolts, &c.	5	15	3	11
Fifty-two 12ft. 6in. diameter well curbs ..	201	14	2	16
Fifty 15ft. diameter well curbs	289	12	1	18
Total weight of iron in contract	491	7	0	6

Tenders addressed, Secretary of State for India in Council, with words "Tender for Ironwork for Well Curbs" on envelope, to be delivered at the India-office before 2 o'clock on Tuesday, 13th January.

"MASON" PASSENGER LOCOMOTIVE.

WE publish this week engravings, for which we are indebted to the *American Journal of Railway Appliances*, of a locomotive just designed by Superintendent John T. Meats, of the Mason Machine Works, Taunton, Mass., for high speed and long runs. The following is the builders' specification:—

Service.—Heavy passenger.

Principal dimensions.—Cylinders, 18in. by 24in.; driving wheels, 68½in. diameter; gauge, 4ft. 8½in.; total wheel base, 23ft. 4in.; driving wheel base, 9ft.

Fuel.—Bituminous coal.

Weight.—In working order: Total about 102,000 lb.; on driving wheels about 68,000 lb.

Boiler.—Of best steel, $\frac{7}{16}$in. thick; form, raised crown with one dome; waist, 54in. diameter at smoke-box end; all seams double-rivetted—horizontal welted.

Tubes.—Of iron; 212 in number, 2in. diameter, and 11ft. 2in. long.

Fire-box.—78in. long, 35in. wide, and 75in. high inside; of best homogeneous steel; side and back sheets $\frac{5}{16}$in. thick; crown sheet ⅜in. thick; flue sheet ½in. thick.

Stack and grates.—Straight stack; rocking grates.

Frames.—Forged solid; of best hammered iron, 3¼in. wide, 4½in. thick. Pedestal caps lugged and bolted to bottom of pedestals.

Cylinders.—Of best close-grained hard iron; placed horizontally; right and left-hand cylinders interchangeable, cast with ½in. saddle.

Pistons.—Heads and followers of cast iron fitted with double excentric ring packing. Piston rods of cast steel, keyed to cross-heads.

Slides and crossheads.—Slides: Of best hard charcoal iron. Crossheads: Of cast steel with babbited bronze bearings.

Valve motion.—Shifting link motion. Links of best iron case-hardened. Balanced valves.

Driving axles.—Of best hammered iron. Journals, 8in. diameter and 8in. long.

Driving boxes.—Of cast iron, with brass bearings babbited.

Tires.—Of best cast steel, 3in. thick, both pairs flanged, 5¾in. wide.

Rods.—Connecting and parallel rods of best hammered iron.

Wristpins and springs.—Wristpins: Of best cast steel. Springs: Of best cast steel tempered in oil. French standard.

Trucks.—Allen wheels with wrought iron frame and braces; wheels 30in. diameter. Axles of best hammered iron, with journals 5½in. diameter and 11in. long. Swing bolster style.

Cab and pilot.—Cab: Substantially built of hard wood and well bolted. Pilot.—Of wood.

Feed-water.—Supplied by injectors.

Finish.—Cylinders cased with iron, steam chest covered with iron, dome casing of iron, hand-rails of iron, boiler jacketted with Russia iron, secured by iron bands.

Furniture.—Engine furnished with sand-box, bell whistle, shelf for headlight, blower and safety valves, steam gauge, gauge cocks, &c. Also a complete set of tools, including wrenches to fit all bolts and nuts on engine.

Tender.—Tank 36,000 gallons capacity, carried on two four-wheeled trucks. Frame of iron. Truck of iron, with Allen wheels 33in. diameter. Axles of best hammered iron, with journals 3¾in. diameter and 7in. long.

To these abbreviated particulars we may add that the crown sheet is flanged into the dome, and is strengthened by a heavy welt in the boiler. All longitudinal seams are strengthened by welts, which are so arranged as to take the strain simultaneously with the rivets of the seam. The slope sides are stiffened by heavy T irons and bolts 1in. in diameter, the latter passing through the feet of the former, with copper washers under the heads and nuts, two rows of tubes being separated sufficiently to admit them and allow for possible vibration. Stay bolts and crown bars are 4in. from centre to centre. The fire-door seam is formed without a hoop, and is protected by a deflector plate. The valves for the cinder pipe and poke-holes are of a new design, faced and held in position by springs to exclude air. The steam pressure carried is 160 lb., the boiler being tested to 200 lb. The frame tongue is secured to the main frame by six 1in. bolts and two keys. The parallel rods are made with solid ends, and fitted with steel distance blocks, to which the keys are secured. The top sides are 4in. wide, and the bottom ones 3in. wide and 4in. deep on the inside. Generally speaking, the wearing surfaces have been increased about one-fifth over the common run of standard engines. With one or two exceptions, every detail has been designed since Mr. Meats' return from Europe last winter. That gentleman states that an engine of this class is now making one of the best records on fuel consumption ever attained with them. The slide valves are cast of the same quality of iron as the cylinders, as hard as can be worked. In both fire-box and boiler the holes are punched, reamed, and annealed—an excellent precaution, tending to "make assurance doubly sure." The wrist pins are flattened top and bottom. There is a foot-plate under the cab 3in. thick. Power brake shoes between drivers are omitted. The valves are equalised at half-stroke. The Colby tender coupling is used.

OPENING OF THE KENILWORTH WATERWORKS.—A new era in the history of Kenilworth was commenced on Thursday, the 1st inst., by the opening of new waterworks for the supply of water to the public. It was only a year or two ago since the Kenilworth Waterworks Company was formed in London, but no one cared to take up shares, and the property was eventually offered to the Local Board; but they set their faces against the scheme, and declined to have anything to do with it. A few public spirited gentlemen in the town saw the advantage to be derived from a public water supply, and a prospectus was issued, the capital being £10,000 in 2000 shares of £5 each. The water is obtained at the base of the hill near the flour mills, and adjoining the brook. Large underground adits or chambers have been constructed for the purpose of collecting and storage, and on the site adjoining has been constructed a pumping station. The water is lifted from a well 20ft. deep, and carried to a water tower some 667 yards distant, situate on Tentors Hill. This tower is a novel feature in the work, having been for many years an old flour mill. The upper portion has been taken down, new brick-work constructed, and upon this a circular wrought iron tank has been placed. This tank contains approximately 26,000 gallons, and is constructed at such an altitude as to supply water to the whole of the houses in Kenilworth and neighbourhood. From this point the water is distributed. In most parts of the town a column of water can be thrown 60ft. high. The reservoir made to receive the water from the springs is 280ft. long, 16ft. deep, and 5ft. wide, the whole having been cut through solid rock. The total cost of the works, inclusive of certain sums expended as capital for the Local Board, and upon which interest is paid, will not exceed £8500. The contractors for the work were as follows:—Cast iron pipes, J. and S. Roberts, West Bromwich; engines and pumps, Messrs. Piercy and Co., Broad-street Works, Birmingham, the engines being Clarke's patent and Sterne's manufacture. The ordinary works of pumping station, water tower, pipe laying, &c., are by Messrs. E. Smith and Son, Kenilworth, and the hydraulic fittings are supplied by the Glenfield Company, Kilmarnock. The engineer is Mr. E. Pritchard, M. Inst. C.E., and the resident engineer is Mr. E. J. Purnell, jun., Kenilworth. The supply already bears twelve hours constant pumping without showing signs of abatement. This represents approximately 110,000 gallons in twelve hours.

THE BELL TELEPHONE PATENTS SUSTAINED.—The great telephone suit has been decided by Judge Wallace in favour of the Bell Telephone Company. The People's Company will, it is said, take an appeal to the United States Supreme Court, but they are in the meantime enjoined from putting up and operating any telephones under the Drawbaugh inventions. The suit of which the present opinion is the result was commenced in 1880, and the principal points relating thereto have already been referred to in these columns. Judge Wallace in his opinion says:—"The issues made by the pleadings are practically resolved into the single question—to which the proofs and arguments of counsel are mainly addressed—whether the patentee Bell, or Daniel Drawbaugh, of Milltown, in Cumberland County, Pennsylvania, was the first inventor of the electric speaking telephone." The theory of the defendants, according to the opinion of Judge Wallace, is that some of Drawbaugh's instruments were made in 1867, and others at various times before 1874. "It is in proof that thirty-three patents were granted for improvements in telephones in 1878, sixty-four in 1879, more than one hundred in 1880, and ninety-four in the first six months of 1881. According to the theory of the defendants, therefore, as early as February, 1875, Drawbaugh had not only distanced Bell in the race of invention, but also Gray and Edison, and had accomplished practically all that has since been done by a host of other inventors." The testimony on both sides is reviewed at length, and the Judge concludes: "Succinctly stated most favourably for the defendants, the case is this: One hundred witnesses, more or less, testified that on one or more occasions, which took place from five to ten years before, they think they saw this or that device used as a talking machine. They are ignorant of the principles and of the mechanical construction of the instruments. But they heard speech through them perfectly well, and through one set of instruments as well as the other. This case is met on the part of the complainants by proof that the instruments which most of the witnesses think they saw and heard through were incapable of being heard through in the manner described by them; and further, that the man who knew all about the capacity of his instruments never attempted to use them in a manner which would demonstrate their efficiency and commercial value, but on the contrary, for ten years after he could have patented them, and for five years after they were mechanically perfect, knowing all the time that a fortune awaited the patentee, and with no obstacles in his way, did not move, but calmly saw another obtain a patent and reap the fame and profit of the invention. Without regard to other features of the case, it is sufficient to say that the defence is not established so as to remove a fair doubt of its truth; and such doubt is fatal. . . . A decree is ordered for complainant."

LETTERS TO THE EDITOR.

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

THE ROCKET.

SIR,—In reference to your last "Link," I can only say that the statements made by Mr. Stenson and "An Old Westbridge Man" are most decidedly not true, and neither of them could have had the slightest knowledge of the Rainhill Rocket. The statements I have sent you have been made upon my own personal knowledge derived from being on the spot at the time. The following is a list of the engines employed on my father's contract during the construction of the line between Salford and Chat Moss in the order in which they arrived on the works:—(1) Lancashire Witch, (2) Dreadnought, (3) Twin Sisters, (4) Rocket, (5) Arrow, (6) Dart, (7) Comet, (8) Meteor, (9) North Star, (10) Phœnix, (11) Northumbrian, (12) Planet, (13) Novelty, (14) King William, (15) Queen Adelaide.

I will now give you an extract from a little book published in 1831, by J. F. Cannell, 81, Lord-street, Liverpool, and written by James Scott Walker, entitled "An Accurate Description of the Liverpool and Manchester Railway, the Tunnel, Bridges, and other Works throughout the Line, with an Account of the Opening of the Railway and the Melancholy Accident which occurred."

Page 42:—"Everything being ready, the signal gun was fired at twenty minutes to eleven. The splendid cavalcade then moved onwards at a slow pace, that the spectators might enjoy an opportunity of seeing it in all its novelty, beauty, and splendour. They then moved on, drawn by eight locomotive engines, in the following order:—

"Northumbrian, with the directors and numerous distinguished visitors, including the Duke of Wellington, in charge of Geo. Stephenson.

"Phœnix, green flag, with visitors and proprietors, in charge of R. Stephenson.

"North Star, yellow flag, with visitors and proprietors, in charge of G. R. Stephenson.

"Rocket, light blue flag, with visitors and proprietors, in charge of Mr. Lock.

"Dart, purple flag, with visitors and proprietors, in charge of Mr. Gooch.

"Comet, deep red flag, with visitors and proprietors, in charge of Mr. Allcard.

"Arrow, pink flag, with visitors and proprietors, in charge of Mr. Swanwick.

"Meteor, brown flag, with visitors and proprietors, in charge of Mr. Harding, R.S."

Page 44:—"A murmur and an agitation at a little distance betokened something alarming, and too soon we learned the nature of that lamentable event which we cannot record without the most agonised feelings. Among the group was Mr. Huskisson, &c. &c. . . . His grace perceiving Mr. Huskisson by the side of the car, extended his hand over to the right hon. gentleman, who shook it most cordially. A few words of mutual compliments passed, when the Duke and the other personages in his car perceiving an engine, *which turned out to be the Rocket*, rapidly approaching upon the other line, called out to the passengers on the road, 'Get in, get in!' Several did get in . . . . but Mr. Huskisson was not so fortunate . . . . before he could sufficiently recover himself the engine knocked him down."

I think, Sir, these extracts settle the question as to whether the Rocket took part in the opening of the line or not, and also as to her running over Mr. Huskisson. In the postscript of your letter you say you are told that the 1829 Rocket was being repaired on the opening day. Such was not the case. The Planet, I believe, was in the shed on that day, having bent an axle which prevented her taking part in the opening ceremony; but the Rocket was there. I saw her myself, and knew her perfectly well to be the same engine that won the Rainhill trial and worked on the line during its construction. These are facts which cannot be altered or disputed by all the drawings and sketches in the world. The book from which I have quoted above I can produce if necessary, as well as sundry other documentary evidence. I remember something of some verses made by a driver, T. George, who was driving on the line in 1831. What I can recollect of them ran as follows:—

A "Star from the North," as bright as the sun,
Intends with the "Rocket" and "Meteor" to run;
Then along comes the "Arrow," the "Comet," and "Dart,"
Saying, "We three also intend for to start;"
Then up rose the "Phœnix" from her fiery nest,
With fair "Venus" and "Planet," to run with the rest;
And up rose the "Sun," with a bright, shining face,
And with "Mars" and "Jupiter" joins in the race;
Then along came old "Vulcan," with hammer and tongs,
With "Goliath" and "Samson," to mix with the throng.

In conclusion, I can only say that it seems very mysterious to me that the engine called the Rocket at South Kensington should have stood there so many years before it was discovered that she was not the engine she was supposed to be. I have no doubt that Mr. Stenson did sketch an engine called the Rocket, as there were several Rockets about 1832 and afterwards, but his sketch was certainly not made from the Rainhill Rocket which took part in the opening of the line. It is nothing at all like it, and I should not think a single rivet of the one ever existed in the other. It has fallen to my lot to be acquainted with nearly all the early locomotives. The Venus was sent up to open the Greenwich line after the failure of one built by Lord Dundonald. I was also at the opening of the Great Western Railway, which was opened by the North Star, after the failure of two engines of the Greyhound class built by Brunel. My father also sent the first engine on to the South-Western line, called the St. George, built by Roberts and Sharp. ROB. STANNARD.

Hull and Barnsley Railway, Howden, E. Yorks,
December 30th, 1884.

[We publish Mr. Stannard's letter, but it will be seen that it has very little bearing on the question at issue. Our correspondent seems to fancy that doubt exists as to whether an engine called the Rocket was or was not present at the opening of the Liverpool and Manchester Railway. Now, on this point there is no doubt of any kind. The question at issue is, was or was not the Rocket which was present at the opening of the railway and killed Mr. Huskisson built in 1829 or in 1830? We have received a letter from Mr. I. W. Boulton, who asserts, in common with Mr. Stannard, that there was but one Rocket on the Manchester and Liverpool Railway. He states that he has documentary evidence to prove this, which he is now getting together and will send to us in due time.—ED. E.]

ELECTRIC LIGHT CABLES.

SIR,—Mr. Lorrain concludes his letter of 29th December with a request for suggestions from some of your readers about other materials for laying lead-covered cables in, and adds:—"That thus some practical value might arise from this correspondence." No doubt some of your readers could give information which would corroborate the accuracy of the practical information I have given on this subject. It has been a hobby with me for more than fifty years, and I know that the practical information I have communicated in these letters is worth thousands of pounds to capitalists who intend investing money in lead-covered cables which are to be buried. I may here repeat that peat is the best of all substances for burying lead-covered cables in. The preserving powers of it are so great that even human bodies are kept by it entire, just as if they had been embalmed. Next to peat is the best clay, fit for puddling with; and if peat or clay cannot be got, black mould, from a garden or field, is better than sand.

Mr. Lorrain writes in his last letter, "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." Mr. Beckingsale wrote to you, "As peat can be obtained in the neighbourhood, and as it forms an excellent bedding, impervious to flowing water, and therefore a good preservative to substances embedded in it, I have decided with the authorities to use it." This sentence, and my writings on this subject, laid before Mr. Lorrain one of the practical reasons why peat is better than sand, namely, that peat prevents the flow of water along the outside of the lead covering while sand admits the flow of water, and all spring water contains either lime or mineral matters in solution, and the continual flow of such water over lead gradually destroys it. A practical illustration of this I gave in my first letter, namely, that at Auchencastle, near Moffat, in 1858, lead pipes were found which had been buried for hundreds of years, part of them in peat, by which the lead had been preserved, while of a part of them which had been buried in sand the lead had entirely disappeared.

With the foregoing information before Mr. Lorrain, why did he write, "I consider sand to be preferable in most cases because it does not retain water?" The reason here assigned why Mr. Lorrain values sand, is the very reason why common sense condemns it, namely, because it permits water to pass through it, and it is the lime or mineral-loaded water passing through it which destroys the lead when buried. The foregoing remarks refer to one reason why sand should be avoided; but there is another reason why it should not be used. To refer to this I must quote at length the passage in Mr. Lorrain's letter of the 10th December, which I tried to condense in my last letter, but which condensation he objects to as being inaccurate. He wrote, "Even in the laboratory, with all appliances at hand, it is not always an easy matter to separate the colouring base, as I know well from a series of such analyses carried out by me some years ago in the Chemical Laboratory of the Royal School of Mines, and in subsequent analyses of sands to be used as fluxes for metallurgical operations. As for their being separated from the quartz sand in which the cables are embedded by any probable natural process, and so to act on the lead, the idea is absurd." In opposition to the foregoing opinion I produced the evidence that an iron pipe which I saw lifted out of the streets of Greenock upwards of forty years ago had on it nodules externally and corresponding nodules internally. The external ones were on their exterior conglomerates of sand and oxide of iron, while the interior of them consisted of a compound of decomposed iron and decomposed quartz, and it was self-evident that the nodules within the pipe were produced by galvanic action, which came through the body of the iron from the exterior nodules. Here we have a process in the ground by which iron and quartz were decomposed, which, so far as I am aware, has not been imitated in our laboratories. There was no appearance of fluoric acid in the bed of sand which lay outside the nodules on the pipe, and there had been no furnace and fluxes there to decompose the quartz, and yet it was decomposed.

Having this evidence before us, that quartz can be decomposed in the earth in contact with iron pipes, and seeing that lead pipes are decomposed when laid in the earth in contact with sand, it is a foolish proceeding to trust to laboratory experience about lead and sand not decomposing one another, and in defiance of the foregoing facts, to run the risk of burying lead-covered cables in sand where water might get access to them.

JAMES JOHNSTONE.

8, Dalhousie-terrace, Edinburgh,
January 5th.

SECONDARY BATTERIES.

SIR,—On the 19th ult. you published an article on the electrical tramcar recently built by the Storage Company, in which you gave certain figures as to the depreciation of the cells, which are likely to be misleading. You say that owing to a new design lately introduced, the useful output for a given weight has been increased without in any way sacrificing the durability; and later, that Mr. Reckenzaun has based his figures for working cost on a depreciation of 50 per cent. as a safe limit. This would naturally imply that the cells used for lighting purposes would depreciate in the same ratio, which is far from being the case.

The type of plate manufactured by the Storage Company enables the conductor and the active material to be disposed to the best advantage, but the proportions are varied according to requirements. The accumulators supplied for lighting purposes are made with a view to obtaining great durability coupled with a high effective return, whereas in the tramcar cells the first consideration is a rapid discharge from a minimum weight. In the latter case the metal is distributed where most needed, but the same durability cannot be expected as with cells designed for lighting or other purposes where weight is of minor importance. We have every reason to hope, however, that Mr. Reckenzaun's allowance for depreciation will be more than ample, as the cells which were first made have been in constant use for over three months and show no signs of deterioration.

It is impossible to say definitely what the life will be of the plates manufactured for lighting purposes with the latest improvements, but it may be mentioned that with the older types the positives frequently lasted eighteen months, and there is little doubt that this will be exceeded with the plates now being supplied.

The depreciation is confined almost entirely to the positives, and the company has already made arrangements to meet its customers in this respect by quoting a special price for renewal plates.

BERNARD DRAKE,
Managing Engineer Electrical Power Storage Company.

January 5th.

THE EFFICIENCY OF FANS.

SIR,—Professor Unwin, in a letter appearing in your yesterday's issue, begins by saying that "Professor Smith tells Professor Herschel and myself that we are quite wrong." I regret he should have fallen into this misapprehension. If he had noticed the date of my letter he would have seen that mine was written before his appeared. My letter was out of my hands several days before I saw his, and therefore clearly I could not have said that he was wrong, nor indeed make any reference to his. On the contrary, I thought that his first letter was so correct that had it appeared before I had written to you I believe I should not have thought it worth while to add anything from myself to the correspondence on this subject. His final equation would give practically identical results with mine, except that he missed out the term h, which he has now inserted in his second letter. As for simplicity, his involves the use of natural or hyperbolic logarithms, and mine nothing but ordinary arithmetic. They give practically the same results because the expansion to be dealt with is a very small one. They certainly differ in principle to a small extent, because he takes isothermal, and I take adiabatic expansion as approximating most nearly to the actual thermal condition under which ventilating fans work. Of course it would be possible to settle by experiment what the actual thermal condition was if we could measure the temperatures very accurately at inlet and outlet; but I purposely avoided basing my equations on any measurement of these temperatures, because I know of no way in which they can be measured accurately. Whatever kind of thermometer might be used, it must be exposed to the flow of the current and the rise of temperature in the instrument due to the impact, and the friction of the stream upon it would be greater than the whole difference of temperature to be measured. Professor Unwin says that 50 per cent. of the work done by the fan is lost in friction in the passages of the fan itself. Those who are acquainted practically with the friction of air currents in passages must be surprised at this statement. For myself, I believe the percentage of work so lost is very minute; and again, most of the heat generated by this friction goes into and through the metal walls of the fan, not into the air. Of course I know that a lot of power is lost in making eddies, as the air passes through the fan, and the more power so lost the worse is the construction of the fan passages. But the energy so spent does not appear as heat until the eddies are rubbed down out of existence by the viscosity of the air, and this certainly does not happen before the air has escaped from the fan outlet. So far, I can see no reason for changing my opinion, that adiabatic expansion is the nearest approximation one can make to the actual thermal condition. As for Professor Herschel being quite wrong, I never said so; but said I thought he was mistaken in subtracting the whole work due to the kinetic energy of discharge. I gave reason for thinking so, but admitted that very possibly a small portion of it might be so subtracted. In this objection to Professor Herschel's rule, it appears that Professor Unwin agrees with me, because he speaks of part of the whole useful work done as being the energy of discharge.

ROBERT H. SMITH.

Mason Science College, Birmingham,
January 3rd.

AUGMENTED RAILWAY RATES.

SIR,—In your issue of the 26th inst., in your article on "Augmented Railway Rates," wherein you deal with the question of profits, you say, "The loss, where loss is incurred, is on passenger traffic, not on goods."

I have been attempting to illustrate the position into which we have drifted—confirming your remark—for many years, but the eye of the public has been constantly misled by the production of figures showing numbers of passengers and fares paid, and omitting the corresponding increases of the number of train miles run and the cost thereof; also the capital per mile of railway open.

I do not imagine the Bills for augmented rates to which you refer can be for any other than the main purpose of classifying goods and terminal charges, for the railway managers must be aware of the fact that the comparative losses by passenger train services are being, and have been all along, recouped by the goods and mineral trains.

If the railways which carry on the principal mineral and goods trades be compared with the southern and other lines, it will be found that the average cost of the train mile run is greatest on those railways doing principally passenger business, from which it may be inferred that the receipts per goods train mile are a better paying quantity per train than the passenger train mile. As I have no means of estimating what ought to be debited to the passenger train mile over and above that of the goods, I have always taken the average cost of the two services, and even then the comparative loss is severe enough, as you will see by the following table.

It is a noteworthy fact that although there is a saving of a farthing per train mile in favour of 1883, the dilution of fares from 10¾d. average in 1872 to 8¼d. in 1883 causes the train mile to absorb 63·40 of the diminished receipts, in lieu of only 57 per cent. as in 1872, whilst the receipts per goods train miles, although less per mile than they were, have, by virtue of the mileages run being controlled, varied but little, viz., 44·80, in lieu of 44·57. The reduction of 2½d. per head average fare on the passengers of the three classes in 1883 comes to a sum of over £7,000,000. The miles open in 1883 were 18,681, costing £42,017 per mile. In 1872 they were 15,814, costing £35,984.

Table of Receipts and Expenditures for 1872 *and* 1883.

RECEIPTS.

