COMPOUND LOCOMOTIVES.

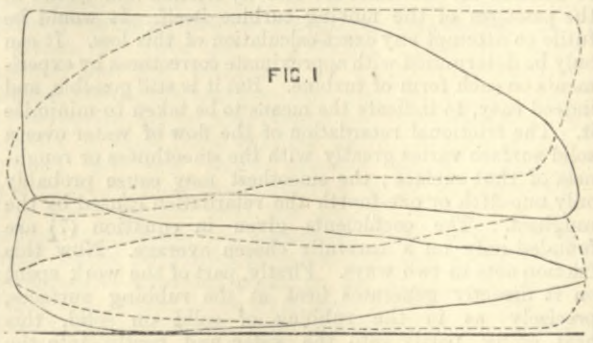
No. IV.

In a portion of our last impression an erroneous statement occurs, which may have puzzled some of our readers, while others will have perceived the error at once, and mentally corrected it, because it is sufficiently obvious. It will be found on page 312, near the end of the middle column. It runs as follows:—"Taking steam for half stroke, the space filled will be 0·1 of the large cylinder, and if it takes steam full stroke the expansion will be five-fold." This should read: "Taking steam for *full* stroke, the space filled will be 0·4 of the large cylinder, and if it takes steam for *half* stroke the expansion will be five-fold." More accurately, the expansion would be six-fold, allowing for clearance spaces. In practice greater measures of expansion than this would of necessity be frequently adopted, and the result would no doubt be disappointing. In no case ought the ratio of expansion in regular work to exceed about five to one. As we shall show further on, it is impossible in practice to keep expansion down to this limit, even in simple engines, when the speed is high, because, first, if the engine is not linked up the exhaust cannot get away freely enough, as already explained; secondly, compression is essential to keep the crank bearings quiet; and, thirdly, the steam ports cannot be made large enough to permit the steam to follow the rapidly moving piston with sufficient velocity to maintain the pressure behind it. Better results would probably be got with an expansion of four to one. It can be shown by the results of daily railway work that about the best duty is got from coal when the steam is allowed to follow the piston for at least one-third of the stroke; and it may be stated here that it is a well-known fact that some drivers run with their engines very little notched up, regulating the work done by the throttle valve; while others run with the throttle valve full open, and adjust the work done by the expansion gear. Now in theory the former practice is all wrong, and must lead to waste of fuel. It so happens, however, that we have never been able to obtain a scrap of evidence to prove this. The consumption of fuel per mile appears to be about the same whichever method of working is adopted. The following extract from Mr. D. K. Clark's paper, before referred to, we give here because it bears strongly in favour of our argument:—"These results sufficiently explain how it happens that expansive working in locomotives, especially in outside-cylinder engines, is in practice carried out to such a limited extent. We have rarely found (1850) on the Caledonian Railway—a line stocked with outside-cylinder locomotives—that a cut-off materially less than 30 per cent. of the stroke is voluntarily adopted by engine drivers. In their own words, they 'lose as much as they gain' if they endeavour to work with a suppression much less than 30 per cent.; and yet it is not easy to conceive a line better adapted than the Caledonian, composed of long and steep double gradients, for the practice of highly-expansive working. The balance of loss and gain above noted is abundantly explained by the extra condensation which attends the earlier cut-off, and is not at all referable to the popular notion that there is something wrong in the nature of the link motion. We may refer to a case in point—the case of the locomotives on that railway, Nos. 25 and 51, taking the same train. As much water was consumed from the tender of No. 51—of which the driver was one of the most economical consumers of coke on the line, and which was worked with variable expansion within the limit already stated—as was withdrawn from the tender of No. 25, an engine worked mostly by the regulator; whereas steam of a higher pressure, if worked expansively under proper conditions, should have consumed a less quantity of water than wire-drawn steam in the performance of the same duty. There is no doubt that much of the economy of fuel effected with No. 51 was due to the judicious system of stoking practised by the driver, and to his unceasing care in preventing waste of steam at the safety-valve—matters to which little attention was paid with No. 25."

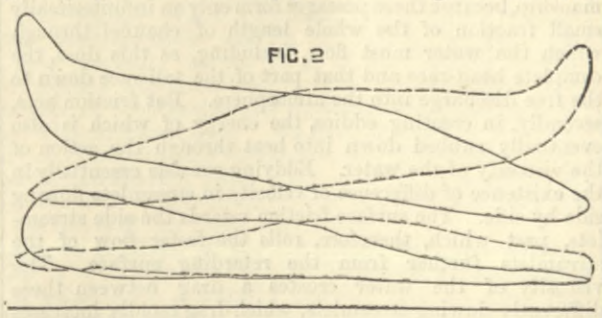
If it is once admitted that there is no gain, but rather a loss, derived from working steam expansively to more than a very moderate degree in a locomotive, the compound engine will appear in anything rather than a favourable light. To obtain the best possible result from it, it must invariably be worked nearly up to its full power. If the load is light the expansion must of necessity be very great in order that the speed may not become excessive, or the regulator must be nearly closed. The back pressure of the atmosphere will then bear an enormous proportion to the steam pressure in the large cylinder, and all the useful work will be virtually performed in the high-pressure cylinder only, the low-pressure becoming a useless excrescence. The cylinder condensation will be very great and the consumption of fuel large. What is true of the compound engine is also true of any locomotive with great cylinder capacity, and this goes far to explain why it is that engines with very large cylinders, unless they also have large wheels, or are employed in hauling heavy loads, have never yet given satisfaction. They have been tried over and over again in this country and in the United States, and over and over again the big cylinders have been either lined up or replaced by others of less bore. Of course when we speak of big cylinders we use a phrase of comparison. A certain capacity of cylinder is requisite to the performance of a given duty. A train of fifteen coaches is regularly worked, let us say, by an engine with 17in. cylinder, 24in. stroke, 6ft. 6in. wheels, and 1100 square feet of heating surface. The duty is performed in all weathers in a satisfactory way. If now, leaving everything else unchanged, we substitute 19in. cylinders, we shall, beyond all question, make a mistake. The average pressure must be less with the big cylinders than it was with the small cylinders. This means more expansion, more cylinder condensation, and more waste of power in overcoming the resistance of the atmosphere. Theoretically the large cylinders are the best; practically all experience goes to show that they are not; and we can only repeat here what we advanced in other words in our first article on this subject, namely that all the advantage there can be got by working steam expansively in a locomotive engine can be had with the normal type by augmenting the lap and the dimensions of the cylinder a little. Thus, for example, we believe that many engines now running with 17in. cylinders and 1in. or 1⅛in. lap would do better with 17½in. or 18in. cylinders and 1⅛in. or 1⅜in. lap; but whether they would or not depends on the work to be done. The compound system is, however, more likely to permit large cylinder capacity to be used with benefit, under favourable circumstances, than is the normal arrangement of cylinders; because, in the first place, for reasons recently set forth in his journal, the compound engine is more economical than the simple engine, and because, in the second place, it gives an opportunity of utilising some of the waste heat in the smoke-box in drying or even superheating the steam on its way from the high to the low-pressure cylinder.

We may here, before going further, recapitulate in a condensed form what we have attempted to place before our readers in a way to secure their adhesion to our views. The compound engine claims public favour on the ground that it is more economical than the simple engine. It can only be more economical because it uses steam more expansively than engines of the normal type. To this we reply that expansion cannot be pushed beyond very moderate limits in a non-condensing engine without loss; that this limit is very nearly, though not quite, reached by the normal locomotive; that it could be quite reached by putting a little more lap on the slide valve, and providing tiny auxiliary ports to prevent the engine from "going blind." That it is, however, possible that expansion can be pushed a little further with advantage in the compound than in the non-compound engine; that compounding entails a very large increase of cylinder capacity, because the dimensions of the low-pressure cylinder determine the power of the engine, or, in other words, the loads it can haul; that the advantage to be derived from the reduction of coal bills may be all swallowed up by the augmented first cost of the engine; that to prevent this the first cost must be kept down, and that this end can only be attained by the use of two cylinders instead of three; that the compound engine will appear to most advantage when regularly loaded to that point at which it is found to give the best duty; that it is quite unsuitable for working much under its power; that, as a consequence, it is not fit for undulating roads, as seems to be proved by the circumstance that although the Webb engines do very well between Euston and Crewe, where the line is level, they have all been withdrawn from the road between Crewe and Carlisle, which is very hilly, and for working which the Dreadnought class was specially built; that the system appears to be much better adapted for goods engines—which always have heavy loads and are worked with little expansion now—than it is for express engines, which are, because of difficulties connected with getting rid of the exhaust steam, of necessity worked expansively to something near, if not beyond, the limit of maximum economy.

The idea that the compound locomotive must be more economical than engines of the normal type is, of course, based on the performance of the marine engine; but the conditions under which work is performed by both are so different that no true analogy exists between them. In the compound marine engine the ratio of expansion is constant, and the load is always the same; and the higher the cylinder pressures the greater is the amount of work done. In the case of the locomotive the power developed is always varying; and, as a rule, the lower the cylinder pressure the greater the power. This latter circumstance, is, of course, due to the fact that the piston speed is greatest when the pressure is lowest. As a practical example of what takes place, we give here two sets of dia-

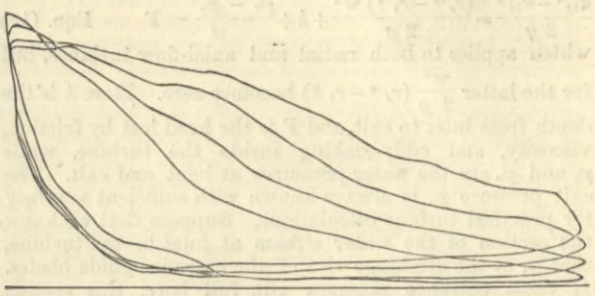


grams taken from one of Mr. Worsdell's compound engines, and two diagrams taken from one of Mr. Stroudley's engines. The blast pipe in the former has since been altered, and some changes made in the valves, which reduce the back pressure at high speeds. But it will be seen that the action of the valve gear—Joy's—is wonderfully perfect. In Fig. 1 we have two



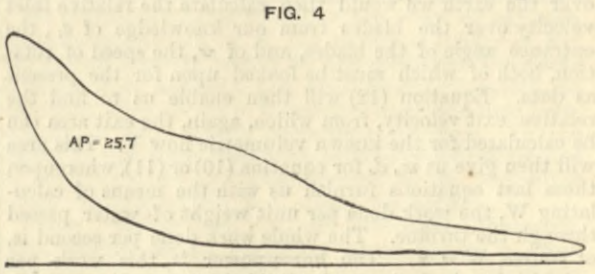
sets of diagrams, taken at the slow speed of twenty-eight miles per hour, while the engine was hauling a train of sixteen coaches up the Brentwood bank. The boiler pressure was 150 lb. The engine was nearly in full gear. The mean effective pressure in the high-pressure cylinder was—front, 63·5 lb.; back, 63·18 lb. In the low-pressure cylinder—front, 33·3 lb.; back, 36·2 lb. The high-pressure cylinder developed 218·75, the low-pressure 250·49 horse power, or a total of 469·24-horse power, Fig. 2 gives a set of diagrams taken from the same engine. with the same load, but running at 61 miles per hour, the cut-off taking place at half stroke in both cylinders. The average effective pressure in the small cylinder was 32·65 lb. front, and 31·7 lb. back; and in the low-pressure, 12·9 lb. front, and 18·8 lb. back. These pressures are rather under one-half those obtained with the engine in full gear; but the total power developed was 491·74-horses, or 22-horse power more at the high than the low speed. Of this the high-pressure cylinder must be credited with 242·87, and the low-pressure with 248·87-horse power. These diagrams will repay careful study. They plainly show how vain it is to attempt to apply any ordinary rule for proportioning the cylinders to each other. The results obtained by Mr. Worsdell are admirable; but it has to be proved that equally excellent results could not have been got with cylinders of different dimensions. At the low speeds the diagrams are all that can be wished; at the high speeds the gap between the diagrams change, and the back pressure rises. The proportion which the useful work done bears to the useless work is much smaller at the high than at the low speeds. This must be so for reasons which we have already pointed out. Furthermore, the drop between the two cylinders, due to the use of an intermediate receiver and unavoidable clearance, virtually reduces the effective pressure still further, so that at high speeds the compound engine is really not able to pull so much as a normal engine with pistons of nominally the same dimensions. Mr. Worsdell's engine has a 26in. low-pressure cylinder, which is the equivalent of two 18⅜in. cylinders. The Gladstone on the Brighton line has two 18½in. cylinders. In our impression for October 26th, 1883, will be found a complete set of diagrams taken from this engine. We reproduce two Figs. 3 and 4 for comparison with the compound engine diagrams, showing the effect of raising the link. In Fig. 3 the cut-off varied from 17 to 50 per cent.; boiler pressure, 135 lb.; steam chest ditto, 130 lb. to 110 lb.; speed, 51 miles an hour; gradient, 1 in

FIG. 3



264 up; number of carriages, 10. Fig. 4 is also from the Gladstone, and shows the effect of high speeds. Cut-off, 33 per cent.; boiler pressure, 110 lb.; steam chest ditto, 105 lb.; speed, 67 miles an hour, = 290·3 revolutions per minute; gradient, 1 in 264 down; number of coaches, 25; total indicated horse-power, 512·4. This last diagram is

FIG. 4



very instructive. It shows to how great an extent expansion unavoidably takes place at high speeds. Although steam is nominally cut off at one-third of the stroke, the steam cannot follow the piston quickly enough, and the expansion, instead of being three-fold, is really nearly eleven fold, and the terminal pressure is actually *less* in this non-compound engine than it is in the compound by a long way. If, now, a four-fold or five-fold expansion is the largest consistent with the economical use of steam in a locomotive, what is to be gained by compounding, when with the simple engine we virtually cannot help getting about an eleven-fold expansion? The mistake that has been made from first to last in compounding the locomotive lies in applying the principle to high-speed engines. It is in goods engines running at slow speeds that it is likely to be useful; and to this branch of our subject we shall return, and we believe we shall have very little difficulty in showing that for the Worsdell type of engine there ought to be a large field.

We have now, we think, shown that the answers to the four questions with which we started must be, on the whole, unfavourable to the compound system as applied to *express* engines. The system must be more costly than that which it is intended to supersede if these cylinders are used. All the available evidence goes to show that at high speeds the compound locomotive is not more efficient or more powerful than others. There is no available testimony that it is more economical. We believe that it has originated in a misconception of the conditions under which locomotives work, and which differentiate it from the marine engine, and that for express traffic it will do no good. There will perhaps be a saving in fuel, which will be more than counterbalanced by losses incurred under other heads. On the other hand, for slow, heavy traffic it ought to prove well adapted, and if Mr. Webb had fitted up a few goods engines in the first instance, and put them to the heaviest and slowest hauling he had, the results obtained would have been much more encouraging than those he has actually got; but the Webb type of engine is not suitable for goods trains, so he must have built something different from the Dreadnought, which is an express engine or nothing.

Naval Engineer Appointments.—The following appointments have been made at the Admiralty:—Jas. D. Nicholson, chief engineer, to the Vernon, additional; Alfred D. Watson, engineer, to the Vernon, additional; George E. Beach, engineer, to the Flora, additional; Matthew R. Miller, chief engineer to the Asia, additional, for the Narcissus; and William W. Watts, engineer, to the Asia, additional.

THE HORSE-POWER OF TURBINES.

By Professor R. H. Smith.

No. III.

Article II. finished with the finding of the values for radial and for axial flow turbines of W, that is, the amount of work done by each unit of weight of water passed through the turbine. Equations (9), (10), and (11) are collected and reprinted at the end of this article, as we need to refer to them frequently in what we have now to say. I now insert the values of W found in (10) and (11) into equation (9)—see below—or in the simpler form, equation (5). The two points of the stream which we will compare are the inlet to and the exit from the rotating turbine. The square of the whole water velocity over the earth is best found by adding the squares of its tangential and radial, or axial, components. The tangential components have been written down above in deducing (10), and the radial and axial components are given in (2) and (3). Squaring and adding, and remembering that the relative velocity over the blades $v_b = \frac{v_r}{\sin.\ \theta}$, we find

$$\frac{(\text{velocity over earth})^2}{2g} = \frac{v_b{}^2 + r^2\varpi^2}{2g} + \frac{V\varpi}{2\pi g m d \tan.\ \theta}$$

for radial flow turbines

$$= \frac{v_b{}^2 + r^2\varpi^2}{2g} + \frac{V\varpi}{2\pi g m (r_2 - r_1)\tan.\theta}$$

for axial flow ditto, with r put for mean radius $\frac{r_2 + r_1}{2}$.

These equations apply to either inlet or exit, the distinction being made by writing in the suffices i or e to v_b, r, m, d, and θ. To form equation (5) we have to subtract this value at inlet from the value at exit, and to add W, which will complete the left-hand of the equation, the right-hand remaining as it is. The result is

$$\frac{v_{be}{}^2 - v_{bi}{}^2}{2g} = \frac{(r_e{}^2 - r_i{}^2)\varpi^2}{2g} + h + \frac{p_i - p_e}{w} - F \qquad \text{Eqn. (12)}$$

which applies to both radial and axial-flow turbines, but for the latter $\frac{\varpi^2}{2g}(r_e{}^2 - r_i{}^2)$ becomes zero. Here h is the depth from inlet to exit, and F is the head lost by friction, viscosity, and eddy-making inside the turbine, while p_i and p_e are the water pressures at inlet and exit. The exit pressure p_e is always known with sufficient accuracy for practical turbine calculations. Suppose that we know the section of the water stream at inlet to the turbine, that is, at the discharge tips of the entrance guide blades. If these entrance passages run full bore, this section is, of course, actually known. It will be explained below how to determine whether the inlet area really runs full bore or not. If the inlet pressure p_i were also always known, we could calculate the volumetric flow V and inlet velocity over the earth from equation (9), putting in it W = O. From this inlet velocity over the earth we would then calculate the relative inlet velocity over the blades from our knowledge of θ_i, the entrance angle of the blades, and of ϖ, the speed of rotation, both of which must be looked upon for the present as data. Equation (12) will then enable us to find the relative exit velocity, from which, again, the exit area can be calculated for the known volumetric flow V. This area will then give us $m_e d_e$ for equation (10) or (11), whereupon these last equations furnish us with the means of calculating W, the work done per unit weight of water passed through the turbine. The whole work done per second is, of course, W w V. The horse-power is this work per second taken in foot-pounds, divided by 550.

This is the process of calculating the power of a turbine when the inlet pressure is known, and when the guide-blade passages run full bore. When it works not drowned in water, and with the buckets not running full bore, the inlet pressure is known to be atmospheric. The above method of calculation is therefore applicable to this case.

If, however, we do not start the problem with a knowledge of the inlet pressure, we must follow another method. Here we must work from the exit pressure alone as data. It will be observed that in equation (9) there are three quantities, namely, V, S, and W, which are at starting "unknown" quantities. S is the exit area, since we are to put $p = p_e$ the exit pressure. We may know the dimensions of the turbine, but cannot know without previous calculation, or experiments on an actually existing machine, whether the exit area will run full bore or not. These three quantities are involved in the three equations (9), (10) or (11), and (6a), and the method of using these to calculate V, S, and W is the following:—

Assume, first, that the flow is full bore up to the exit from the turbine. On this assumption we can find S and $m_e d_e$. In equation (10) or (11) the only remaining unknown quantity on the right-hand side is then V. Inserting the value of W, shown by equation (10) or (11) in equation (9), this latter then becomes a quadratic equation for the only unknown quantity V. The solution of this quadratic gives V on the assumption of full bore flow. This quadratic is reduced to its forms most convenient for direct application in equations (13) and (14) below, to be used respectively for radial and axial flow turbines.

Investigate now by the help of equation (6a) all the limits of maximum possible flow through every section from the top of the head-race, where p_o and s_o are always known, down to the entrance to the turbine. In practical work a curve should be plotted along a plan of the race, the height of which at each point will represent to a convenient scale the limit of possible flow through the corresponding section as obtained from (6a). If now all these limits lie above the value of V, found by equation (13) or (14) formed by combining equations (10) or (11) with (9), then the latter value of V will be actually obtained and the turbine will run full bore. In this case the calculation of W can be at once completed by help of (10) or (11), and thence that of Ww V and of the horse-power made.