1872.		1883.	
Proportion of passenger train miles	49·55 p. c.	Proportion of passenger train miles	51·91 p. c.
Goods	50·45 ,,	Goods	48·09 ,,
Average cost per mile run..	2s. 8¾d.	Average cost per mile run..	2s. 8½d.
Passenger train miles ..	92,995,324	Passenger train miles ..	138,176,940
Goods	94,693,818	Goods	127,983,253
Fares of the three classes for 422,874,822 passengers..	£18,836,147	Fares of the three classes for 683,718,137 passengers..	£24,049,861
Season tickets, luggage, mails, &c.	3,451,408	Season tickets, luggage, mails, &c.	5,458,872
Passenger trains	£22,287,555	Passenger trains	£29,508,733
Goods trains	29,016,559	Goods trains	38,701,319
Railway receipts	£51,304,114	Railway receipts	£68,210,052
Steamboats, &c. &c. ..	1,931,396	Steamboats, &c. &c. ..	2,852,218
	£53,235,510		£71,062,270

EXPENDITURE.

1872.		1883.	
Proportion to receipts—		Proportion to receipts—	
Passenger trains	£57·00 p. c.	Passengers	£63·40 p. c.
Goods trains	44·57 ,,	Goods	44·80 ,,
Fares of the three classes at 57 per cent.	£10,736,577	Fares of the three classes at 63·40..	£15,249,354
Season tickets and other items	1,966,597	Season tickets and other items	3,460,879
Passenger trains	£12,703,174	Passenger trains	£18,710,233
Goods, 44·57	12,933,915	Goods trains, 44·80 ..	17,333,373
All miles	£25,637,089	All miles	£36,043,606
Steamboats, &c., their own charges	640,551	Steamboats, &c., their own charges	1,324,956
Total expenditure.. ..	£26,277,640	Total expenditure.. ..	£37,368,562

The preceding table shows that the increased profits from the passenger train service from all sources in 1883 over 1872 were only £1,114,119, equal to earning only 11s. 3d. per cent. on the capital added.

FREDK. T. HAGGARD.

East Burnham, Bucks, December 30th, 1884.

COOPER'S HILL, COLLEGE.

SIR,—In your issue of 21st November you have a leading article on Cooper's Hill College. You allege the education given there is expensive, the training too theoretical, and point out that the College has not produced any successful engineers. If you are correct about the expense, the style of the College must have altered much in the last few years. You say, "The training at the College costs parents £700 to £800;" "The style of the place conduces to outlay;" "It is an establishment where moderation in spending money is the last thing thought of." I was at the College from September, 1876, to September, 1879. My College fee amounted to £450, my extra expenses for board and lodging, gratuities to servants, &c., amounted to £9; subscriptions to College clubs, £10; books and stationery, £16; workshop tools and materials, £4; total, £490. If my parents had availed themselves of the rule by which £180 of the College fees could be deferred and recovered from my salary in India, the amount would have been £310 instead of £490.

The College fees included board and lodging and theoretical instruction for two-thirds of three years, and a premium to an engineering firm for permission to learn "office routine and workshop practice" at their works. The other £40 included professional books and other things, for which I received full value. Other private amusements, such as theatres, &c., could be indulged in or not, according to taste, and were not more necessary or more expensive to students at Cooper's Hill than they are to students at any other College, or to private pupils or apprentices of engineers, except, however, that each visit to London cost 10s. in train fare. Some men may have spent £700; if so, they were the exception and not the rule. Immediately on leaving College I received a salary which was sufficient for my subsequent expenses.

It was not true, then, that "the style of the place conduced to outlay." For instance, wine was seldom drunk at dinner; water was frequently drunk from choice, or when the draught beer was not what it ought to have been. The sweepstakes on the Derby was 1s. The subscriptions to the clubs were moderate. It was not true, then, that moderation in spending money was the last thing thought of by the College authorities. Students were allowed to purchase extra articles of food, wine, &c., at the College, and to entertain guests at their own expense. Bills incurred in this way were not allowed to exceed £2 in any one month, and had to be paid monthly. Before students entered the College their parents were asked by letter whether they wished the student to be eligible or not as a member of football or other representative teams, as members of the teams incurred higher expenses than other students. A student who neglected to turn out his gas light on leaving his room was fined, and an alteration was made in the pattern of gas burner used with the avowed object of reducing the gas bill, which was paid by Government. The students certainly thought of moderation in spending money. They purchased books and stationery from a firm who attended College and gave discount for ready money, and charged interest if bills were not paid monthly, when there was a stationer close by who would allow bills to accumulate. Several men entered the College under the arrangement for deferring £180 of the College fees; I suppose these men were more careful about their expenditure than others. Nevertheless, their economy did not make them conspicuous, for no one knew which they were while at College; therefore, it was hardly correct to say "the necessary incidental expenses were large, like those of an officer in a crack cavalry regiment."

With regard to the training, no one ever supposed, either in the College or elsewhere, that theory could be made to supersede practice. The contrary was always impressed on us by the professors. You say the College has not produced successful engineers: I know of exceptions to this. *Exceptio probat regulum.* I deny that this is the fault of Cooper's Hill College. It is the fault of the organisation of the Public Works Department. If Cooper's Hill men do their duty with ability and zeal in the offices which are available for them, no one but their senior officers knows of it or can ever know of it. If they are honourably mentioned in the Government *Gazette*, no one but their comrade knows or cares whether they are Cooper's Hill men or not.

I think the reason of the failure of the College is this. It was established for fifty men to enter annually and study for three years. There would therefore be 150 men always at the College. The Department became overfilled, and the fifty men have been reduced to fifteen men annually studying for three years each, having forty-five men at the College. A college so small cannot pay its way, and the place has been made a training college for engineers generally, with competition for fifteen Indian appointments. Formerly 250 men would compete for fifty appointments; unsuccessful candidates could compete again the following year. Once successful they were sure of an appointment, and the appointment was stated by a printed Government prospectus as probably worth £420 a year, with an increase of £120 every three years. The competition is now between sixty men for fifteen places, and consists of at least nine examinations extending over three years. Illness at any examination means a loss of marks and position difficult to recover. The rupee has fallen in value and Indian prices risen, and promotion is slower than was expected. The salary is now £350 a year, with increase of £100 about every five years.

COOPER'S HILL, 76-9.

Bengal, December 3rd, 1884.

THE CANDLE MANUFACTURE.

SIR,—Will you allow me to call your attention to one or two trifling inaccuracies which have crept into your able article on the manufactures of Messrs. Field and Co.?

In the first place, the firm styles itself J. C. and J. Field, and has never been a company, or connected with one. Field, Field, and Co., are our consulting engineers, of which firm Mr. Edward Field, well known in connection with boiler tubes, is senior partner.

Secondly, as to the invention of the candle machine, Mr. Edward Cowles has furnished me with several interesting details, which fix the date of the invention beyond a doubt. In 1854, a Mr. Stanthorpe, of Buffalo, U.S.A., suggested to Mr. Cowles that it would be far easier to push than pull a candle from the mould. This idea was worked out by both parties, and in 1855 Stanthorpe patented his invention in America. As is usual with inventors, he found much difficulty in inducing anyone to work the patent, but none whatever in finding an infringer. Messrs. Horniston, of Troy, machinists, turned out a number of machines, which were worked by the Staten Island Stearine Company, New York, under the auspices of Mr. Seguin. The invention was patented in England almost simultaneously by Horniston and Newton, and J. Pitman, acting for Stanthorpe. In 1859 Mr. Cowles came over, and introduced the invention to J. C. and J. Field, who were then laboriously extracting paraffine candles from hand frames cooled in tanks of water. This firm and Messrs. Hales and Co. started making candles from the machines as improved by Mr. E. Cowles, who thereupon devoted himself to the perfection and manufacture of this specialty, ultimately producing a machine to make the patent end candles invented by J. Lyon Field. Mr. Cowles must therefore be regarded as the father of the present candle machine. Even now, he has just patented a modification, by which consumption, water, and heat are reduced to a minimum, and is busy with an invention for facilitating the manufacture of self-fitting ends.

Thirdly, we are not, I regret to say, the sole manufacturers of self-fitting ends. At first the public was slow to recognise their advantage, and by the time this had become patent to them the invention was no longer so to us. Several of our competitors started the manufacture on the day of the expiration of the patent; now the trade is universal. Curiously enough, neither Germany nor France has made any effort to imitate or adopt this invention—an oversight of which English inventors are not wont to complain.

Patent Self-fitting Ozokerit and Paraffine Candle Works, Lambeth Marsh,
London, January 1st.

LEOPOLD FIELD.

ENGLAND AND AMERICA.

SIR,—The favourable reference you have made to my bevel gear machines induces me—as a matter of interest, if not instruction—to notice some incidents in their early career.

In the first instance, the matter was warmly taken up by two American gentlemen, and one of the ablest experts in America gave it as his opinion that the invention was one of the most useful and remarkable that he had ever come across; but after much negotiation the matter fell through, from causes which did not touch the value of the invention in a scientific sense. But some said I was mad to think the object attainable at all; and I was so disgusted with this that I gave the matter up, as I saw that the influence of ignorance, or prejudice, or interest, was too strong for me.

Some time after this I wrote to the then Secretary of the Navy, in the States, to make the offer that if they would take two sample machines, to show how they should be manufactured, which would have been admissible, free of duty, to the Government, I would make a present to the latter of my American patents. The answer which came was to the effect that the matter had been referred to a board of examiners, whose conclusion it was that the machines manufactured in the States were sufficient for their purposes. No doubt this seemed more patriotic than intelligent, as I knew that they could not have examined the model of the principle on which the invention depended, as it had been lost in the Washington fire. Its principle had passed the Patent-office there with warm approval, after a long search after its novelty.

It strikes me that this is a remarkable proof of the superiority of our English system of permanent officials over the American system of those who are dependent upon the popular voice for their election. It is only thus that the most valuable traditions can be preserved for use.

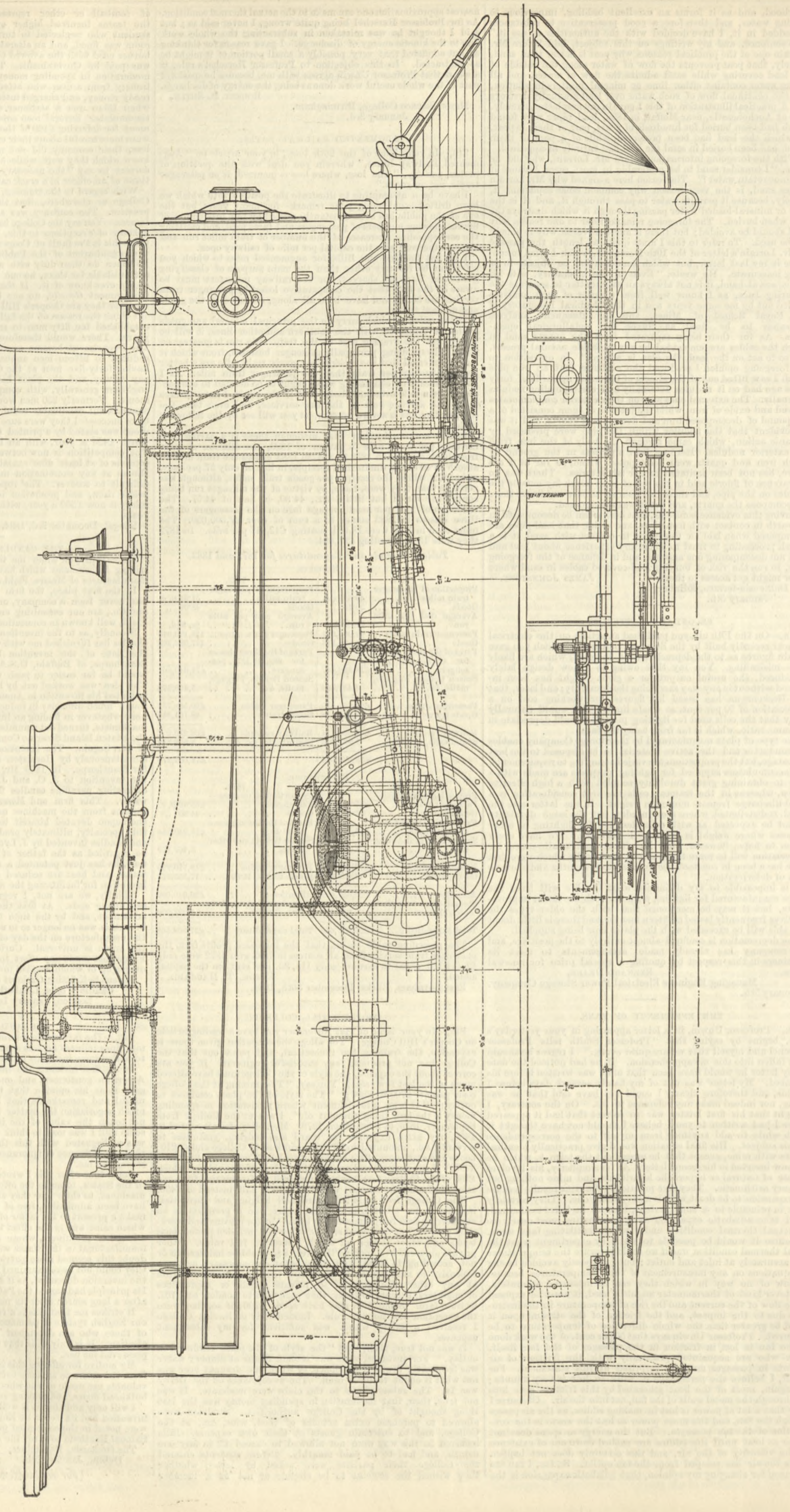
My motive for offering this invention to the American Navy was from the desire to advance useful knowledge, and I had seen the valuable use made of cut wheels in our own dockyards for closing bulkhead doors, and making very perfect steering gear.

I will only add that it is well known that almost every American invention had its roots in England, and that the most of them were noted in the celebrated prophetic specification granted to Sir Samuel Bentham towards the close of the last century.

The Orchards, Rathmines,
Dublin, January 5th.

WM. TIGHE HAMILTON.

[*For continuation of Letters see page* 34.]



AMERICAN PASSENGER LOCOMOTIVE.

THE MASON MACHINE WORKS CO., TAUNTON, U.S.A., ENGINEERS.

(*For description see page* 26.)

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PARIS.—Madame BOYVEAU, *Rue de la Banque.*
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TO CORRESPONDENTS.

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

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

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

T. R.—*The cone drawn by the base will offer least resistance.*

F. R.—*Send on your drawing and we will give you an answer.*

J. H. (Pittsburgh).—*There is no book of the kind published in this country.*

T. R.—*No. It would be a strong boiler but very expensive to make, and by no means economical as a generator.*

TRANSFER PRINTS.—*A correspondent, in reply to "J.," refers to Messrs. Tearne and Sons, All Saints-road, Hockley, Birmingham.*

T. S.—*Instead of the stamp duty, £50, which you would now have to pay under the old law, you need only pay £10 before the expiration of another year.*

J. H. W.—(1) *Yes.* (2) *In practice, no. Water is almost incompressible, and although it, in theory, might be possible to construct a body so nearly of the same specific gravity that it would sink only until the water became dense enough to acquire the same specific gravity, it would not be possible to carry out the experiment in practice.*

H. W. B.—(1) *You will find a full description of the Westinghouse brake in* THE ENGINEER *for July 25th,* 1879. (2) *Joy's valve gear has been illustrated several times in our pages as fitted to locomotives and marine engines. See* THE ENGINEER *April 20th,* 1883, *for a Great Eastern railway locomotive fitted with it.* (3) *You will find full particulars of the London and Brighton Railway locomotive Gladstone, with diagrams, in* THE ENGINEER *for October 19th,* 1883.

WEST TOFTS.—*The torsional strain on the axle due to the difference in the distances passed over by the wheels inside and outside a curve is not the cause of broken axles, and is very much less than you suppose. The coning of tires is too trifling to spread the rails; that is caused by the lateral oscillation of the train. The loose wheel system has been patented and tried over and over again. It is very expensive, and the advantage gained has not been found worth the cost.*

E. P. (Barnes).—*How do you intend to supply air to your fire, and to take out the ashes that fall through the grate? Your boiler is complicated, expensive to make, and very difficult to keep in order. The vertical tubes you will find it almost impossible to keep tight, as the upper ends in the steam space will get nearly red-hot, steam abstracting heat very slowly. No launch builder now uses a vertical boiler with vertical smoke tubes if he can help it. The general arrangement of the boiler is not new.*

SHELLING MAIZE.

(*To the Editor of The Engineer.*)

SIR,—Can any of your readers give me the name of a maker of a machine for shelling maize? C. E. W.

COMBINED BORING AND SHAPING MACHINES.

(*To the Editor of The Engineer.*)

SIR,—Can any reader give me the name of any makers of a machine for boring and shaping at the same time small steam cylinders—for instance, of portable engines? E. K.

Baden, January 4th.

SMALL DYNAMO-ELECTRIC MACHINES.

(*To the Editor of The Engineer.*)

SIR,—I shall be obliged if some of your correspondents can give me the names of makers of dynamo machines of small power, in different sizes for supplying from five to fifty incandescent lamps? J. S.

London, January 3rd.

PAPER ROLLERS.

(*To the Editor of The Engineer.*)

SIR,—Can any of your readers kindly inform me of the names of the manufacturers of paper bowls or rollers, suitable to work in a machine for rolling floorcloth, the paper rollers being required about 78in. long by 24in. diameter in the body? T. W. S.

Gloucester, January 6th.

PUMPING MACHINERY.

(*To the Editor of The Engineer.*)

SIR,—In your "Lancashire Notes" your correspondent was kind enough to refer to some large work we have in hand in pumping machinery. Please correct the statement that the large pumps, 16in. by 22in. by 18in., pump "1000 gallons per hour;" it should be "1000 gallons per minute."

West Gorton, Manchester, January 7th. FRANK PEARN AND CO.

THE COST OF HORSE-POWER.

(*To the Editor of The Engineer.*)

SIR,—Replying to "A. O.'s" inquiry as to cost per horse-power per annum working ten to eleven hours daily, I have a vertical condensing engine indicating 105-horse power driving a rolling mill. This I find, allowing for depreciation, interest, labour, oil, coal, &c., costs me £4 12s. 11d. per horse-power per annum; consumption, 4 tons 19 cwt. of coal per horse-power. The above has been constantly at work the last twelve years. H. H.

Wyke, January 3rd.

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

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, Jan. 13th, at 8 p.m.: Ordinary meeting. Inaugural address of the President, Sir Frederick J. Bramwell, F.R.S. Thursday, Jan. 15th, at 8 p.m.: Special meeting. First of the series of six lectures "On the Science and Practice of Hydromechanics"—"Physiography," by Mr. John Evans, V.-P. and Treas. R.S., Assoc. Inst. C.E. Friday, Jan. 16th, at 7.30 p.m.: Students' meeting. Paper to be read and discussed, "Secondary Batteries," by Mr. F. Geere Howard, Stud. Inst. C.E. Mr. W. H. Preece, F.R.S., Member of Council, in the chair.

CHESTERFIELD AND DERBYSHIRE INSTITUTE OF MINING, CIVIL, AND MECHANICAL ENGINEERS.—The next general meeting will be held in the University-buildings, Nottingham, on Saturday, 10th Jan., at 2.45 p.m. The following papers will be open for discussion:—Mons. J. B. Marsant's paper (translated), entitled "Miners' Safety Lamps." Mr. A. H. Stokes' paper, entitled "Colliery Explosions." Mr. Henry Johnson's, jun., paper, "On the Mining and Geological Features of a Drive through the Black Country." Mr. Arthur Sopwith's paper, "Additional Details of Haulage at Cannock Chase Collieries." Mr. Herbert Porter's paper, "The Porter-Clark Processes for the Removal of Mineral, Organic, and Earthy Impurities from Water." Mr. George Addenbrooke's paper, "The Bulkley Patent Injector Condenser." The following papers will be read, or taken as read:—"Counterbalancing Winding Ropes," by C. Meinicke, of Clausthal, North Germany; translated by Mr. J. Clarke Jefferson, Leeds. "Colliery Winding Ropes and their Attachments to the Cage," by Mr. P. M. Chester, Blackwell Collieries.

SOCIETY OF ARTS.—Monday, Jan. 12th, at 8 p.m.: Cantor Lectures. "Climate, and its Relation to Health," by Mr. G. V. Poore, M.D. Lecture I.—The chief constituents of climate, latitude, heat, light, barometric pressure, &c. Wednesday, Jan. 14th, at 8 p.m.: Sixth ordinary meeting. "The Employment of Hydraulic Machinery in Engineering Workshops," by Mr. Ralph H. Tweddell, M. Inst. C.E. Sir Frederick Bramwell, F.R.S., President Inst. C.E., will preside.

DEATHS.

On the 2nd inst., at 6, Amersham Park Villas, New-cross, ALFRED REYNOLDS, C.E., aged 59 years.

On New Year's Day, at Melville, Chatham, HENRY GLADSTONE COCKING, R.N., Chief Engineer H.M.S. Flamingo, eldest son of the late Joseph and Lucy Cocking, of Arundel-street, Strand, W.C., aged 42. Interred in Chatham Cemetery.

THE ENGINEER.

JANUARY 9, 1885.

AN OFFICIAL PROJECT FOR A WATER SUPPLY TO LONDON.

A PARLIAMENTARY return, issued within the last few days, gives us the text of two important reports recently addressed to the President of the Local Government Board, by Mr. John Thornhill Harrison, Memb. Inst. C.E., one of the engineering inspectors of the Department. The reports are couched in a form by no means hostile to the London water companies, though it is quite possible that these corporate bodies would rather be left to their own devices than be pressed to carry out a plan prepared for them by a Government official. Mr. Harrison commences by saying that, as an officer of the Department to which, under the Presidency of Sir Charles Dilke, is entrusted the supervision of the existing supply of water to the Metropolis, he ventures, as the most proper course that he can adopt, to submit in the first place a kind of summary report to Sir Charles, showing in outline a scheme for "an improved water supply." Having stated the leading features of his plan, Mr. Harrison concludes by saying that, if this preliminary report should meet with the approval of the President, he should be happy to lay the more detailed observations before him with as little delay as possible. Apparently Sir C. Dilke was favourably impressed with the scheme, for a month afterwards we find Mr. Harrison submitting the full particulars, illustrated by maps, plans, and a model. Mr. Harrison observes that the present supply of water is seriously objected to by many persons. He does not wish to express any opinion on these objections, but if it can be shown that an abundant supply of water, of unexceptionable quality, "can be obtained and delivered by the companies—more especially those who take water from the Thames—to the consumers, without adding to, but not improbably diminishing, the annual cost which they at present incur," he ventures to hope that the proposal will receive a favourable hearing. As to the quality of the water, that is apparently assured by the fact that the supply will be taken direct from the chalk, at a depth of from 10ft. to 20ft. below the surface, having undergone natural filtration in its passage from a widespread and elevated gathering ground. On the score of quantity, there is the promise of having at command "at least double the volume of water at present withdrawn from the Thames." As to the annual cost, sundry expenses now incurred would be avoided. No filtration would be required, and a large amount of pumping would be no longer necessary, while lands now occupied for reservoirs and filter-beds would be at the disposal of the companies for other purposes. The saving under these heads is expected to be considerable, and Mr. Harrison thinks it might be found to exceed the annual cost consequent upon the scheme which he proposes. The companies might also be relieved from the payment of £10,000 per annum to the Thames Conservancy Board. We may remark that the payments made to the Thames Conservancy in the year ending last March by the five water companies drawing from that river, amounted to £11,478, independently of the East London Company, which paid a total of £5657 to the Thames and Lea Conservancies. The New River Company pays £1819 per annum to the Conservators of the Lea, so that the total paid by the London water companies to the two Conservancy Boards is about £19,000 per annum. In return, the Conservators have to keep the Thames and the Lea as clear from pollution as they can above the companies' intakes.

It must be understood that the Thames water companies are already drawing to some extent from the underground waters. This is, indeed, admitted and specified by Mr. Harrison, on the authority of Sir Francis Bolton. The Grand Junction Company, two years ago, provided itself with machinery and appliances for raising, during times of flood, 12 million gallons per day from the water that had passed through the natural beds of gravel and sand, which exist in the neighbourhood of Hampton. Four years ago the Lambeth Company had supplemented the river supply by spring water from the gravel beds at West Moulsey; this source affording about 8,000,000 gallons per day. The Southwark and Vauxhall Company has nearly completed its new works at Hampton, designed to effect a similar purpose to those of the Grand Junction, collecting underground waters rendered pure by natural filtration. The same company has been sinking a well into the chalk at Streatham, which has had the unfortunate effect of drying up a number of private wells in the vicinity. This latter circumstance, coupled with others of a like kind, raises a question as to the extent to which the chalk may be expected to yield an adequate and permanent supply for the metropolis. Concerning the Lambeth and Grand Junction Companies, and the Southwark Company in respect to its Hampton works, Mr. Harrison observes that the underground supply will come from "the subsoil gravel." "It does not seem," he says, "that any of the companies have examined into the source of the supply, the probabilities of its being polluted, or the maximum volume of water which may be derived from it." Mr. Harrison proposes to take a supply from that part of the chalk formation within the watershed of the Thames which lies to the north and west of Windsor, including the areas within the basins of the rivers Kennet and Colne. He contemplates that a large receiving well should be constructed at a locality called "Black Pots," situated near the main road from Eton and Upton to Datchet, this well to have an overflow into the Thames below the Windsor lock. According to the plan which he proceeds to suggest, a tunnel would be driven westward for a length of five miles, nearly meeting the Thames at a spot to the north-east of Bray. It is anticipated that it would be found advisable to sink wells into the chalk at various places near the tunnel, and to drive headings northward from it. The tunnel would be below the summer level of the Thames throughout its length, and should be carried in the chalk. A well and overflow weir would be constructed near the Grand Junction Works at Hampton, and a main carrier would connect this well with the one already described as situated at the eastern end of the gathering tunnel. From the well thus constructed at Hampton there would proceed cast iron mains, 4ft. in diameter, distributing the supply to the pumping wells of each of the water companies. The main carrier would be 12ft. in diameter and eleven miles long. It is advised that a strip of land 100ft. wide should be purchased over the whole length of the main carrier and the collecting tunnel, and that power should be obtained to sink wells at any points along this length, also to drive headings or drifts, for the collection of water in any direction throughout an area of about five miles by four miles in the neighbourhood of Farnham Royal, Maidenhead, Bray, Windsor, and Slough. It is proposed that the gathering tunnel should have a diameter of 12ft. at the lower end, passing on through gradations of 8ft., 6ft., and 4ft., to the upper end, the inclination throughout being 18in. per mile. The inclination of the main carrier would be 1ft. per mile. The purchase of land, and the cost of the works to collect the water, to convey it to Hampton, and to distribute it to the pumping stations of the several companies, is estimated at about £700,000.

Such being the proposed works, it is important to understand how much water is to be obtained, and also what would be the effect of abstracting a supply in this manner from the underlying strata. The gist of the whole scheme is that of taking the supply from the subterranean sources of the Thames, instead of deriving it from the river. The plan has the recommendation of seizing the water while it is pure, and avoiding those sources of pollution which subsequently affect the supply as it rolls along the river bed above-ground. As to the quantity to be reckoned upon, Mr. Harrison says: "The question of the volume of water which can be obtained from the chalk at Windsor is most important." In April last year, Mr. John Taylor, the engineer of the Lambeth Waterworks Company, gauged the Thames and its tributaries below Maidenhead, at Mr. Harrison's request, and found the volume of water which imperceptibly entered the Thames between Maidenhead and Thames Ditton to be about 250,000,000 gals. per day. Further gaugings took place on five successive days during the latter part of July. The volume of water flowing over Teddington weir was considered equal to 450,000,000 gals. per day. Adding to this the quantity abstracted by the water companies, there is a total of 530,000,000 gals. per day as the natural discharge. Deducting the quantity poured in by the Colne, the Wey, and the Mole, the actual volume, independent of the tributaries, appears as 506,000,000 gals. But the flow at Maidenhead was only 390,000,000 gals., thus leaving 116,000,000 gals. per day to be accounted for as entering the river by subterranean springs. This quantity, considering the long drought prevailing at the time, is pronounced very satisfactory. The plan proposed by Mr. Harrison not only takes hold of the supply before it reaches daylight, but draws the water from a higher source than that which is now appropriated. Of course the water taken at Sunbury, Molesey, and Hampton is originally derived from a higher district, but it forms an integral part of the river at the intakes, and has undergone some change in consequence. The effect on the *régime* of the river, supposing the point thus changed where the supply is appropriated, is a matter of interest. The effect at Teddington may be considered *nil*, unless the 80,000,000 gallons per day now taken from the Thames should be increased by making the new source supersede the present supply from the River Lea. In fact, this may be considered the main question. The East London Company has an intake at Sunbury, and we find that in November last, while it drew 9,000,000 gallons daily from the Thames, they took 27,000,000 gallons daily from the Lea. The New River Company in the same month took above 20,000,000 gallons daily from the Lea. Mr. Harrison, in his preliminary report, reckoned on having at his command "at least double the volume of water at present drawn from the Thames." This would imply more than 160,000,000 gallons per day. But the underground increment between Maidenhead and Teddington last July was only 116,000,000 gallons daily, and subsequently it must have been less, the volume at Teddington being quite 100,000,000 gallons per day less than in October. Indeed, the quantity actually flowing over the weir in October fell to as little as 250,000,000 gallons per day, as if there had been an entire failure of the springs in the river bed below Maidenhead. This occurred in time of drought, and was purely exceptional, the flow becoming more than 500,000,000 gallons per day in the latter part of November. But the time of drought is the time of need, and it is essential that the water supply should always be adequate. The Thames is fed by a much wider area than that which would be tapped by the tunnel from Black Pots to Bray, including the auxiliary shafts and headings. But there is no invincible reason why steps should not be taken for getting at the subterranean sources of the Thames. The springs are purer than the river, and the companies are already showing some appreciation of this fact. It may be asked whether it would not have been wise on their part to have expended a larger amount of capital in appropriating the underground waters. They might then have spent less in the construction of impounding reservoirs and filter-beds, besides giving more satisfaction to the public. But it is necessary to estimate with caution the volume of water to be obtained from the chalk. Experience shows that the first flow from the chalk may excite expectations not afterwards verified. Mr. Harrison gives some very interesting geological reasons for his faith in the scheme which he proposes, and it is to be hoped that he is substantially right. He has studied the subject very sedulously, and has been gathering facts in reference to it during a long series of years. His scheme has the merit of harmonising with the existing interests of the water companies, thereby avoiding that enormous sacrifice of capital which some of the opponents of the companies contemplate with so much equanimity. We confess that we regard it with considerable doubt, while we admit that it is original in conception, and deserves careful discussion. What now becomes of the water which Mr. Harrison proposes to utilise?

THE REGULATION OF STEAM ENGINES.

THE introduction of electric lighting has stimulated engineers who never before gave the subject much attention, to produce efficient governors. Twenty or five-and-twenty years ago anything was good enough to regulate the speed of small steam engines. Indeed, it was only in cotton and flour-mills that refinements in governors were to be found. Mr. Porter created a sensation in 1862 with the Porter governor, at the International Exhibition held in London that year. Since that period hundreds of governors have been invented; yet it is doubtful if any real advance has been made for some years past; and we think we may, perhaps, supplement the article on the "Theory of Governors," which appeared in our last impression, with a few remarks, not so much on governors as on the principles involved in regulating the speed of steam engines. Within a recent period it has become the fashion to make the governor of an engine operate directly on the expansion gear. So far, however, as we are aware, it has never yet been demonstrated that any special economy of fuel is obtained by adopting variable expansion gear of this kind in the case of engines of moderate dimensions, and working with fairly constant loads; and it is quite certain that no governor has yet been invented, or at all events, brought into use, which is more efficient as a speed regulator because it acts on expansion gear than it would be if it operated on a properly made and placed throttle valve. In fact, all governors working expansion gear are much more unfavourably situated than governors working throttle valves. As this proposition may be disputed, it is well, perhaps, to consider it a little in detail. It will be understood, we hope, that we are not now dealing with large Corliss engines, or engines fitted with trip gear. Such machines have special advantages and defects; but as they are not made in this country, at least, of small size, we need not further refer to them.

In engines such as semi-fixed and semi-portable, capable of indicating, say, 100 to 150-horse power and under, we find that a link motion of some kind is employed to control the point of cut-off, and the link is itself controlled by the governor. Now, as the link rocks, the thrust or pull exerted by it on the die block can only be momentarily exerted in a direction at right angles to the then driving face of the link slot, and the result is that the die tends at every revolution of the crank shaft to run up and down in the slot; or, when the die is fixed, the link will tend to run up and down on the die, which is just the same thing in the long run. This jumping motion must be arrested by the governor, and is so violent in its effects in some cases, where large cut-off valves with a long stroke are used with high pressures, that enormously powerful governors are required to control the link or die. In nine cases out of ten, however, the governor has to be assisted by a dash-pot—that is to say, a piston moves a loosely fitted piston in a cylinder filled with oil. The piston can rise or fall slowly, the oil passing round it, or through a small hole in it, but the oil prevents the piston from jumping. But an efficient dash-pot cannot be used without interfering with the sensitiveness of the governor—that is to say, it must be more or less tardy in its action, according as the dash-pot is more or less efficient. Many attempts have been made to overcome this difficulty, or to get rid of the dash-pot; one of the best we have seen being that used by Messrs. Hornsby, of Grantham, who suspend the die from an excentric ring of considerable diameter. The sheave of this ring is so coupled to the governor as to make a partial revolution as the balls rise or fall, and so raise or lower the die block. The theory is, that the excentric makes a good driver, but can only be driven with difficulty, and that, as a consequence, while the governor has plenty of control over the die, the die has little or none over it. So numerous are the objections to the link and revolving pendulum, that many engineers both here and in America resort to the system of rotating an excentric on the crank shaft by main force, as it were; and to this end they put large masses of revolving weight controlled by springs into the fly-wheel itself or its equivalent. Apart from the mechanical difficulties attending all this, we have the radical trouble that it is nearly impossible to use a parabolic governor or its equivalent. Our readers will understand that with any true centrifugal pendulum there are determinate positions for the balls for every given speed. For a complete explanation of the why and the wherefore, they have only to turn to the first page of our last impression. If, then, an engine is making 100 revolutions with the governor in a given place, and some of the load is taken off, the engine will run, say, at 102 revolutions. The governor immediately responds and takes up a new position, and the throttle is a little closed, and the engine will settle down, say, to 101 revolutions. It cannot possibly remain at 100 revolutions, for that corresponds to a speed of governor which gives too much opening to the throttle valve. But in the case of the parabolic pendulum the phenomena are different. It is a matter of indifference to the balls what position they are in. Nothing affects them but a sudden change of velocity, and in such a case as that just cited the balls of a parabolic governor would fly apart, partially close a throttle valve, and might remain in their new position, although the engine got back to 100 revolutions. It will be readily understood that a governor of this type in proportion as it is indifferent to its position with regard to velocity is feeble in its action, and for this reason is quite unsuitable for actuating link cut-off gear. The action of the die in the link of such a governor would set it jumping violently. Indeed, it is more than doubtful if there is in existence such a thing as a true parabolic governor attached to and controlling a steam engine, although there are large numbers of approximate parabolic governors, such as the cross-armed pendulums, in daily use, but they are injured by the presence of controlling springs.

If our readers have followed what we have written, they will understand that the centrifugal pendulum to be really efficient must be left as free in its action as possible, and that all manner of link motion gears compel the revolving pendulum to do work, and thereby harm it, and interfere with it. Sometimes, as when Corliss or trip gear is used, the governor is in no way affected by or cognisant, so to speak, of what happens among the various parts of the expansion gear. In the same way the work of controlling a throttle valve is so minute that the governor may be said to be left to itself. If now we have an engine intended, let us say, to produce the electric light, and that this engine has valve chests of small capacity, and a throttle valve fitted quite close to the chests, then with a good governor that engine can be made to run at a more uniform velocity of rotation than any similar engine fitted with link motion expansion gear. Of course if the throttle valve is placed a long way from the cylinder the governing may be very bad, because of the steam stored, so to speak, in the steam pipe; but with proper arrangements such a system of governing as that which we indicate will be found to leave nothing to be desired, and will be in every way preferable to the ordinary system of operating the expansion gear. So much for the bare question of regulation; we have next to consider the question of economy of fuel.

If an engine is run under conditions of constantly varying load, we have very little doubt but that variable expansion gear will prove on the whole advantageous; but that it can be of any service when the loads are fairly constant we take leave to doubt. Let us suppose that the variation in load is so great that the expansion is at one time five-fold, and at another six-fold. The work got out of a pound of steam will, in the first place, be $1+1{\cdot}61=2{\cdot}61$, and in the other case it will be $1+1{\cdot}79=2{\cdot}79$. This represents the maximum saving to be effected, but in practice the difference obtained, by working a pound of steam, say, at 60 lb. pressure, with a five-fold expansion, and a pound of steam, say, at 50 lb. initial pressure, with a five-fold expansion—the reduction being due to the wire-drawing past the throttle valve—would be almost infinitesimal. It is only where any great changes in load—as, for example, in the case of engines working iron rolling mills—are concerned that an adequate return can be got for the cost of automatic expansion gear; and in the case of electric lighting it seems that, upon the whole, that arrangement is best which permits the amount of expansion to be settled by hand, while the speed is controlled by an astatic or other very delicate and sensitive governor, working a properly-constructed throttle valve. At any moment that a considerable change takes place in the amount of work being done, the attendant can regulate the point of expansion, of course without stopping the engine, its speed being the while perfectly controlled by the governor; but the governor intended for such duties ought to be carefully designed and skilfully made and put to work.

Lastly, we may observe that neither a throttle valve nor an automatic expansion gear can regulate minutely a compound engine, simply because the store of steam already in it at any time will counteract the operation of the governor; and when extreme delicacy is required, a throttle valve ought to be put in the exhaust pipe of the high-pressure cylinder. Such a valve would, it is true, cause a small, a very small, loss of fuel. In theory, of course, the automatic expansion gear ought to be fitted to both high and low-pressure cylinders, but we have not found any engineer who thinks it worth while to go so far. It is unanimously agreed that this game would not be worth the candle. For the rest, we invite our readers to ask themselves, or to ascertain for themselves by experiment, when the experiment can be made, what the pecuniary value of an automatic expansion gear is per annum, as compared with that of gear adjustable by hand and a good governor and throttle valve; never forgetting, however, that what we have said only applies to engines with fairly uniform loads, and not at all to those whose loads are at one moment heavy and another light.

THE CONDUCT OF MECHANICAL EXPERIMENTS.

IF experience be the foundation of all knowledge in general, it may be said with at least as much truth that experiment is the foundation of much that engineers know. Indeed, we may go so far as to add that the great difference between the ancient and modern engineer is to be found in the circumstance that the latter knows much better than the former did—and this, too, beforehand—in what way certain structural combinations will behave under given sets of conditions. This knowledge has been acquired for the most part by experiment. The old Romans built splendid stone bridges; but it is at least doubtful if any Roman engineer or architect could have calculated in advance the precise nature, direction, and amount of the strains to which the various parts of the finished structure would be submitted. Coming down to more recent days, we may call attention to the experimental work done by Fairbairn in order to accumulate data on which to frame practical formulæ for calculating girders. Barlow's inquiry concerning the strength of materials opened a new world, we had almost said, to engineers. The experiments of Kircaldy put the behaviour of iron and steel under stress in a novel light. We might go on to pile example on example in proof of our proposition. As, however, we cannot imagine that anyone will dispute its soundness, the few examples we have cited must be taken rather as serving to illustrate our meaning than as being intended to convince our readers that we have stated a truth. Experimental work is still being done by engineers, and must continue to be done; but much time may be wasted in this way by men who fail to comprehend exactly what the nature of the work to be performed is. It is very commonly assumed that the carrying out of an experiment is an extremely easy matter. This may, perhaps, be true in some cases, but they must be very few. Only those who have served an apprenticeship, so to speak, to experimental work can realise the difficulties which are encountered in arriving at anything like a legitimate result. We may take, as an example, an experiment to ascertain the economical efficiency of a steam engine and boiler. Inquiries of this nature are constantly being made, and in nine cases out of ten the figures obtained after much labour do not represent the truth, because, we shall not say of the incompetence, but because of the want of experience of the experimenter; something being due, no doubt, in many cases to sheer force of adverse circumstances. It will not serve any good purpose to deal further in general terms with this matter, but it may prove useful if we give some examples of the difficulties which have to be overcome, say, in testing the power and economy of a boiler or boilers and an engine.

When the economy of an engine alone is to be tested, nothing more is necessary than that the horse-power should be got from indicator cards or a brake, the feed-water measured, and the percentage of water in the steam as it leaves the boiler ascertained. When the quality of the boiler has also to be tested, the coal must be weighed; and here we are at once face to face with the first difficulty standing in the road of the experimenter. In almost all cases the daily work of the engine must not be interfered with. Indeed, the main object of the inquiry is, usually, to ascertain how the engine does its daily work. The engineer with his staff arrives, let us say, at 5 a.m., and finds the fires banked, and steam up, let us say, to 30 lb. At this time the fireman draws his fires forward and prepares to get up steam. How much coal was on the grates before he commenced operations? To this question no accurate answer can be given. By 6 a.m. steam is at its working pressure, say 70 lb, and the fires are in full action. How much coal has been expended in raising steam from 30 lb. to 70 lb.? No one can tell, because no one knows how much coal is then on the grates—put on them, be it observed, during the time that steam was being raised. A run of nine hours is made; at the end the fuel on the grates may be drawn and weighed; but it cannot be weighed hot, and must be quenched with water. As a rule, however, the experiment terminates while the engine is running at full speed, and the quantity of coal then on the grate must be estimated. Now the furnaces of a Lancashire boiler with grates 6ft. by 3ft. will hold, with case, half a ton of coal, and it is quite impossible to estimate by mere inspection to a couple of hundredweight how much coal is in them at any moment. The course we have pursued under the circumstances is as follows:—We pay no attention to the coal used in getting up steam. The engine being started, and with its proper load on, steam is raised to, say, 70 lb., the feed is put on, the dampers left untouched, and the fires as carefully levelled as possible. No fresh coal is put on, and the fires are allowed to burn down until the steam pressure has fallen, say, to 65 lb. The time is then accurately noted, the height of the water in the gauges, and any other points requiring remark. Firing then commences with weighed coal. At the end of the day, the water is brought as nearly as possible to the original level, and steam is raised to 70 lb. Then the feed being on, the damper in the original position, and everything, in fact, as nearly as possible as it was at the beginning of the experiment, the fires are again suffered to burn down until the pressure falls to 65 lb. This ends the experiment, and it is assumed that like causes producing like effects, the fires must then be in as nearly as possible the same condition as they were in the beginning. In both cases steam was falling in pressure, and as the draught, load, speed of engine, &c., were alike in both cases, the assumption is not far from minute accuracy. It must not be supposed, however, that conditions so favourable can always be realised. The load on the engine may be variable, for example; and different conditions may come in to cause trouble and perplexity. In any case we have an element of uncertainty as to the precise quantity of coal used. In many instances attempts are made to take flue temperatures. Now, to say nothing of the difficulty of getting good pyrometers, or rather pyrometers kept in good order, there are so many temperatures in boiler flues that almost anything can be got out of a pyrometer. It just depends on where it is put. Thus, for example, a case was cited a little time back in our pages where the temperature at one side of the damper was 200 deg., and at the other about 370 deg. Of course, in the first case the pyrometer had been placed inadvertently in the current of cold air rushing in round the damper, loosely fitted in its frame. We have repeatedly had reports of the performances of boilers brought before us, in which the flue temperature was considerably less than that of the boiler—an impossible state of affairs. It may be worth while to add, before leaving this branch of our subject, that the work of weighing coals requires more skill than is commonly supposed, and the arrangements for weighing them are only too often of the crudest possible nature. The weighers, as a rule, require to be sharply locked after.

Turning next to the measurement of water, the experimenter finds himself beset with difficulties. No one who has not tried can conceive how hard it is to get accuracy in this respect. In some cases a large tank is provided, in others a small tank. In the first case it is more than probable that a number of pipes run away from the tank, which does much more than supply the boiler. The statements contained in Mr. Schönheyder's letter in another page supply a practical illustration of this. All these have to be hunted down and cut or sealed. Then the tank has to be measured, and the bigger it is the more difficult it is to arrive at exactitude. The sides bulge when the tank is full, which is just the time when its dimensions cannot be properly taken. Again, it is assumed to be rectangular, and it turns out to be nothing of the kind—not one right angle about it. The only really accurate method of measuring the water supplied to a boiler is to have a cask mounted on trunnions so that it can be swung over when needed. The cask is to be placed on scales or hung from the end of a scale beam. It may be placed under a tap or have a hose led to it, and when it has received enough to turn the scale loaded to a given amount, the cask may be tipped on its trunnions into a temporary tank of any kind, from which the boiler feed pump draws. With large engines using much water this arrangement is impossible. Two tanks should then be provided of moderate dimensions, one of which can be filled while the other is being emptied, and the true contents of each ought to be ascertained by weighing water into it. Failing such precautions as these, the most puzzling and outrageously erroneous results may be obtained. Thus we hear of boilers evaporating more water than the coal could convert into steam. It is a very good boiler indeed which has an efficiency of 80 per cent.; that is to say, if the theoretical calorific value of the coal burned indicates that, say, 1 lb. of it would convert 10 lb. of water into steam, then it is an excellent boiler which will permit this coal to convert 8 lb. of water into steam. We have heard, however, of boilers which had an efficiency of 120 per cent., or thereabouts. Assuming in such cases that the coal has been properly weighed, and that there is no foul play, either of two things happens—the measurements of water are all wrong, or water has passed out of the boiler in some unknown way. We can call to mind a case in which a given boiler, after a careful trial, was ascertained to have evaporated 14 lb. of water from a temperature of 130 deg. per pound of coal. Every one was satisfied except the engineer who had carried out the experiment, which took place some ten or a dozen years ago in Birmingham. He knew that such a result was barely possible with the given coal—which was of splendid quality and burned to great advantage in the furnace of an excellent boiler—if the water had passed through an economiser, but no economiser was used. He refused point blank to certify that the boiler had evaporated so much as 14 lb. per pound of coal. He was challenged to say where the water had gone. He had examined the blow-off cock, the flues showed no sign of leakage. He had himself certified that the percentage of water in the steam did not exceed 6. The boiler was fed by a donkey which drew from a tank for the time specially filled by a hose and cut off from all communication with anything else. The pipe from the donkey to the boiler was above ground, in full view, and allowance was made for leakage at the ram stuffing-box, but there was practically none. The circumstances were, no doubt, extremely puzzling; but the engineer was not to be beaten, and after some trouble the defect was discovered. The feed pipe from the donkey lay along the floor of a kind of warehouse for some distance; it was of wrought iron, about $1\frac{1}{2}$in. diameter, the lengths being coupled with unions in the usual way. It was found, on careful examination, that one of the apparent unions was really a tee-piece, and that a small pipe ran from this under the floor of the warehouse and up the opposite wall to a small tank, from which water was drawn for manufacturing purposes. In this tank was a ball cock. The pressure on the boiler was always much greater than enough to overbalance the head in the vertical pipe. The donkey therefore first pumped the small tank full, when the ball cock shut, and then it supplied the boiler. No one engaged in carrying out the experiment knew anything about this arrangement. The secret, if we may call it so, was only cleared up by one of the foremen, who incidentally heard that "a fuss was being made about the boiler feed." A second experiment was made without the obnoxious arrangement, and the boiler was then found to evaporate a little over 11 lb.—a very satisfactory result, no doubt, but not at all what had at first been got.

It will be seen that in this instance nothing but great caution and a competent knowledge of his duties prevented the experimenting engineer from sending in an erroneous report. It was very nearly possible that the boiler could have done what it seemed to have done. The danger lay here in the fact that the engineer knew that the coal used was of very high quality, and that the boiler was of excellent design and proportion. He expected under the circumstances to get a very high result, and it is not perhaps too much to say, that if he had got an apparent evaporation of 13 lb. he would have accepted the result as accurate and inquired no further. The actual performance of the boiler was, on the other hand, much worse than it ought to have been; and he was enabled to suggest a few small modifications in the construction of the grates, the bridges, &c., which considerably improved the economic efficiency and here we may point out that, especially in dealing with boilers, nothing but patient investigation will enable the best result to be arrived at. This is one of the highest values of experiment. A case came under our own knowledge, where two very large Lancashire boilers evaporated but $7\frac{1}{2}$ lb. of water with good coal from 120 deg. An alteration in the grates and in the construction of the bridges in the flues raised the evaporative efficiency to a trifle over 8 lb., with, of course, a saving of fuel which very quickly paid the cost of inquiry.

The limits of space prevent us from pursuing this subject further at the moment, but much remains to be said which we shall say on a future occasion.

SHEFFIELD STEEL AND THE GUN FACTORIES.