If, on the other hand, the value of V, found by combining (10) or (11) with (9), is found to be greater than any one of the limits given by (6a), then evidently the turbine will not run full bore, and the actual flow obtained will be determined by the conditions higher up the stream than the turbine. It will be equal to the *smallest* of the limits shown on the curve obtained from (6a). We have then to deal with equations (9) and (10) or (11) with V as a *known* quantity, and S (or $m_e d_e$) and W as two unknowns. S is involved in both of these equations because S and $m_e d_e$ involve each other, and it is necessary, therefore, to express S in terms of $m_e d_e$. This is most simply done by remembering that $\frac{V^2}{S^2}$, the quantity that appears in (9) is the square of the velocity of the water over the earth as it leaves the turbine, and this square is obtained by adding the squares of the radial and tangential velocities over the earth. Performing this operation and then subtracting equation (10) or (11) from (9) in order to eliminate W, we find

$$V^2\left\{\frac{1}{2g}\left(\frac{1}{(2\pi r_e m_e d_e \sin.\ \theta_e)^2} - \frac{1}{S_0{}^2}\right) + \cdot0001\,\Sigma\frac{L}{S^2\delta}\right\} + \frac{V\varpi}{2g\pi m_i d_i \tan.\ \theta_i} + \frac{\varpi^2}{2g}(2r_i{}^2 - r_e{}^2) = h + \frac{p_o - p_e}{w}$$

Equation (13) for radial flow turbines,

and

$$V^2\left\{\frac{1}{2g}\left(\frac{1}{\{\pi(r_2{}^2 - r_1{}^2)m_e \sin.\ \theta_e\}^2} - \frac{1}{S_0{}^2}\right) + \cdot0001\,\Sigma\frac{L}{S^2\delta}\right\} + \frac{V\varpi}{2g\pi m_i (r_2 - r_1)\tan.\ \theta_i} + \frac{\varpi^2}{2g}\left(\frac{r_1 + r_2}{2}\right)^2 = h + \frac{p_o - p_e}{w}$$

Equation (14) for axial flow turbines.

In these two equations the only unknown is now $m_e d_e$ in (13), or simply m_e in (14). This quantity can, therefore, be directly found. Inserting the values thus calculated in equation (10) or (11), we find W, the work per unit weight of water used, and thence the whole rate of working per second W w V, and the horse-power $\frac{W w V}{550}$.

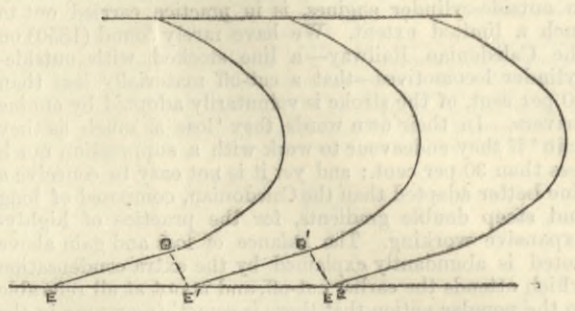
In the previous case of atmospheric pressure being established at the inlet area, we proceed in a similar manner to find whether this inlet area runs full bore. Placing in equation (9) W = O, S = inlet area, and p = inlet pressure, we use this equation to determine V, on the assumption that the inlet area runs full bore. We compare this V with the limiting values of the flow for the various sections of the head-race, as obtained from (6a). If it is less than any of these limiting values, we adopt it as the true value, and proceed as explained previously. If it be not so small as the smallest of these limiting values at sections higher up, then we must use this smallest limit as the true volumetric flow.

In this connection it should be pointed out that, if the head-race tube debouch in such a manner as to leave the air free to mount up the pipe, then we must not hope to get at any place in the pipe a less pressure than atmospheric pressure, and the limits of flow for each section should be calculated from the supposition that the pressure at it cannot be less than atmospheric. This is done by placing ($\cdot016\,p_o$ − 34) in place of $\cdot016\,p_o$ in formula (6a). A pipe can be got to deliver a larger flow by "drowning" its extremity—that is, by having its open mouth under water. This prevents the escape of air up the pipe, although the pressure near the mouth may still be atmospheric. The writer presumes that a good ⁓ trap, placed in the pipe near its discharge end would have the same effect as drowning its open mouth.

In interpreting these equations, it must be remembered that the term representing the frictional loss must be made to include an allowance for loss by friction and eddies in the passages of the moving turbine itself. It would be futile to attempt any exact calculation of this loss. It can only be determined with approximate correctness by experiments on each form of turbine. But it is still possible, and indeed easy, to indicate the means to be taken to minimise it. The frictional retardation of the flow of water over a solid surface varies greatly with the smoothness or roughness of that surface; the smoothest may cause probably only one-fifth or one-fourth the retardation caused by the roughest. The coefficients given in equation (7) are founded only on a carefully chosen average. Now this friction acts in two ways. Firstly, part of the work spent on it directly generates heat at the rubbing surfaces, precisely as in the rubbing of solid on solid, this heat going partly into the water and partly into the solid wall of the pipe or channel. So far as this part of the frictional expenditure of work is concerned, the refined smoothing of the surfaces of the entrance guide blades and of the rotating turbine blades would quite evidently be waste labour; the saving in mechanical economy would be so inappreciably small as not to pay for the extra workmanship, because these passages form only an infinitesimally small fraction of the whole length of channel through which the water must flow, including, as this does, the complete head-race and that part of the tail-race down to the free discharge into the atmosphere. But friction acts, secondly, in creating eddies, the energy of which is also eventually rubbed down into heat through the action of the viscosity of the water. Eddying consists essentially in the existence of difference of velocity in streamlets flowing side by side. The surface friction retards the side streamlets, past which, therefore, rolls the faster flow of the streamlets further from the retarding surface. The viscosity of the water creates a drag between these differently flowing streamlets, which drag rapidly increases with the transverse rate of variation of velocity from stream-line to stream-line. It is in the work done on this viscous drag that most of the loss termed "frictional loss of head" occurs. It is out of our power to diminish the viscosity of the water; we can only lessen this loss by minimising the transverse differences of velocity across each section of the stream. In a straight run these differences arise primarily from the friction of the solid pipe or channel surface. But wherever the stream is curved, evidently differences of velocity at once arise through the action of centrifugal force, which prevents a uniform distribution of pressure across the section. In all such curved passages special smoothness of the solid surface is of great importance. Particularly in small turbines where the passages are contracted, and where, therefore, the influence of side friction is relatively great, it has been found by modern makers to pay well to spend workmanship freely in smoothing the blade surfaces.

But it can be shown that the sharpness or gentleness of the curvature has not so much effect in eddy-making as has the rapidity with which the curvature changes. No one but a thorough ignoramus would put in any sharp angles in his water channels. But it is still quite common to imagine that if the straight and curved reaches run into each other tangentially, and if junctions of curves of different radii are also tangential, all has been done that can be desired. This is not so. The radius of curvature should never change suddenly from point to point. Such sudden change of curvature inevitably results in more or less violent eddying, the streamlets dash through each other, the flow is broken up and disturbed, the orderly distribution of pressure and velocity across the section is destroyed.

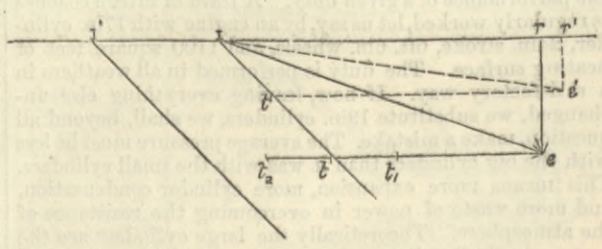
This is the teaching of the most modern theory as well as of experiment. The lesson to be drawn from it, and applied to the construction of turbines, is that both tips—inlet and discharge—of the guide blades, as also both tips of the turbine blades, should be made straight. There is a straight run in the head-race, and the water in being led from it into the wheel should be guided through a passage which is also straight at its outer edge, which quite gradually increases its curvature towards the middle of its length, and which again diminishes in curvature gradually till it becomes once more straight at its end. The reason for straightness at the wheel end may not be at once apparent, but becomes so when it is remembered that the curvature in the wheel is always contrary to that in the guide blades, and you cannot change gradually from one curvature to its contrary without passing through zero curvature. The wheel blades should begin at their inlet tips with straightness, and should have their radius of curvature only gradually shortened towards the exit side of the turbine. It would seem, at first sight, that it can be of no importance to diminish the blade curvature again to zero at the exit from the wheel; but it appears from further consideration that it is desirable to do so. This will be recognised by looking



at the accompanying sketch. Considering the relative flow, the discharge section for one bucket is not E E' but E e. All the water so soon as it has passed through section E e is practically relieved from all restraint by the wheel blades. All the streamlets should, therefore, cross this section with the same direction of velocity. If they do not, they will impinge on each other as they leave the wheel, and by such impact will upset the orderly flow and propagate backwards into the wheel a disturbance injurious to its action. Such strictly parallel discharge cannot be obtained if the buckets run full bore, unless the opposite sides of the bucket are at this section parallel, and this obviously cannot be so unless the length e E be straight.

As regards the junction between the head-race and the entrances to the guide blades, there is very general neglect of the principles I have just enunciated. The head-race should debouch easily and with good curves into a casing that will guide the water gradually and without sharp alteration of curvature into the guide blades. How barbarously many forms of turbine-case break this rule of good construction it is hardly necessary to point out. Indeed, the fault is so common that it is really surprising that such high mechanical efficiency is obtained as actually occurs. Many turbines work in the bottom of a large cast iron or brick tube or well whose diameter is several times larger than that of the series of gates. In this case there is ample room for the water streams to form themselves into those curves along which they flow with least resistance, and which they naturally assume when left free to do so. In such circumstances, of course, there is no need for any artificial guidance.

Much greater care is always bestowed upon the design of the junction between guide blades and wheel blades, although here again we find exclusive attention paid to avoiding instantaneous change of direction in the flow, and none at all to avoiding instantaneous change of curvature. This latter will be eliminated, as previously stated, by making both blade tips straight. The relations that ensure avoidance of sudden change of direction and consequent shock are best explained with the help of a diagram.



Let I I' be the inlet area of one bucket. Let I e represent to scale and in direction the entrance velocity of the water

over the earth ; thus I e gives the direction of the final edge of the guide blade. If there is to be no shock the relative velocity must be in the direction of the blade I t, and therefore its magnitude must be I t and inlet tip speed of the wheel must be measured by $t\,e$. $r\,e$ is the component velocity perpendicular to the inlet area, this component being the same for both velocities, that over the earth I e and that along the blade I t. The volumetric flow through this one bucket is the area I I^1 multiplied by $r\,e$. If the wheel speed be diminished or increased from exactly $t\,e$ while I e remains the same, there will be shock at entrance. If it be decreased to t_1 e there will be shock on the forward face I of the bucket and consequent waste of power. If it be increased to t_2 e, the relative velocity being then I t_2, the water will impinge on the backward surface of the bucket I^1, and the effect of this first impact of the water will be to hinder the forward motion of the wheel, actually to drive it back. It is well worth noticing that this is by no means an impossible, probably not even an uncommon case, because, although its first effect is in the wrong direction, it by no means follows that the water loses all driving power. A little further into the bucket it impinges again on the forward side and sweeps round, thus driving the machine.

It should here be mentioned, in order to avoid misunderstanding, that in the equations $\theta\,i$ means the angle between the direction of relative velocity and that of wheel motion. This is the inlet angle of the blade only so long as the above relations of speed are preserved. If, therefore, $\theta\,i$ be taken as the blade inlet angle, it must be assumed that the speed of the wheel is regulated in accordance with these conditions.

Now, in no turbine that has yet been made is the inlet angle of the blade capable of alteration. Let us see what restrictions this fact puts upon the possible variation of wheel speed, always retaining the condition of inflow without shock.

Firstly, suppose that the guide blade passages run full bore, and that the wheel buckets do not run full bore. Under these conditions a definite pressure is established at inlet which does not depend on the speed of the wheel. From equation (5) we deduce that the linear velocity over the earth at inflow is also independent of the wheel speed. We can now set our guide blades so as to diminish the angle of entrance ; as, for instance, the velocity over the earth may become I e^1. The passages between the guide blades have now become narrower, so that the volumetric discharge V has decreased in the ratio of $r\,e$ to $r^1\,e^1$ because I e^1 = I e. But the wheel speed may, and must to preserve good working, be increased from $t\,e$ to $t^1\,e^1$. In the product V ϖ, therefore, one factor has increased, and the other diminished. By an easy application of the differential calculus it can be shown that this product reaches its maximum when the angle r I e between the inlet surface and the inlet tips of the guide blades is just half the angle r I t between the inlet surface and the inlet tips of the wheel blades. The quantity W of equations (10) and (11), which is the direct measure of the efficiency of the turbine, largely depends on the product V w. It also depends on the value of m_e which, under the conditions we are now supposing, varies also with the wheel speed. The influence of this latter variation is to be found from equations (13) and (14). To solve the problem exactly would be very complicated, but careful investigation shows that the influence is to make the highest efficiency appear with the angle r I e a little less than half r I t. In axial flow turbines nothing else modifies the condition of best efficiency ; but in radial flow turbines we have the extra term $\frac{\varpi^2}{g}(r_i^2 - r_e^2)$. This does not involve V, the volumetric flow, but rapidly increases W by increase of wheel speed provided $r_i > r_e$, as in inward flow turbines, and has the contrary effect on outward flow turbines where $r_i < r_e$. The effect of this term then in inward flow wheels is to make the highest efficiency reached when angle r I e is still less than half r I t, while in outward flow wheels the guide blade angle of best efficiency is somewhat increased in consequence of this term.

Before dealing with this problem of highest efficiency under other conditions, it must be pointed out here for most careful attention that the attainment of this highest pitch of mechanical efficiency is not what is to be aimed at in practice. From the above it is evident that by increasing the guide-blade angle beyond that proper for maximum efficiency, we obtain a materially larger value of V ; that is, we pass a larger quantity of water. Now, the horse-power of the turbine is proportional to the product V W. Thus, by sacrificing efficiency to a certain degree, we obtain more power with our turbine of given size and cost. The extent to which we should deviate from maximum mechanical efficiency to obtain greater horse-power depends on the relative importance of reducing first cost in the machinery.

If now the passages through the guide blades do not run full bore, this means that the volumetric discharge is fixed by the limiting conditions up stream expressed in equation (6a). In this case, the entrance linear velocity will also be fixed, and we can only vary the wheel speed by setting the guide-blades to different angles. From (10) or (11) in which V is now a constant, it is evident that W will increase with ϖ far beyond the point last investigated. Referring to the last diagram, clearly ϖ must not be increased so far as to make the wheel speed at inlet equal to the water velocity over the earth. But it may approach it. The limit is to be settled by the necessity of leaving the inlet velocity over the earth with a component normal to the wheel inlet surface large enough to get the water into the wheel. Divide the given volumetric flow by the inlet area of the wheel; this gives the above necessary component. Then set your guide-blade at such an angle as to give this necessary component. It will be found that this process gives a high wheel speed, and this is only what experience has shown necessary for this class of wheel.

Consider, lastly, the case in which the wheel buckets run full bore. In this case V, the volumetric discharge, is found from (13) or (14). Examining these by the usual differential means, we find that as ϖ is increased V decreases. The product of the two, viz., V ϖ, first increases and then decreases. The process of finding theoretically and in general terms when its maximum is reached is a complicated and tedious one, but the result may be given here. Abbreviating the coefficients of (13) and (14) to c_1 c_2 c_3 c_4, so that these equations stand

$$C_1\,V^2 + C_2\,V\varpi + C_3\,\varpi^2 = C_4.$$

I find that the maximum value of V ϖ is reached when the wheel is run at the speed given by

$$\varpi^2 = \frac{C_4}{2\,C_3 + C_2\sqrt{\frac{C_3}{C_1}}}.$$

If this speed be established, then V ϖ will have the value

$$V\varpi = \frac{C_4}{2\sqrt{C_1\,C_3} + C_2}.$$

These values will give maximum efficiency to axial flow turbines. For inward flow turbines the speed of maximum efficiency will be greater than the above value, while it will be less for outward flow wheels.

It must not be forgotten that if the best speed obtained from the foregoing considerations be very high, it may often be desirable to run at a lower velocity on account of the increased difficulty and expense of effective lubrication.

It remains to observe the influence of the setting of the wheel blade angles, viz., θ_i and θ_e. A single glance at equation (10) or (11) shows that W, or the efficiency, is increased by making tan. θ_i small, that is by making the entrance angle of the blades small. But here again other considerations have an opposing influence. The whole amount of work done by the machine is, of course, proportional to V, the flow through it, and this V equals the product of the entrance area by the radial or axial velocity in radial or axial-flow turbines. By making θ_i small this radial or axial velocity is diminished and the inlet area necessary for a given V is increased, this involving, of course, a general enlargement of all the dimensions and a rise in the cost of the machine. Evidently it may often and even usually be more advantageous to the user to employ a turbine of less size and first cost, and at the same time to submit to get his power at a lower mechanical efficiency. Similar remarks apply to θ_e the angle of the discharge tips of the blades. This angle is nearly always made greater than 90 deg., and its tangent is therefore negative. The second quantity within brackets in equations (10) and (11) is therefore really a quantity to be *added*, although it appears as if it were to be subtracted. W is therefore made greater by making tan. θ_e as small a negative quantity as possible, that is, by making θ_e as nearly as possible 180 deg. But, again, making this small diminishes the radial discharge velocity, and involves increasing the discharge area and the general size of the machine in order to obtain any desired volumetric flow V.

ROBERT H. SMITH.

HOROLOGY AT THE INVENTIONS EXHIBITION

No. III.

SINCE our former visits to the Horological Section of the Exhibition, many of the exhibits which were then incomplete have been filled up, the awards have been distributed, and the Inventions Exhibition of 1885 is now drawing to a close.

It only remains, therefore, to consider the remaining exhibits worthy of notice which have been hitherto crowded out, and to conclude this short series with a brief *résumé* of the state of the manufacture and the trade—its causes and results—as indicated by the material to hand in the shape of the inventions and productions here shown.

Messrs. E. Dent and Co., Strand. This firm have justified our first prediction by worthily representing English horologists, and have been awarded a gold medal for improvements in turret clocks and chronometers. In addition to their other exhibits which we have already noticed, their new patent galvanic contact apparatus applied to chronometers is particularly worth inspection. This is a departure from the ordinary method, as the current is constant, the mechanism being employed to break instead of to make contact at short intervals through the agency of a second wheel on the axis of the escape wheel, and, as this action takes place after the impulse is given to the escapement, the transmission of the signals does not affect the rate of the instrument in any way.

Mr. R. G. Webster, 5, Queen Victoria-street, E.C., has a very good display of English quarter and other clocks and high-class watches, a chronometer with new compensation balance for obviating the secondary error, a clock showing universal and local time, and a regulator with a new gravity escapement.

The English Watch Company, Birmingham, exhibit their machine-made watches of various designs, and a new speciality in the form of an English double chronograph which has been invented and patented by Mr. Douglas, of Stourbridge, and registered under the name of the "chrono-micrometer." We have not had an opportunity of examining this instrument, but it is gratifying to find that an effort is being made to upset a monopoly in this branch of watch-making which has been too long left in the hands of our Swiss competitors.

Mr. J. F. Hills, of the Post-office, Sudbury, Suffolk, exhibits a novelty of his own invention in the shape of a watch with a specially designed dial, showing the code letters for the use of postmasters and telegraphists, by whom it will doubtlessly be largely adopted. Mr. Hills is to be congratulated in being the first to conceive an idea, the obvious utility and simplicity of which renders it difficult to believe has never occurred to anyone before.

Messrs. A. and H. Rowley, 180, Gray's Inn-road, W.C., show a large clock with automatic figures and perpetual calendar, and chimney and striking work, a collection of chimney and striking clocks, and parts illustrative of process of manufacture, and ships' timepieces to strike the different bells and watches.

Messrs. G. Bendon and Co., 36, Ely-place, E.C., show clocks with their keyless mechanism for winding from the centre of the dial, and regulating arrangement applied. The winding handle is a jointed piece which goes through the centre arbor, and by pulling this piece out and bending it twice a crank is formed by which the clock can be wound. This arrangement gives greater power than in their original plan, in which the winding was effected by means of a knob standing out from the centre of the dial, which was turned by the fingers. The clock is regulated by turning a projecting button at the top of the dial, at the end of whose arbor is a wheel gearing with another wheel at the top of a screw, to which are attached the movable chops which hold the pendulum spring. But, however desirable it may be to dispense with a key in the case of watches, where it is a constant source of anxiety to the wearer, the same can hardly hold good of clocks, which are stationary, and to which it can be easily attached, and we can see little to recommend in this arrangement to compensate for the necessary extra complication it involves.

Mr. N. C. Firth, 125, Foregate-street, Chester. Of the numerous time-checking clocks, for registering the times of arrival or departure of operatives, the specimen exhibited by this firm seems to be the best adapted for securing the end in view, in affording a sure means of checking any irregularity or attempted fraud. The clock is constructed to drop a number of small metal discs into a tube singly at any intervals of time for which it may be adjusted, which pile one upon the other. And the operatives, being required to drop a similar disc into the tube upon arriving or departing, their time can thus be easily checked by a superintendent or foreman.

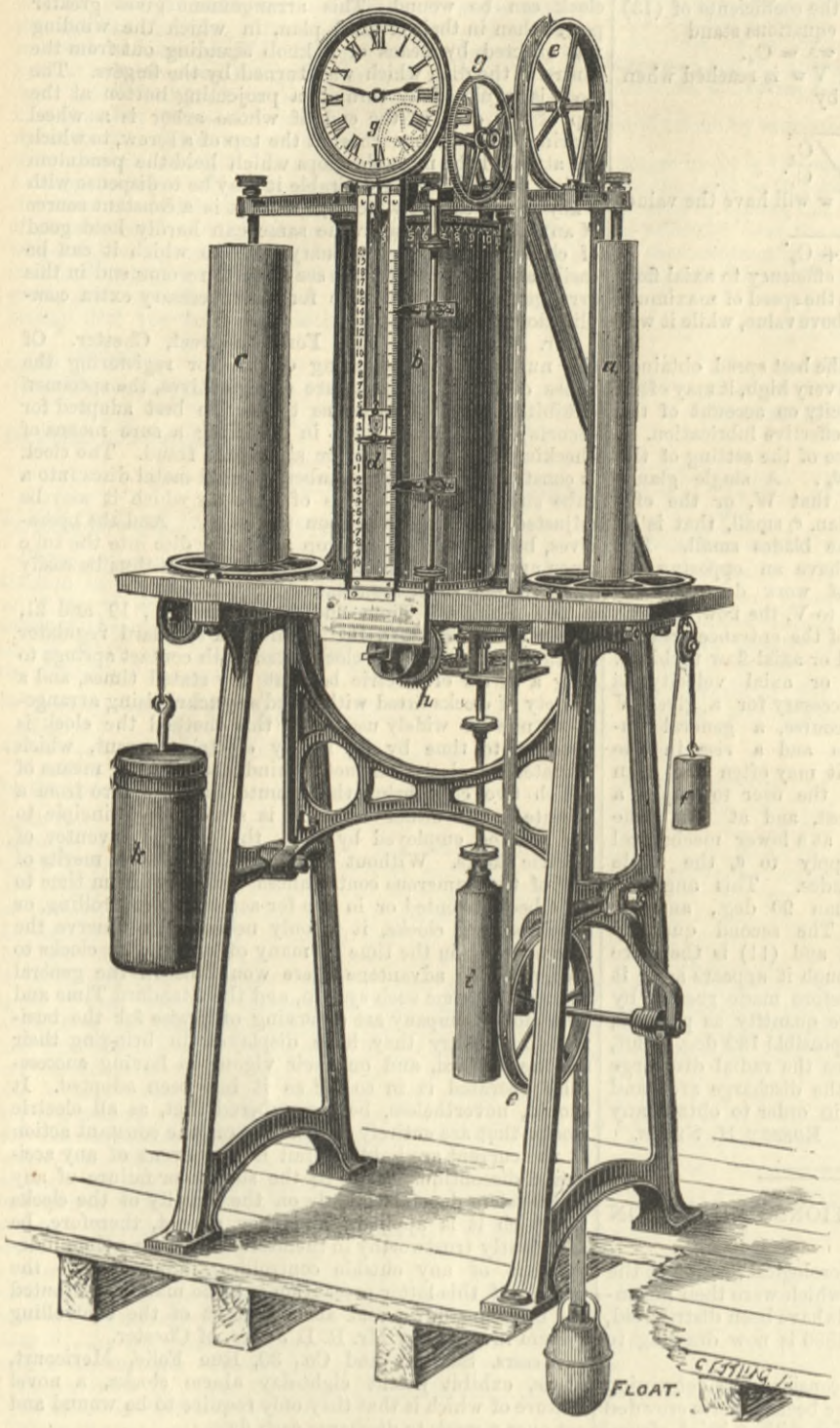
The Standard Time and Telephone Co., 19 and 21, Queen Victoria-street, E.C., exhibits a standard regulator of the usual pattern, a clock fitted with contact springs to ring a series of electric bells at any stated times, and a variety of clocks fitted with Lund's synchronising arrangement now so widely used. In this method the clock is brought to time by an hourly electric current, which actuates an electro-magnet behind the dial, by means of which two clips bring the minute hand to zero from a minute or two either way. It is similar in principle to the method employed by Bain, the original inventor of electric clocks. Without going into the relative merits of any of the numerous contrivances that have from time to time been invented or in use for actuating, controlling, or synchronising clocks, it is only necessary to observe the discrepancies in the time of many of our public clocks to recognise the advantage there would be in the general adoption of some such system, and the Standard Time and Telephone Company are deserving of praise for the business-like energy they have displayed in bringing their scheme forward, and on their vigour in having successfully operated it in so far as it has been adopted. It should, nevertheless, be remembered that, as all electric clocks that are entirely dependent on the constant action of the current are liable to fail in the event of any accidental discontinuance of it, the success or failure of any such system depends largely on the quality of the clocks to which it is applied ; and they should, therefore, be sufficiently trustworthy in themselves to go for a time independent of any outside controlling influence. To the neglect of this latter precaution is to be mainly attributed the breaking down and abandonment of the controlling system invented by Mr. R. L. Jones, of Chester.

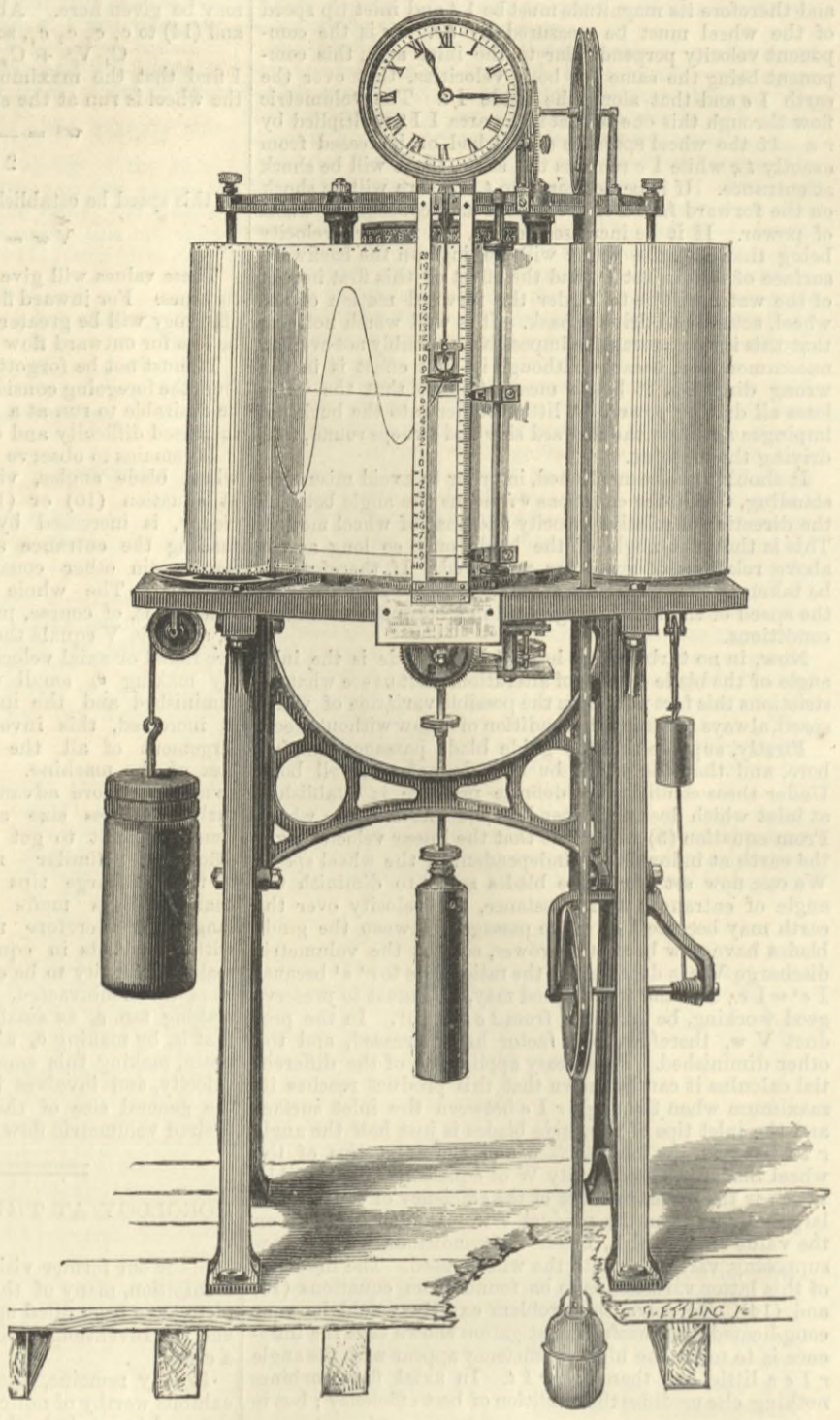
Messrs. Samper and Co., 30, Rue Folie, Mericourt, Paris, exhibit patent eight-day alarm clocks, a novel feature of which is that they only require to be wound and set once a week to discharge each day.

The De Gruyter Clock Manufacturing Company, 147A, Aldersgate-street, E.C., exhibit Warder's patent torsion pendulum 400-day clock, which requires winding only once a year. But apart from its scientific novelty and mechanical ingenuity which render this exhibit interesting, there is not much in it to attract the serious attention of horologists, as this clock must be considered rather as a scientific mechanical toy than as a good timekeeper.

In Group XXVIII., which embraces philosophical instruments and apparatus, Messrs. Légé and Co., Turnmill-street, E.C., exhibit the tide-predicting machine of Mr. Roberts, of the "Nautical Almanack" office, which has been already fully illustrated and described in THE ENGINEER of the 19th December, 1879. Apparatus for measuring, recording, and registering depths of liquids—and a new mercurial compensation seconds pendulum. In this compensation M. Légé has gone a step further in carrying out Vissière's principle of having more than one jar of mercury for the bob, in order that the mercury may be acted on the more quickly in slight sudden changes of temperature to be more in accord with the expansion and contraction of the rod in like changes, by constructing the bob of a brass cylinder of about the usual size, which is packed with a number of steel cylinders, turned to the same diameter as the rod, as closely as they will stand together, each cylinder being filled with mercury. But whether or not this is a real improvement or is necessary is not at all certain, many eminent horologists holding the contrary opinion that, even with the single jar, the centre of oscillation is raised all too quickly by the extreme sensitiveness of the mercury to changes of temperature. Clock movements and detached parts showing different stages of progress are also exhibited. In this section several novel departures from the usual practice are observable, especially in the mode in which the crossings, or spokes, of the wheels are formed and the pallets shaped. In the former the spaces are first stamped out roughly, and afterwards finished by a rotary milling process, the flats being lapped; and the latter are first stamped out, then forced through a die, and afterwards finished by lapping on the flats and acting surfaces, after being hardened and tempered. The tide gauge, of which we give an illustration, contains several new and interesting features. The middle cylinder, or drum, is turned by clockwork, and is geared at the bottom through an intermediate wheel with the left-hand cylinder, upon which the paper as it is marked is rolled, and as this second cylinder, through the agency of the mechanism, is always made to travel a little faster than the first, the paper is kept tight. The right-hand cylinder carries the roll of paper, and is in its turn regulated by

INVENTIONS EXHIBITION.—MESSRS. LÉGÉ AND CO.'S TIDE GAUGE.





means of a friction spring at its lower end. The middle cylinder turns once in twenty-four hours, each of which is indicated by a pin, which pricks through the paper, and obviates the necessity for the use of the usual ruled or squared paper. The paper is marked by a pencil, which is pressed against it by a spring, the movement of which up and down the graduated scale is governed by the raising and lowering of the float. The float acts on the mechanism through a copper band or riband running on pulleys, the top one of which is geared to the wheels at the top of the frame.

The counterpoise to the float shown at the right of the stand has a cord running over a grooved truncated cone, or fusee, by means of which the difference in weight of the copper band is equalised and the float balanced.

The force and direction of the wind are also registered through the agency of an anemometer and dart attached to this machine—not shown in the cut—the pencils and indices registering and recording each being fitted to the lower part of the scale, and marking the paper in the same manner as the tide register; and a barometer is attached, the self-registering attachment of which is a very ingenious contrivance. The delicacy of the movement of the mercury would not permit of a pencil being kept closely pressed by a spring against the paper without interfering with the action of the barometer, and the density of the atmosphere is registered by means of a clever device in the form of a click spring which ratchets over the teeth of the wheel at the lower end of the middle cylinder, and thus causes the pencil to dot the paper at intervals of ten minutes. The whole of the work in these machines is of a very high quality, and the firm well deserve the silver medal they have been awarded.

Mr. Alfred J. Frost, Westminster-chambers, S.W., has a collection of the simplified forms of transit instruments, by Mr. Latimer Clark, M.I.C.E., &c. These instruments have been specially designed by the inventor for the use of amateurs and others who have no pretence to scientific knowledge of any sort, and from their extreme simplicity, portability, and lowness of price, they will no doubt come into general use amongst country watch and clockmakers, and others. An accompanying elementary treatise on the transit instrument and a small book of yearly transit tables, compiled from the "Nautical Almanac," by Mr. Clark, render it a very simple matter for the merest tyro to manage one of these instruments, and observe the transits of any of the principal stars. The small window transit is very portable, and is perhaps the best adapted for general use.

Mr. James Rigg, 11, Queen Victoria-street, E.C., shows models of ellipses to explain the mode of obtaining the pitch circles of toothed wheels, a model of conical toothed wheels, and models illustrating the different forms and actions of cams and the principal kinds of motion which they are employed to produce, and other educational apparatus. This form of instruction is particularly pertinent and useful to the younger students of mechanics and to those practical men who have such an inexpressible antipathy to diagrams and scientific theories, and might with advantage be more widely adopted in those modern schools of horology which are fast taking the place of the old apprenticeship system.

In concluding our notices of the horological and cognate sections of the Exhibition, it will be well to consider the position of our manufacturers with regard to those of the other countries with whom we must reckon our account as serious competitors. There would be no use in denying the fact that the English manufacturers have not come to the front as strongly as they might have been expected, but have shown a serious falling off in their exhibits as compared with those of the different foreign exhibitors. This may be variously accounted for. The introduction of automatic machinery in watch making, to which change their foreign rivals have adapted themselves more readily than our home producers; the present unprecedented and universal depression of trade in this country; the want of energy and enterprise of British manufacturers, have all been offered as explanations of the relatively poor display in the English section. But the first can hadly prove a satisfactory explanation of the apparent declension of this portion of our manufacturing industries.

To a nation which has always taken the lead in every branch of science, the well-earned and sustained reputation of whose horologists has ever kept them in the front rank in the markets of the world; and in a country where machinery is perhaps more universally employed than in any other, such an explanation as the first would indeed be a reproach. But that the want of machine tools has in no way contributed to the meagreness of the English Horological Exhibition may be judged by the excellent examples of machine-made watches shown by Messrs. Benson, D. Buckney—in the case of the Horological Institute—the English Watch Company, and others, the first of whose machine-made Ludgate watch is not excelled, if it is equalled, by any foreign machine-made watch in the Exhibition; and we are sure that if any of the above firms had shown some of their machinery in motion, it would have done much to remove a prevailing impression from the mind of a portion of the public that English makers are not "going with the times."

The second hypothesis would hold equally good of the Swiss or other sections, and the last is hardly worth discussing, and is contradicted in the answer to the first. The fact is the English watch trade is at the present time in a state of transition—from the old apprenticeship system, which is fast becoming a thing of the past, its place being taken by technological training schools more in consonance with modern ideas and tastes, to the state and conditions of the manufacture, which is undergoing a complete change, owing to the introduction of going barrel keyless watches, and machinery, and an assimilation to the factory system, and other causes—and until the whole method is resolved into a more harmonious homogeneity, we cannot look forward to any marked advancement. The change must necessarily be slow, and must take place *pari passu* with other gradual developments. Individual efforts in the direction of violent and radical alterations would probably only produce chaos.

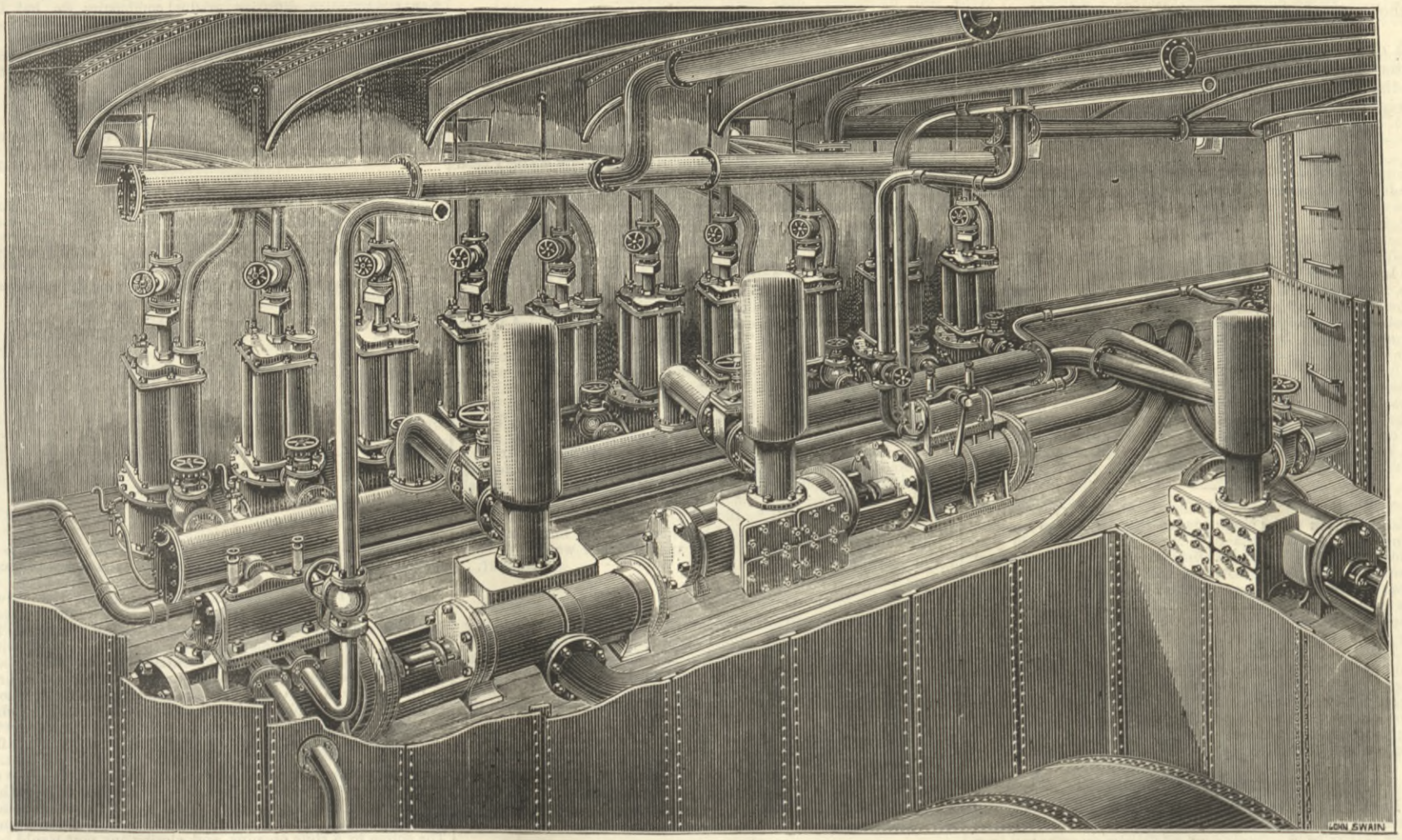
Leicester Water Supply.—After an exhaustive discussion, the Leicester Corporation, acting upon the advice of Messrs. T. and C. Hawksley, of Westminster, subsequently confirmed by a detailed report from Mr. J. B. Everard, of Leicester, has decided to acquire the Blackbrook, a stream upon Charnwood Forest, as their next source of supply.

University College, London.—The following awards have been made:—Medical Entrance Exhibitions—£100, Mr. T. L. Pennell; £60, Mr. S. B. Mitra; £40, Mr. J. J. Macnamara. Andrew's Entrance Prizes of £20 each—for Science, Mr. C. F. T. Blyth; for English and other languages, Mr. Arthur Vaughan. Gilchrist Entrance Engineering Scholarship (£35 for two years)—Mr. R. J. Durley.

Wages of Mechanics in New South Wales.—An official publication says:—In some departments wages have evinced a tendency to rise, in others they have remained stationary, while in several there has been a slight decline. Among the former may be mentioned the rates paid machine men in fitting-shops, which range from 11d. per hour in 1876 to from 10d. to 1s. 2d. per hour in 1884. Among stationary rates are the following:—Furnacemen, per hour, 1s. 3d.; iron turners, per hour, 1s. 5½d.; engine fitter, per hour, 1s. 5d.; general fitters, per hour, 1s. 2d.; blacksmiths, 1s. 6d.; blacksmiths' strikers, 10d.; iron moulders, 1s. 4d.; boilermakers, 1s. 4d.; patternmakers, 1s. 3d.; brass moulders, 1s. 3d.; and brass finishers, 1s. 3d. In several of these and other trades there is a marked tendency to increase in the wages of the more skilled mechanics. Among the few instances in which wages have perceptibly declined are those of coppersmiths, which have sunk from 1s. 6d. per hour in 1876 to 1s. 3d. in 1884. As a considerable—in fact the greater—portion of the manufactured iron used in the colony is imported, persons desirous of obtaining employment in iron manufactories should be extremely careful in coming out, the number of such establishments in New South Wales being limited. Handy mechanics, willing to make themselves useful, readily find employment, either in town or country, and generally do well.

CONDENSERS ON BOARD THE S.S. CALABRIA.

MR. J. KIRKALDY, WEST INDIA DOCK ROAD, ENGINEER.