THE letter of Mr. E. H. Carbutt, M.P., formerly of the firm of Messrs. Thwaites and Carbutt, hammer makers, Bradford, which appeared in the *Times* of the 26th ult., contains three statements which call for notice. The first is this :—"Other nations," states Mr. Carbutt, "have had steel guns for the last fifteen years, but Mr. Brand, the Director-General of Ordnance, says that the Sheffield trade cannot supply the department with steel ingots of the size and quality required." The reply to this is that the Government have never yet asked Sheffield manufacturers to produce steel ingots which they have not been able to supply, and they are prepared to produce anything the Government may want if they will only place the orders. Mr. Carbutt, in the second place, states :—"We pride ourselves on being the largest manufacturing nation in the world, and we are told that our engineers and steel manufacturers cannot supply steel forgings which can bear the necessary strain, and the Government have actually made a modification in the test which will enable the War-office inspector to pass English-made steel. Now, Sir, the question is, will the steel that has passed this modified test make guns which will stand their work ?" The modification of the test Mr. Carbutt speaks of is easily explained. Formerly the portion taken for the Government test was from the centre, which formed no part of what was to be afterwards used. The makers, holding that the core of the material did not indicate the quality of the tube, asked that the test piece should be taken out of that portion of the forging which was to form the tube of the gun, instead of out of the core, which formed no part of the gun. What was the use of testing that which was not going to be used ? All the other conditions of the specifications, as to tensile resistance, elongation, elasticity, &c., were left unaltered. Mr. Carbutt, in the third place, adds :—"There is no difficulty in casting any sized steel ingots—it is a question of compressing the metal afterwards. Until the hydraulic forging press was constructed, this was done by steam hammers. In England there is no steam hammer above 25 tons weight, but Schneider, at Creusot, has, with Government help, put up one of 100 tons weight. Krupp, in Prussia, has one the same size, and, no doubt, if our Government would guarantee a reasonable amount of orders, private firms here will put down plant capable of forging the large masses of steel required. When the Government wanted 18in. armour plates, Sir John Brown, of Sheffield, built in six months an armour-plate mill capable of rolling the heaviest plates." As a matter of fact, Messrs. Charles Cammell and Co. are stated to have a 30-ton hammer in their works at Grimesthorpe; but there are other, and, it is believed, better, means of compressing metal than by gigantic hammers. It is true enough that there are 100-ton hammers in the Creusot and Essen works ; but it is not a question of hammers, and it may be sufficient here to state that the Sheffield manufacturers are not asleep to the requirements of the period. They do not deem it advisable to let all the world know what they are doing, but the most successful local firms are those who have been able to keep their trade concealed from foreign eyes. If the Government will only place the orders, the Sheffield firms will produce the work. Our authorities, however, cannot expect any private firm to spend £100,000 to £200,000 in laying down heavy plant on the bare speculation that they may receive some Government favours. Sir John Brown and the late Mr. Mark Firth were able to do everything the Government required in their day—the one had three-fourths of the entire armour-plates required for the British Navy, and the latter had the guns. There will be no difficulty, under similar circumstances, in getting the work done. It seems to be forgotten that the largest guns which have yet been made, the 110-ton guns, for the Duilio, Dandolo, Italia, and Lepanto, though made at Elswick, were entirely produced from Sheffield steel. Our Government have had similar guns manufactured for them, which they have mounted on the fortifications of Gibraltar and Malta. No such guns have been produced abroad, and yet every ounce of steel in them came from Sheffield. It is useless disguising the fact that our Government are at present hurrying forward the construction of several large war-ships for which they have everything ready except guns ! There are nine war-ships, for the majority of which the plates have already been delivered, and the others will soon be delivered, and yet there is not a gun to mount upon them. The Government tried to get one gun from Krupp. The German manufacturer offered to supply the gun on condition that if it was satisfactory he should receive an order for ordnance to the value of one million. This shows how they proceed abroad, even in a gigantic State-protected establishment like that of Essen. Is it likely that private firms will run greater risks ? The French Government order steel shells by the thousand ; England asks for half-a-dozen to see how they will act. It is contended here that the Government should rely on the firms who have laid down, and are now laying down, large plant for ordnance, and not discourage enterprise by threatening Woolwich competition at every turn. Then the country would know where to secure prompt supplies of the heaviest guns which could be required in any emergency.

YORKSHIRE MINERS AND LABOUR REPRESENTATION.

THERE is just now a good deal of interest taken in the question of labour representation in Parliament, especially among the mining community. South Wales, Northumberland, and Durham, it is said, have already chosen their candidates. In Yorkshire a Miners' Political Association has been formed in connection with the Yorkshire Miners' Association. The question is creating a good share of attention, and it is reported that Mr. B. Pickard, the corresponding secretary of the Union, is likely to be named as a candidate for one of the eight divisions into which the South-West Riding has been divided. At the annual meeting of the Council of the Yorkshire Miners' Association, held at Barnsley, on Monday, the following resolutions were passed :—"That this Council is of opinion the time has arrived when active steps should be taken to select an electoral division or ward where a labour candidate may be run to represent miners' and labour interests generally in the House of Commons in the next Parliament, in connection with the South West Riding, seeing Northumberland, Durham, and South Wales are already prepared with their candidates." Also "that a general Conference be held, so that miners and others interested may attend, for the purpose of selecting a candidate and promulgating questions to be put to other candidates who may seek the suffrages of miners and other workmen in the other seven divisions of the South-West Riding and the other divisions and boroughs of Yorkshire." It has also been desired to hold a Yorkshire Labour Conference, at Barnsley, on Monday next, to consider the above resolutions. Many of the divisions, as at present suggested, have distributed the miners' voting power. The most likely division for a labour candidate is No. 7 Barnsley, which is the least in area, but having the largest population, viz., 65,356. All the ten townships are intimately connected with colliery operations.

BASIC STEEL.

THE Thomas-Gilchrist method of making dephosphorised steel and ingot iron has in the past year made striking progress, certainly upon the European Continent. Authentic returns of the outturn as well in England as upon the Continent, in the twelvemonth ending with the close of September last, indicate a grand total of 864,000 tons. Of this yield 685,000 tons is credited to the Continent, and 179,000 tons to England. The increase upon 1882-3 is nearly a quarter of a million tons. We need scarcely say that Siemens as well as Bessemer furnaces are utilised. The total of both now at work is nearly eighty ; and eight more are so far advanced in construction that they are likely to be started early this year. Perhaps the larger comparative yield upon the Continent than in England of oolitic and similar ores accounts in much part for the greater favour than in this country in which the process is held across the British Channel. British steelmakers do not seem to have quite satisfied themselves that the balance of advantage from the basic method is great enough to make it desirable that they should adopt it in preference to the acid process. It may be that if a duty fourfold what was before levied should be ultimately levied upon Spanish ore, a decided stimulus would be given to the manufacture. Meantime the fact remains that here, where two million more tons of pig iron are annually made than throughout the whole of the Continent, the make of basic steel aggregates only a little more than a fourth of that run out by the trans-Channel steel masters.

LITERATURE.

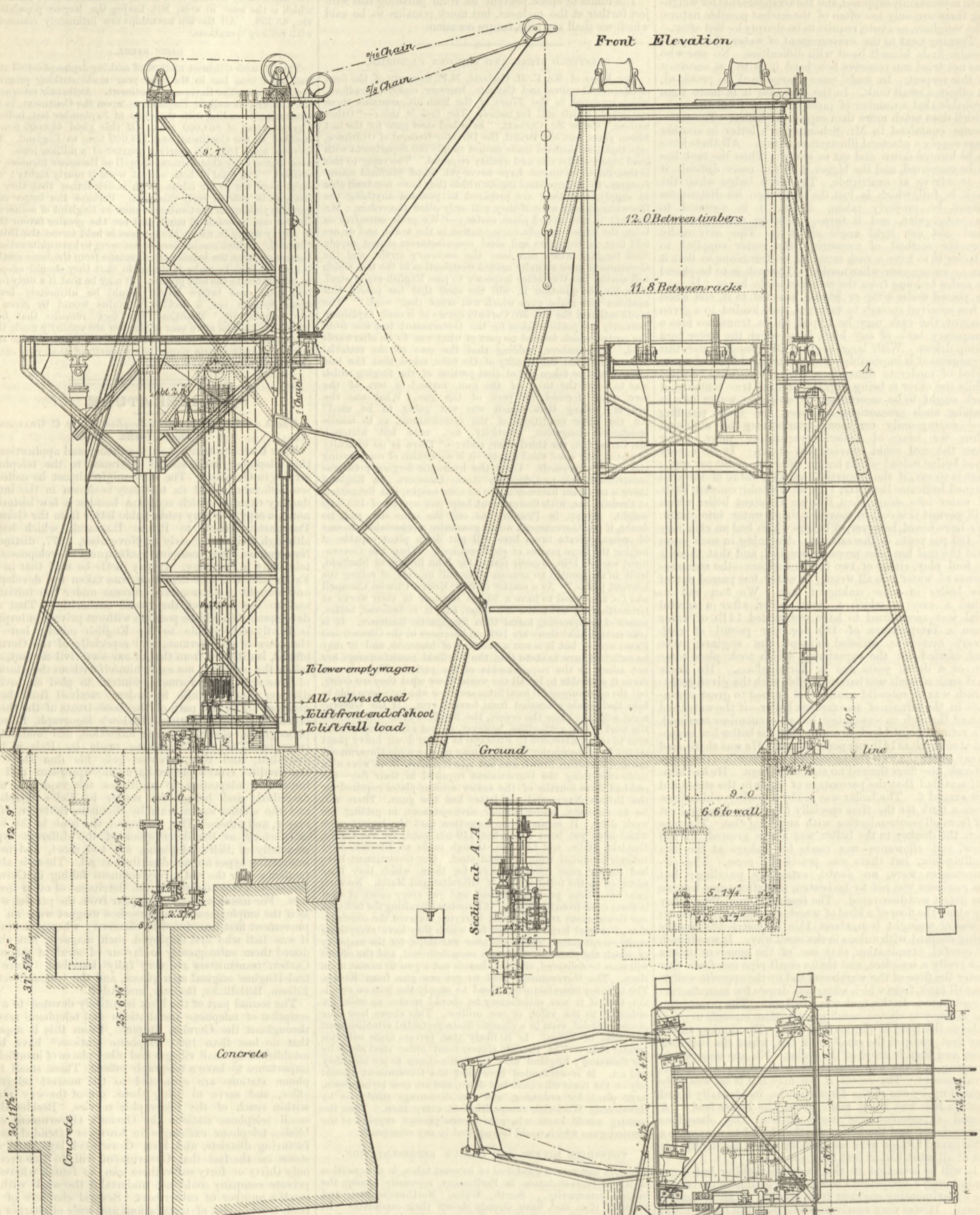
Lehrbuch der Telephonie und Mikrophonie. By C. GRAWINKEL, Springer, Berlin. 1884.

THIS book is a treatise on the theory and application of the telephone, with special reference to the telephone service in Germany. The work might almost be called a semi-official one, and its tendency is shown in the introductory chapter, which contains, besides a few historical notes, a copy of a very remarkable letter from the German Postmaster-General to Prince Bismarck, which letter, although written as early as November, 1877, distinctly foreshadows the enormous subsequent development of telephony in Germany. It may justly be said that in the Fatherland the new invention was taken up, developed, and brought to a commercial success under the initiative and to the order of the postal authorities. That any development should be possible without private enterprise is hardly conceivable to the English mind ; but the character of the German, and especially of the German official, is different from that of our own civil servant, and where the latter will not exert himself without the stimulus of fame or gain, the former is content to plod on, invent, discover, and organise to orders received from headquarters. The first part of the book treats of the theory of waves, sound vibrations, Barlow's logograph, Edison's phonograph, electro-magnetic induction, and undulatory currents. The first telephone made by Reis is here described, and this inventor gets his due share of the credit. Gray's electro-harmonic apparatus and its important adaptation to multiplex telegraphy is next described, and brings the reader to Bell's telephone and the similar instruments by Siemens, Bottcher, Neumeyer, and others. This portion of the book is the least satisfactory, as the descriptions of the different types, especially of Bell's telephone, are too short, and many interesting types are not described at all. There is also a tendency—for the rest a very common failing in German books—to extol Siemens to the detriment of other inventors. For instance, it would appear from the present work as if the employment of a horseshoe magnet were an improvement first introduced by Siemens ; whereas in reality it was Bell who first employed such magnets, but abandoned them subsequently in favour of straight magnets. Carbon transmitters are very fully described. Here we find Hughes' original microphone, and the transmitters of Edison, Bell-Blake, Berliner, and Ader.

The second part of the book is entirely devoted to a description of telephone installations and telephone service throughout the German Empire. From this it appears that no less than 1600 telephone stations* have been established in small villages and other places of insufficient importance to have a telegraph office. These small telephone stations are connected to the nearest telegraph office, and serve to bring these out-of-the-way places within reach of the telegraphic service. Besides these small telephone stations the German Government establishes telephone exchanges in towns or extended manufacturing districts, and Herr Grawinkel lays particular stress on the fact that Government will do this even if only thirty or forty subscribers can be found, whereas a private company could not undertake the work with so small a number of subscribers. Several chapters of the book treat of cost of installations and scale of charges and general routine of the service. The latter is very fully and clearly described, and will be instructive reading to telephone men generally. The same may be said of the chapters dealing with the line, supports, insulators, lightning conductors, switch boards, call bells, and all the other fittings of exchanges. It is, however, to be regretted that the author has so little to say on underground lines and on the means adopted to get rid of induction, the bugbear of all telephone engineers. We should also have liked to see some account of the Van Rysselberghe system of simultaneous telegraphy and telephony on the same wire, which, although as yet only introduced on some Belgian lines, might, on account of its great ingenuity and practical importance, find a place in a special work on telephony. But apart from these sins of omission, the author deserves the thanks of all professional men interested in the subjected. The book is well printed and profusely illustrated.

* According to Dr. Stephan, the number has since then considerably increased, and was 2530 on the 1st of October, 1884.

BOSTON DOCKS—HYDRAULIC COAL HOIST.



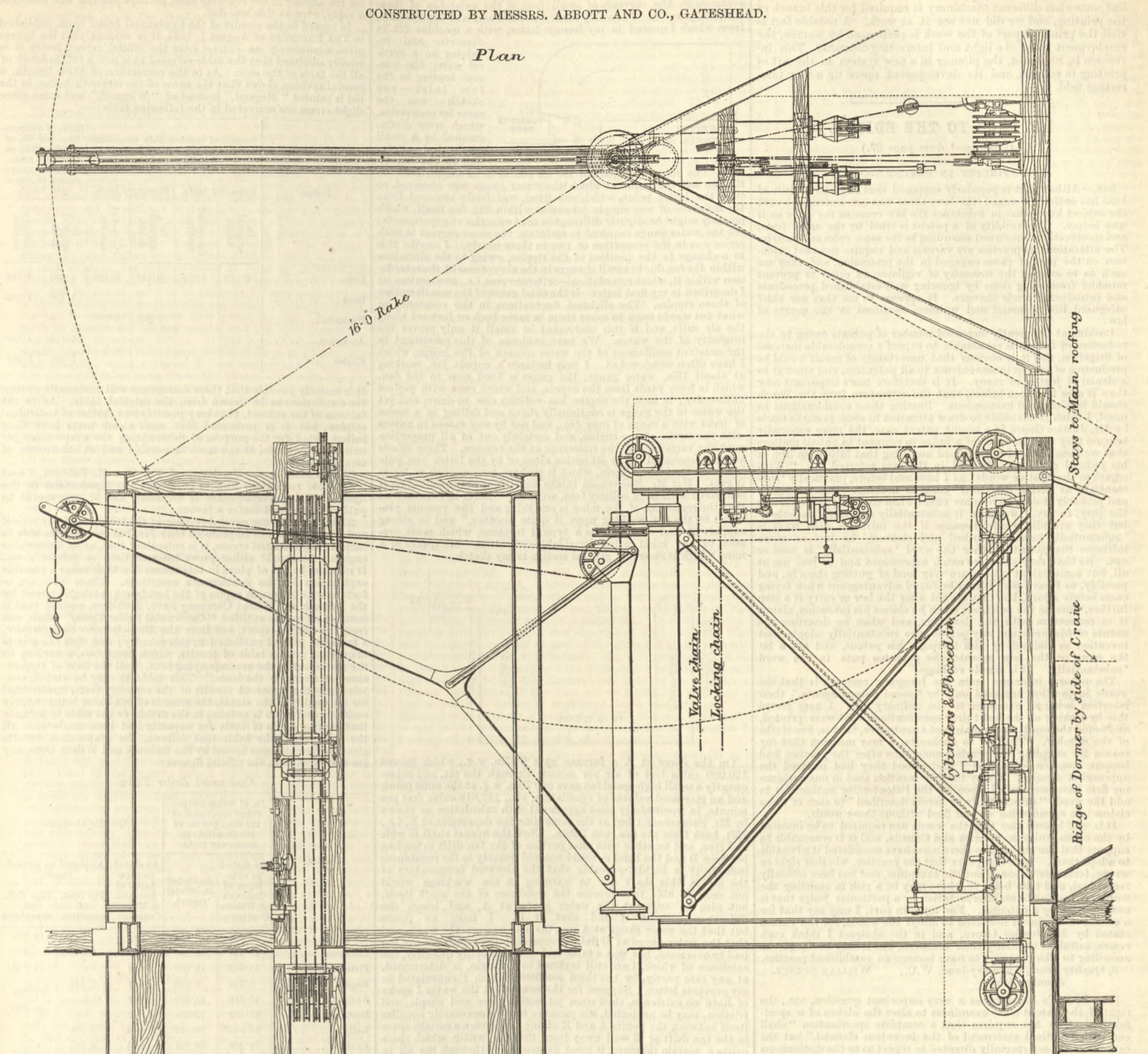
BOSTON DOCK—HYDRAULIC MACHINERY.

On this and the next page we now illustrate some of the hydraulic lifting machinery erected at the Boston Dock, of which we gave illustrations in THE ENGINEER of the 26th December last. The engravings are sufficiently clear to make but a short description necessary.

The coal hoist consists of a wrought iron frame, with cradle for receiving a railway truck, and is capable of lifting a gross load of 20 tons through a height of 30ft. The cradle is made to tip the wagon when raised to an angle of 45 deg. for the discharge of end delivery trucks. There is also a hopper fixed below the cradle for taking the contents of drop bottom wagons, so that either class of truck can be dealt with. The diameter of the lifting rams is 10in. and 7in. respectively, the small ram having a constant pressure from the accumulator to counterbalance the cradle when lowering. The shoot is 20ft. long, 11ft. wide at top, and 6ft. at bottom, with doors for regulating the run out of coal. A 20 cwt. crane is also provided for lowering the coal when first starting loading by means of a bucket into the hold of the vessel, so as to form a cone for the coal from the shoot to fall on and prevent breakage as far as practicable. The trucks are brought up to the hoist and turned round on the turntable by means of small hydraulic capstans. Hydraulic capstans are fixed round the dock for moving the trucks along the quays and in the sheds. The engines further have three 2¼in. rams, with 12in. stroke, with gun-metal oscillating joints. Four capstans are also fixed at the inner and outer ends of the

BOSTON DOCKS—HYDRAULIC LIFTING MACHINERY.

CONSTRUCTED BY MESSRS. ABBOTT AND CO., GATESHEAD.



lock for warping vessels in and out, arranged with power equal to 2½ and 5 tons respectively. The engines have three 3in. rams, with 12in. stroke. These capstans are arranged to work by hand.

Gate engines.—Eight hydraulic engines are provided for opening and closing the two pair of gates, so arranged that they can be thrown out of gear and worked by hand if necessary. The engines have three 1⅛in. rams, with 9in. stroke, with gun-metal oscillating joints.

Cranes.—These consist of one wrought iron pedestal quay crane, which is adjusted to lift weights up to 15, 10, and 4 tons, through a height of 40ft., with a radius of 30ft.; one similar crane adapted to weights of 3 and 1½ tons respectively; two cranes, each to lift 1½ tons, and fixed on cast iron columns on edge of quay, with cast iron girders spanning the space between the quay and the sheds, the jib made to swing so as to deliver into the trucks or into the sheds. The pipes bend down both sides of the dock and rest on a set off on the walls. They have oval flanges, turned and bored, spigot and faucet joints, with gutta-percha packing, the diameter varying from 5in. to 3in.

POLYCHROMATIC PRINTING.

WE recently visited the works of the Polychromatic Simultaneous Printing Company, in the Deptford Lower-road, and witnessed an exhibition of the patent process for printing in colours, introduced by them some short time back into this country. The principle underlying the process is the construction or building up of a mosaic block of colour materials, and with whatever character of design or with any number of colours, an exact *fac simile* of the block is produced upon the material or fabric to be printed on. Nor does the size of the pattern create any difficulty in its production. In technical language, the size of the repeats is limited only by the size of the machinery used in printing, so that designs which it has not been possible hitherto to produce, except by the expensive mode of block printing, are by this new method perfected at what is said to be a tithe of the cost.

We had the opportunity of inspecting printed tapestries in such exact imitation of the originals as to make it difficult to tell the one from the other. These were for the most part in panels three yards by two yards, and admirably suited for wall decoration or portierres. We especially noticed a fine piece of old Gobelin, supposed to have been worked 300 years ago. This we were assured was printed by a single impression. We should think that this tapestry, when generally obtainable, will attract the notice of builders, and be agreeable to the eye as a satisfactory imitation of the tasteful tapestry which our ancestors possessed, but which for many years past, owing to the difficulty of obtaining anything of the kind at a reasonable cost, has been superseded in too many instances by meretricious French and other papers. One great advantage is that it may either be fixed to the walls or hung loose, and so become movable from room to room.

The machinery by which such important results are obtained has been specially designed for the purposes of the patent, but is very simple and of very moderate cost. We saw some fine designs for cretonnes and that class of work, and witnessed the printing of several hundreds of yards of a thirty-colour pattern by a rotary or continuous printing machine, which we were informed would readily complete 10,000 yards a day of ten hours. One of the noticeable features of the process appears to be that it is capable of printing upon almost any description of material, and we saw the same designs upon the coarsest jute and on fine lace. Independently of printing upon textile fabrics, the process is applicable to the production of pictures; but somewhat different machinery is required for this branch of the printing, and we did not see it at work. A notable fact is that the principal part of the work is performed by women, the employment being of a light and interesting character. This invention is, no doubt, the pioneer in a new system in the art of printing in colours, and its development opens up a very interesting field.

LETTERS TO THE EDITOR.

(*Continued from page* 27.)

CONTINUITY IN PATENT LAW.

SIR,—Although it is popularly supposed that the new statute of 1883 has entirely changed the law, those who are conversant with the subject know that in substance the law remains the same as it was before. The validity of a patent is tried by the same tests, and specifications construed according to the same rules as formerly. The alterations in practice are various and require constant attention on the part of those engaged in the profession, and they are such as to suggest the necessity of vigilance in order to prevent mischief from being done by ignoring well-established precedents and introducing crude changes. It appears to me that our chief safeguard lies in sound and uniform decisions in the courts of law.

Looking at the greatly increased number of patents owing to the reduction of fees, it is reasonable to expect a considerable increase of litigation, and it is obvious that uncertainty of result would be productive of serious inconvenience to all patentees, and amount to a denial of justice to many. It is therefore more important now than it ever has been before, that the utterances from the Bench should be clear and harmonious. Bearing these considerations in mind, I think it advisable to draw attention to some remarks made by Mr. Justice Grove in a recent patent case, the more especially because they are the words of a judge so eminent in patent matters that we cannot afford to disregard anything that falls from him in his judicial capacity. He said in the case referred to: "With regard to these latter words; as I have said before, practically 'substantially as herein described' come to nothing. It is supposed, and probably it does have some effect when counsel are addressing the jury, to say, 'we claim it substantially as herein described,' but they are idle words, because if the infringer does what is 'substantially herein described and claimed,' he just as much infringes the patent whether the word 'substantially' is used or not. So that they are mere catch expressions and no real use at all, but some patent agents are very fond of putting them in, and possibly, as I have said, it may be found advantageous when trying cases before a jury, but they do not alter the law or carry it a step further, because the patentee, when he claims his invention, claims it in connection with the drawings, and when he describes the nature of his invention, any person who substantially adopts that invention as claimed by him infringes his patent, and not a bit the more or the less because the patentee puts in the word 'substantially.' It is simple verbiage."

The natural inference from the foregoing remarks is that the words in question are used only by "some patent agents," their insertion being an exception to the ordinary rule. I have tested this by looking at the last thirty specifications that were printed, and found the words in the claims of twenty-five, that is, five-sixths of the number. Then as to authority, I may mention that my reason for adopting the words—some time after the practice had become common—was that I understood they had received the approval of a judge. I may further mention that in one instance my firm have been called upon by the Patent-office authorities to add the words "substantially as herein described" to each of three claims in a specification we had filed without those words.