SURFACE CONDENSATION.

Numerous experiments have, at different times during the past thirty years, been made with a view to determine the quantity of heat which could be conducted by the surface of different metals. The experiments—which were made with steam, the heat from which was transmitted by a metallic medium to water—were in almost all cases made with either flat surfaces or the cylindrical surfaces of tubes, and results have been arrived at which have more or less guided engineers in determining the area of surface necessary, under given circumstances or conditions, to condense a given quantity of steam. The experiments of Péclet and others gave the conductivity constants which have been very generally used, and showed the heat-transmitting capacity of a metal to transmit heat by conduction, varied directly as the difference of temperature on the two surfaces, and inversely as the thickness of the conducting plate. Péclet gave 515 units per hour per square foot of plate 1in. in thickness, and per degree Fah., as the conducting power of copper, and 233 units for iron. Experiments by Messrs. Easton and Amos with a wrought iron tube, 1·5in. in diameter and 0·0625in. in thickness—the tube being placed vertically in 3ft. 7in. of water, and filled with steam at 212 deg.—gave 230 units per square foot per hour per degree difference of temperature, which is a very much smaller conductivity than that arrived at by Péclet if the thickness of the metal is considered. By experiment with a steam-jacketted cauldron-shaped vessel, Péclet derived 235 as the conductivity; but from experiments made with steam in long coils, he derived results so much higher than these that doubt has often been expressed as to their accuracy. With a coil of pipe 1·35in. outside diameter, and 138ft. in length, 974 units; and with two coils, each 49ft. in length, and of pipe 1·35in. inside diameter, 1020 units were obtained. These results have been looked upon as incredible, especially when compared with those obtained with steam passed through or into straight pipes of comparatively short lengths. In The Engineer of the 12th of March, 1880, we gave the results of a large number of experiments on the condensation of steam in pipes exposed to the air. The mean of a large number of these experiments with bare pipes gave about 500 units, and in the case of a pipe nearly 2300ft. in length, but partly covered and in a coal pit plane, 225 units were obtained. All these tubes or pipes were, however, again straight, and, with one exception, comparatively short. These and many other experiments point to the conclusion that not only thickness but length of pipe providing the heat transmitting surface, is a very important factor, and that the coil form of pipe is more effective than the straight. We should, perhaps, not have noticed the difference between the efficiency of flat surfaces or of straight pipes and coiled pipes, but that the remarkably high efficiency of some coiled tubes with which we recently made some experiments caused a reference to the figures obtained from previous experiments. On this page we illustrate a group of the "Compactum" condensers, as fitted on board the s.s. Calabria by Mr. J. Kirkaldy, of West India Dock-road, London, at the time when fresh water was supposed to be wanted in large quantities for the soldiers in the Soudan. Each of these small condensers—there are ten in the group—will condense a minimum of 60,000 lb. of steam per twenty-four hours, or 2500 lb. per hour; the group would thus provide 25,000 lb., or 2500 gallons per hour, or about 66,000 gallons per day. These condensers were tested under Government inspection, with the result that they condensed 128·34 lb. of steam per square foot of tube surface per hour, the steam being at 47 lb. per square inch, or at a temperature of 295 deg. Fah., and the water from the condensed steam passing away at 70 deg., the circulating water being at about 40 deg. The surface is, however, here measured as though the tubes were ordinary tubes of circular section. They are, however, corrugated in the direction of their length, or fluted, and this makes a difference of about 10 per cent. in the actual surface. Making the necessary correction for this, the quantity of water condensed per square foot of surface will be 115 lb. We thus have as the amount of heat conducted by one square foot of this surface per hour 130,410 units, which, taking the mean difference of temperature on the inside and outside of the tubes as 295 − 70 ÷ 2, or 142·5 deg., gives a conductivity of 914·4 per square foot of surface per degree of difference of temperature. These figures agree very closely with those of Péclet, which have been looked upon as inaccurate. Box arrived at the conclusion that these results were incredible, but had neither noticed that the vessel or the tubes experimented with were thin, or that length of traverse of the steam had an important bearing on the matter, as we shall see. He gives it as a fact that the conductivity varies inversely as the thickness of the plate, but omits to see that if a plate 1in. thick will transmit 515 units per hour per square foot and per degree difference of temperature, that there should be nothing incredible in the Péclet experiments with a worm 138ft. in length, and probably not more than, perhaps, a sixteenth of an inch in thickness. In fact, experiment would seem to throw doubt on the relation given by Péclet on the thickness and rate of transmission, for if a copper plate 1in. thick will transmit 515 units, a plate $\frac{1}{16}$in. should transmit 8240, and no experiments seem to support this. Joule found that by passing water through the annular space between two tubes, one inside the other, and carrying steam, that 100 lb. steam could be condensed per hour, and this would represent about 100,000 units per square foot, and at least 1000 units per degree of difference of temperature. Experiments mentioned by Rankine, as well as others, show that the quantity of heat which a metal may conduct depends not only on the metal itself, but also upon the disposition of the metal and mode of supplying the medium which is to carry off the heat.

The experiments made on board the s.s. Calabria induced us to make some further experiments with similar condensers, fitted with fluted and with plain tubes, and with an experimental condenser of different proportions, but fitted with similar tubes. A condenser containing two coils made of 34ft. of fluted tubes, one coil within the other, and both tubes of about equal lengths of 0·5in. and 0·375in. tubes, the total surface of which was 4·23ft., or practically 4¼ square feet, was placed at our disposal, and another condenser of similar form, but fitted with twenty-one straight tubes of 0·75in. outside diameter, presenting 7·9ft., or practically 8 square feet, was also at our disposal for comparative test. The steam supplied to the condensers was exhaust steam from a small engine, and the cooling water was from the mains. The result of experiments with these two condensers, briefly stated, was that the fluted tubes condensed almost exactly double the quantity of steam condensed by the plain tubes; that is to say, that a given amount of surface in one of the "Compactum" condensers has just double the efficiency of the same amount of surface in an ordinary condenser with straight plain tubes, so that a Compactum condenser may be used of half the usual size. There seems to be but little gain in the use of fluted straight tubes; they must be coiled as under Kirkaldy's patents to do the most work, and the coiling moreover causes them to move freely and allow for expansion and contraction, and this prevents the accumulation of incrustation.

The experimental condenser referred to was made with a view to ascertain the minimum quantity of circulating water necessary to condense a given quantity of steam. It consisted of a 6ft. length of 6in. cast iron pipe containing two coils of tubes 70ft. in length, in all 140ft. of tube, each tube consisting of 30ft. plain tube 0·375in. diameter, 21ft. fluted tube 0·5in. diameter, 12ft. 0·625in. fluted, and 7ft. 0·75in. fluted tube, presenting a surface in all of 19·44 square feet. Some curious results were obtained in the following experiment, in which the minimum quantity of circulating water is about one gallon to one gallon of steam condensed, and the condenser thus acting at great disadvantage as a condenser, but showing its capacity as a heater. Steam was led to this condenser, the steam passing through the tubes, the pressure in the boiler a few feet away being 61 lb., and may be taken at about 58 lb. at the condenser and a temperature of 306 deg. The condensed steam passed away at the rate of 62·7 gallons or 627 lb. per hour, and at a temperature of 96 deg., the circulating water from the mains entering at 62 deg. and passing away as steam at a mean temperature of 225 deg. The heat given up by the steam was thus 306 − 96, or 210 deg., which added to the latent heat gives 1111 units per pound, or a total of 696,597 units. The total surface being 19·44 square feet, the units of heat transmitted per square foot = 35,833 units, or per degree of mean difference in temperature under such unique and unfavourable conditions of 241·9, or practically 242 units.

In numerous experiments these figures were confirmed, that is to say, that the surface in these condensers gives such a high efficiency that a gallon of circulating water produced a gallon of distilled water from steam at 58 lb. on the square inch. The significance of this fact is that, properly applied, the feed-water to an engine ought to be nearly or quite enough to condense all the steam from the the engine, and there is no doubt that the Compactum condensers could be made to do this, but the conditions of working would not often be convenient, and it is seldom that twice the amount of the feed-water could not be obtained. A condenser of this kind acts as a remarkably efficient feed-water heater, as will have been seen from the figures of numerous experiments showing that 10 lb. of steam was condensed with 10 lb. of circulating water, all of which was converted into steam. The trial condenser referred to gave the following figures as the mean of a number of measurements: pressure of steam 58 lb., temperature of circulating water 70 deg., temperature of condensed water 102. One gallon of circulating water in 55 seconds gave one gallon of condensed water in 57 seconds.

It is needless to point out that under these conditions the apparatus apparently gives a higher efficiency as a feed-heater than as a condenser, but this would disappear if a greater mean difference of temperature were maintained. In the experiments the steam entered the tubes at the end where they were surrounded by steam at a lower temperature. If the tubes at the circulation outlet end had been surrounded by water a much higher duty could have been obtained, just as in the Calabria condensers, and as in the Compactum condensers generally. One of these condensers, for example, of but 5·5in. by 5·5in. by 29in. outside dimensions, will condense 62·5 gallons per hour, so that an almost incredibly large efficiency is obtained per square foot of surface when sufficient circulating water is obtained. In the experimental apparatus, which we might imagine acting as both condenser and heater to an engine, the surface was sufficient to condense all the

steam from an engine doing about 30-horse power with 20lb. of steam per indicated horse-power, that is to say, about two-thirds of a square foot would be sufficient under the circumstances narrated, but with plenty of circulating water much less than this would perform the work of a surface condenser. The Calabria condenser tests indicate that about one-sixth of a square foot would perform the work.

Each of the condensers in the Calabria is of the following external dimensions and capacity:—12in. by 12in. by 23in., the filter beneath them being 15·5in. by 12·5in. The weight of each is 370 lb.

LETTERS TO THE EDITOR.

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

DR. LODGE'S MECHANICS.

Sir,—Will you allow me to thank the writer of the able review in your last issue of my little book, not only for his encouraging remarks, but also for his thoughtful criticisms? Of many of these I shall hope to make some use at a future time, and with only one do I wholly and entirely disagree. This one is the criticism of my passage about "curvilinear motion," "centripetal acceleration," and "to-morrow never comes." So far as I can yet perceive, the passage in question is perfectly correct, but far be it from me to dogmatise on the point. I only wish to point out, in explanation of a probable retainment of the present words, that I am unable to see the point of the learned reviewer's objection to them; but I shall be only too delighted to amend them, or any other words of mine, if on further reflection I detect a flaw. Oliver Lodge.

University College, Liverpool, October 24th.

Sir,—Will you permit me to call the attention of your reviewer of Dr. Lodge's book to the circumstance that Dr. Lodge accepted my definition of inertia, namely, Capacity for Motion, in your impression for May 15th. This definition is simply the reciprocal, so to speak, of the received definition that momentum is quantity of motion, and is in every way superior to the explanation—for it is not a definition—given by Dr. Lodge in his "Elementary Mechanics."

I have procured the book, and I need not say with what gratification I find that the letter which you did me the honour to publish on the 3rd of April has not been devoid of influence on Dr. Lodge.

With all that your reviewer has said I cordially agree, save as regards one or two criticisms, which I think are scarcely justified by anything Dr. Lodge has written. Φ. Π.

London, October 26th.

DRIVING AN ADIT.

Sir,—In the correspondence column of your issue of October 16th Messrs. G. Anderson and Co., of Arbroath, describe a method, which they believe to be entirely new, of driving an adit, and they state that provisional protection has been taken out for the invention and mode of operation.

I am sorry they have wasted their money, but the identical method they describe was explained to me fully ten years ago by a sewer contractor, who had executed such a work in the North of England.

Some time ago I drove a tube 26in. outside diameter and 50ft. long under a waterworks aqueduct, conveying 40,000,000 gallons daily, and with the greatest success, and in exactly the same manner as Messrs. Anderson describe, saving one particular, and that was, I used a hydraulic jack instead of a screw, with spur wheel and pinion attached. The provisional protection is worthless. W. B. B., M. Inst. C.E.

London, October 24th.

THE HORSE-POWER OF TURBINES.

Sir,—"*Parturiunt montes, nascetur ridiculus mus*," aptly describes the authoritative style adopted by Professor Smith in his exordium, and the miserable *fiasco* of his peroration. His first paper is chiefly occupied with a rambling description of a method of gauging the flow of water in open channels—a question which has nothing to do with the theory of turbines, although a knowledge of it is absolutely necessary for the mechanician who undertakes to utilise any source of water power, whatever kind of machine he decides to adopt.

The first equation in paper No. II.,

$$\frac{v^2 - v_0^2}{2g} = h + \frac{p_0 - p}{w}$$

is simply the analytical statement of Bernouilli's law about the steady flow in pipes of varying section. The expression $\frac{v^2 - v_0^2}{2g}$ simply expresses the difference between the kinetic energy of the water at the two sections, and may represent either an increase or a diminution. p_0 p are simply the statical pressures at the two sections, and do not represent the forces causing velocity of flow. If the sectional area increases, the head due to pressure in fact increases, whilst the head due to velocity decreases.

If W F represent the work done in producing motion in the walls of the channel, and overcoming friction by a unit of weight of the water in passing from one section to the other, equation (5)

$$\frac{v^2 - v_0^2}{2g} + W = h + \frac{p_0 - p}{w} - F$$

is perfectly correct, but does not afford the slightest aid towards the discovery of the values of W and F. Professor Smith himself, in point of fact, does not really attempt to make use of it.

I cannot follow Professor Smith's reasoning, and will not, therefore be guilty of attempting to review the rest of the paper No. II., but will content myself with analysing the final equations. In these there are two symbols m_i m_e of the meaning of which I cannot find any description in the paper, and therefore my analysis must be so far incomplete.

The two final equations are as follows:—

For outward and inward flow turbines

$$W = \frac{V\varpi}{2\pi g}\left(\frac{1}{m_i d_i \tan.\theta_i} - \frac{1}{m_e d_e \tan.\theta_e}\right) + \frac{\varpi^2}{g}(r_i^2 - r_e^2) \quad . \quad . \quad . \quad (10)$$

For parallel flow turbines

$$W = \frac{V\varpi}{2\pi g (r_2 - r_1)}\left(\frac{1}{m_i \tan.\theta_1} - \frac{1}{m_e \tan.\theta_2}\right) \quad . \quad (11)$$

The term on the left-hand side is of one dimension, viz., a force multiplied by a linear dimension; if, therefore, m_i m_e are abstract numbers both equations (10) and (11) are correct in dimensions, otherwise they are not. I shall feel obliged if Professor Smith will state what is meant by the symbols m_2 and m_e, and whether I am not correct in stating that his expression for the initial absolute tangential velocity of the water represents the sum of the absolute tangential velocity of the water initially, plus the velocity of whirl of the outer periphery of the wheel, and the expression for the final tangential absolute velocity, the sum of the tangential component of the final relative velocity plus the velocity of whirl of the inner periphery of the wheel; and also whether in his opinion the turbine ought not to be so proportioned that these last would be equal in value but would act in opposite directions.

I have adhered to the well-known conventional term "absolute velocity" to designate the velocity of all objects relatively to the earth, which in terrestrial mechanical investigations is supposed to be at rest. If Professor Smith will read over his paper, he will see what an immense flow of useless verbiage would have been avoided if he had adhered to the established term "absolute velocity." W. Donaldson.

Seathwaite, October 28th.

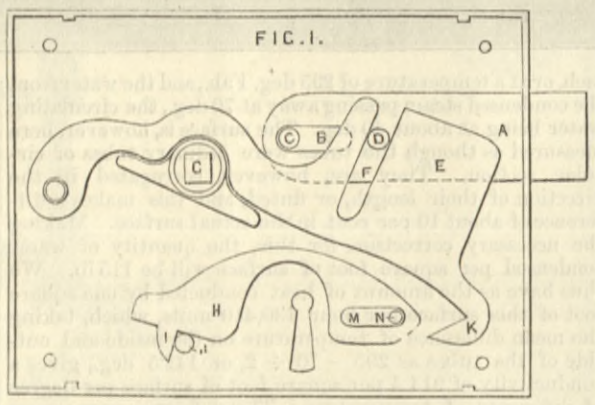
PATENT-OFFICE ADMINISTRATION.

Sir,—Colonel Wethered's letter furnishes a proof, if any were needed, of the utter discredit into which the administration of the Patent-office has fallen; but how could this be otherwise when judicial duties of a delicate and complicated nature were entrusted to gentlemen who, I believe, do not even lay claim to the requisite legal and scientific knowledge, having been educated exclusively in a routine department of the Board of Trade. When a tribunal does not command public confidence it is necessary that a change should be made. The recent articles in a publication which I need not name, in which the Comptroller and his deputy were openly charged with incapacity, have not improved matters, and so far as the public is aware those articles have neither been withdrawn or apologised for. Inventors have clearly a right, when any question affecting their patent arises, to be able to bring the case to a thoroughly competent tribunal, from which appeals should be rare.

There is, however, another point which I should like to bring forward, and that is, that whereas the issue raised by the Examiner in his report is that the conflicting applications "appear to comprise the same invention," the only point decided by the Comptroller is as to their "identity," as is shown from Mr. Clark Hall's letter to Colonel Wethered, published in your last issue. It can hardly be doubted that Mr. Chamberlain's intention was to benefit the inventor, but the breakdown of the judicial and administrative machinery of the Act has rendered this good intention abortive. The possibility of this was clearly foreseen by Sir John Lubbock, who said in his speech at the second reading of the Bill in March, 1883:—"Seeing that the Comptroller was to be a subordinate officer of the Board of Trade, he could not help fearing that it was not intended to appoint a person of sufficiently high standing. It seemed to him that they ought to have some one possessing a similar qualification to the Commissioner of Patents in the United States. It would be a good economy in the long run to get the very best man for such an important work that they could possibly find anywhere." Expert.

London, E.C., October 26th.

Sir,—I trust you will allow me space to make a few observations in reply to your correspondent, Col. E. R. Wethered. The application of Samuel Guinery, October, 1884, No. 14,058, was abandoned because it was found in a measure to have been anticipated by an application of W. C. Jones, dated January, 1884, No. 827, by which, your correspondent's first claim is also anticipated. As regards the second, if he imagines he can claim a weighted lever connected to and actuating a sliding bolt, he labours under a delusion, which is easily proved by reference to prior patents. Brown and Guinery's is new in all its arrangements, and different in every respect to



Col. E. R. Wethered's, the only novelty about which is the retaining pawl, and possibly the striking plate, and cogged arms; to call it a lock is a misnomer, as it provides no arrangement for locking, and some special plan is required. It would have shown a higher appreciation of fair play if Col. E. R. Wethered had given an illustration of Brown and Guinery's lock, Fig. 1, which they distinctly state they prefer to the arrangements shown in Figs. 1, 2 and 3. I therefore ask you to be good enough to insert the correct illustration of Fig. 1 showing the arrangement which Brown and Guinery give preference to in their specification. I have before me the written opinion of Messrs. Carpmael and Co., dated 14th July, 1885, which confirms all I have said with reference to Col. E. R. Wethered's claims. Frederick Brown.

Luton, Oct. 28th.

WATER METERS.

Sir,—You describe in your issue of the 23rd inst. Walker's water meter, exhibited by Mr. G. Kent at South Kensington, and you mention that this meter will register under a very small head of water. As one interested in this class of instruments, and one who has worked for years in this special branch, I wish to express my doubt about the accuracy of the statement made by the manufacturer. A meter on this principle could possibly be got up for a special show, and when in good working trim made to show fancy results; but my humble opinion is that this meter will cause either a considerable loss of head of water when made to be watertight, or else will allow large quantities of water to flow through without registration. A still greater evil is attached to this class of water meters, viz., that they are liable to be completely stopped by grit or other hard substances always present in water, which means cutting off altogether the water supply for the time being. It would be very instructive and interesting to have a fair but crucial and public testing of water meters, without any prizes or medals, so as to arrive at a certain standard of their respective merits.

6, St. Paul's-churchyard, E.C., J. A. Muller, C.E.
October 29th.

STEAM ENGINE ECONOMY.

Sir,—In the "Scientific Notes" of *Chambers' Journal* for April 26th, 1873, I read as follows:—"Some months ago we gave notice of Warsop's aero-steam engine, showing that by pumping hot air into the boiler the power of the engine was increased, the inside of the boiler was kept quite clean and fuel was saved. These advantages had been satisfactorily proved in fixed engines on land, in sea-going steamers, and now a year's experience had demonstrated that the Warsop method can be employed with equal advantage in locomotives on railways. The Lancashire and Yorkshire Railway Company have experimented during the past twelve months with one of their goods engines, and have found that the inside of the boiler does not become foul, that less fuel is burnt, and that the engine does its duty with a spirit and liveliness never shown before. These results are so satisfactory that the company are now fitting the Warsop apparatus to six other engines, which is a promising recognition of its merits." I have copied the above not to advertise the system, but because I see by your paper how much the behaviour of steam in the compound engine is exercising the minds of engineers, and I think that if highly-heated air were introduced either into the boiler, or perhaps better, direct to the steam pipe, a beneficial result might be attained; at least, with high-pressure engines. Some few years ago I had some favourable experience with the introduction of air into a high-pressure engine, and this makes me feel the more desirous to bring the system to your notice, trusting you may find it worthy of the same. W. J. H.

3, Craigie-crescent, Perth, N.B., October 27th.

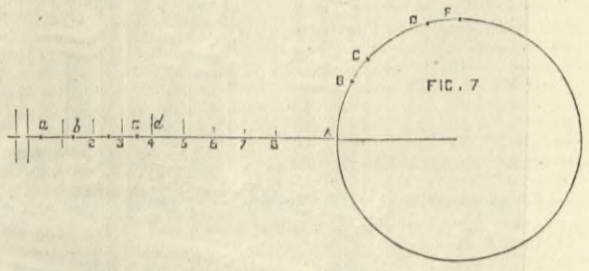
THE LENOIR ENGINE PRACTICALLY CONSIDERED.

Sir,—There have been lengthened disquisitions upon dissociation, stratification, diffusion, gradual combustion, &c., but, I think, inadequate inquiry as to matters which can be weighed and measured, and are within the range of exact science. Not a mechanical engineer, I submit my conclusions with diffidence, confident, however, that examination in detail and correction in measurement, if necessary, will place the action of the engine beyond dispute.

In a ½-horse engine of the earlier modification of the Lenoir patent, which worked for a long time at the office of the company, the following are the dimensions:—

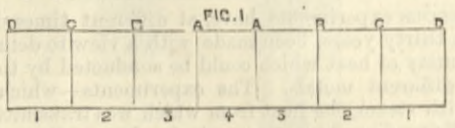
	Inches.
Area	17-72
Clearance (half)	8-86
Port, 4 by ⅜ by 4¼ long	6-375
Valve, 4 by ⅞ by 3½	12-25
Length of stroke, 8in.; ignition at half stroke	
Entire charge, 17-72 by 4½	79-74
Clearance port and valve (not quite a third)	27-485

The following figure will assist in determining the contents of the cylinder:—



Assuming the charge follows by suction the piston, it would travel to *a* take in the contents of the port—products of combustion—and the crank would move from A to B, from *a* to *b* would take in the contents of the valve and bring the crank to C, from *b* to *c* mixture would be taken and leave the crank at D, where the gas is cut off, and from D to E the valve would be exhausted of mixture and be filled with air. The setting of the crank and excentric might vary the speed, but could not make quantitative alterations. Therefore Lenoir takes in first the air in the valve. By the same reason Otto, who takes in gas after the supply of air, fills a large valve or mixing chamber with gas which first is taken into the cylinder, and, mixing with the after inflow of air, supports the contention of thorough diffusion, because experiment shows the absence of gas in the exhaust.

In ascertaining the kind of mixture taken in, unless it can be denied that if you open a door, window, or beer tap—with equal pressure—the flow will increase until the full open and decrease until the close, the following diagrams will assist our purpose. The action by a slide opening and closing any port would be thus. Assume a gas port:—



The air port is larger in Lenoir. Assume thus:—

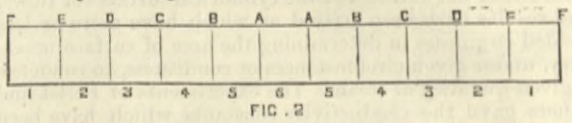


FIG. 2

Apply the gas port to the air port centrally, so that the air entering first and last are equal:—

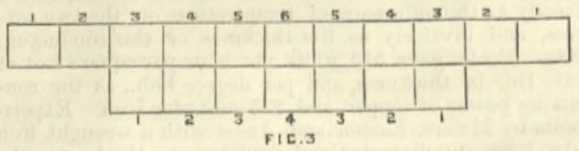


FIG.3

Take the whole of the air in first:—

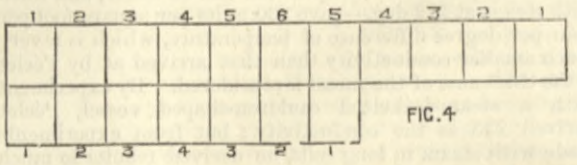


FIG.4

Take it in last:—

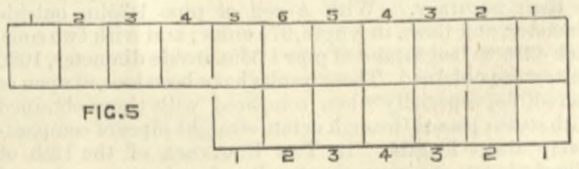


FIG.5

Let the supply of air be constant:—

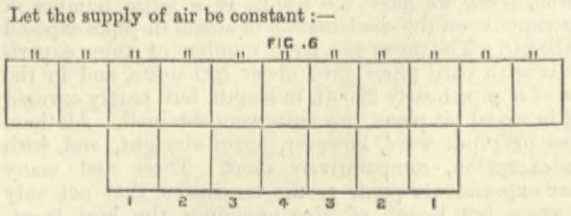


FIG.6

Where ports of different sizes open and close at different times, stratification or gradation, supposing it possible, must exist; and as a fact, in Lenoir, the supply of air being almost constant, would approximate closely the sixth diagram. Air.

October 29th.

Another large and important addition has recently been made to the list of New South Wales coal mines, by the formal opening of the Gladstone Colliery at Katoomba, one of the most picturesque portions of the Blue Mountains. It is situate nearly 1500ft. below the level of the railway, the coal being raised by specially constructed appliances to the edge of the precipice. The seam at present being worked—the middle one—has been opened out by two horizontal drives from an adit in a gorge 1½ mile south from the company's railway siding—which is almost exactly at the sixty-third mile-post from Sydney, on the Great Western line—and is 1200ft. below the railway level, or 2000ft. over the level of the sea. It opens out on the side of a hill facing a gorge, and the entrance is at the bottom of a cliff nearly 1000ft. clear in depth, necessitating the use of ladders to reach it. The drive is already about 750ft. in the hill, and even yet the best quality of the seam has not been touched. A thousand tons per week is the guaranteed output.

RAILWAY MATTERS.

Mr. Hope, accompanied by Sir Donald Stewart, on Wednesday opened the Lower Bolan Railway, the line running from Perchowki to Mutch. It is expected that the railway will reach the Quetta plateau—a distance of twenty-five miles—in about six weeks.

The Indian State Railways are requiring locomotive and carriage bearing springs, and for the new Southern Government railways tenders for twelve four-wheels coupled outside cylinder passenger bogie locomotive engines, with tenders, are being inquired for.

The 24th of this month the Wasa-Gamla-Karleby Railway in Finland was so far finished that the first locomotive passed to Gamla-Karleby, its northern end. It is the farthest towards the north that any locomotive has yet advanced, or nearly to the 64th deg. of latitude. The railway is next year to be extended to Uleaborg, or to still higher latitudes.

As will be seen by reference to the letter from our Birmingham correspondent, the order given out by the Midland Railway Company to a Belgian firm for steel sleepers was but 250 tons for trial, and would have been given to English makers if they had been in possession of the necessary plant, or had not quoted a price high in consequence of their not having this.

A Midland express train from Leeds to Leicester had a very narrow escape of being wrecked, on the 22nd inst., in Alfreton Tunnel, where an inspecting ganger had just discovered that a rail had been broken and completely displaced. He had no lamp or fog signals with him, and to his dismay he heard the express coming down the incline at full speed of sixty miles an hour. Realising the perilous situation, he ran as fast as possible to the mouth of the tunnel. He reached daylight just in time to give the driver the danger signal. The brakes were at once applied, and the train safely brought to rest. The ganger was warmly thanked for having so happily saved the train from destruction. After an hour's delay the rails were restored, and the train proceeded to Leicester.

A few days ago a serious collision occurred at Batley, on the London and North-Western Railway, doing considerable damage to the rolling stock and delaying the traffic. An express goods train from Leeds, comprising twenty carriages and brake van, and laden with butter from Hull, was about to pass through the Batley station when it was shunted to the Birstall siding so as to allow the 10.15 express passenger train to pass. The goods train dashed with considerable force against the stop blocks, and three of the first carriages were smashed to pieces. Other carriages were damaged, and kegs and boxes of butter were hurled about in all directions. The North-Western line and the Great Northern were blocked. The driver and stoker escaped injury by jumping off the engine; the guard received a shock and some contusions. The evidence shows that every care was taken to prevent the accident, the engine being reversed and the brakes applied.

The following illustrates the recent marked development of railway enterprise during the last thirty years in New South Wales, which is rapidly assuming the place of the leading British Colony. Comparative statement of results for period 1855-59 as against 1880-84:—1855-59: Number of passengers, 1,580,958; per average mile of railway, 4,604. 1880-84: Number of passengers, 42,856,909; per average mile of railway, 35,390. 1855-59: Tonnage of goods, 99,861 tons; per average mile of railway, 2628. 1880-84: Tonnage of goods, 12,355,239 tons; per average mile of railway, 10,202. 1855-59: Net earnings £58,377; per average mile of railway, £1536. 1880-84: Net earnings, £3,522,072; per average mile of railway, £2909. These figures will show the importance of the New South Wales railways, as a means of bringing produce from the distant interior of the colony to Sydney and other ports. The colonial population is too sparse to enable the passenger traffic beyond the Sydney suburbs to speedily become remunerative, but the goods traffic is increasing so rapidly as to frequently outstrip the facilities afforded by the various lines.

The cable railroad or elevator by which the summit of Mount Royal, back of Montreal, is reached, has now—a recent *Railroad Gazette* says—been in successful operation nearly a week. The railroad is 403ft., horizontal measurement, the height 275ft., and the length of track 510ft. It is built in a segment of a circle with a reversed side of 12ft., and has an incline of about 33½ deg. The road is supported by sixteen iron pillars set in stone foundations, and the balances are of wood, 12in. by 12in. The gauge of the road is 5ft., with a distance between the tracks of 4ft. The cars are drawn to the top by means of a stationary engine of 75-horse power at the top of the mountain. The wire ropes are three in number, two of them being 1⅛in. diameter, and the middle one 1¼in. The two smaller ones have been tested with a strain of 35 tons, and the centre or safety rope with a strain of 43 tons. The ropes pass over sheaves 6ft. in diameter, and are wound over two drums of wood and iron 10ft. in diameter, and are a direct pull upon the cars. The centre or safety rope runs independently of the engine, and is attached to both cars, so that, in event of the two outside ropes breaking, the centre one would hold the cars in check, beside which the large wheel of 11ft. diameter is provided with brakes, which may be applied from the platform at the top of the incline by the engineer. The fare on the incline is 5 cents up and 3 down.

In a report on the accident which occurred on July 12th, when a carriage left the rails at Mansion House Station, on the Metropolitan District Railway, and then turned over at Cannon-street Station, on the Joint Metropolitan and District Railway, Major-General Hutchinson says, the cause of the accident was to be found in the condition of the left rail at the spot, and that "it is, in my opinion, quite time that some of the rails in the Mansion House Station were renewed, those in the immediate vicinity of the accident being now more worn on the inside of the top table than was the case when it was considered desirable to turn them some time ago end for end. Had there been a check rail round this 10-chain curve, it is highly probable that the accident would have been prevented. Considering the low speed at which trains are travelling round the curve, the super-elevation of 1in. to 1¼in. is probably sufficient. This accident draws attention to the great need of a means of communication between the driver and rear guard of a train. In this case the rear guard was aware of the accident immediately it occurred, and tried, but in vain, as also did some of the station staff, to attract the driver's attention by shouting, his only resource. Had some reliable means of communication existed, the driver could have been stopped at once, and the upsetting of the carriage, which was within an ace of causing a collision with an up train, would have been avoided."

A collision occurred on the North British Railway on August 5th, at Sunnyside Junction, which simply shows how, with the best appliances, the human element brings in uncertain effect. Major-General Hutchinson concludes that "the collision was caused (1) by the neglect of the fireman, Moffatt, who had coupled the engine to the passenger train at South Airdrie, in not connecting the pipe of the Westinghouse brake on the engine to that on the front of the train; (2) by the driver, English, of the passenger train failing to acquaint himself before he started from South Airdrie as to whether the brake connection was made between the engine and train, either by personal inspection or by asking the guard or the fireman who had coupled the engine to the train; (3) by the driver, English, when he went, on finding the brake was not acting, to the back of the engine to see what was amiss, not having the presence of mind to turn the tap in front of the first vehicle, and thus to bring the Westinghouse brake into action; (4) by the negligence of the guard, Cowan, who, instead of looking out for the junction signals, kept himself shut up in his van, and never heard the brake whistles, which were repeatedly given before the junction was reached; had he kept a proper look out for signals, he would have seen that the junction was being overrun, could have applied the Westinghouse brake (the air pressure in the brake cylinders being about 60 lb.), and could have stopped the train in ample time to have prevented the collision."

NOTES AND MEMORANDA.

The rainfall at West Molesey during September was 4·27in., the rainfall during the whole of the year 1884 having been 15·06in.

There are 100,000 more males than females in New South Wales, births and immigration both continuing to contribute to the difference.

According to Dr. Frankland's analytical report "the quality of the water after filtration delivered to the metropolis during the whole of the month of September was very good."

Rich deposits of saltpetre of very high quality were recently, it is reported, discovered in the transcaspian region near the Atreck River and in the neighbourhood of Sukum.

The depths of the lakes in Scotland have been given as follows:—Loch Lomond, maximum depth of 105 fathoms, Loch Ness of 129 fathoms, and Loch Morn of 180 fathoms. The bottom of this lake is the lowest level in the British Islands.

The annual rate of taxation per head in Australasia is—South Australia, £1 16s. 7d.; New South Wales, £2 8s.; Victoria, £2 9s.; Tasmania, £2 13s. 7d.; New Zealand, £3 7s. 7d.; Queensland, £3 13s.; Western Australia, £3 18s. 9d.

The number of tons of coal exported from the port of Newcastle, New South Wales, during the six months from the 1st of January to the 30th June last, to foreign ports, was 791,636, being an excess of 35,579 tons over the quantity for the corresponding period of 1884.

The rapid progress of population in New South Wales is shown by the fact that, with an area of 310,700 square miles, it contains a larger number of inhabitants than South Australia, Queensland, Western Australia, and Tasmania, with a combined area of 2,658,402 square miles.

L'Illustration states that a manufacturer of Breslau has built a chimney 16 metres high (51ft. 6in.) entirely of paper. The blocks used in its construction, instead of being of brick or stone, were made of layers of compressed paper, jointed with some siliceous cement. The chimney is very elastic, and at the same time is fireproof, and is less liable than ordinary chimneys to be struck by lightning.

Messrs. Martin et Cie have taken out a French patent for the coating of the metallic cages of the hydro-extractors in such a way that they resist the action of the chemicals. The inventors employ a coating of caoutchouc; they first apply a solution of india-rubber, and before it has time to dry they apply on the same a caoutchouc sheet, which is thus strongly bound to the metal. The perforations of the interior of the cage are also coated with india-rubber, and so is the exterior of the cage itself. The *Scientific American* says: "The whole is exposed to vulcanisation, and the holes bored or cut in such a way that the holes in the caoutchouc are smaller than those on the metal."

The deaths registered during the week ending the 17th inst. in twenty-eight great towns of England and Wales corresponded to an annual rate of 17·7 per 1000 of their aggregate population, which is estimated at 8,906,446 persons in the middle of this year. In London 2582 births and 1346 deaths were registered. The annual death-rate per 1000 from all causes, which had been 13·8, 16·0, and 16·7 in the three preceding weeks, rose last week to 17·2. During the thirteen weeks of last quarter the death-rate averaged 18·1 per 1000, against 20·0 in the corresponding periods of the nine years 1876-84. In Greater London 3379 births and 1624 deaths were registered, equal to annual rates of 33·9 and 16·3 per 1000 of the population. In the Outer Ring one fatal case of small-pox was registered in West Ham, and two of fever in Sunbury sub-districts.

In his account in the London *Graphic* of his journey to Kilimajaro, Africa, Mr. H. H. Johnston describes a native forge:—The Ma-Chaga, he says, are clever smiths, and forge all kinds of utensils, weapons, and ornaments from the pig iron they receive from the country of Usanga, near Lake Jipé. The forge is but a pair of goat-skin bellows, converging into a hollow cone of wood, to which are added two more segments of stone, pierced through the centre and ending in a stone nozzle, which is thrust into the furnace of charcoal. The bellows are kept steady by several pegs thrust into the ground, and a huge stone is often placed on the pipe to keep it firm. After the iron has been heated white hot in the charcoal, it is taken out by the iron pincers and beaten on a stone anvil. The Chaga smiths not only make spear-blades and knives of apparently tempered steel, but can fabricate the finest and most delicate chains.

In an abstract in the *Journal of the Chemical Society* of a paper on the percentage of oxygen in the air, by W. Hempel, it is remarked that Kreusler lately—*Landwirthsch. Jahrb.* xiv. 305—published a long series of oxygen determinations of atmospheric air, made during 1883-84 with an improved form of Jolly's apparatus. His results show fluctuations between 20·88 and 20·94 per cent. oxygen, the mean of ninety-nine observations made during 1883 being 20·91 per cent. The author refers to alleged sources of error in his own and in Jolly's method, and defends the accuracy of the former. The author has made a similar set of forty-five determinations from February 3rd to March 28th, with the apparatus lately described by him—*Ber.* xviii. 267. His results show fluctuations between 20·877 and 20·971 per cent., the mean being 20·93 per cent. Morley, making daily experiments in America during six months in 1880, obtained 20·949 per cent. as the mean.

In their monthly report on the water supply of London, Messrs. William Crookes, F.R.S., William Odling, F.R.S., and Dr. C. Meymott Tidy, F.R.S., say:—"The uninterruptedly excellent quality of the water supply during the past three months, in respect to its degree of freedom from organic matter and from turbidity and tint of colour, has exceeded anything that we have had occasion heretofore to report on during the corresponding quarter of the year. Altogether we have examined during the past quarter 546 samples of water, the whole of which were found, without exception, to be clear, bright, and well filtered. The maximum quantity of organic carbon found in any one sample was ·146 part in 100,000 parts of the water; while the mean quantity present in the Thames-derived supply was ·119 part, and the mean quantity in the entire supply ·110 part in 100,000 parts of the water—corresponding, respectively, to just a little over and to just a little under two-tenths of a grain of organic matter per gallon, or to less than the 3000th part of 1 per cent.

Eighteen hundred buildings for dwelling purposes, more than half of them being large flats or tenement houses, were erected in New York last year at an expense of over 30,000,000 dols. Yet the increase of houses only keeps pace with the steady growth of the population of the city, which now numbers about 1,400,000. When the fire department made its last count there were 101,735 buildings of all kinds standing within the city limits, and the present number is about 103,000. Of buildings used exclusively for dwelling purposes there are 48,780. If the population were distributed evenly each house would contain eighteen persons, but there are 21,580 tenement houses which contain from two to four families on each floor. About 3600 of these houses are more than four stories in height, and 1800 of them are rear houses. There are also 16,800 flat houses or tenement houses which have an average of one family on each floor. A gradual thinning in tenement house districts is being brought about by the law which provides for the erection of fire escapes on the front walls of houses which contain more than two families on each floor. The proprietor, however, objects to the erection of such fixtures and they accordingly knock out some partitions, drive out a few families, and bind themselves by affidavits filed in the Bureau of Buildings not to permit more than two families to occupy a single floor. Only 47 dwellings in the whole city are regarded by the officers of the fire department as fireproof. No fewer than 17,600 dwellings, 4190 of them being tenement houses, are wooden buildings.

MISCELLANEA.

The Great Eastern steamship was sold at Lloyd's on Wednesday for £26,200.

Messrs. John Lysaght, Limited, of St. Vincent's Galvanised Ironworks, Bristol, have removed their London offices from 28 to 36, Gracechurch-street, E.C.

Messrs. R. Hornsby and Sons have received information that their binder has taken first prize at the Field Trials of the Royal Agricultural Society of South Australia, at Smithfield.

Recently two leases have been taken up at Back Creek, near Rockley, New South Wales, 167 miles from Sydney, for manganese, and already 200 tons have been sent to London from these mines.

Mr. C. B. Harness, of the Medical Battery Company, suggests that the ordinary penny stamp should be perforated diagonally, and that either triangle should be available for use as a half-penny stamp. The convenience of this device will be at once apparent.

A notice to the following effect is posted up outside the office of a large works in the Manchester district:—"Notice! The hours of attendance in this office are: To canvassers for Church subscriptions, 10 to 2; book and insurance agents, 2 to 4; commercial travellers, beggars, and advertising men, all day. We attend to our own business at night."

Those who are gathering material for a farce concerning vestry work and vestrymen's ways must not omit to look at the Richmond papers. An engineer, who has been some time engaged as a borough surveyor under a corporation with some jack-of-all-trade members of council, says he thinks Paul must have referred to council affairs when he spoke of the beasts of Ephesus.

The Canadian correspondent of the *Liverpool Journal of Commerce*, says:—The steam plough—Mr. Ingleton's patent—is now working in the neighbourhood of Virden, and is giving the highest satisfaction, getting over two acres of stubble land per hour. It has been on view at the Virden Agricultural Society's Show, and it excited a great deal of interest amongst agriculturists.