It is well known also that the words are required to be inserted by the official rules in America and Canada, and it is reasonable to suppose that the authorities there must have considered it advisable to adopt them. It thus appears that the practice, whether right or wrong, forms the rule and not the exception, and has been officially recognised, and that being so, there may be a risk in omitting the words, of leading to an interpretation by a particular judge that is not intended by a patentee. For my own part, I may say that for a considerable time I hesitated to adopt the words, for the reason stated by Mr. Justice Grove, and in the abstract I think such reason sufficient to justify their omission, but it may be dangerous according to what appears to have become an established practice.

8, Quality-court, Chancery-lane, W.C., WILLIAM SPENCE.
January 5th.

[Mr. Spence's letter raises a very important question, viz., the right of the Patent-office examiners to alter the claims of a specification. The Act requires that a complete specification "shall end with a distinct statement of the invention claimed," but the examiners are not specially directed to report as to the distinctness or otherwise of the claim. We understand that it is the practice of the Controller, not only to require very large alterations in claims, but also to send cut-and-dry claims to applicants for their approval. It should be clearly understood that these official claims "to pattern," if contested in Court, will be treated with no especial favour either by the bench or the bar.—ED. E.]

TRIPLE EXPANSION ENGINES.

SIR,—In your able remarks on "Triple Expansion Engines," in your valuable paper of the 2nd inst., I note an example is given, which I take to be the s.s. Para, owned by Messrs. Geo. Steel and Co., and engined by Messrs. Thos. Richardson and Sons, of Hartlepool. Some of the particulars which you give are inaccurate, and therefore misleading. The following particulars of the ship and engines are correct, viz.:—Length, 257ft. 6in.; breadth, 34ft. 6in.; draught above keel, 19ft. 4in.; displacement, 3648 tons; displacement coefficient, ·77; dead weight carried, 2338 tons; cylinders, 19in., 35in., and 53in. diameter; stroke, 33in.; pressure, 150 lb.; speed—average at sea—9·2 knots; average indicated horse-power, 616; consumption, Welsh coal, 8·7 tons per day.

The s.s. Para was the first vessel fitted with triple expansion engines by the above firm, the sixth and latest, sent to sea in the beginning of October last, being the s.s. Longnewton, owned by the Marquis of Londonderry. The particulars of this vessel are as follows, viz.:—Length, 275ft.; breadth, 38ft.; draught, 17ft. 5½in.; displacement, 4017 tons; displacement coefficient, ·77; cylinders, 20½in., 34in., and 55in. diameter; stroke, 33in.; pressure, 140 lb.; speed—average at sea—10 knots; average indicated horse-power, 710; average consumption, inferior North-country coal, 11½ tons per day.

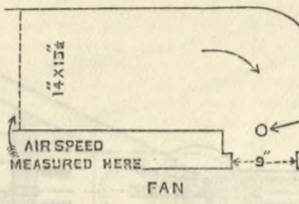
I trust you will insert this in your next issue.

Hartlepool Engine Works, Hartlepool, ROBERT WYLLIE.
January 7th.

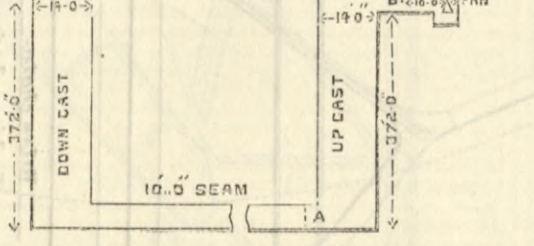
THE FALSE WATER GAUGE.

SIR,—I like the romantic title Mr. Steavenson has given to this question, and also the ingenuousness of his letter. I believe there is no man in this country better acquainted than he is with both the theory and practice of mine ventilation and mine-ventilating appliances, and I am therefore loth to uphold any theory of my own in opposition to any conclusions of his.

I still believe in the phenomena I termed, for want of a better name, ripples. I regard their existence in some degree as a certainty, but I must extend my observations considerably before I shall be able to say confidently either that they are or that they are not quite sufficient to account for the facts which Mr. Steavenson produces, and I am sorry that circumstances prevent me from going systematically and thoroughly into the matter. Whatever the behaviour of large colliery fans may be, there is strong evidence in the currents of small fans of the existence of these stationary waves. I recently carried out two series of experiments, from which I quoted in my former letter, with a machine 2ft. in diameter and revolving on a vertical axis; the passage leading to the fan inlet—see sketch—was the same for each series, which were distinguished by a small mechanical alteration in the fan itself.



The narrowest part of the air course is, as shown, between the fan and the point at which the water gauge was observed, so that the latter point, which was fixed, was fairly removed from the influence of any simple jet action within the fan itself, which possibly might be slightly different in the two series of experiments; yet the water gauge required to maintain the same current in each series was in the proportion of two to three nearly. I ascribe this to a change in the position of the ripples, owing to the alteration within the fan due to small changes in the abruptness of the retardation within it, which retardation—or its converse, *i.e.*, acceleration, as I described in my first letter—is the chief cause of the manifestation of these ripples. The slightest fluctuations in the resistance or what not would seem to cause them to move back or forward along the air drift, and if this movement be small it only proves the intensity of the waves. We have evidence of this movement in the constant oscillations of the water column of the gauge, which I have often wondered at. I may instance a cupola fan, working at about 12in. water gauge; the gauge is fixed near to the fan, which is forty yards from the cupola, and which runs with perfect uniformity; in fact, the engine has nothing else to drive, and yet the water in the gauge is continually rising and falling in a series of jerks with a range of over ½in., and not by any means in unison with the stroke of the engine, and certainly out of all proportion with the variations of the resistance at the tuyeres. These effects are not accounted for by jet action alone or by the letter you publish from Professor Unwin, which is perhaps true enough as far as it goes. But Mr. Steavenson thinks small fans may mislead us if compared with large colliery fans, and says, "Let it be remembered that the resistance of the mine is one thing and the vacuum produced by the fan working upon it quite another," and in strong support of that view he cites a typical instance, which must present to any mind rather formidable difficulties. He speaks of a mine which is shown in general section in my sketch.



On the doors at A a furnace gave 0·45in. w.g., which moved 120,000 cubic feet of air per minute through the pit, and subsequently a small high-speed fan gave in 0·70in. w.g. at the same point, and an increased volume of ventilation, viz., 149,618 cubic feet per minute, in wonderfully close agreement with calculation as shown by Mr. Steavenson; but at the same time the depression at B, *i.e.*, 10ft. back from the fan, was 1·28in. Now the upcast shaft is wide and free, and together with that portion of the fan drift extending between B and the bend *a*, could not add notably to the resistance; indeed, it is highly probable that the elevated temperature of the air in this shaft due to warming in the workings would not only be able to overcome the resistance of the shaft itself, but also to augment the water gauge at A, and lessen the difference between it and that at B. I have no doubt but that the water gauge at A was the one nearest the truth, and that the water gauge at B did not represent the resistance the fan had to overcome, but was a false and untrustworthy quantity, the existence of which, I am still inclined to maintain, is determined, at any rate partly, by the third condition which I enunciated in my previous letter. Suppose for the nonce that the waves I spoke of have no existence, then since jet action pure and simple, and friction, may be neglected, the pressure must immediately equalise itself between the points A and B at any rate; given a certain space in the fan drift at B well away from the fan, within which space exists a certain pressure, it must assuredly be through the air in this space that the energy from the fan on one side of it is communicated to the air in the mine on the other, and I cannot see that the size, or species of the fan, which produces this negative pressure in this space can, under these conditions, by any possibility affect the air beyond it. Mr. Steavenson says, "The fan creates the vacuum but cannot swallow the volume." But if we admit the existence of the ripples as set up by sudden changes of velocity, from whatever cause arising, then it is possible to understand how alterations in the fan may affect the water gauge in its neighbourhood, and render it untrustworthy. I can see no reason why similar effects should not be met with underground in the locality of bends, and of sudden widenings or narrowings in any air course; but not having had experience of them, I of course cannot say whether or not this is so. I would account for the false water gauge, of which Mr. Steavenson furnished an illustration, in this wise, assuming, of course, that the gauge pipe opening is removed from the sphere of miniature tornadoes or whirlwinds: The air column rising in the upcast encounters the bend at *a*, where its motion must be abruptly checked, and it simultaneously acquires a degree of compression in consequence which causes it literally to spring away toward the fan and reach a speed which becomes greater than normal, and it is only restrained from parting company with the air behind it by the increased rarefaction, that is to say, by the increased water gauge, but which water gauge, alas! is false as fair. If the cross section of the fan drift be less than that of the upcast, the effect will be increased.

It will, I dare say, be readily understood that these ripples can require very little energy for their actual resistance, that little being necessary to overcome the slight increase of friction where the air moves at abnormal velocity in the rarefied portion of the wave; so it will be seen there is but little to resist their development, and if it be granted that there is a slight increase of water gauge in the rarefied portion of the wave, this increase must be exerted in overcoming the resistance which has occasioned it; but this reaction must increase the current, and, therefore, also the resistance which depends upon the current, and, therefore, itself, until it reaches such a degree as is necessary to keep the air passing at the speed which corresponds to the true water gauge.

Hough-green, Widnes, December 16th. R. SNOWDON.

BOILER EFFICIENCY.

SIR,—Quite recently the attention of the writer was called to a letter from Mr. Geo. H. Babcock, published in THE ENGINEER for August 15th, 1884. The editorial foot-note appended to this letter is thoroughly appreciated, for the science of engineering receives no advancement by the intrusion of personalities into a discussion. In his letter Mr. Babcock accuses me of reporting the results of some boiler trials incompletely, unfairly, and incorrectly. As a charge of this character made by one professional man against another is very serious for the accused if true, and equally serious for the accuser in the contrary case, perhaps you can find place for a reply, even at this late day.

In regard to the results of the Centennial boiler tests, published in THE ENGINEER of August 1, 1884, it is evident that the figures given were simply an extract from the official report, hence it is readily admitted that the table referred to is not a full account of all the facts of the case. As to the correctness of these figures, a careful revision shows that the name of the eleventh boiler in the list is printed "Megand," instead of "Wiegand," and some other slight errors are corrected in the following table:—

Boiler.	Pounds of combustible consumed hourly per square feet of heating surface. Capacity tests. In original table.	Capacity tests. Corrected results.	Economy tests. In original table.	Economy tests. Corrected results.	Ratio of evaporation per lb. of combustible in economy tests, to similar evaporation in capacity tests. In original table.	Corrected results.
Lowe	0·189	0·281	0·185	0·180	1·062	1·068
Root					1·159	1·158
Harrison			0·288	0·289		
Anderson..					1·111	1·110
Exeter					1·003	1·007

It is scarcely possible that these corrections will materially change the conclusions to be drawn from the original table. As to the fairness of the extract, that may possibly be a matter of individual opinion, but it is presumed that most steam users have their boilers tested for the purpose of determining the evaporation per unit of combustible, at the most favourable and at other rates of combustion.

Shortly after seeing the letter of Mr. Geo. H. Babcock, I sent him a note requesting him to point out the inaccuracies in the figures. The correspondence is enclosed, and if you see fit to publish it, you will confer a favour.

Although, after the careful revision of the table—made by myself and others—it seems improbable that Mr. Babcock will be able to indicate any essential errors, it is submitted that, as an honourable engineer, he should either prove his assertions or retract them. It may not be out of place in this connection to advance a possible explanation for the gentleman's assertions. Those who are so fortunate as to possess copies of the handsome catalogue issued by the Babcock and Wilcox Company have, doubtless, noticed that it contains an article entitled "Centennial Boiler Tests," taken, not from the official report, but from the *Manufacturer and Builder*, a technical journal published in this country; and that the article in question gives a table of results, which comprises, according to the statement in the accompanying text, "all the data of importance pertaining to the tests." This table, it may be stated, contains only the apparent results of the economy tests, uncorrected for the quality of the steam, the records of one boiler being entirely omitted; and there is nothing in the article or the table to indicate that another series of tests for capacity had been made with all the boilers. In the table that follows, the evaporation results given in the catalogue issued by the Babcock and Wilcox Company are compared with the official figures:—

Centennial Boiler Tests.

Boiler.	lb. of water evaporated from and at 212 deg. per lb. of combustible in economy tests. As stated in catalogue of Babcock & Wilcox Company.	As stated in official report.	Quality of steam. As stated in catalogue of Babcock & Wilcox Company.	As stated in official report. Per cent. of moisture.	Deg. Fah. of superheat
Wiegand	10·730	10·834	dry	—	20·526
Harrison	10·437	10·930	dry	0·935	—
Firmenich	11·762	11·988	dry	—	32·633
Rogers and Black ..	9·808	9·613	dry	2·140	—
Andrews	10·616	11·039	dry	—	71·735
Root	11·802	12·094	dry	—	41·350
Kelly	10·943	10·312	wet	5·586	—
Exeter	10·486	10·041	wet	4·165	—
Lowe	11·848	11·923	dry	—	9·457
Babcock and Wilcox	12·131	11·822	dry	2·670	—
Galloway..	11·558	11·583	dry	—	1·411
Anderson	10·216	10·618	dry	—	15·668
Pierce	10·565	10·021	wet	5·240	—
Smith		11·906		1·306	—

The difference between these two sets of figures is considerable—they cannot both be correct—and it is easy to see that an engineer who believed in the figures contained in the catalogue of the Babcock and Wilcox Company could honestly think that any one who published the other figures had falsified the record. It is proper to add that the article and table to which reference has been made do not appear in the most recent editions of the catalogue issued by the Babcock and Wilson Company. RICHARD H. BUEL.

New York, U.S.A., 1884.

Geo. H. Babcock, Esq., 206, Broadway, N.Y.,
30, Cortlandt-street, N.Y. November 22nd, 1884.

Dear Sir,—Since the appearance of a letter, signed with your name, in THE ENGINEER of August 15th, 1884, which letter contains the following paragraph in reference to some figures published by me in the same journal, under date of August 1st, 1884:—"The above statement also makes it scarcely necessary to add that the extract from the Centennial tests, given by Mr. Buel, is not a full, correct, or fair statement of the facts in the case;" I have, in addition to making myself a careful revision of the figures referred to, submitted them to the examination of a number of engineers, and neither they nor I have been able to find anything in the extract that is not "correct" and "fair," although, naturally, we are all agreed that an "extract" is not a "full statement." As a reputable engineer could hardly accuse a professional man of falsifying an official record without having some other reasons than those which are given in your letter of August 15th, I venture to ask you to point out anything which is unfair or incorrect in the table published by me in THE ENGINEER of August 1st, 1884. Respectfully,

RICHARD H. BUEL.

The Babcock and Wilcox Company,
R. H. Buel, Esq., 30, Cortlandt-street, New York,
206, Broadway, New York. November 25th, 1884.

Sir,—I have ample grounds for the statement complained of, but as you have not hesitated heretofore to make an unauthorised, unfair, unwarranted, and ungentlemanly use of private letters, I must decline to be drawn into any correspondence with you.—Yours,

GEO. H. BABCOCK.

THE PANAMA CANAL.

SIR,—Being detained two days in the beginning of this month in Colon, Aspinwall, I took some trouble to make myself familiar with the extent of the works done on this end. The entrance of the canal will be defended by a breakwater under construction, which is about half finished, and consists of big bolsters. The breakwater will have this form > filled in with earth. The basin or harbour of the canal is at present half its width, by one-third of its proposed length, and an average depth of 9ft. A dredger was at work, dredging for the foundation of the concrete wall, or retaining wall, where the warehouses will be erected, but where at present the machine shops are constructed. Some of the concrete blocks for this wall are ready on shore. From this part of the basin there runs at present a channel of about 60ft. wide by two miles long, and an average depth of 6ft. All this will be ultimately widened to form, with the first-named part, the basin or harbour, about 500ft. wide. All the above has been done in very swampy land, which is always about 3ft. under water.

The canal company has made a good show on land. It has improved Colon considerably, by filling up swamps, building a new part of the town with timber cottages, and making in this new part excellent roads—the more creditable because this is all done on newly filled-up swamps. This immense quantity of earth was removed from some hills about half a mile distant. The company has also a good show of tugboats, steam barges, and small boats, and a good many iron barges under construction; that is to say, they come out in sections from Belgium, and are put together in Colon. All the excavation on this section of the work has been done by dredgers, and gives one a first-rate practical idea of the efficiency of the different dredgers at work. The famous—or rather the much-talked-of—American dredger, which was going to do such wonders, has entirely failed to come up to expectations. According to the calculations, it should have done 3000 metres a day, but its actual work is as follows: In very swampy ground, without coming into contact with any coral—because it cannot get through it—its work has been 1000 metres per day. It was put to work in heavier soil for one month, and did 1000 metres in the month, and, of course, left it. It has been three months on the works, broken down three times, had to undergo very heavy repairs, and actually, when I visited it, was broken down, and waiting for some pieces to come from the States. It looks like a huge monster, and cannot propel itself. There is a Scotch dredger at work, looking, in comparison with the American, like a small tugboat, which the people of the company told me does its regular 1000 metres a day, and as I saw it, in heavy coral, 800 metres. It has never given any trouble, and propels itself. The Belgian dredgers, I am told, give satisfaction, but are only for light work. Of the three American dredgers, one is at present a floating dwelling for the men. It struck me that there was a great want of materials, dredgers, &c., on this part of the work. I was told that this section of the work represents double the amount done on the other section. At this rate, what will be the cost and time necessary to finish this work, taking also into account the bad climate and death-rate, which cannot be ascertained, owing to no register being kept? JOHN I. DE JONGH, C.E.

San José, Costa Rica, Central America,
November 26th, 1884.

THE BLOWPIPE FLAME FURNACE.

SIR,—In your number of December 26th, page 487, in the footnote to Mr. Engert's letter, you state, "With all due deference to Mr. Engert, Mr. D. K. Clark, and Mr. Schönheyder, we decline to believe in the accuracy of their figures. It is due to Mr. Schönheyder to add that he has said he does not believe in them himself." As a different meaning may be, and has been, attached to these words than that which I believe to have been intended, will you allow me a few lines in explanation? When requested by Mr. Engert to test his furnace arrangements, he wrote that "the dryness of steam is not necessary to be tested." I, therefore, as stated in my report, did not make any special test of the dryness of the steam; but from general observations made, it appeared to be fairly dry, and there were not any signs of excessive priming, as also stated in the report; this, I submit, is very different to a positive statement that "the steam was dry," which Mr. Engert is under the impression that I have made. In examining the boiler and connections previous to the test, I found quite a network of pipes and numerous cocks connected with the feed arrangements, and also sundry draw-off pipes from the tank; all of these I carefully examined, and wherever it appeared possible that a leaky cock, or a cock left inadvertently half open, might cause the waste of some of the water intended for evaporation, I had the pipe severed and the end left free. Further, I was present myself during the whole time the test lasted, had one assistant constantly in the boiler-house, and one at the measuring tank. I also watched the tank for half an hour after the test, to ascertain if the water leaked from it; I had the scales and weights checked; measured the tank myself—in short, took all the precautions dictated by experience and reasoning in order to get accurate results, and feel certain that the amount of water stated in the report to have been withdrawn from the tank really was taken away, and, as far as is possible to ascertain, was pumped into the boiler, and I also feel certain that not any more coal was thrown into the furnace than stated. While, therefore, quite positive as to the accuracy of my figures as to water used and coal burnt, I cannot, as already inferred, say if any or what portion of the water went over with the steam without being evaporated, nor had I any means of knowing if the boiler leaked, and when the apparent evaporation was found to be so much higher than that shown to be possible by Mr. Hartley's calorimeter tests, I could but infer that some of the water had been wasted in either of the two ways indicated. Mr. Engert now writes me that the boiler has been examined by the Boiler Insurance Company's inspector and has been found to be tight; and, therefore, if not any other outlet for the water than the steam pipe existed during the test, the supposition is that much water did pass over with the steam, although there was not any appearance of it doing so.

With these remarks I must leave the matter in your hands and those of your readers—only adding that while I believe all my figures to be accurate, I do not believe it possible to obtain in practice an evaporation of over 13 lb. of water from coal in which only sufficient heat is stored for evaporating 12½ lb. without loss of any kind. W. SCHONHEYDER.

January 7th.

THE COST OF ELECTRIC LIGHTING.

SIR,—In your able and comprehensive leading article "On Engineering Progress in 1884," you refer to the electric lighting plant in the buildings of the Royal Courts of Justice Chambers Company, and state that comparative trials of cost have resulted in the determination to resume the electric light.

From this illustration it might be supposed that an exhaustive test of cost, resulting in the victory of electricity, had taken place; and we therefore beg leave, as consulting engineers to the company, to inform you that such is not the case. Comparisons between the cost of the two systems are still in progress, but are by no means yet complete. Probably the directors of the company may allow the figures to be made public when they are finally ascertained. FLANNERY AND BAGGALLAY.

9, Fenchurch-street, London, January 7th.

SPECIAL PLANT FOR WAGON BUILDERS.

SIR,—With reference to the article on "Special Plant for making Wagon Iron Underframes" in your issue of November 21st last, we wish to state that the horizontal drilling machine with forty-three spindles, referred to in Fig. 1, page 357, has two parts that are protected by a patent No. 2039, June, 1875, namely, the driving screw having half its length right-hand and half its length left-hand, to balance the pressure endways on the screw, and the application of worm wheels, which are alternately above and below the centre of the driving screw. This was omitted to be stated in the description of the machine above referred to. CRAVEN BROS.

Manchester, January 5th.

COALOWNERS' INSURANCE SOCIETY AGAINST STRIKES IN SOUTH YORKSHIRE.—Active steps are being taken in South Yorkshire for the purpose of forming a Coalowners' Insurance Society, in order to protect members from losses by strikes, or their collieries being shut down, by the men who of late years have combined and, at times, have been successful in enforcing advances when the owners declare the state of trade did not warrant such a proceeding. The owners now hold that the prices received for coal are so low that they consider they ought to recover back the 10 per cent. advance conceded some two years ago. It is stated that most of the leading coalowners have already joined the combination, the chief object of which is to afford protection and compensation in case of strikes. The members of the new society will insure upon the tonnage raised at the colliery during the past year, and will recommend compensation on the same scale in case of a stoppage at their collieries. Auditors connected with the firm of Messrs. Swithenbank, professional accountants, London, have visited most of the leading collieries and inspected the books in order to ascertain the tonnage on which the insurance premium shall be paid. The greater part of the first sale, it is stated, has been paid into the bank, so that it is anticipated the new combination will be shortly in working order. The idea is by no means a new one, for in November, 1874 a society was registered as the Yorkshire and North Derbyshire Coalowners' Association, Limited, with a nominal capital of £500,000. The largest shareholders were the Staveley Coal and Iron Company, Derbyshire, who subscribed for 1000 shares of £10 each. Messrs. Newton, Chambers, and Co., the owners of the Wharncliffe Silkstone Colliery, and the Dockworth and Silkstone Coal and Iron Company, were also shareholders. The object of the society named was the protection of members who might be inconvenienced by strikes.

FATAL ACCIDENT TO AN ENGINEER AT WEDNESBURY.—On Saturday Mr. Hooper, coroner for South Staffordshire, held an inquest at Wednesbury on the body of Mr. Solomon Huffam, 30, engineer and deputy manager of the Monway Iron and Steel Works, Wednesbury, the property of the Patent Shaft and Axletree Company. Mr. R. Williams, director, Mr. J. W. Wailes, general manager, Mr. J. F. Cay, secretary; Mr. S. Smith, manager of the Monway department, and others represented the company. The evidence showed that on Wednesday the deceased was superintending the raising of a wrought iron stack, 76ft. high, belonging to one of the Siemens' furnaces, by means of derricks and ropes, the intention being to lengthen the stack 30ft. by adding five 6ft. sections, when the mass toppled over. It had not been raised more than an inch or so at the time, and when the deceased saw that the stack was falling, he hastily put his hand on the shoulder of a workman named Hollyhead, who was standing by him, and crying out "For God's sake, run, John," attempted to draw him to one side. He had not gone far when just as he turned his head to look at the stack, one of the flanges holding the sections together struck him on the head, cleaving the skull down to the chin and scattering the fragments around. It was also found subsequently that his body was frightfully injured. All the arrangements were made according to the deceased's instructions, and he twice carefully examined every chain and appliance, the last time in consequence of Hollyhead having expressed a doubt of some kind. One witness said the toppling over was probably due to a gust of wind; and Mr. Wailes said it might have been caused by the snapping of a chain which was afterwards found to be broken. Mr. Williams and Mr. Wailes, on behalf of the company and the workpeople, both testified to the high esteem in which the deceased was held for his abilities and personal qualities, and the deep sorrow which his untimely end had caused. A verdict of accidental death was returned. The deceased was formerly a pupil of Sir W. Siemens. He had returned to the works only a few days from Leeds, where he had been superintending the erection of a Siemens' furnace.