Rolled gimlet-pointed screws made with machines and under Harvey's patents, are being sold by Messrs. J. H. Ladd and Co., of Queen Victoria-street. The threads are rolled up, are strong, and there being the same quantity of metal in the screw part as in the shank, they are more perfect than the ordinary screw. The sample we have received shows them to be a commendable article.

The total number of horses owned by the General Omnibus Company of Paris, at their various depôts, is 13,679; of these, 9377 are employed for the omnibus service, 3541 for the tramways, 586 for the omnibus service from the railway stations, and 175 at Versailles. This would give an average per vehicle, for the omnibuses, of 15 horses, 13·73 for each tram-car, and 14·19 for the service from the railway station.

Eleven tenders had, at despatch of recent news, been opened by the New South Wales Board of Land and Works for the erection of a new bridge at the site of the old Prince's Bridge across the Yarra. The lowest tender, *India and the Colonies* is told, was that of Mr. D. Munro, who undertakes to carry out the whole of the works included in the contract for £136,998, if he has the option of using some of the material of the old bridge, and £141,000 if only new material is to be used.

According to the German Imperial law for the protection of trade marks, dated November 30th, 1874, section 5, No. 3, a registered trade-mark is forfeited if ten years have elapsed since its registration without any notice having been given of its further extension, or if the same period has elapsed since such notice, without a renewal of the same. As this law took effect May 1st, 1875, the provision of section 5, No. 3, has been applicable since May 1st last. With foreign manufacturers, some grace may be allowed, so that it may not actually take effect until somewhat later.

Ships sometimes "come down in the world," instead of sinking in the sea. The Czar Alexander's famous yacht, the Livadia, turned up not long ago as a coal hulk in the harbour of Sebastopol. This is an ignominious ending for a craft which was expected to revolutionise marine architecture. Her hull was hidden in a projecting basement, which supported a row of pillars; she had four tiers of decks paved with black, white, and red marble; there was a magnificent marble fountain; the baths were hewn from white marble blocks; rows of electric lights illuminated the saloons and avenue-like corridors, and the many sets of apartments were finished in rare woods and stones. But the Livadia was not a safe sailor, and she was practically discarded as worthless.

The first meeting of the twenty-ninth session of the Institution of Engineers and Shipbuilders in Scotland was held in Glasgow on Tuesday evening, when the following awards for papers read during 1883-84 were made:—The Institution medal to Mr. Ralph Moore, C.E., for his paper on "Cable Tramways;" the Marine Engineering medal to Mr. John Harvard Biles, for his paper on "The Stability of Ships at Launching;" a premium of books to Mr. Robert L. Weighton, M.A., for his paper on "The Compound Engine, viewed in its Economcal Aspect;" and a premium of books to Messrs. Purvis and Kindermann, for their paper on "The Approximations to Curves of Stability from data to known Ships."

The report of the examination made by Colonel Sir Francis Bolton, C.E., Official Water Examiner appointed under the Metropolis Water Act, 1871, of the water supplied by the several metropolitan water companies during the month of September, 1885, states that the water in the Thames at Hampton, Molesey, and Sunbury, where the intakes of the West Middlesex, Grand Junction, Southwark and Vauxhall, Lambeth, Chelsea, and East London Companies are situated, was good in quality, and during the whole of the month of September, with the exception of the 12th and 13th, when it was indifferent. The intakes are closed as much as possible during floods, to avoid taking in turbid water. The highest flood state of the river at West Molesey during this month was 7in. above summer level mark, and the lowest was 6in. below that mark.

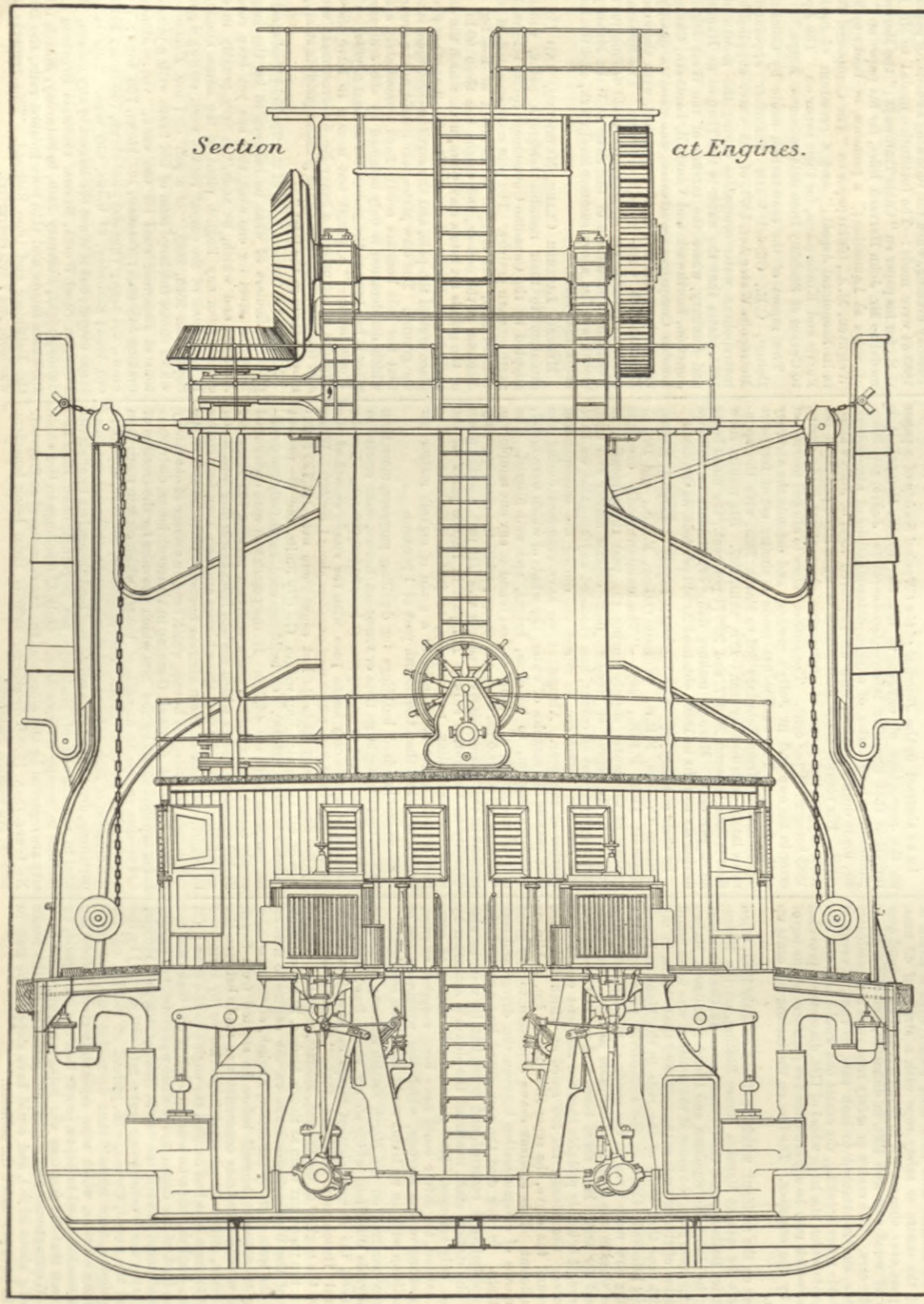
Messrs. Latimer Clark, Muirhead, and Co. are drawing attention to their metallic telegraph poles, which have been adopted by the Canadian Government for its telegraph lines on the north-western prairies. The pole is constructed of malleable galvanised iron, and is 1½in. in diameter at the top and 2½in. in diameter at the bottom, and weighs less than 50 lb. The bottom of the pole is set into a claw plate, upon which the earth is closely packed to a height of about 2ft. Then another plate is put into place around the pole, and the earth packed upon it to the level of the ground. The claw plates take a hold in the ground at once, so that the pole becomes solidly fixed immediately after being set, which desideratum is only obtained by the ordinary wooden pole after it has been in the ground for at least a year. The *Electrical World* says:—"A recent test is said to have shown the great strength of the pole, as a heavy No. 6 Government wire was strung and the poles subjected to the greatest possible strain, but without moving them in the least."

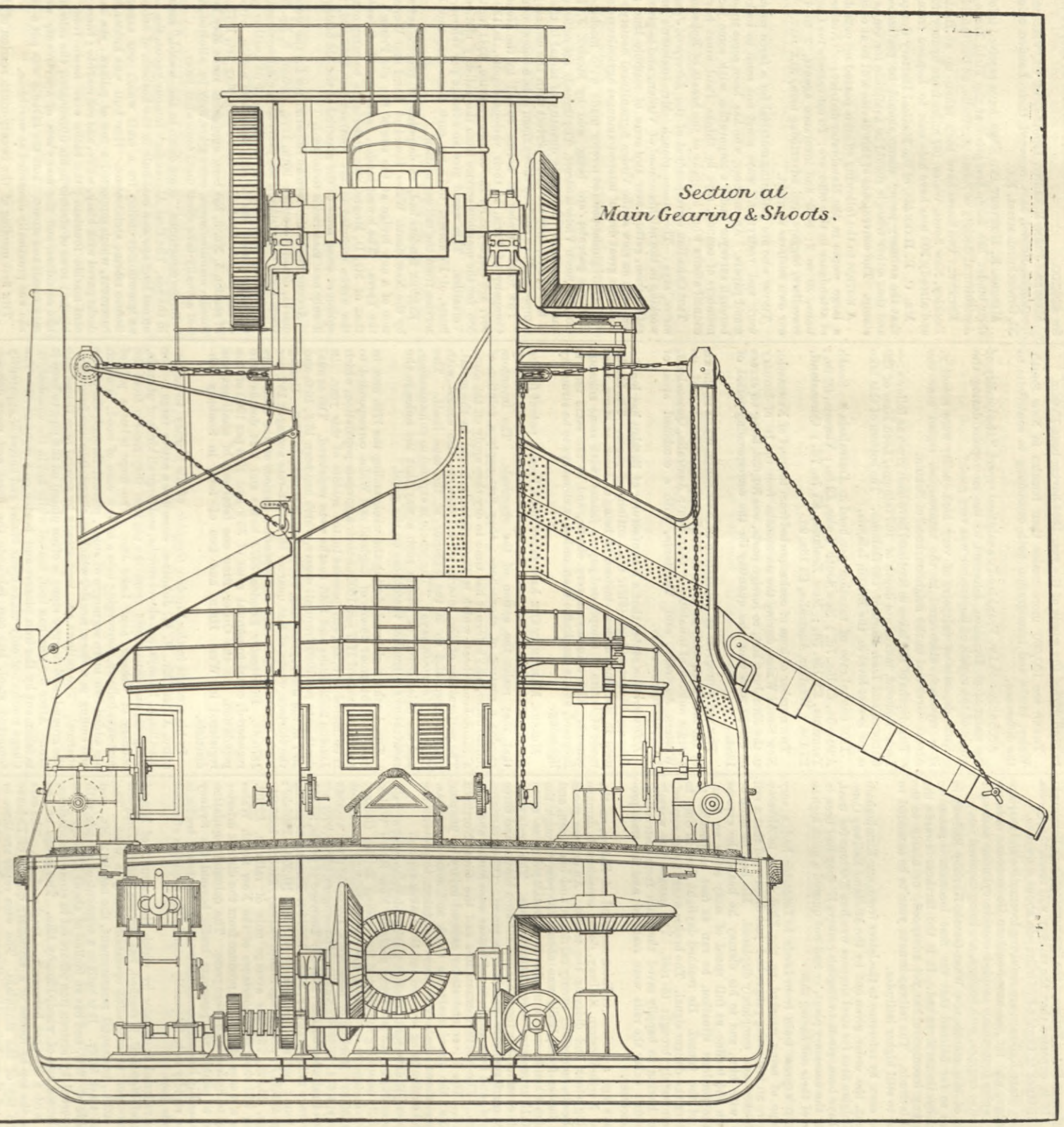
Mr. W. H. Greenwood, of the Sheffield Technical School, supplies particulars of what he believes to be the largest make of Bessemer steel for one week that has yet been recorded even in America, and which, he adds, "is very greatly in excess of the output from any English plant of the same nominal capacity." It is a record of the output for the week ending 4 p.m., Saturday, September 26th, 1885, "of a pair of 7-ton Bessemer converters, which shows the large total of 551 heats with a production of 4005 tons of Bessemer steel for the week," viz.:—Monday, 75 blows, making 545 tons; Tuesday, 103 blows, 755 tons; Wednesday, 95 blows, 691 tons; Thursday, 102 blows, 743 tons; Friday, 92 blows, 661 tons; Saturday, 84 blows, 610 tons. This is undoubtedly a large output, but it is not the largest by any means. At the Edgar-Thomson Steel Works, Messrs. Carnegie Brothers and Co., from Sunday night, February 24th, to Saturday, March 1st, 1884, made 4653 tons ingots and 4110 tons finished rails, the latter being for the Baltimore and Ohio Railroad. This remarkable production was from two 7-ton converters.

BARGE-LOADING DREDGER "MELBOURNE," FOR THE MELBOURNE HARBOUR COMMISSIONERS.

MESSRS. W. SIMONS AND CO., RENFREW, ENGINEERS.

(*For description see page 337.*





THE BARGE DREDGER, "MELBOURNE."

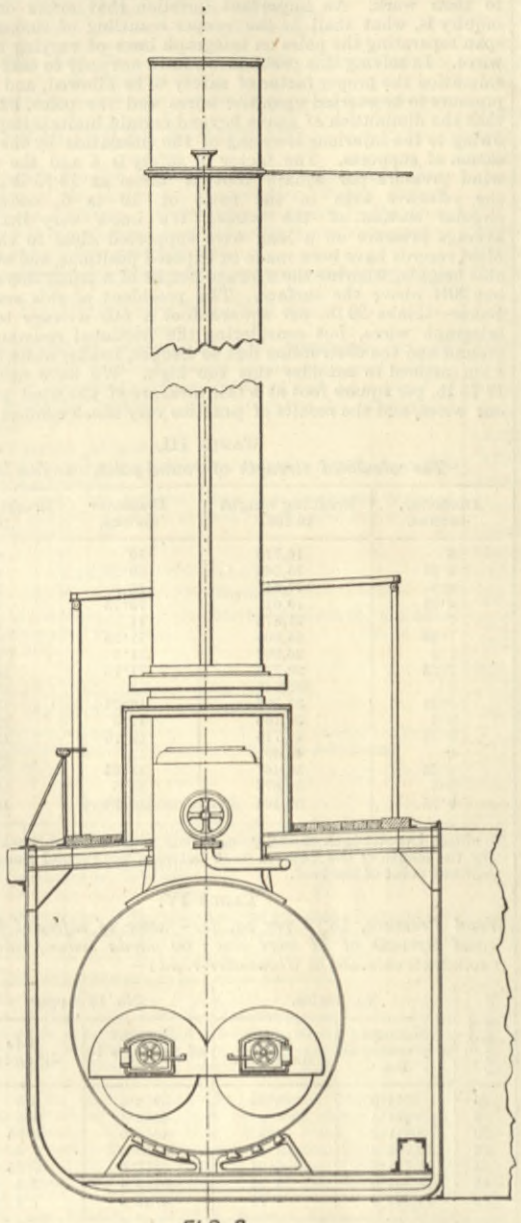


FIG. 2.
AT BOILERS

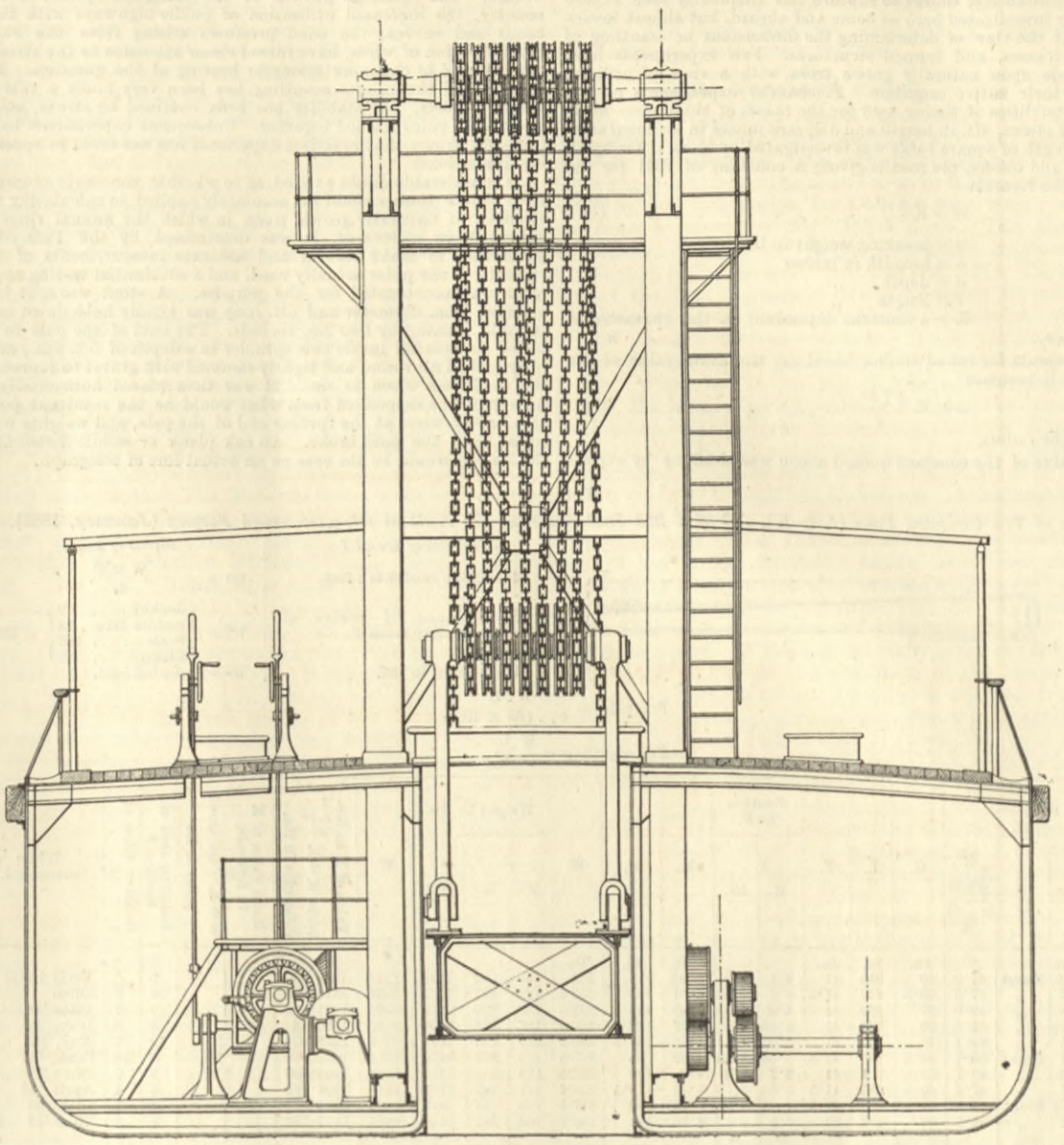


FIG. 1.
AT SHEARS

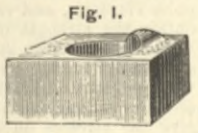
THE DREDGER "MELBOURNE."

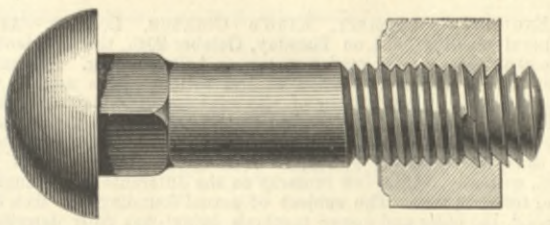
Above and on page 336 we give further illustrations of this big dredger. These will be supplemented by engravings of the machinery and a description in another issue.

THE EUREKA LOCK-NUT.

The lock-nut illustrated in the accompanying engravings is now being brought out by the patentees and manufacturers, Messrs. Bayliss, Jones, and Bayliss, of Wolverhampton and Cannon-street. A simple and effective locking arrangement for such work as fishing rails is a great desideratum. Many forms have been brought out, but none so simple as the Eureka, which is made in the ordinary way, with the exception that on the outside surface of it a small pyramidical prominence is left, as seen in Fig. 1. After screwing the nut this prominence is compressed and the outside surface made level, but in the act of compressing it three threads of the nut are deformed where the prominence has been pressed into the nut, as shown by Fig. 2. The nut will run easily on the male screw or bolt until the deformed or irregular threads are reached in the nut, when the spanner is

Fig. 1.





necessary, and with its aid the nut, while passing along the bolt, deforms the thread—as seen in Fig. 3—so that at the point where the operation of screwing terminates the threads of the bolt accommodate their shape to the deviation in the three

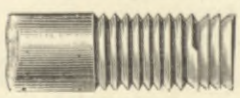


Fig. 3

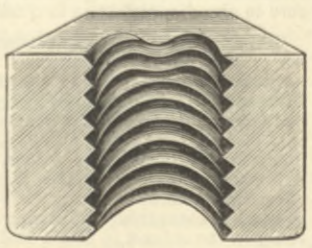
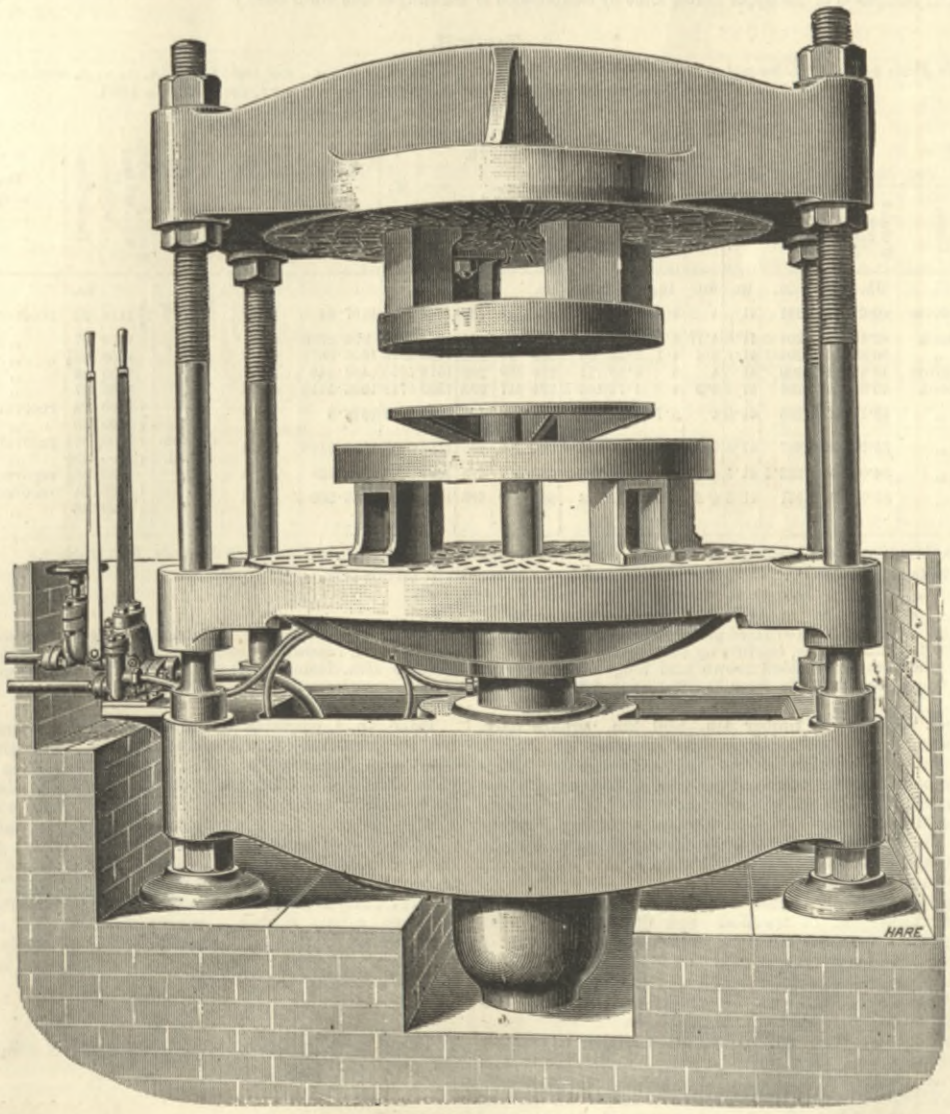


Fig. 2

threads of the nut in such a way that it is impossible for the bolt or nut to be moved either way without the aid of a spanner and considerable force. The makers have had these nuts on a large and powerful multiple press for nine months without requiring to be touched, whereas previously they had used other lock-nuts, which, owing to the continual vibration of the machine, needed constant supervision and daily tightening. They claim several advantages as possessed by this nut, including simplicity, security, cheapness, that it will not move even if the bolt becomes elongated in work, and that it can be used several times. They make them in iron and in steel, but they specially commend mild steel bolts and nuts.

BERRY'S HYDRAULIC FORGING PRESS.

The illustration above shows an improved hydraulic plate flanging and forging press, capable of flanging a plate 6ft. diameter and ¾in. thick, made by Mr. Henry Berry, Croydon Works, Leeds. The improvement consists of having one centre vice ram, the main ram acting as the cylinder for it. The usual practice was to have four small vice rams, with their cylinders, placed round outside the main ram. The objection to this plan is that they cannot be got into a small plate—nothing smaller than 3ft. diameter—and also much more complication. The mode of operation is:—The plate about to be flanged is placed upon the small table; the pressure is then let on the small ram by one of the valve levers shown. The ram rises and holds the plate between the table and die, as in a vice, keeping it perfectly level until the large ram is sent up, bringing up the large table which carries the matrix, and does the flanging. Mr. Berry has made several of these presses, and wherever supplied they have given very great satisfaction. He has two in hand at present.



BERRY'S HYDRAULIC FORGING PRESS.

ON THE STRENGTH OF ROUND TIMBER.

By W. H. Preece, F.R.S., Memb. Inst. C.E.*

The resistance of timber to rupture has frequently been experimentally investigated both at home and abroad, but almost invariably with the view of determining the dimensions or scantling of beams, trusses, and framed structures. Few experiments have been made upon naturally grown trees with a view of utilising them in their native condition. Fincham's† experiments on the relative qualities of timber used for the masts of ships were made upon cut pieces, 4ft. in length and 3 square inches in sectional area. The strength of square balks was investigated by Messrs. Tredgold, Barlow, and others, the results giving a constant of 1341 for red pine in the formula

$$w = K \frac{b\,d^2}{l} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where w = breaking weight in lbs.
b = breadth in inches
d = depth ,,
l = length ,,
K = a constant dependent on the character of the timber.

The formula for round timber based on the same value of the constant K becomes

$$w = K \frac{4{\cdot}7\,r^3}{l} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

r being the radius.

The value of the constant quoted above was obtained by experiments on small sections of timber 1in. and 2in. square only. Wisely distrusting results obtained in this manner, Mr. Edwin Clark during the construction of the Britannia tubular bridge caused trials to be made with beams of red pine 12in. square, which gave a constant of 810 only, whilst experiments on balks of Baltic fir made by the Mersey Dock Board gave results varying between 771 and 873. Mr. Gavey, during certain investigations made in Bristol in 1876, obtained a constant of 804 from square sections cut out of Norway round telegraph poles.

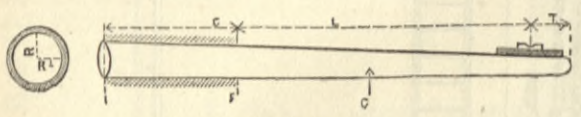
Telegraph poles in England now consist principally of native grown unhewn Norwegian or Swedish red fir, preserved with creosote. They have acquired their pre-eminence by a species of natural selection, after extended trials of cut Memel timber, native grown larch, and preserved Scotch fir. The Scandinavian red fir is now almost exclusively employed. It seems to have been provided by nature specially for telegraphic purposes.

The specifications for telegraph poles, in addition to quoting dimensions, prescribe that they are to be winter felled, sound and hard grown—*i.e.*, well-hearted, with the annual rings closely pitched—straight, free from large or dead knots and other defects, to have the bark completely removed, and to contain the natural butt of the tree. They are usually from 5in. to 6in. diameter at the top, and they grow with a taper that accords satisfactorily with the theoretical law that should give the greatest strength at each section of their length. No systematic inquiry has, as far as I am aware, been made into the mechanical properties of Scandinavian red fir in its native or unhewn state, though at different times isolated experiments have been made on its resistance to flexure. The immense growth of the telegraph system in this country, the increased utilisation of public highways with their bends and curves, the wind pressures arising from the rapid multiplication of wires, have forced closer attention to the stresses applied, and to the more scientific bearing of the question. The selection of the proper scantling has been very much a rule-of-thumb process, but stability has been obtained by struts, stays, and double poles framed together. Subsequent experiments have, however, shown that practical experience has not erred in specifying dimensions.

As considerable doubt existed as to whether constants obtained from square timber could be accurately applied in calculating the strength of naturally grown trees, in which the annual rings of growth were unsevered, it was determined by the Post-office authorities to make careful and accurate measurements of the strength of the poles actually used, and a substantial testing apparatus was constructed for the purpose. A stout wrought iron cylinder 14in. diameter and 6ft. long was rigidly held down on a suitable framing by two 2in. tie rods. The butt of the pole to be tested was placed inside this cylinder to a depth of 5ft. 6in., carefully packed all round and tightly rammed with gravel to represent the conditions when in use. It was then placed horizontally, a scale pan was suspended from what would be the resultant point of a line of wires at the further end of the pole, and weights were added until the pole broke. An oak plank or saddle distributed the load as would be the case on an actual line of telegraph.

Table I.

Tests of Ten Creosoted Poles (A *to* K), *and of a Red Deal Scantling* (1), *made at Gloucester-road Factory* (*January*, 1885).



Details of L *and* T.

M = cubic contents : feet.

C = distance of centre of gravity from F.

W = weight in lbs.

Details of Load.

$W^1 = \frac{W \times C}{L}$.

W^2 = Jockey .. 9; Saddle tree. 84; Scale .. .. 165; Chain .. .. 35 } = 293.

W^3 = Added load.

For poles $= \frac{W \cdot L}{4{\cdot}7 \cdot (R^2 \times R^1)}$.

For scantling $= \frac{W\ L}{D^2\ B}$.

Index.	Length.	Class.	Weight per cub. ft. in lb.	G.	L.	T.	Section at F. R.	Section at F. R^1.	M.	C.	W.	Weight in lbs. W^1.	Weight in lbs. W^2.	Weight in lbs. W^3.	W.	Value of K in formula $W = K\frac{4{\cdot}7\,r^3}{l}$ Results in lbs.	Mean value of K in formula, $W = K\frac{D^3}{l}$ for stout poles in lb.	Relative area of Section F.	Relative value of K.	When creosoted.	
	ft. in.			in.	in.	in.			c. ft.	in.	lb.										
a	26 3	Stout	41·9	60	214	41	4·1	3·9	6·02	110	252	129	293	1431	1853	1286·88		5	3	Early in '81	(1)
b	26 2	,,	37·3	60·5	212	41·5	4·2	4·15	6·31	109	235·4	121	293	1723	2137	1316·672		6	5	Ditto	(2)
c	28 4	,,	49·0	67	239	41	4·6	4·55	7·99	116	391·5	190	293	2019	2502	1321·488		9	7	Ditto '82	(3)
d	30 0½	,,	51·0	60	252	41	4·45	4·4	7·97	122·5	406·5	197	293	1656	2146	1320·48		8	6	Dec., '84	(4)
e	34 5	,,	44·1	66	306	41	5·0	4·75	11·13	136·5	490·8	219	293	1797	2309	1265·936		10	2	May, '82	(5)
f	24 1	Light	50·7	64·5	193	41·5	3·54	3·45	4·09	96	207·3	103	293	1175	1571	1483·776		1	10	Sept., '84	(6)
g	26 0	,,	49·7	60	209	41	3·7	3·6	4·8	108	238·5	123	293	1212	1628	1468·880		2	9	Ditto '83	(7)
h	28 1	,,	47·3	60·5	235	41·5	3·95	3·75	5·46	110·5	258·2	121	293	1107	1521	1299·766		3	4	April, '82	(8)
i	29 10½	Stout	45·2	64·5	252	41·5	4·05	3·95	7·69	142	347·5	196	293	949	1438	1190		4	1	Ditto '84	(9)
k	33 8	,,	39·5	66	298	40	4·5	4·2	8·78	143	346·8	166	293	1442	1901	1417·136		7	8	'70 or '73	(10)
							D	B													
l	13 11½	,,	32·3	36	89	42·5	5·5	4·0	1·67	65·75	54·2	40	120	789	949	698·0176		—	—	—	(11)

Constant mean of *a*, *b*, *c*, *d*, *e*, *i*, *k*, for formula, $W = K\,4{\cdot}7\,\frac{R^3}{l} = 1302{\cdot}56$ lb.

Ditto ditto for formula, $W = K\,\frac{D^3}{l} = 765{\cdot}2512$ lb.

Quality of timber and remarks.—(1) Very hard grown; (2) medium grown; (3) medium grown, sapwood large, fracture flakey; (4) very hard grown; (5) medium hard grown; (6) medium hard grown; (7) medium hard grown; (8) very hard grown; (9) very hard grown; (10) very hard grown, fracture flakey; (11) rather a coarse piece, placed in error heart side up, fracture at a knot just inside F. (Note.—Some of the poles fractured by elongation of the upper fibres, some by compression or buckling of the lower ones.)

Table II.

Further Pole Tests made at Gloucester-road Factory (*in April and May*, 1885), *viz., six indexed l, m, n, o, p, and q, creosoted, and erected in* 1870 *or* 1871, *and three uncreosoted, indexed r, s, and t, imported in* 1884.

Index.	Length.	Class.	Weight per cub. ft.	G.	L.	T	Section at F. R.	Section at F. R^1.	M.	C.	W.	Weight in lb. W^1.	Weight in lb. W^2.	Weight in lb. W^3.	W.	K for result in lb.	Relative area of section at F.	Relative value of K.	When creosoted.	Load in., when W^2+W^3 was equal.	Deflection.	Recovery when weight removed.	
	ft. in.		lb.	in.	in.	in.	in.	in.	c.ft.	in.	lb.										in.		
l	28 0	medium	40·22	64	231	41	4	3·6	5·81	120	234	121	293	1342	1756	1497·44	1	8	1870 or 1871.	1414	32	recovered	(12)
m	26 0	stout	42·46	66	204·5	41·5	4·75	4·25	6·56	98	279	133	293	1674	2100	952·8736	8	1	,,	1776	27	,,	(13)
n	26 0	,,	36·85	65	205·5	41·5	4·4	4·1	5·55	95	204	95	293	1530	1918	1056·5072	6	3	,,	1250	23½	,,	(14)
o	27 11	medium	40·45	64·5	229	41·5	4	4	6·53	121	264	139	293	1518	1950	1484·448	3	7	,,	1355	29	,,	(15)
p	26 0	stout	40·93	64·5	206	41·5	4·3	4	5·72	103·5	234	117	293	1339	1749	1036·4816	4	2	,,	1480	27	,,	(16)
q	26 0	,,	43·11	65·5	205	41·5	4	3·7	5·49	109·5	237	126	293	1789	2208	1626·8	2	9	,,	1700	28	recovered	(17)
																				1969	35	,, all but 1½in.	
r	29 7	,,	35·27	66·5	247	41·5	4·8	4·6	8·08	113	285	130	293	1794	2217	1099·3136	9	4	uncreosoted.	1629	35½	recovered	(18)
s	30 0	,,	34·06	66	252·5	41·5	4·5	4·25	7·72	122	263	127	293	1602	2022	1262·128	7	5	,,	1855	43½	,, all but 2in.	
																				1668	36½	recovered	(19)
t	29 10½	,,	39·97	66	251	41·5	4·3	4·25	7·58	124	303	149	293	1520	1962	1333·360	5	6	,,	1280	31	recovered	(20)
																				1429	48	,, all but 3½in.	(21)

Note.—For explanation of the headings see Table of Tests, *a* to *k*, made at Gloucester-road Factory in January, 1885, Table I.

Note.—Poles indexed .. .. .. *l* to *q* are believed to have been erected in 1871 or 1872.
,, ,, ... *m*, *n*, *p*, *q* were taken down in March, 1882.
,, ,, ... *l* and *o* were taken down in August, 1883.

Quality of timber and remarks.—(12) Hard grown, very sound, fracture 2ft. from F; (13) sound timber, still smells strongly of creosote, fracture short 17in. from F; (14) medium quality, fracture by compression 3in. from F; (15) soft grown, fracture by compression 18in. from F; (16) knotty and soft grown, fracture 3ft. from F; (17) hard grown and tough, fracture by compression 18in. from F; (18) soft, fracture by compression 18in. from F; (19) sound hard wood, fracture 31½in. from F; (20) no cut, fracture 2ft. from F; (21) no cut, fracture 6ft. from F.

Table No. I. contains the results of the experiments made upon ten comparatively newly creosoted poles. This gives a mean constant with formula 2 of 1337, that obtained from the seven stout poles alone being 1302, and from the thin light poles 1417. As the investigation referred primarily to lines built with stout poles, 1302 is the value used in calculating subsequent tables.

Table No. II. contains the results of similar experiments made upon six old poles creosoted fifteen years ago, and upon three new creosoted poles, the constants being 1276 and 1232 respectively. As previously stated, formula 2 is really derived from experiments made on square timber, a multiplier being used to reduce results when round timber is in question. But obviously the strength of round timber varies as the cube of the diameter, so a constant has been obtained for the formula

$$w = K\,\frac{D^3}{l} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad 3$$

D being the diameter; whilst for poles of elliptical section it becomes

$$w = K\,\frac{D^2 \times D_1}{l} \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

D being the axis in the line of stress, and D_1 that at right angles to it. The value of K, for formulæ 3 and 4, as deduced from the mean of the experiments on new stout creosoted poles, is 765. It appears from these experiments that creosoting does not impair the strength of red fir, and age has had no apparent influence on its qualities. The curves formed by the poles in bending were very perfect. Rupture invariably took place at the ground line, and about half broke by fracture of the upper fibres under tension, while the other half buckled in the fibres under compression, showing that nature had proportioned them well to their work. An important question that arises out of this inquiry is, what shall be the proper scantling of timber and the span separating the poles on telegraph lines of varying number of wires. In solving this problem we have not only to take into consideration the proper factor of safety to be allowed, and the wind pressure to be exerted upon the wires and the poles, but the fact that the diminution of spans beyond certain limits is impracticable owing to the injurious lowering of the insulation by the multiplication of supports. The factor of safety is 4 and the maximum wind pressure per square foot is taken at 18·75 lb., reducing the effective area in the ratio of 10 to 6, owing to the circular section of the wires. We know very little of the average pressure on a long wire supported close to the ground. Most records have been made in exposed positions, and at considerable heights, whereas the average height of a trunk line of wires is but 20ft. above the surface. The president of this section—Mr. Baker—thinks 30 lb. per square foot a fair average to take for telegraph wires, but considering the frictional resistance of the ground and the obstruction due to hedges, banks, walls, trees, &c., I am inclined to consider this too high. We have usually taken 18·75 lb. per square foot as a fair measure of the wind pressure on our wires, and the results of practice very much confirm this view.

Table III.

The calculated strength of round poles, one foot long.

Diameter. metres.	Breaking weight in lbs.	Diameter metres.	Breaking weight in lbs.
6	13,776	10	63,773
6·25	15,568	10·25	68,678
6·5	17,517	10·5	73,819
6·75	19,611	10·75	79,218
7	21,873	11	84,874
7·25	24,304	11·25	90,798
7·5	26,902	11·5	96,992
7·75	29,725	11·75	103,454
8	32,648	12	110,196
8·25	35,807	12·25	117,219
8·5	39,166	12·5	124,555
8·75	42,716	12·75	132,182
9	46,491	13	140,100
9·25	50,467	13·25	148,344
9·5	54,678	13·5	156,901
9·75	59,102	13·75	165,782

To obtain the strength of any pole, divide the tabulated breaking weight by the length of the pole in feet between the ground line and the resultant point of the load.

Table IV.

Wind Pressure, 18·75 *per sq. ft.—factor of safety of* 4; *Strains and Strength of* 17 *wire line*; 60 *yards spans*; *calculated to constants obtained at Gloucester-road* :—

Length of Pole.	No. 8 wire. Moment of pressure in lbs.	No. 8 wire. Safe diameter.	No. 14 copper. Moment of pressure in lbs.	No. 14 copper. Safe diameter.	Present specification diam.
26	8344·0	8·25	3953·6	6·0	8·25
28	9374·4	8·5	4446·4	6·5	8·75
30	9811·2	8·5	4648·0	6·75	9·0
32	10,796·8	8·75	5118·4	7·0	9·25
34	11,771·2	9·25	5577·6	7·25	9·75
36	12,264·0	9·25	5790·4	7·5	10·0
40	14,224·0	9·75	6742·4	7·5	10·75

Table V.

Wind Pressure, 18·75 *per sq. ft.—Strains and Strength, of* 20 *wire line*; 60 *yards span*; *Calculated on Constants obtained at Gloucester-road.*

Length of pole.	No. 8 wire. Moment of pressure in lbs.	No. 8 wire. Safe diameter.	No. 14 copper. Moment of pressure in lbs.	No. 14 copper. Safe diameter.	Specification diam.
26	9811·2	8·5	3953·6	7·5	8·25
28	10,964·8	9·0	5196·8	8·0	8·75
30	11,547·2	9·0	5465·6	8·0	9·0
32	12,700·8	9·25	6014·4	8·5	9·25
34	13,854·4	9·5	6563·2	8·5	9·75
36	15,545·6	10·0	7369·6	9·0	10·0
40	16,732·8	10·25	7907·2	9·5	10·75

Table No. 3 has been drawn up showing the strength of round poles 1ft. long, and varying in diameter from 6in. to 13¾in. To obtain the strength of any pole it is only necessary to divide the tabulated breaking strain by the length of the pole in feet. The strength of the timber being satisfactorily settled, and a maximum wind pressure and factor of safety having been accepted, the length of spans for varying lines is readily calculated. Tables IV. and V. give the stresses on 17 and 20 wire lines, so arranged as to fulfil the implied conditions. The experiments and calculations in this paper were done by Mr. Andrew Bell and Mr. James Gavey, of the Post-office Telegraph Department.