RAILWAY PROGRESS IN NEW SOUTH WALES.—Nowhere in the whole of the British Empire are the advantages of railways better understood than in New South Wales, where the policy of the Government in obtaining loans for railway purposes is heartily approved, the only grounds of dissension being in connection with the choice of lines to be first proceeded with. It is twenty-nine years since the opening of the first railway in Australia. On the 26th September, 1855, the railway line from Sydney to Parramatta was opened for traffic, and since that time railway construction has proceeded until there are now over 1600 miles of railways in use, about 300 in course of construction, and proposed extensions representing over 1400 miles under the consideration of Parliament. The total capital expenditure on railways opened and in course of construction at the end of last year was £19,188,464, of which there was expended in 1883 £2,411,822. The gross earnings from all sources last year were £1,931,464, being an increase over the amount for 1882 of £232,602, a sum which would have been £100,000 more but for a reduction which was made in railway rates. The working expenditure amounted to 1,177,788. The mileage run was 1,086,134 miles in excess of the number for 1882. If the rates for 1883 had been maintained at what they were in 1882, the revenue from the railways would have been £2,079,278; and but for an increase of wages, the expenditure would have been £34,300 less. There were added to the rolling stock during the year twenty-eight locomotives, and 275 passenger and 797 goods vehicles. Within the last two years this Colony has been particularly busy in railway extension, and the railway openings have been numerous. It is expected that in a little more than two years the railway system of this Colony will be joined to that of Queensland, and that within the same period the connecting link between the Great Southern and Great Northern railways will be completed. There will then be uninterrupted railway communication between the three capitals of Queensland, New South Wales, and Victoria; and the four principal Colonies will very soon be joined together by railways.

WATER PURIFICATION.—The secretary of the Franklin Institute recently alluded to the experiments that were being conducted under the direction of Chief Engineer Ludlow, of the Water Department of Philadelphia, with the object of purifying the water supply by a system of artificial aëration. These experiments had proved very encouraging, and promised to yield important practical results. The plan employed, which is that suggested by Dr. Albert R. Leeds, differs from others that have been employed for a similar purpose. Laboratory experiments made by Dr. Leeds indicated that the advantageous action of atmospheric air in modifying and, in part, removing the impurities of water in contact with it, was greatly increased by producing the intermingling of the two under pressure. The greater the pressure, the greater is the absorption of oxygen, and consequently the greater the reduction of the impurities. The precise measure of this increase has not yet been ascertained. In order to try the experiment on a larger scale, and in such a manner as to afford some evidence of its value in practical operation, one of the Fairmount turbine engines—No. 8—was altered so as to convert it, in part, into an air pump, by simple mechanical artifices unnecessary to describe. The result reached by the action of the pumps thus modified was the delivery of about 20 per cent. by volume of free air into the water discharged into the main, this proportion being that which had been shown by experiments of Professor Leeds to be sufficient to surcharge the water. By subsequent comparison of samples of water from the Fairmount pool taken into the pump, and of the water discharged into the Corinthian basin after passing through 3600ft. of main, the results of the experiment were made apparent. The percentage of oxygen in the aërated water was 17 per cent. greater than before; that of carbonic acid was 53 per cent. greater; and that of the total dissolved gases 16 per cent. greater. The percentage of free ammonia was diminished to one-fifth of its former amount. The percentage of free oxygen represents the excess over and above what was required to effect the oxidisation of the organic impurities. These results are most favourable, and point clearly to the entire feasibility of reducing the percentage of organic matters contained in water unduly contaminated with sewage, within the limits of safety.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, December 27th.

THE iron trade is greatly depressed; the predicted improvement is not at hand. Heavy requirements are known to be withheld. Reductions in wages to the extent of 10 per cent. are probable in the steel mills, and one or two may close down in the event of refusal. Rails are 27 to 29 dols.; old rails, 16 to 18 dols.; wire rods, 45 dols. Scotch irons: Coltness, 21·50 dols.; Gartsherrie, 21 dols. to arrive; Glengarnock, 19·50 dols. to arrive; Eglinton, 19 dols. to arrive. Bessemer pig, 19 dols.; spiegel, 26 dols. for 20 per cent. American foundry: 18 dols. for No. 1, 17 dols. for No. 2, 14·50 to 16 dols. for gray forge. Over one-half the furnace capacity is idle. Foundry has dropped 2 dols. per ton during the year, while steel rails dropped 9 dols. per ton. The present week has been an idle one in the iron and coal districts, and very little iron-making or mining will be done until January 5th; and even then resumption will be only partial, because of the indifference of consumers in all markets to present their requirements. A few large bar iron contracts were taken at 1·70 dols. to start up with. Nails are 2 dols.; steel nails continue to crowd in. Structural mills are short of orders, and prices are weak. The Cambria Iron Company secured an 8000-ton order for spring delivery rails. Pipe mills are crowded with winter orders, to fill demands for natural gas purposes. Merchant steel mills are booking good orders for tool and machinery steel. The boiler makers throughout the East have a fair share of work. Serious troubles threaten the anthracite coal combination. A meeting takes place here next week to determine ratio of production. The iron manufacturers desire reductions in cost. Manufacturing requirements are far below the average of former years, but domestic demand in new markets is enlarging. Coal lands and properties are depreciating. The Reading Company has made the largest expenditures for improvements, and has by far the heaviest interest debt to carry. It is threatened with internal dissensions. The railroads are reporting fewer earnings. The transcontinental railway managers have been in session several days at Chicago, endeavouring to arrange amicable terms for the future, but failed. Competition will now rage. A considerable improvement in railway building is probable next year. This year's mileage is 3600. A good many new roads are projected, but the full rail-making capacity will probably not be employed for three years. The facilities already furnished anticipate the country's growth. The railway system will earn more in 1885 than in 1884, because of increasing cultivation and growth of population.

Bitter opposition has been made to the Spanish treaty. The Nicaraguan Canal scheme will not go through Congress this session. Inside estimate of cost, 140,000,000 dols. No radical legislative measures will pass. Silver coinage legislation will be influentially demanded; bankruptcy legislation will fail. Clearing-house returns indicate a steady increase in the volume of trade. Last week's figures were 807 million dols., against 1059 millions for same week last year. Outside of New York the decrease was only 5 per cent. as against the same week last year. The shrinkage in values continues. Wages and prices are declining. An improvement in trade and manufacturing circles will not be general until the limits of the downward tendency have been clearly defined.

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

(From our own Correspondent.)

THIS week the winter quarterly meetings of the Midland iron trade have been held in Wolverhampton and Birmingham respectively. The events have fallen so early in the month that sufficient time has not elapsed since Christmas turned to allow of the formation of any definite opinion as to the probable prospects of the new quarter. The meetings themselves have been beyond doubt very flat. The attendances were large, and included, especially at Birmingham, many leading iron and steel masters, merchants, and general manufacturers from all the iron and steel making centres the kingdom over, and from London, Liverpool, Manchester, Bristol, and elsewhere. Inquiries to test prices were numerous, but the business which followed was unusually small.

Neither merchants nor consumers were prepared to speculate, and the satisfying of their actual necessities was an easy matter. Unquestionably, the inquiries made this week, and the negotiations commenced, will result in the placing of some fair contracts during the next three or four weeks, particularly from merchants; but the feeling on 'Change to-day in Birmingham was that merchants have but few large orders to give out, and that no improvement of trade worth the name must be looked for yet awhile.

In all departments prices were loudly complained of. In numerous instances sellers had unhesitatingly to inform would-be buyers that the acceptance of the terms which they offered were an impossibility. This was the case alike as to raw as well as manufactured iron, though it applied more in the latter than in the former branch. The meetings were certainly no improvement upon those of a twelvemonth previously. They were, as to several features of trade, such as the lowness of prices, the difficulty of obtaining specifications, and the re-declaration of the former official crucial prices, almost a repetition of the meetings of January, 1884.

The marked bar houses at the Wolverhampton meeting re-announced their quotations as £8 2s. 6d. for the bars of the Earl of Dudley, with £7 10s. for the bars of the few other "list" houses. Earl Dudley's quotations therefore stand at, for rounds £8 2s. 6d. lowest quality, £9 10s. single best, £11 double best, and £13 treble best. His lordship's rivet and T-iron is £10 10s. for single best, £12 for double best, and £14 for treble best. Angles and also strips and hoops, from 14 to 19 w.g., are £8 12s. 6d. lowest quality, £10 single best, £11 10s. double best, and £13 10s. treble best. Strips and hoops of ⅞in. and 20 w.g. are £9 12s. 6d., £11, £12 10s., and £14 10s., according to quality; and of ⅝in. £10 12s. 6d., £12, £13 10s., and £15 10s. respectively.

The New British Iron Company's prices for bars are:—Best Corngreaves, £6 10s.; Lion, £7 10s.; best Lion, £9; best best scrap Lion, £10; best best best Lion, £11; best charcoal, £11 10s.; best Corngreaves plating, £7; Lion plating, £8; best Lion plating, £9 10s.; best Lion turning, £11; best Lion rivet, £9; best best Lion rivet, £10; best Lion chain, £9; best best Lion chain, £10; best Corngreaves horseshoe, £6 10s.; and Lion horseshoe, £7 10s.

Excellent bars, declared by the vendors to be little, if any, inferior to the best makes of the list houses, were plentifully offered at £7 and at £6 15s. Second-class bars were £6 10s.; ordinary, £6; and common might have been had as low as £5 10s., a drop as to the last-named of 10s. per ton on the year.

Hoop and strip makers complained of the scarcity of orders from local consumers, and makers of nail rods were not at all well furnished with orders. Common hoops were £5 15s. to £6 a ton and upwards, also a reduction on the year of 10s. per ton. Better qualities were quoted £6 5s. and £6 10s. Common strips for tube-making were £5 12s. 6d. upwards, likewise a drop of 10s. per ton.

The demand for sheets showed most life, and every quarter this branch is becoming increasingly important as the output becomes larger and larger. Makers of their descriptions for stamping and for working-up purposes did a fair business, and reported their order books as well placed. Working-up qualities they quoted £10 to £11; stamping sorts, £12 to £13; and best sorts, £15 per ton. Tin-plates the same people quoted 16s. to 18s. for best cokes, and 19s. to 20s. for charcoal qualities. Some concessions had to be allowed, however, on these rates to get trade.

Makers of merchant and galvanising sheets did not do nearly as much business as they could have wished, and competition for the orders offering was severe. Prices suffered in consequence. Although £7 was the general quotation for singles, and some makers asked even £7 2s. 6d., it was scarcely a secret that in some instances they might have been obtained at something under

£6 15s., and while £7 10s. was mostly quoted for doubles, still clever buyers might have obtained supplies at £7 5s. A year ago singles were quoted £7 5s. upwards; doubles, £7 12s. 6d. to £8; and lattens, £9. Thus, singles show a drop of about 10s. per ton, and doubles in proportion. Prices of sheets in the galvanised state were very varied. Ordinary qualities generally ranged from £11 12s. 6d. to £11 17s. 6d. for 24 w.g., delivered Liverpool in bundles.

For boiler and girder plates the demand was very small, the keen competition of other districts resulting in much trade passing away from the Staffordshire mills. Tank plates were quoted £7 10s. upwards; ordinary boiler plates were £8 to £8 10s., and best £9 to £9 10s.

The pig iron trade languished, particularly in native sorts. Some lots of pigs from other districts of 500 tons and 1000 tons respectively changed hands here and there, but large sales were exceptional. Shropshire and Staffordshire all-mine makers re-declared their quotations as 80s. for cold blast pigs, and 60s. for hot blast, but in actual business supplies might have been easily had at 2s. 6d. per ton under these rates. Native part-mine pigs were 46s. 3d. down to 42s., and cinder pigs down to 37s. 6d. to 36s. 3d. Spring Vale pigs were quoted:—Best quality, 52s. 6d.; second, 47s. 6d.; and third, 37s. 6d.; but good contracts might have been placed at 1s. 3d. per ton less. Derbyshire and Wiltshire pigs were 42s. delivered to works, Northamptons 41s., and common Wigan 43s. Hematites from Barrow, South Wales, and South Yorkshire, were 55s. per ton.

At Birmingham to-day—Thursday—the prices announced at Wolverhampton were confirmed in every particular. Hot blast all-mine pig makers, though quoting 60s., sold at 57s. 6d. and 55s. Makers who were firm at 60s. and 62s. 6d. could not sell. The demand in all departments was very flat. The Welsh Tin Plate Makers' Association held their quarterly meeting, and quoted ordinary cokes 14s. and charcoals 17s.

Early next month the annual meetings of the South Staffordshire Ironmasters' Association, and of the Iron Trade Wages Board will be held in Birmingham.

To some hardware manufacturers the opening year has been fairly favourable. There are many contracts to be given out, and tenders are being sent in for Government supplies. More than before hardware manufacturers are putting themselves in a position to supply every class of article that can at all be said to rank under the individual industry or industries to which they have relation. Numbers of manufacturers are just now busily engaged in extensions of premises with a view to add other branches. The chief reason for this step is that commercial travellers have in the past quarter found that they could do best when they were prepared to take from customers "lines" made up of a very varied assortment of articles.

The National Amalgamated Association of Operative Nut and Bolt Makers decided a few days ago in Birmingham that the associated masters had determined that unless the men assisted them in putting a stop to the underselling which was going on in prices, they would have to enforce a 10 per cent. reduction in wages. The only way to do this, it was stated, was by withdrawing the operatives from those works where the proprietors did not belong to the masters' association. The associated masters, in return, would agree to employ only men who belonged to the Nut and Bolt Makers' Association. It was decided by the meeting to withdraw all the men employed by the non-associated masters, and to support them whilst out of employment. The question is considered by the operatives to be the most important which they have had to consider during the last ten years. In the Birmingham and South Staffordshire district alone they calculate that they will have to call out the men from twenty works of one size and another.

There was much complaining on 'Change on Wednesday at the delays in getting minerals to the furnaces, arising out of a dispute between the Canal Company and the Mines Drainage Commissioners respecting the terms upon which the latter will consent to supply the former with water pumped from their mines. It was stated that there is little short of a general block of local traffic through the requirement that no lock over a certain area shall be emptied unless boats are ready to go through it from opposite directions.

At a quarterly meeting this week of the North Staffordshire Coal and Ironmasters' Association, held at Stoke-on-Trent, it was resolved that the support of the Association should be given to any steps which the Mining Association of Great Britain intend to take on the subject of railway rates, as proposed to be varied by the new Bills deposited in the House of Commons. These Bills were also considered, and after a lengthy discussion it was decided to give the British Iron Trade Association the aid of the Association in opposing the Bills.

The Town Council of Birmingham, at their meeting on Tuesday, determined, upon the recommendation of their Public Works Committee, that by way of obtaining a *locus standi* they would petition against the Bill of the Birmingham Tramways and Omnibus Company, and they resolved to defer for another year their assent to any of the existing proposals for new tramways. During an animated discussion Alderman Collings, Mr. Moore, and others spoke very strongly upon the practice of speculating in tramway orders, indulged in largely by syndicates, who have no capital wherewith to construct lines.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—Business is only just now settling down again after the holidays, and during the past week there has been little or nothing doing upon which to base any accurate estimate as to the actual state of trade. Generally, however, a dull tone continues throughout the market, with a want of confidence in the future. There is nothing to indicate any large weight of work ahead that is likely to give a stimulus to trade, and pig iron makers generally look forward rather despondingly, whilst finished iron makers are feeling seriously the slackness of trade, and some of the local forges have only work to keep them partially employed. As regards prices, there seems very little probability of any material change; on the one hand they are generally admitted to have already touched about the lowest possible point consistent with legitimate trade, whilst, on the other, there is no present apparent likelihood of any appreciable upward move, and, apart from anything that may arise out of existing political complications, the coming year does not, so far as can be seen, promise more than a continuation of dull trade at low prices.

The Manchester iron market on Tuesday was moderately well attended, but there was extremely little business stirring, and the few enquiries reported were scarcely sufficient to afford any real test of prices. Where buyers had orders to place, and these were of no great weight, they were generally held over pending the result of the quarterly meetings, not so much that there was any anticipation of prices being materially affected, but rather because the present unsatisfactory condition of the market induces a very general hesitation in entering into transactions. Lancashire pig iron makers are moderately well off for orders, and still quote 41s. for forge, and 41s. 6d. for foundry, less $2\frac{1}{2}$, delivered equal to Manchester, and these prices represent about the average figures for good district brands delivered here, although there are some sellers at as low as 40s., less $2\frac{1}{2}$. For hematites makers generally hold on to their recently advanced quotations, but where business has to be done, sellers have to come back to about the late low rates. For manufactured iron prices remain at about £5 10s. to £5 11s. 3d. for good ordinary qualities of bars, £6 for hoops, and about £7 per ton for local made sheets delivered into the Manchester district.

The engineering works have for the greater portion of the past week been closed for the holidays, but so far as the leading branches are concerned operations have generally been restarted with a fair amount of orders in hand. In railway plant and constructive work there is a considerable amount of activity; locomotive builders have their shops fairly full of work, and railway carriage and wagon builders are busy, Messrs. Ashbury and Co., besides carriage work, having recently secured a large order from abroad for iron wagons. In bridge and girder work there is also a good deal of activity, and the new Lancashire and Yorkshire line from Pendleton to Hindley will next week result in about 8000 tons of ironwork being given out. Boiler-makers, tool-makers, and machinists are also mostly fairly well employed.

The last monthly report of the Steam Engine Makers' Society records a slight decrease in the list of unemployed. The reports from the shipbuilding centres are also returned as rather more cheerful, a few orders having been booked, with the result that there is a lessened number out of employment. On the other hand, however, stationary engine and millwright districts show a serious decline, which is specially noticeable in the reports sent in from the Wigan, Preston, and St. Helen's branches. With reference to the recent grant by Parliament for strengthening the Navy, the report observes that this may have an effect in time, but at present it has only resulted in a limited number of men being put on overtime at Chatham and Pembroke Dockyards, but Portsmouth, Sheerness, and Plymouth do not show any revival whatever. The action taken by the Barrow Steel Works at the commencement of the year with regard to the hours of labour is also referred to as follows:—"In 1875 the trade was very much agitated by the action of the Barrow Steel Works introducing the longer hours' system, and as the nine hours' was only just established, much interest was taken in the matter." The firm employed a good number of the trade, but all society men were withdrawn, and from then till now no society men have been employed. We have pleasure in announcing that with the new year this firm acknowledge and work their men only nine hours, which throws it open to our members. What is the cause for this course is not openly declared, but the act is a voluntary one, and it can only be assumed that they are satisfied it is useless to ignore any longer the standard hours, but by acknowledging them they will in future have free choice of men and secure good legitimate tradesmen.

Messrs. Spencer and Co., of Hollinwood, near Manchester, have in hand several special tools for some of the leading makers of large stationary engines for driving cotton mills, &c. Amongst them is a special bed, fitted with three compound slide rests, with copying attachment, for turning and shaping the grooves in rope-driving pulleys up to the largest diameter. Also a large treble-geared slide and surfacing brake lathe, with 24in. centres, to turn up to 12ft. diameter, with duplex pillar rests and compound slides, specially adapted for turning large wrought iron and steel cranks. There are also in hand two medium sized planing machines for heavy cutting, with several recent improvements; one with four tool-boxes, with self-acting broad traverse feed motion for finishing, to give $1\frac{1}{2}$in. traverse at each cut. The bed works on flat slides, which are becoming more generally adopted by the best makers. Amongst several hollow spindle lathes, with capstan rests, which the firm are making, there is a very powerful one for turning small crank pins in steel from the solid bar without forging, up to 4in. diameter. The firm, who also do a large trade in weighing machines and weighbridges for railway work, have recently completed an order for fifty machines for the Great Indian Peninsula Railway, and their patent steelyard, to weigh in two or more denominations, has been very largely adopted by the State and other railways in India.

The New Year holidays, with the stoppage of both collieries and works, have caused practically a suspension of business in the coal trade during the greater portion of the past week. For house fire coals there has been a moderate demand, which, however, has been amply met out of stocks in hand, but in other classes of fuel there has been very little doing. A depressed tone continues generally throughout trade, and the stocks transferred over to the new year have at some collieries been larger than has been known for a considerable time past. Prices remain without material change, best coal at the pit's mouth averaging about 9s., seconds 7s. 6d., common house coal 6s. 6d., steam and forge coals 6s., burgy 4s. 6d. to 5s., best slack 4s. to 4s. 3d., and common 2s. 9d. to 3s. 3d. per ton.

Shipping during the past week has been quiet, with good steam coal delivered at the high level, Liverpool, or the Garston Docks averaging about 7s. 3d. to 7s. 6d. per ton.

The *Liverpool Journal of Commerce* in a *résumé* of the year, states that, although during the past twelve months the pressure in the shipbuilding yards on the Mersey has been strong as compared with other parts of the United Kingdom, the kindred branch of marine engineering has, in a general sense, been far from brisk.

Barrow.—I have to report that with the advent of the new year the prospects of the local hematite iron trade have slightly improved, though not to the extent either of justifying makers in putting up prices or inducing them to go in for an increase of the output. Stocks, I learnt, though they have been considerably reduced of late, are still large enough for any emergency in the way of new orders that may arise. The fact that makers are asking 1s. per ton on forward deliveries may, I think, be regarded as proof of a legitimate expectation that the clouds will roll by shortly. The quotations for No. 1 are 45s. 6d.; No. 2, 45s.; and No. 3, 44s. 6d. Makers of steel rails have a few more orders on hand, though most of the large works are still closed on account of the holidays. Heavy samples are quoted at £4 18s. 6d. per ton. The plate trade is fairly busy, and more work is in hand than for some time past. Iron ore has experienced an improved demand, but prices have not changed from 8s. 6d. to 10s. per ton at mines. Coal trade steady. Shipping inactive and freights low.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

New Year's Day was spent by your correspondent at Penistone. The sad accident which took place at what is known as Barnsley Junction, within about 400 yards of Penistone Station, on the Manchester, Sheffield, and Lincolnshire Railway, has revealed a new danger in railway travelling, and once more brought into special prominence the paramount importance of the axle. An excursion train from Rotherham and Sheffield to Liverpool and Southport left the former station at 7.45 on New Year's morning. It was full of passengers, mainly for Liverpool. At 5 o'clock a goods train left Ardwick for Kiveton Park. It picked up and dropped trucks at Guide Bridge, Old Dinting, and Hadfield, and among those left when it started for Penistone were several belonging to Shireoaks, Waleswood, and Kiveton Park Collieries. A Shireoaks wagon, running back empty, was the cause of the mischief. The axle broke down, and threw the wagon on to its side. The accident appears to have been promptly observed by the driver, who immediately applied his brake—Smith's vacuum—which seems to have acted effectively. But at the moment "the fire was seen to fly," as a witness remarked, the excursion train, travelling in the other direction, was within a few yards—"just far enough off," as the goods guard put it, "to see between the engines." The excursion was running at about twenty-five miles an hour. The goods at between ten to twelve miles an hour. The loose wagon struck the passenger engine, rebounded, and then, missing the three carriages next the tender, grazed the fourth, and completely smashed the fifth and sixth. The others had more or less damage to them. Four people have been killed and about forty injured.

The peculiarity of this accident is the fact that the wagon which broke down belonged to private owners, and the company, it is believed, will not be legally responsible for the loss of life and injury to limb caused by the calamity. The railway company is obliged to run other people's wagons, and all it can do is to examine them as frequently and as carefully as its own; but in this case, as at Bullhouse, no external examination revealed the flaw in the axle. Though the axle of the Shireoaks wagon appears to have been in very bad condition, nothing of its state was visible to the eye or responded to the tap of the examiner. How many wagons may now be running belonging to colliery and other companies which are really unfit to travel?

On the 5th inst. another axle of a wagon broke near Waleswood Colliery, also on the Manchester, Sheffield, and Lincolnshire Railway. Two wagons were thrown off the road and blocked both lines. In this case, as at Barnsley Junction, the wagon which broke down belonged to a private owner, and was attached to a goods train travelling to Ardwick. There was, fortunately, no passenger train passing on the other line at the time.

The Steel Rail Makers' Combination was expected to advance the price of rails; the effect of the expectation was, for the time, to do so; but from what I hear, it would appear that recent contracts have been taken at very low prices. The Great Northern wanted 15,000 tons, and several local firms competed. One company (not connected with the associated rail makers) quoted £5 4s. 2d.; but they did not get the work to do. It fell to a firm in the Combination, who quoted £4 8s. 6d. per ton. As the rails have to be delivered at Doncaster or Netford, the cost of carriage will reduce the price to about £4 5s. per ton. It is hard to see where a profit can be made at that figure.

The steel wire-drawers at several leading establishments have been asked by their employers to submit to a reduction of wages stated to be equivalent to 20 per cent. The request has been fairly considered by the men, who, seeing that the concession has been granted elsewhere, after a painful and costly strike, admit the injustice of expecting Sheffield firms to pay 20 per cent. more than the manufacturers of Birmingham, Warrington, and other centres.

On Wednesday afternoon the Barnsley magistrates committed William Haynes, a miner of mature years, to one month's imprisonment for smoking a tobacco-pipe in the workings of the Stanhope Silkstone Colliery, near Barnsley, which is entirely worked with safety lamps. Notwithstanding the defendant's age, the bench considered that no fine would be a sufficient punishment for such reckless conduct, defendant deliberately smoking a pipe whilst men were working all round him. It is a marvel explosions are not more frequent in the fiery Barnsley seam.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

Nothing unusual occurred at the quarterly meeting of the Cleveland iron trade held at Middlesbrough on Tuesday last. The attendance was small, very few people being present from other districts. Consumers showed no inclination to buy largely at prices quoted, and the general tone of the market might be described as melancholy. The unfavourable returns issued by the Ironmasters' Association on Monday last contributed without doubt to the feeling of depression. For small lots of No. 3 G.M.B. merchants accepted in some cases $1\frac{1}{2}$d. to 3d. per ton less than they realised last week; but their quotations were, for the most part, at the old rate, namely, 35s. 6d. per ton. Makers are not urgently in need of orders, and maintain their prices, which are 36s. to 36s. 3d. for No. 3 for early delivery, and 34s. to 34s. 6d. for forge iron. Some merchants have sold forge as low as 33s. 9d. per ton.

Warrants are 35s. 6d. per ton, but sales are few and far between.

The stock at Messrs. Connal's stores at Middlesbrough was 52,109 tons on Monday last, being a decrease of 310 tons for the week. At Glasgow they held 579,485 tons, being a slight increase.

No change of any moment is to be reported as to the finished iron trade. There are, however, some considerable enquiries in the market, and it is expected the demand will improve shortly. The mills have mostly resumed work after the holidays, but specifications come slowly to hand. There is no alteration in prices.

The North-Eastern Steel Company's works at Middlesbrough, and Messrs. Bolckow, Vaughan, and Co.'s. works at Eston have resumed work this week, and are fairly well supplied with orders for rails. The plate mill at the last-named works is still idle, but some large orders for steel plates have been secured. Work will be commenced so soon as specifications are to hand.

The statistics issued by the Cleveland Ironmasters' Association show that the make of pig iron of all kinds last month amounted to 204,030 tons, being an increase of 5351 tons, as compared with November. The stocks on December 31st amounted to 338,689, or an increase of 37,136 tons on those for November. The quantity of pig iron shipped was 68,562 tons, the principal items being:—Scotland, 37,265 tons; Holland, 8300 tons; Wales, 6427 tons; France, 4670 tons; and Italy, 3500 tons. During last year the make of pig iron of all kinds in the Cleveland district was 2,484,340 tons, or 276,400 less than in 1883. Stocks have increased during the year 85,584 tons. The quantity of pig iron exported was 926,856 tons, or less by 65,959 tons than the exports of 1883. Of manufactured iron and steel, 374,193 tons were shipped, being an increase of 17,814 tons over the previous year's shipments. The average price of No. 3 g.m.b. was 36s. 6d., as compared with 39s. 10d. per ton in 1883.

Messrs. Palmer's Shipbuilding and Iron Company, of Jarrow, has, it is said, received orders to build three screw steamers and one large sailing vessel. It has in hand two steel despatch boats for the Government, of which one will be launched in February. Messrs. Raylton Dixon and Co. are occupied with two large vessels and four smaller ones, and have now about 600 men at work. Nothing definite has been settled as to the wages of shipbuilding operatives, but it is believed that an amicable arrangement will be shortly arrived at.

The average net settling price of Northumberland coal during the quarter ending November 30th was 5s. 1·39d. per ton. The wages of miners in that county will therefore, under the sliding scale arrangement, be reduced $1\frac{1}{4}$ per cent.

Messrs. R. and W. Hawthorne, of St. Peters-on-the-Tyne, have just received the order for a pair of engines of 6000-horse power for H.M.S. Forth, now under construction at Pembroke Dockyard.

Mr. A. J. Dorman, head of the firm of Dorman, Long, and Co., of Middlesbrough, is still in a very critical state of health. It is several months since he was able to attend to business. Great sympathy is felt for him and for his family under the circumstances. Mr. Dorman is at present at Eastbourne.

Mr. Sidney G. Thomas, principal inventor of the basic process, is also in delicate health. He is at Paris in lodgings, being unable to proceed to Algiers, where he spent last winter, and whither he is ordered to return when practicable.

The report that the Spanish Government were about to raise the navigation or export tax on iron ore from $2\frac{1}{2}$d. to 10d. per ton turns out to be for the present a false alarm. It is said to have originated in a resolution passed by the local authorities at Carthagena, and to have had reference to the manganiferous ores of that district only. If put in force it may affect the value of spiegel iron, but only to an insignificant extent in proportion to the selling price. But, although recent fears have proved groundless, it would be the height of folly not to take to heart the lesson they ought to teach. That lesson is to beware lest the danger just escaped should recur some future day. The iron and steel trades of South Wales now depend almost absolutely and entirely upon Spain for hematite ore. Other British iron and steel districts are more or less in the same position. It is in the power of the Spanish Government at any moment to check, and perhaps even check-mate, these British industries. Some day they may use their power capriciously, or under compulsion; or they may threaten to use it unless we concede some demand or other which we should otherwise refuse. Squabbles are often arising—to wit, the one about the admission of Spanish strong wines on the same terms as French light wines; to wit, the recent capture by us of a Spanish boat, the crew of which had been misbehaving off Gibraltar; and to wit, our possession of Gibraltar itself, which is to them always a sore point. Indeed, if Spain should desire to punish or force England on any question, what more likely than she should cut off or handicap our supplies of ore, or threaten to do so. The remedy is to cultivate other sources of supply, and not to lay our plans as we are now so largely doing for dependence on her alone. We must, in short, have two strings to our bow or more.

The pressure produced by want of employment is, to a certain extent, having a demoralising effect on the lower stratum of the population of the North. Stealing brasses and stealing coal has become quite a business at Middlesbrough. Thieves infest the neighbourhood of the ironworks—which are seldom walled in—and, after nightfall, they prowl about like so many wolves. Should they find any engines, or shafting, or duplicate parts of machines containing brasses, in out-lying places, they post as sentinels one or more of their number, whilst others unscrew the nuts, take off the keeps, and make off with the brasses. This has been repeatedly done lately, and so far the thieves have not been caught. No doubt there must be a receiver of stolen goods somewhere, melting them down; but the police have not been able to lay hands on him. Coal stealing is also going on to a serious extent. Woman, children, and boys, generally Irish, come about the works at all hours, professedly to pick up cinders from the tips. They are fairly cautious what they take by day, for fear of being stopped and searched; but they generally manage to loiter about till after dark, and then, there being less fear of detection, they pull the coal off the trucks found standing, fill their bags with it, and escape. If a watchman approaches, he hears a shrill whistle and distant footsteps, but finds no one near the trucks when he reaches them. Such are some of the minor difficulties which encumber the iron trade at the present time, besides the major one of unremunerative prices.

WALES & ADJOINING COUNTIES.

(*From our own Correspondent.*)

OUR industries do not show so much animation as I would wish to chronicle. Perhaps it is early yet to form any opinion; and, in respect of coal, it is certain that any movement of the fleet such as we had this week would at once tell upon our coal trade. On Saturday last the collection of laden coal trucks on the sidings at Cardiff was greater than I have ever known it. Most of the principal firms and the ironworks companies were represented. It was quite a rueful picture, showing the condition of things at the docks, and hinting at absent ships and empty books.

During the last few days there has been a freer clearance, and some contracts have been secured, notably one by the Powell Duffryn Company for the Admiralty requirements at Vigo, and by the Dowlais Company for Gibraltar.

Great interest was awakened in all coal circles by the orders given to the fleet this week, though, thanks to Barry, our coal depôts are well stocked.

Cardiff sent off close upon 106,000 tons last week to foreign destinations; Newport, which has not recovered its buoyancy, 26,000 tons; Swansea, which also suffers from the prevailing depression, figured better, its coal clearances being 38,793 tons. Judging from the shipping coming in, things show a tendency to mend at Swansea. For instance, eighty-seven vessels came into port last week, and tin-plate and patent fuel branches are waking up.

America still figures as a good customer for tin-plates with the Swansea makers. Last week 1015 tons went to New York, and 1236 tons to Philadelphia. Prices remain low, and another bad feature I note is that stocks are accumulating. Makers of best brands are resisting the effort to bring down prices of ordinary coke plate below 14s.; steel plates fetch 15s.; best Bessemer, 15s. 6d. Newport has been clearing tin-plates for foreign destinations.

The Evence Coppee Company is being floated at Cardiff with a capital of £8000, in £10 shares. The object is the manufacture and sale of coke ovens and coal-washing machines. The success of the Coppee ovens and washing machines has been well shown at Dowlais and in the Rhondda Valley, and I quite anticipate a good future for the venture. It is a singular fact that in our coal valleys the utilisation of coal should be so neglected, and as for the production of bye-products which could be so well attached to certain collieries, no one seems to pay any attention to it.

It is not generally known that it is claimed in this district that the first discovery of colour from coal-tar, magenta, mauve, &c., was made in the Valley of Aberdare, and was noticed by a manager of a coal level, who observed that in tarring the wheels the drops falling into little pools on the tramway made brilliant colours, which had, however, nothing to do with dye stuffs. He tried to fix these colours, but failed until he was associated with a London savant. The inventor died some time ago, leaving a fortune of one million sterling.

There is little to record in connection with iron and steel. Experiments with the new condensing engine at Cyfarthfa have been signally successful. The new plant at Cyfarthfa Steel Works is of the first character. Mr. Edward Williams has certainly arranged one of the finest steel works of the country. No expense has been spared, and Cyfarthfa, with its advantages of latest engineering skill and ample water supply, must do a paying trade if any trade is to be done, which, of course, is only a question of time. The longer life of a steel rail, compared with that of iron, and the general depression of the country, have told hitherto, but steel rails must be had.

There has been a difficulty with the railmen at the Goat Mill, Dowlais, consequent upon work being let out by contract.

A large colliery in the district has been stopped, and the creditors written to by an accountant, asking for time until a report has been prepared.

The Plymouth colliers are beginning a crusade against existing medical arrangements. A preliminary meeting has been held.

There has been a partial resumption of work at Llantwil Colliery, Caerphilly. The stoppage was due to an accident in connection with the winding engine. Mr. Beacham, a Staffordshire gentleman, is to be the new manager.

The strike at Cwmglo, Bedwas, continues, but efforts are on foot which, it is to be hoped, will bring about a satisfactory arrangement. The Pentwyn dispute has been settled by arbitration; colliers to have 2s. 6d. per ton for cutting, with 17½ per cent. added.

A most satisfactory report of the condition of the Penrhiwceiber Colliery workings has been issued by an exploring party, reflecting much to the credit of the manager, Mr. Bevan.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE New Year holidays, although not of such long duration as was expected, have rendered business very dull this week. The inquiry for all sorts of iron has been comparatively poor, the total shipments being only 4557 tons, as against 5815 in the preceding week and 5190 in the corresponding week of last year. Makers have done little in the course of the week, but the probability is that in coming weeks a better inquiry will be experienced. As a result of the small shipments, the stock of pigs in Messrs. Connal and Co.'s stores has been increasing, and is several hundred tons larger than it was a week ago.

Business was done in the warrant market on Monday at 41s. 11½d. per ton cash. On Tuesday forenoon the market was depressed by the unfavourable returns issued for the past year of the Cleveland iron trade, and 41s. 10¾d. was quoted; in the afternoon a slight improvement took place, and buyers were at 41s. 11½d. cash. Business was done on Wednesday at 42s. 1d. to 42s. 3d. cash. To-day—Thursday—the tone was stronger, with business at 42s. 4½d. cash.

The slow inquiry for makers' iron has naturally told upon the quotations, which are for the most part lower, as follow:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 52s. 6d.; No. 3, 47s. 9d.; Coltness, 56s. 6d. and 51s. 6d.; Langloan, 56s. 6d. and 51s. 6d.; Summerlee, 53s. and 47s. 3d.; Calder, 53s. and 48s.; Carnbroe, 49s. 6d. and 47s.; Clyde, 47s. 6d. and 44s.; Monkland, 43s. 6d. and 41s. 3d.; Quarter, 43s. and 40s. 9d.; Govan, at Broomielaw, 43s. 3d. and 41s.; Shotts, at Leith, 53s. and 51s. 6d.; Carron, at Grangemouth, 49s. (specially selected, 53s. 6d.) and 48s.; Kinneil, at Bo'ness, 45s. and 44s.; Glengarnock, at Ardrossan, 49s. 6d. and 43s.; Eglinton, 44s. and 41s.; Dalmellington, 47s. 6d. and 43s. 6d.

There has been a rather better feeling manifest in the manufactured iron trade, but it is not easy to see upon what actual data it is based. Of course, the least improvement in the demand for malleable iron or steel will be of advantage in present circumstances, when expenses are so much reduced. A few orders have been booked in the shipbuilding trade of the Clyde, but much more are required to place it in a prosperous condition. There are also some appearances of a revival in the shipbuilding trade on the east coast.

The week's shipments of iron manufactures from Glasgow included six locomotives, valued at £16,460, for Calcutta; six do., £11,674, for Bombay; £9500 worth of machinery; £1700 sewing machines, chiefly for France; a small steel steamer, valued at £3900, shipped for Rangoon; £7250 general steel goods; and £28,000 iron manufactures of various descriptions.

In the past week the coal trade has been quiet in consequence of the holidays. At Glasgow the shipments of coals were scarcely a half of the usual weekly quantity. There were 234 tons despatched from Greenock, 1469 from Irvine, 6732 from Ayr, and 7460 tons from Grangemouth. The coal business of the past year, so far as the shipments are concerned, is regarded as satisfactory, the entire quantity sent away being fully equal to that in the preceding year. There has, of course, been a considerable decrease in the amount of the home consumption, because of the greatly curtailed requirements of manufacturers, and the domestic consumption also exhibits a marked decline. The quotations are without alteration.

The Walkinshaw Oil Company has closed two of its shale pits at Inkerman, and the miners have been discharged.

The liquidators of the Uphall Oil Company have presented a report to the shareholders, which shows that the operation of the nine months ending 31st December has resulted in a loss of £164, and this notwithstanding that Young's Company, with which the concern is now amalgamated, had conceded that no capital depreciation was to be deducted for that period. It has been agreed that the liquidation be closed, and that the books, &c., be handed over to Young's Mineral Oil Company.

THE Tarakeswar Railway was formally opened on the 5th inst. by the Viceroy and the Lieutenant-Governor of Bengal. This is the first broad gauge railway constructed by private enterprise in India.

MANCHESTER AND THIRLMERE.—The Waterworks Committee of the Manchester Corporation have resolved to ask the Council for authority to begin the works necessary for conveying the water of Thirlmere Lake to Manchester, for which Parliamentary powers were obtained five years ago.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty: — James Lane, engineer, to the Hibernia; and Benjamin J. Barnes, engineer, to the Pembroke. Thomas F. Brown, engineer, to the Falcon, William Walker, (*b*), chief engineer, to the Decoy; and William T. Paul, assistant-engineer, to the Temeraire.

ROYAL INSTITUTION.—Professor H. N. Morley will on Tuesday next, January 13th, begin a course of five lectures, on "Colonial Animals; their Structure and Life Histories;" Professor Dewar will on Thursday, January 15th, begin a course of eleven lectures, on "The New Chemistry;" and Dr. Waldstein will on Saturday, January 17th, begin a course of three lectures, on "Greek Sculpture, from Phidias to the Roman Era." The Friday evening meetings will begin on January 16th, when Professor Tyndall will give a discourse on "Living Contagion."

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.

30th December, 1884.

17,013. Shuttle Tongues, T. Felton and R. Bleasdale, Manchester.
17,014. Gas Lighting Apparatus, H. Defty, Manchester.
17,015. Cutting Machines, T. Baum, Berlin.
17,016. Cutting and Chipping Potatoes, &c., E. Birch, Manchester.
17,017. Electrically Indicating the Level of Water in Steam Generators, B. H. Thwaite, Birkenhead.
17,018. Hinges, J. J. Jones, Birkenhead.
17,019. Supporting Incandescent Electric Lamps, E. C. Walker, Darlington.
17,020. Tap-hole Plug for Beer Casks, E. Reynolds, Beighton.
17,021. Horseshoes, G. Poyser and T. A. Amies, Ashbourne.
17,022. Packing for Steam, &c., Pistons, A. MacLaine, Belfast.
17,023. Joints, &c., for Water Tube Boilers, C. C. S. Knap, Birmingham.
17,024. Pervious Fire-bricks for Fire-grates, F. T. Bond, Gloucester.
17,025. Velocipedes, J. A. Deering, London.
17,026. Games, A. F. A. Vogelsang, Philadelphia.
17,027. Combined Self-laying Rail Wheel, C. S. Young, Lozells, near Birmingham.
17,028. Applying Magnetism to Boots and Shoes, J. Holbrook and C. D. Wiltshire, Bristol.
17,029. Silencing the Exhaust of Gas Motor Engines, T. M. Williamson, J. Malam, and W. A. Ireland, Southport.
17,030. Rotary Engines, W. P. Thompson.—(*J. Harrington, U.S.*)
17,031. Drawing Ellipses, W. P. Thompson.—(*H. T. Hazard, U.S.*)
17,032. Elevators, &c., for Excavating, &c., Earth, A. Musker and C. W. Vaughan, Liverpool.
17,033. Roasting Coffee, &c., A. M. Clark.—(*W. H. Bruning, U.S.*)
17,034. Galvanic Batteries, G. Nifosi, London.
17,035. Stoppering or Closing Bottles, C. Davage and W. Goodall, London.
17,036. Spring Balances, J. de L. Watson.—(*A. A. Watkins, Hanover.*)
17,037. Breech-loading Fire-arms, &c., D. Bentley, London.
17,038. Compound Armour-plates, J. H. Johnson.—(*Marrell Brothers, Rive de Gier.*)
17,039. Drying Chambers for Drying Founder's Moulds and Cores, R. Buchanan, London.
17,040. Wind Gauge Arms, W. Graham, London.
17,041. Dental Engines, D. Brown, London.
17,042. Bearings for Block and Pulley Sheaves, G. Hughes, London.
17,043. Water Cranes, R. J. Ransome and R. C. Rapier, London.
17,044. Internal Stoppers for Bottles, W. R Lake.—(*W. L. Roorbach and S. and O. Twitchell, U.S.*)
17,045. Substitute for Ivory, W. R. Lake.—(*J. B. Edson, U.S.*)
17,046. Measuring Vessels, J. Douglas, London.
17,047. Safety Appliances for Lifts, H. J. Haddan.—(*J. Brandt and G. W. von Nawrocki, Germany.*)
17,048. Automatic Safety Apparatus for Boilers, T. R. Shillito.—(*J. Roebruck, Aachen.*)
17,049. Condensing Exhaust of Engines, A. Greig, London.
17,050. Oil Lamps, F. H. W. Livesey, London.
17,051. Couplings for Carriages, P. Jensen.—(*L. Koppel, Dresden.*)
17,052. Thermo-ventilating Stoves, P. Jensen.—(*L. Koppel, Dresden.*)
17,053. Elevators, &c., H. E. Newton.—(*G. H. Reynolds, U.S.*)
17,054. Apparatus for Shipping Coal, P. G. B. Westmacott, London.
17,055. Burnishing Edges of Boots, &c., W. R. Lake.—(*The Beaudry Edge Setting and Heel Burnishing Machine Company, U.S.*)

31st December, 1884.

17,056. Material for Boats, R. S. M. de Ricci, Kingston-on-Thames.
17,057. Breech-loading Ordnance, J. Needham, Hammersmith.
17,058. Preventing the Slipping of Engines in Greasy, &c., Weather, T. R. Shelley, Smethwick.
17,059. Sleepers, &c., for Railways, J. C. Bunten and A. Murray, Glasgow.
17,060. Compound Automatic Pumping Engines, A. B. Brown, Glasgow.
17,061. Starting Engines, D. Rankin, Glasgow.
17,062. Metallic Handles for Furniture, I. Whitehouse, Birmingham.
17,063. Stoppering and Opening Bottles, H. Cochrane, Dublin.
17,064. Lubricating Shafting, E. Whiteley, Halifax.
17,065. Peat or Turf Fire-lighter, C. G. Satterthwaite, Ancoats.
17,066. Preventing the Passage of Air, &c., Past Doors, W. Parr, Liverpool.
17,067. Liquid Injector, C. L. Jackson and J. Westley, Manchester.
17,068. Removal of Waste Materials from Clay Pits, &c., W. P. Thompson.—(*L. Turpain, Les Colettes.*)
17,069. Candle Extinguishers, A Sievers, Gloucester.
17,070. Circular or Oval Hollow Dovetail Joint, T. Ray, Sunderland.
17,071. Therapeutic Inhaler for Pulmonary Diseases, H. H. Sultzberger, Anerley Park.
17,072. Supporting and Tilting Barrels, &c., H. Meadows, London.
17,073. Umbrellas, &c., H. J. Felton, London.
17,074. Metal Belting for Machinery, F. T. K. Firmin, Liverpool.
17,075. Movable Pens for Pheasant Breeding, J. J. D. Paul and J. Sendall, London.
17,076. Preventing Down-draught and Inducing Up-draught for Chimneys, &c., E. and J. M. Verity, London.
17,077. Igniting Gas by Electricity, P. M. Justice.—(*C. W. Weiss, United States.*)
17,078. Insulators for Electrical Conductors, P. M. Justice.—(*H. L. James, United States.*)
17,079. Band Brake, J. Jackson, London.
17,080. Paste or Dough, R. Oliver, London.
17,081. Packing Tea, &c., J. Dick, Glasgow.
17,082. Metallic Packing for Piston-rods, R. White and N. S. Hawks, London.
17,083. Treating Vegetable Fibres, J. Smith and P. W. Nicolle, London.
17,084. Preventing Corrosion, &c., in Boilers, A. J. Marquand, E. Hancock, and J. R. Powell, London.
17,085. Locks or Fastenings, R. C. Jones and J. W. Cunningham, London.
17,086. Nut Lock Washer, H. Bosshardt, London.
17,087. Advertising, Sir R. H. Roberts, London.
17,088. Drop-down Small-arms, J. F. Swinburn, London.
17,089. Balances, &c., for Weighing, J. M. Napier, London.
17,090. Producing Rapid Motion of Rotation, &c., E. Ciotti, London.
17,091. Magnetic-electric Machines, H. F. Joel.
17,092. Treating Megass, G. W. Parbury.—(*G. Kottmann, New South Wales.*)
17,093. Wheels, N. Salamon, London.
17,094. Treating Gaseous Contents of Rooms, J. S. Williams, Riverton, U.S.
17,095. Treating Sewers, &c., J. S. Williams, Riverton, U.S.
17,096. Making Incandescent Lamps, J. S. Williams, Riverton, U.S.
17,097. Treating Metals, J. S. Williams, Riverton, U.S.
17,098. Controlling Appliances for the Transformation of Matter or Force, J. S. Williams, Riverton, U.S.
17,099. Conducting Distributing Matter, &c., J. S. Williams, Riverton, U.S.
17,100. Conducting Distributing Matter, &c., J. S. Williams, Riverton, U.S.
17,101. Steering Apparatus, A. J. Bickmore.—(*L. Heydt, Strassburg.*)
17,102. Erecting Binocular Prisms, C. D. Ahrens, London.
17,103. Venetian Window-blind Laths, A. Mullord, London.
17,104. Recording the Score in Lawn-tennis, &c., S. Morrison, London.
17,105. Gravity Friction Ratchets, A. D. Simpson, London.
17,106. Preserving or Improving Liquids, H. J. Haddan.—(*P. Prat, Lanildut.*)
17,107. Electric Dynamo Machines, W. H. Whitfield, London.
17,108. Carburetting Gas for Lighting Purposes, W. G. Little, London.
17,109. Lace-clipping Machine, J. H. Johnson.—(*The Wilcox and Gibbs Sewing Machine Company, United States.*)
17,110. Built-up Cranks, W. Putnam, London.

1st January, 1885.

1. Machines for Sewing Button-holes, J. H. Tyler, London, and F. Cameron, Glasgow.
2. Operating the Guide Rails, &c., of Machinery for Spinning and Doubling Fibres, S. Tweedale, Halifax.
3. Mounting, &c., the Guide Wires of Machinery for Spinning and Doubling Fibres, S. Tweedale, Halifax.
4. Generating Steam, B. H. Thwaite, Tranmere.
5. Tricycles, &c., J. Cheshire, Birmingham.
6. Spindles, J. W. Shepherd, W. Ayrton, and C. Siddall, Manchester.
7. Nut, Bolt, and Screw Blanks, E. K. Dutton.—(*Lüben and Buhse, Berlin.*)
8. Motor Governors, H. J. H. King, near Stroud.
9. Rim Locks, &c., J. Hill, London.
10. Adjusting the Driving Chains of Safety Bicycles, F. J. Cocks, Birmingham.
11. Sleepers and Chairs for Railways, J. Riley, Glasgow.
12. Pianofortes, T. C. Turner, Bristol.
13. Kettles, &c., W. G. Richardson, Liverpool.
14. Signalling Apparatus for Railways, J. Kennedy, Liverpool.
15. Tricycles, &c., J. A. Griffiths, Liverpool.
16. Cover for Protecting Gas Bags, A. McNeill and R. W. Vining, Liverpool.
17. Hay-makers, T. H. Ramsden, Bramhope, near Leeds.
18. Guards for Hats, W. Watson, Glasgow.
19. Bleaching Kiers, R. H. Ainsworth and E. B. Manby, London.
20. Automatic Alarm Whistles, A. S. Garvie, Leith.
21. Hydrants, J. W. Mathews, Newcastle-upon-Tyne.
22. Process of Fermentation in order to Prepare Alcoholic Solutions of Aromatic Colouring Matters, J. H. Loder, Netherlands.
23. Opening, &c., Sashes, Ventilators, &c., D. Aubert, London.
24. Droppers for Wire Fencing, J. McDonald, London.
25. Indicating Time on Watches, &c., D. Osborne and J. Darling, Glasgow.
26. Manufacture, &c., of Hermetically-closed Cans, &c., T. H. Campbell, London.
27. Wire Cloths, J. H. Johnson.—(*MM. Blanchet Brothers and Kléber, Rives, Isère.*)
28. Preparation of Roots into Food, G. S. Parkinson, London.
29. Coated Metallic Tubes, F. Madeley and A. Oldham, London.
30. Colouring the Edges of Velvet, &c., E. Weild and H. Rickards, London.
31. Incandescent Lamps, R. A. Lee, London.
32. Galvanic Batteries, J. E. Chaster and R. A. Lee, London.
33. Bicycle Lamps, F. Powell & F. Hanmer, London.
34. Scouring, &c., Machines, E. Kemp, Leeds.
35. Velocipedes, C. M. Linley, J. Biggs, and G. G. Tandy, London.
36. Safety Lamps, W. J. Clapp and W. Sandbrook, London.
37. Taps for Drawing Liquids from Casks, J. C. Mewburn.—(*M. Savigny-Vallet, Brou.*)
38. Feeding Bottles, R. C. Baker, London.
39. Euphorbia Paints, S. R. Hooper, London.
40. Kettles, W. Stobbs, London.
41. Extracting Alcohol from Coal, A. Collingridge, E. de Gobard, and A. de la Roche, Paris.
42. Bicycle Brakes, H. J. Haddan.—(*K. Marschütz, Nürnberg.*)
43. Joining Inlaid Floors by Steel Pins, V. Bitzenhofer, London.
44. Dog Kennels, L. Q. Kermode, London.
45. Harness, W. Gummer.—(*J. Gummer, U.S.*)
46. Kilns for Drying Malt, P. Platt and J. M. Aitchison, London.
47. Gloves, &c., T. J. Gamble, London.
48. Galvanic Batteries, C. Maltby-Newton, London.
49. Communicating Heat to Cylinders, H. Kühne.—(*R. Proell, Dresden.*)
50. Pocket Inkstands, A. J. Boult.—(*C. E. Courtois and E. Reinié, Argenteuil.*)
51. Felt Slippers, G. Hill, London.
52. Couplings for Vehicles, A. J. Boult.—(*C. L. Schulze, Berlin.*)
53. Railway Signalling, H. J. Gardner.—(*C. D. Tisdale, U.S.*)
54. Reel, &c., Holder for Sewing Machines, W. S. Simpson, London.
55. Driving Belts, H. Simon, London.
56. Placing Detonating Signals upon Lines, J. H. Johnson.—(*G. Lorand, Chatellerault, and E. Gaupillat, Paris.*)
57. Ordnance, G. Quick, London.
58. Brewing, A. Manbré, London.
59. Flexible Material, F. C. Nutter, London.
60. Roofing Tiles, H. W. Robinson, London.

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61. Powder Distributor, W. S. Biffen and C. G. Gill, London.
62. Machines for Cutting Files, &c., R. Denison, Cheltenham.
63. Clip Binders for Holding Sheets of Paper, T. E. Lewis, Liverpool.
64. Tires of Wheels for Bicycles, &c., J. Hudson, Birmingham.
65. Applying a Rising Box at one or each end of the Going Part of a Loom by means of Tappits, J. T. Jowett, Farsley, near Leeds.
66. Case for Flowers, W. Cutler, Birmingham.
67. Tinning Circles, Ovals, &c., Plates, J. R. Turnock, Loughor.
68. Multiplex Tin-plates, &c., J. R. Turnock, Loughor.
69. Hot and Cold-water Valves, J. C. Threadgold, Luton.

70. Door Lock Furniture, E. R. Wethered, Woolwich.
71. Portable Ovens, J. C. Richmond, Hammersmith.
72. Tools used by Rivetters and Lasters, A. Bailey, Finedon.
73. Door Latches and Catches, W. Sanderson and T. A. Moffit, London.
74. Dynamo-electric Machine, W. H. Beck.—(*H. Cadisch, Paris.*)
75. Holder and Switch for Incandescent Electric Lamps, A. Grundy, London.
76. Studded Connecting Link, T. H. Lester, London.
77. Call, &c., Bells, J. H. Stone, London.
78. Releasing Animals in case of Fire or Flood, F. Chawner, Hanley.
79. Capstan Engine, J. W. Brooke, Lowestoft.
80. Telescopic Spirit Stove and Kettle, J. W. Jones, London.
81. Soles for Lawn Tennis Boots and Shoes, C. K. Gibbons, Newcastle-on-Tyne.
82. Safeguard against the Bursting of Water-pipes from Frost, H. Curzon, London.
83. Novel Non-alcoholic Drink, T. F. Wilkins, London.
84. Drying Trays, E. M. Saunders, London.
85. Assorting Granular, &c., Materials, J. H. Johnson.—(*Nagel and Kaemp, Hamburg.*)
86. Washing, &c., Fibrous Materials, H. Giesler, London.
87. Springless Locks, C. D. Douglas, London.
88. Loose Points to be used on Tramways, P. A. Bourke, London.
89. Packages for the Conveyance of Flowers, &c., J. W. Hoffman, London.
90. Christmas, &c., Cards, J. F. Bennet, London.
91. Staiths for the Shipment of Coal, &c., S. Butler, London.
92. Double-crushing Sugar-cane Mills, T. Dale, London.
93. Working Slide Valves of Engines, J. Milner, London.
94. Desiccating the Air Supply to Furnaces, C. Cochrane, London.

3rd January, 1885.

95. Tandem Tricycles, W. E. Hart, Wolverhampton.
96. Holding Cut Flowers, E. J. Guy, Nottingham.
97. Boot and Shoe Lasts, W. E. Partridge, New Oscott.
98. Closing and Opening Bottles, S. Bunting, Dublin.
99. Billiard Tables, H. Gibson, St. Albans.
100. Mounting, &c., Heavy Guns, E. Kent, Shepherds-bush.
101. Hinge, T. Greenwood, London.
102. Drawing Kitchen Fires, &c., C. E. B. Holt, Halifax.
103. Securing Shuttle Pegs in Looms, T. A. Greenwood, Halifax.
104. Preventing Rugs, &c., being Unequally Cut, J. Beever, Halifax.
105. Chronometers, R. F. Brocklebank and C. F. Hall, Liverpool.
106. Domestic Kettles, &c., D. Massey, Manchester.
107. Garden Shears, W. Wilkinson, London.
108. Pocket Saws, F. Thompson, London.
109. Bearings for Axles and Shafts, J. Barkby, Sheffield.
110. Reversible Shirt Cuff, E. W. Whiffin, London.
111. Couplings for Pipes, Hose, &c., N. Thompson, London.
112. Steam Generator, W. E. Gedge.—(*P. L., J. A., and L. Buisson, St. Etienne.*)
113. Pouches for Tobacco, Cigarettes, &c., R. L. Hickes, London.
114. Cooking Stoves and Bakers' Ovens, C. Morfit, London.
115. Heating Air and Fluids, J. A. and A. A. Clarke, London.
116. Adjusting Balls or Rollers in Bearings, J. Jackson, London.
117. Chimney-pots, J. Bennison, London.
118. Regulating the Flow of Liquids, J. L. and J. L. Shorrock, Accrington.
119. Filters, H. Favarger, London.
120. Lamps, F. Plaister, London.
121. Gloves, E. G. Coltman and T. Billson, London.
122. Cricket, &c., Balls, W. E. Bussey and J. S. Pinder, London.
123. Spooling, Winding, and Doubling, J. H. Burton and H. Sands, London.
124. Grain Roller Mills, H. J. Sanderson and J. W. Gillespie, London.
125. Air-heating Apparatus, H. J. Haddan.—(*J. Dyharcabal, Bayonne.*)
126. Filter Presses, J. Norman, London.
127. Refrigerators, S. Briggs, London.
128. Fastening for Studs, R. J. S. Joyce.—(*J. P. G. G. W. Sohn, Barmen.*)
129. Dials of Timepieces, C. Fincken, London.
130. Heating and Cooking, A. Martin, London.
131. Sample Racks for Boots and Shoes, S. Smith, London.
132. Generating Gas, H. Hutchinson, London.
133. Mattresses, &c., M. Phillips, London.
134. Wagonettes, &c., J. B. Ellis and S. Whiteley, London.
135. Ornamental Surfaces, A. Otz, London.
136. Girders, A. M. Clark.—(*E. A. Werner, U.S.*)
137. Electrolysis, S. Pitt.—(*J. A. J. Follod, Paris.*)

5th January, 1885.

138. Tricycles, J. R. Bell, Liverpool.
139. Holder of Wire, &c., A. Nightingale, Birmingham.
140. Brackets, J. J. Rugg, Birmingham.
141. Exhausting Apparatus, M. Evans, London.
142. Preventing Accidents to Machinery, R. Hitchin, J. Townsley, and T. Richmond, London.
143. Ensilage, C. R. Clark, Stoke-on-Trent.
144. Ordnance and Cartridges, J. H. Dunn and A. C. Cronin, London.
145. Incombustible Composition, J. and T. Tulloch, Glasgow.
146. Self-acting Engine, R. W. Hewett, Birmingham.
147. Rapidly Producing Vacuum, E. Creed, London.
148. Handling Reins, W. Horsfall, Halifax.
149. Watches, &c., C. T. Burrows, London.
150. Buttons, T. F. N. Finch, London.
151. Anhydrous Oxide of Barium, L. Q. and A. Brin, London.
152. Breech-blocks and Cartridge Extractors, H. W. Holland, London.
153. Making Wine from Dates, W. H. and H. H. Bliss, Anerley.
154. Electric Telegraphs, A. Muirhead, London.
155. Ships' Steering Apparatus, G. D. Davis, London.
156. Manufacturing Halogen Salts of Aluminium and Beryl, L. A. Groth.—(*R. Grätzel, Hanover.*)
157. Separating Oxygen and Nitrogen from Atmospheric Air, L. Q. and A. Brin, London.
158. Soap, J. B. Spence, London.
159. Manufacturing Soap with Bye Products, J. B. Spence, London.
160. Brick Mould Stock, T. E. Fielder, Binfield.
161. Adjustable Cranks, J. G. Hinnell, London.
162. Producing Imitation Oil Paintings, B. J. B. Mills.—(*R. Fidau, Fano.*)
163. Spinning Cotton Yarn, T. T. Abbot, London.
164. Apparatus for Registering the Time of Attendance of a Watchman, T. W. Morris, London.
165. Apparatus for Measuring Electrical Currents, J. V. Jones, London.
166. Fastening Devices for Gloves, W. R. Comings, London.
167. Utilisation of Bye Products of Galvanic Batteries, J. Rapieff, Barnet.

SELECTED AMERICAN PATENTS.

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

308,152. Process of Extracting the Metal Aluminium, *William Frishmuth, Philadelphia, Pa.—Filed December 5th*, 1883.

Claim.—(1) The process of producing metallic aluminium, which consists in simultaneously generating sodium vapour and a volatile compound of aluminium in two separate vessels or retorts, and in mingling the vapours thus obtained in the nascent state in a third vessel, wherein they react upon each other, substantially as described. (2) The process of producing metallic aluminium, which consists in mingling in a chamber or receiver sodium vapour and a compound of aluminium, also in vapour form, said sodium vapour being obtained in the nascent state by heating in a separate vessel or retort a mixture of a sodium compound with charcoal or other reducing agent, and said aluminous vapour being simultaneously produced in the nascent state in another vessel or retort from aluminous material. (3) The process of producing metallic aluminium, which consists in simultaneously generating sodium vapour and the chloride or fluoride of aluminium, also in vapour form, in two separate vessels or retorts, and in mingling the two vapours thus obtained in the nascent state in a third vessel, wherein they react upon each other, substantially as described. (4) The process of producing metallic aluminium, which consists in

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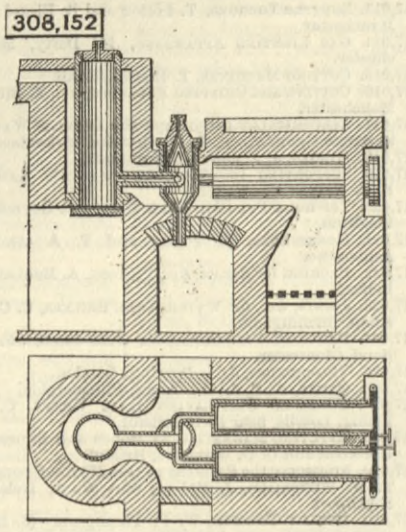
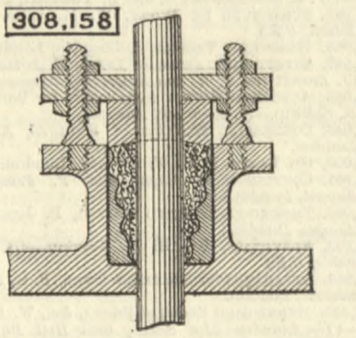


simultaneously generating sodium vapour and the double chloride of aluminium and sodium, also in vapour form, in two separate vessels or retorts, and in mingling the two vapours thus obtained in the nascent state in a third vessel, wherein they react upon each other, substantially as described. (5) The process of extracting metallic aluminium from its ores or compounds, which consists in converting such aluminous material into the form of vapour by heating it in a vessel or retort with chloride of sodium and at the same time subjecting it to the action of a stream of chlorine gas, and in mingling in a chamber or receiver the vapour of the double chloride of aluminium and sodium thus obtained with sodium vapour simultaneously generated in another vessel or retort by heating a mixture of carbonate of soda and carbon, substantially as described.

308,158. Piston Packing, *William Heston, Mount Union.—Filed February 11th*, 1884.

Claim.—As an improved article of manufacture, the elastic piston packing herein shown and described, consisting of a cylindrical cup of rubber or other suitable material having a central perforation in the

308,158

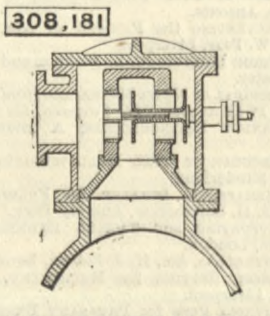


bottom, and forming an inside conical chamber having ribbed or corrugated sides and adapted to receive textile packing, substantially as and for the purpose set forth.

308,181. Cut-off Valve, *James H. Man, Denver, Colo.—Filed May 3rd*, 1884.

Claim.—(1) The method of automatically actuating cut-off valves herein described, which consists in first opening the valve by a defined limited force and then closing the same against the operation of such force by differential pressures on opposite sides of said valve, as specified. (2) An automatic cut-off valve provided with means for normally holding the same open, such valve being so arranged with relation to the passages that it is automatically closed by the fluid-current induced by the difference of pressure on opposite sides thereof caused by the piston movement, substantially as described. (3) In combination, a

308,181

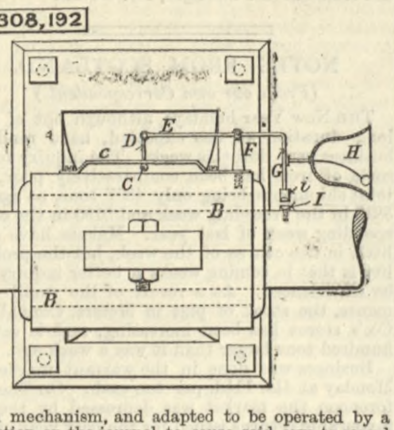


valve actuated in one direction by differential pressures on its opposite sides, and means for adjusting the valve and thereby regulating the area of the steam passages with relation to the speed of the engine and varying the point of cut-off, substantially as specified. (5) A valve consisting of a hollow stem having two flaring right-angle projections forming two parallel discs of different diameters, the stem being adapted to receive a spindle or bar, which supports and guides the said valve, and which in turn is firmly supported, so as to bear a fixed position relative to the valve seats, the whole being arranged to operate to cut off the steam in its passage from the steam chest to the cylinder, substantially as and for the purpose set forth.

308,192. Automatic Alarm for Friction Bearings, *John O'Connell, Providence, R.I.—Filed May 26th*, 1884.

Claim.—(1) The combination, with a journal bearing and its journal, of a fusible material adapted to be fused by undue heat of said parts, and connected to an alarm, said alarm being constructed to be operated directly by the journal upon the fusing of the plug, substantially as shown and described. (2) The combination, with a shaft journal bearing, of a fusible head retained on the bearing, and a bell-carrying lever connected with the fusible head, and arranged to be struck by a tappet on the shaft when the fusible head melts, substantially as described. (3) The combination, with the wrist pin of an engine, of a bell supported thereon, and fusible plugs held in the wrist pin and connected by wires to the clappers of the bell, substantially as described. (4) The combination, with the journal bearing B and the bridge *c*, secured thereto, of the pivotted lever E, connected at its inner end with the bridge *c* by a fusible head C, and provided on its outer end with an arm G, connected with an

308,192

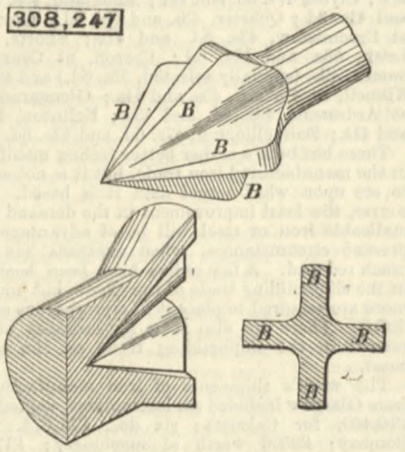


alarm mechanism, and adapted to be operated by a projection on the journal to cause said arm to sound said alarm upon the fusing of the head, substantially as set forth. (5) The combination, with the journal bearing B and the bridge *c*, secured thereto, of the lever E, pivotted to standard F, and connected with the bridge by a link D, and fusible head and arm G, provided with the projection *i* and alarm bell H, said projection *i* being constructed to be struck by the tappet I on the journal upon the fusing of the head, substantially as shown and described.

308,247. Screw-driver, *John Frearson, Birmingham, county of Warwick, England.—Filed December 7th*, 1883.

Claim.—A screw-driver, the working head of which has tapering angular ribs B and tapering angular

308,247

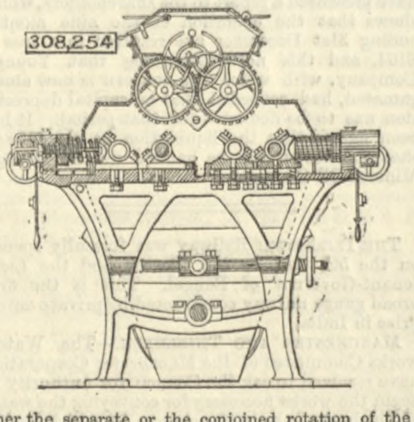


grooves A, rounded or concave at the bottom, as set forth.

308,254. Roller Grinding Mill, *Cyrus T. Hanna, Allegheny, Pa.—Filed May 13th*, 1884.

Claim.—(1) In a roller grinding mill, the combination of a bed-plate, a pair of adjusting bolts engaging internal threads therein and having rounded ends, a roll bearing supported adjacent to each of its sides upon said adjusting bolts, and having a transverse segmental groove to receive the rounded ends thereof, a locking bolt fixed to the bearing between the adjusting bolts and passing freely through the frame, and a nut engaging a thread on said locking bolt, substantially as set forth. (2) In a roller grinding mill, the combination of a pair of roll bearings, a bed-plate provided with standards, threaded stems connected to said bearings and carrying nuts which transfer applied pressure to said standards upon the bed-plate, two worm wheels, each adapted to rotate one of said nuts, and two worm shafts mounted in line axially, each of said shafts carrying a worm engaging one of said worm wheels, and a pair of hand wheels, one of the hand wheels of each worm shaft being fixed thereon adjacent to the adjoining worm shaft, and the other hand wheel at a point nearer to its worm wheel, these members being combined for joint operation to effect

308,254

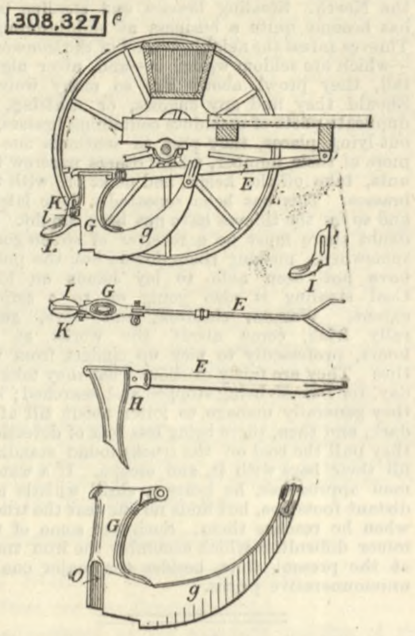


either the separate or the conjoined rotation of the worm wheel and nuts, substantially as set forth. (3) In a roller grinding mill, the combination of a pair of worm shafts mounted in line axially, one of said shafts having a cylindrical projection concentric with its body, which enters a corresponding recess in the adjacent end of the other shaft, a pair of operating hand wheels, each fixed upon one of said shafts, said wheels being in such proximity as to be adapted to simultaneous rotation by an operator, a pair of hand wheels, each fixed upon one of said shafts at a point closer to the worm thereof than the hand wheel first specified, a pair of roll bearings, and mechanism, as described, for adjusting said bearings by the rotation of the worm shafts, substantially as set forth. (4) The combination of a threaded adjusting stem, a nut thereon, a worm wheel fitted by a key or feather on said nut, a cam-faced disc fitting around said stem, and bearing at one side against the nut and at the other against a corresponding face in a standard or housing, a casing inclosing said worm wheel and disc, and secured to the housing, and a worm engaging said worm wheel and supported by a bearing-casting secured to said casing, substantially as set forth. (5) In a roller grinding mill, the combination of an adjusting and supporting bar, mounted with the capacity of longitudinal movement in bearings in the frame, a sleeve or socket fitting freely on said bar, so as to be adjustable axially thereon, clamping screws engaging threads in the socket and bearing on the bar, and a tightening pulley mounted on a shaft fixed in said socket, substantially as set forth.

308,327. Grain Drill, *Andrew Runstetler, Dayton, Ohio.—Filed March 17th*, 1884.

Claim.—(1) In a seeding machine, the colter *g*, with the split covering heel O, secured to the hoe shank G, the parts being rigidly connected together and adapted to be attached to the ordinary drag bar of a grain drill which is hinged to the main frame, substantially as specified. (2) In a seeding machine, the drag bar E

308,327



hinged to the main frame of the drill, and adapted to be connected interchangeably with the combined shank G, colter *g*, having the split covering heel, and to the detachable hoe H, whereby the drill may be readily converted from a hoe to a runner drill, substantially as specified. (3) In combination with the colter *g*, having the split covering heel O, shank G, provided with lug K, the adjustable covering plate I, with its slotted shank *l*, secured to the lug K, substantially as specified.

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The Engineer, January 9th, 1885.