Engineering Society, King's College, London.—At a general meeting held on Tuesday, October 20th, the president in the chair, Mr. Archer read a paper on bell-founding. Beginning his remarks with a description of the various alloys used in the casting, with a short history of the experiments which ultimately led to the result of the compound Cu_6Sn being found theoretically correct, he then proceeded to show with the aid of diagrams how to draw the section or sweep, as it is technically termed, of the bell, correctly, with a few remarks on the difference of the English and foreign plans. The subject of actual founding was then discussed, the older and newer methods being each fully described. After dealing with the method of casting a bell to produce a given note, and the ratio that the weight holds to the diameter, the paper concluded with directions as to the most suitable weight for any given note, stating that the greatest mistake that could be committed was procuring a thin bell, which, although cheaper, was sure to give dissatisfaction in quality of tone.

Silver Ores and Metallurgy in New South Wales.—An official publication says:—"New South Wales presents a magnificent chance for those who understand the proper treatment of silver ores. Large quantities being sent almost every week to English and German ports, in consequence of the absence of proper means of treatment in the Colony, except at one or two places. The New South Wales Inspector of Mines, referring to this says:—"Notwithstanding the great strides New South Wales has made in the silver mining industry during the year 1884, she has still a great deal to learn in cheapening the raising and reduction of silver ores. In America the ore can be raised and treated and the silver refined far cheaper than has yet been accomplished in New South Wales. There is no reason to suppose that we, in New South Wales, should not be able to raise and treat our silver ores as economically and effectively as our American friends are doing in America. We have everything in our favour; coal and other requisites in abundance, and railways within easy reach. Our mining community is noted as intelligent, energetic, and persevering; we only require the assistance of scientists we already have in our midst, and the necessary capital to carry their theories into practical results, to cope with difficulties of whatever magnitude which may present itself in the economical and effective working, treating, and refining of our silver ores."

* British Association.
† "Papers on Naval Architecture," Vol. I., pp. 53-4.

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PUBLISHER'S NOTICE.

*** *With this week's number is issued as a Supplement, a Two-Page Engraving of the Compound Locomotive, Webb's Patent, for the Companhia Paulista. Every copy as issued by the Publisher contains this Supplement, and subscribers are requested to notify the fact should they not receive it.*

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.*

G. and H. R.—2·79 *gallons per minute.*

H. B. (Salford).—*Yes; there was a machine in the French Exhibition in* 1878 *which would drill square holes.*

A. M.—*According to your own statement there is a substantial difference between your motor and Mr. Allin's—quite sufficient to constitute a patentable distinction between the two.*

CLARK ON SEWERAGE.

(To the Editor of The Engineer.)

Sir,—Allow me to ask through your columns the name of the publisher of the book "On Sewerage" by Clark. W. P. C.
Drayton, October 27th.

EBEVE PETROLEUM GAS ENGINE.

(To the Editor of The Engineer.)

Sir,—Can any correspondent furnish me with the names of makers or any particulars of Ebêve engines, the fuel for which is petroleum?
London, October 26th. J. H. H.

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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.

Society of Engineers.—Monday, Nov. 2nd, at 7.30 p.m.: A paper will be read "On Tidal Approaches and Deep-water Entrances," by Mr. J. B. Redman, M. Inst. C.E., of which the following is a synopsis:—Altered character of our naval depôts, due to rapid increase in size of steamers—peculiarity of British tides—non-tidal sites—London and Liverpool approaches—character of Thames reaches—existing, intended, and proposed dock sites—direction in which our great tidal estuaries admit of improvement—foundations for deep-water entrances.

Engineering Society, King's College, London.—Tuesday, Nov. 3rd, at 4 p.m.: Paper to be read by Mr. C. H. Wordingham, A.K.C., "On Standards of Light."

THE ENGINEER.

OCTOBER 30, 1885.

ADMIRAL PORTER AND THE AMERICAN NAVY.

Admiral David D. Porter, of the United States Navy, is announced as the author of an important work about to be published by subscription, entitled "The Naval History of the Civil War." In a quarto volume of about 600 pages, profusely illustrated, we are to have a complete account of the part taken by the American Navy in the great War of Secession. It is predicted that the book will be specially popular with the American Navy, as it is "the first time they have had justice done them." The heroic deeds of the Confederates are to be recognised, as well as those of the Federals. Immense pains appear to have been taken to gather up the materials requisite for writing a lucid and comprehensive history of the various events relative to the subject. What Grant, Sherman, and others have done for the Army, Admiral Porter is now endeavouring to do for the Navy. We have been favoured with an advanced chapter of the forthcoming work, and it certainly bears out the promise that while the gallant author has reached the ripe age of seventy-two, he is able to throw into his sentences the fire and vigour of youth. The "swift and graceful pen" brings the scenes of the conflict vividly before the mind of the reader, while the matured experience of the writer seizes on those points which are of practical moment. There are some valuable lessons to be learned from such a history, although the events are receding to a distance which seems to sever them somewhat from our own day. But history repeats itself, and a parallel may be drawn between some of the circumstances which now surround us and those to which Admiral Porter has made immediate reference. The chapter sent forth as a sample of the book describes at considerable length the achievements of the Merrimac in her attack on the Federal ships. This episode in the American Civil War, occurring in the dawn of the ironclad era, incontestably proved the formidable character of armoured ships, including the Monitor class. Concerning the latter, certain sea-going defects soon became apparent, but the value of the turret was immense. Lissa, four years after the fight in Hampton Roads, showed that something more than armour was necessary to constitute a victorious fleet; but the defeat of the Italians by no means convinced the latter that ironclads were superfluous. They dismissed their Admiral, but went on building armoured ships, giving the world by this time the example of the largest of this class, though armoured in a manner both peculiar and daring.

Admiral Porter describes the Merrimac, on her way to Hampton Roads in March, 1862, as being "at the moment the most powerful fighting ship in the world." The Gloire, launched in 1860, we presume is left out of the account. Anyhow, there was abundant reason for the Federal Government to be anxious. The Navy department, says Admiral Porter, was "rather" taken by surprise. They knew the ship was being prepared, but under-estimated the energy and rapidity with which the Confederates were conducting their work. The Federals were pushing on the construction of Ericsson's Monitor, and hurried her still faster towards completion when they found that the Merrimac was further advanced than they had supposed. But the Confederates were on the watch, and worked day and night to gain the race. They got ahead of their rivals by one day, and just that difference brought a catastrophe on the Federal cause which filled its friends with dismay. When the Merrimac descended Elizabeth River on March 8th her commander is said to have known the weak points of every vessel in the Federal fleet, and the number and calibre of their guns. He knew that none of their shot could penetrate his armour, and that he could choose his distance and fire with his rifled guns at the ships as if at a target, should he think proper to do so. Hence he resolved that the "trial trip" should be a day of battle, in which he would have the victory. There was no "measured mile" business in this affair. From the hands of her constructors the Merrimac went out at once to the grim realities of war. It was a beautiful day, we are told, following a storm. But there was something more fatal than an ordinary storm impending over the Federal ships, swinging lazily at their anchors in Hampton Roads, no one on board having the least idea that the Confederate ironclad was ready for service. Neither was there anything like an adequate conception as to the peril which the presence of that vessel would involve to the objects of her attack. "Three small steamers" were reported as coming round Sewell's Point, but one proved to be the Merrimac. Almost the first act of the Confederate ironclad was to ram the wooden Federal ship Cumberland. The blow was fatal, and the ship ultimately sunk, her heroic crew firing their guns to the last, despite the murderous shells poured in upon them by the Merrimac. The Congress, which was in company with the Cumberland, accidentally ran ashore, whereupon the ironclad, keeping at a safe distance, continued "boring her through and through with her shells," finally setting her on fire. One hundred guns, of the class called "heavy" in those days, are said to have pounded away at the Merrimac from the Federal ships and the shore batteries, and yet she suffered no serious harm. But everything outside her armour went to wreck. Surely there was proof that however needful seamanship might be, the coat of mail was not to be overlooked. The deadly efficiency of the Merrimac was simply due to her armour. This appliance was of the rudest description—simply two layers of iron plates, each 2in. thick, placed crosswise over each other. But this rude defence served as an impenetrable shield against the enemy's shot, while the Confederate shell went home at every stroke. The 10in. pivot guns of the Minnesota, which ran herself helplessly aground at the outset, could drive off the Confederate gunboats, but her shots glanced like pebbles from the plates of the Merrimac.

Such were some of the critical events of a single day, and but for the existence of one particular ship in the Federal fleet, the Confederate cause would in all probability have gained the ascendancy, rendering the issue of the great struggle between North and South the exact reverse of that which is now on record. "The little cheese-box on a shingle" was to undo on the second day what the Confederate ironclad had done on the first. There was a battle which "seemed as if it would never end" between the turret ship and the ironclad. If the commander of the Monitor had not been restricted by his orders, he would have made the powder charge of his 11in. Dahlgren guns 25 lb. instead of 15 lb., and would have sent his steel shot clean through the Confederate plates. As it was, he hammered away in vain, and so was hammered in return. There was something wanting to turn the scale. The commander of the Merrimac tried ramming, and for an hour he manœuvred to strike a blow on the flank of his adversary. But the little Monitor danced round the slow, unwieldy ship "like a yacht round a three-decker." Had the Merrimac been swifter, or had the Monitor put 10 lb. more of powder into each of her guns, the equilibrium of the fight would have been upset. The Merrimac would have possessed greater speed had not her smoke-stack been partly shot away the day before, whereby the draught in the furnaces became so weak that there was great difficulty in keeping up steam. On such contingencies may the result of an important conflict depend. On the whole, it seems to be acknowledged that if the battle had been prolonged the advantage would have been on the side of the Monitor. As it happened, the engagement became a drawn battle, each ship retiring from the scene without being pursued. It was a marvellous encounter, considering the date at which it happened. Both vessels soon disappeared from the seas. The Merrimac was blown up to prevent her from falling into Federal hands, and the Monitor not long afterwards foundered in a gale off Cape Hatteras. It is well remarked that the latter was lost through attempting the impossible, since it was never intended she should be used as a cruiser. The ill-fated Captain might in like manner have been preserved to the British Navy had her qualities been better understood. We shall await the full text of Admiral Porter's "History" with much interest.

TRIPLE EXPANSION ENGINES.

To the first volume of the "Transactions" of the recently established North-East Coast Institution of Engineers and Shipbuilders we have already referred in connection with an article on the use of zinc in boilers, which appeared in our impression for October 9th, when we quoted from a paper by Mr. John Rowe. The same volume contains a paper on "Triple Expansion Engines," by Mr. Taylor, which is well worth notice. Mr. Taylor was one of the first engineers—always bearing in mind the preliminary work done by Messrs. Randolph and Elder and Messrs. Rowan—to make triple expansion engines a success at sea—notably in the case of the steam yacht Isa. What he has to say on the subject claims attention. His hearers are all practical men, and the discussion which followed was lively, interesting, and may be read with advantage. We do not propose to follow Mr. Taylor or the discussion right through, but to consider some of the statements made by himself and his hearers. The subject has not been nearly thrashed out, and much more can be said on it with advantage. Mr. Taylor attributes the superior economy of the triple expansion engine to the fact that larger measures of expansion may be used with it, without entailing disastrous cylinder condensation, than is possible with any other form of engine, and apparently to nothing else; and he asserts, as do a great many other engineers, that this result is due to the smallness of the range of temperature in each cylinder. In other words, the triple expansion engine enables the heat trap theory to be applied in practice to a greater extent than is practicable with the ordinary compound engine. It is, we think, worth while to consider whether this is really the case or not. The economy of the triple expansion engine is, we believe we shall be able to prove, due to an entirely different cause.

If steam could be used in a cylinder of slate, or other material which did not take up or give out heat, it would, according to the accepted laws of thermodynamics, behave very nearly like a permanent gas. If it was so far superheated that none of it would be condensed in the performance of work, it would behave precisely like a permanent gas, and the consumption of coal as compared with the very best engines now running would be reduced by about 25 per cent.; that is to say, an engine now burning 100 tons in making a given voyage could do it under the new conditions with 75 tons. This result would be due entirely to the circumstance that there would be no condensation and no re-evaporation in the cylinder. We say "cylinder" advisedly, because no advantage of any kind in the way of economy of fuel could then be derived from the compound principle. The turning moments would be more irregular, and the strains more severe, and the valve gear more complex; but with these things we have nothing to do at this moment. According to the heat trap theory the quantity of steam condensed in an engine is determined, other things being equal, by the difference between t and t^1, or the initial and terminal temperatures in the cylinder. If, for example, we use steam with an absolute pressure of 175 lb. on the square inch, and expand it ten times, the values of t and t^1 will be respectively 371 deg. and 221 deg. If the engine is fitted with a condenser the value of t^1 will fall to about 120 deg. Deducting 120 deg. from 371 deg., we have 251 deg. as the range of temperature. Assuming, for the sake of argument, that the crank shaft makes 100 revolutions per minute, then the cylinder will alternately be heated and cooled 100 times in a minute; and it is usually assumed that the average temperature of the cylinder will be a mean between t and t^1, or, let us say, 249. This is the temperature of steam with an absolute pressure of 30 lb. on the square inch. The absolute average pressure proper to a ten-fold expansion of 175 lb. steam is 57·75 lb., corresponding to a temperature of 290 deg.—that is to say, 41 deg. higher than the average heat of the metal. From this it would appear that there must be a direct loss of heat under any possible circumstances; or that, in other words, the cylinder will always condense more steam than it can re-evaporate—a result due to the fact that the time during which the temperature is high within the cylinder is less than that during which it is low, because it is open to the condenser temperature of 120 deg. during a whole stroke, and open to the boiler temperature for only a fraction of a stroke. There is, however, practical reason for believing that this line of argument is deceptive, and that in every steam cylinder it will be found that the re-evaporation will very nearly balance the condensation provided the loss by external radiation is disregarded or prevented. If this were not the case, water would always be found free in engine cylinders; but it is well known that under certain conditions the steam, even with unjacketted cylinders, is quite dry. It is clear that in an engine running at a good speed the temperature of the cylinder metal can never either fall to that of the condenser or rise to that of the steam, save for a very small thickness indeed; and if it can be shown that the energy of steam is greater to heat up than that of the condenser is to cool down, the average temperature of the cylinder may be sufficient to insure complete re-evaporation. That the point is in favour of steam is demonstrated by the circumstance that the cylinder is always hotter than the condenser. It is evident that the influence which mere surface bears on cylinder condensation must be very great indeed. When steam enters the cylinder the heat proceeds outwards through its walls. The moment the steam port closes and expansion commences, it will begin to travel back again, and the thickness of metal thus affected will depend materially on the rate at which the alteration of temperature occurs. In any screw engine, at all events, it may be taken as proved that surface is a most potent factor in fixing the quantity of steam that shall be condensed or re-evaporated. Now it requires no genius to see that the

surface in a compound engine is very much greater than the surface in a non-compound. For example, let us take the case of a triple expansion engine, with cylinders 23in. + 37in. + 58in. × 36in. The whole of the power may be referred to the low-pressure cylinder. Its surface will be, in round numbers, about 131 square feet. This is counting two piston-faces, two cylinder-covers, and adding about 10 per cent. for ports, clearance, &c. The intermediate cylinder, in like manner, will have a surface of 65 square feet, and the high-pressure cylinder will have a surface of 33 square feet. The total cylinder and piston surface of the engine will be 130 + 65 + 33 = 228 square feet, or 65 + 33 = 98ft. more than the non-compound engines. It is not possible to give precise figures in this connection, but let us, for the sake of argument, say that the condensation will be as the surfaces multiplied by the range of temperature. The total expansion will be about thirteen-fold, if steam follow the high-pressure piston half-stroke. Then we shall have for the non-compound engine, 365 − 150 = 215 and 215 × 130 = 27,950, which we shall call the coefficient of condensation. It must be understood that this does not represent heat units. It is simply a number intended for comparison, and nothing more. Treating the engine as triple expansion, and taking Mr. Taylor's temperatures as given for the steamship Isle of Dursey, we have for the small cylinder a range of temperature of about 60 deg., and 60 × 33 = 1980. In the intermediate cylinder the range will be about 67 deg., and 67 × 65 = 4355. In the low-pressure cylinder the range will be 105 deg., and 105 × 130 = 13,650. Adding these three coefficients together, we get 19,985 as against 27,956 for the non-compound engine. From which it appears that the entire saving due to the heat traps is, at the most, about 29 per cent.; whereas those who most believe in the theory seem to persuade themselves that there is next to no condensation at all in the triple engine, as compared with the non-compound engine; and it must be clearly understood that this 29 per cent. does not represent 29 per cent. saving in fuel, or anything like it. It could only do this under impossible conditions—namely, that no re-evaporation ever took place during the period of expansion.

So far we have dealt with the question of cylinder condensation from what may be regarded as a theoretical point of view. The practical aspect of the case is that there is some special condition or factor operating to cause cylinder condensation, which is not fully explained by theory. In spite of the advantage apparently gained from the use of more than one cylinder, the fact is that condensation seems to be augmented rather than diminished. There is no obvious reason why as much as 43 per cent. of all the steam that enters the high-pressure cylinder of a compound engine should be condensed; but if indicator diagrams tell any truth, the condensation does reach, and even exceeds that point. In Mr. Perkins' triple expansion engine the condensation reached as much as 47 per cent., although the cylinder was jacketted. Allusion was made in the discussion on Mr. Taylor's paper to Perkins' engine, and Mr. Taylor mixed things up in his reply for we find him saying "he did not think that in two cylinders they could use steam of 150 lb. pressure as economically as they could in three cylinders, because they get their cylinder cooled from 406 deg. down to 298 deg. It was no joke, this difference of temperature, —the exhaust rushing away at 300 deg., and the next instant the steam at 400 deg. coming in must be condensed, and this lost power." Mr. Taylor is here all at sea about his temperatures. That of steam of 175 lb. absolute = 150 lb. safety valve load, is 370·8 deg., not 406 deg. The temperature of steam of 265 lb. absolute is about 406 deg. A temperature of 300 deg. corresponds to 67 lbs. on the square inch absolute. In the course of the discussion Mr. Heck called attention to Mr. Seaton's paper, read before the Institute of Naval Architects. Mr. Seaton stated that the results which he had obtained from a three-cylinder engine, with steam at 100 lb. to 110 lb. pressure only, were almost as good as those which he obtained with 160 lb. Accordingly he had reduced his pressures, and he found that he did just as well with 140 lb. as he did with 180 lb. This is very important testimony, as Mr. Seaton probably knows as much now about triple expansion marine engines as any other engineer.

The fact is that the heat-trap action of multi-cylinders has little or nothing to do with the economy of the compound or triple engine. This must be sought in an entirely different direction, the nature of which we have already glanced at in an article, "Why the Compound Engine is Economical," in our impression for October 2nd. We shall take an early opportunity of going more fully into this matter. It will suffice to say here that cylinder condensation is not an evil, provided all the condensed steam is re-evaporated under conditions which will permit it to be usefully employed. It is no more an evil than a fly-wheel is an evil; and the triple expansion engine supplies more facilities for using initially condensed steam to advantage than the simple engine does.

THE TOWER BRIDGE.

The last phase in this scheme, which recently received the sanction of Parliament, is somewhat ludicrous. It will be remembered that the design of Mr. Horace Jones, the City Architect, was adopted, a gentleman who had no experience in bridges, the Corporation jealously confining the matter to their own officer, and neither inviting nor allowing any suggestions from the outside. This course being also followed when the Bill came before Parliament, no alternative bridge design could even be considered, and the monstrous structure, about which we have already expressed our opinion, was authorised. Now, however, when the question of the architect's remuneration comes before the Court of Common Council, the same Bridge Committee which before Parliament said they had "full confidence in their own officer" announce, what every one outside the Court knew long ago, that the designing of bridges was not a proper function of the architect, that therefore his ordinary salary of £2000 a year does not cover this particular matter, and that he must be paid sufficient to depute the work to some one else. The sum of £30,000, recommended as the remuneration for conducting so important a work, namely, about 5 per cent. on the estimated expenditure, would not be excessive if it were to be paid to any one but a salaried officer; but instead of the money being paid to the engineer, over whom the Corporation would then have direct control, the amount is to be divided as the architect and engineer may agree. The justification given for this extra remuneration to the architect is that his design was the only one approved by Parliament, and that therefore he merits a substantial reward. Coming from the same Corporation Committee which had control of the Bill, and which, having the power, exercised it, of preventing any but their own design from even being considered, this plea may be characterised as audacious. We have had a lingering hope that the actual commencement of the works might be postponed till such time as the present Corporation was disestablished, and the proposed spoiling of the river prevented by the new municipality. We fear, however, there is no longer much chance of this, and Londoners must submit to this, and accept a structure which not only would any body of independent engineers condemn, but which would have been impossible if the Corporation had taken ordinary steps to elicit independent suggestions.

THE LIVES OF STEAMERS.

Some time ago we drew attention in The Engineer to the question of the age at the time of loss of vessels, and it may be interesting now to revert again to the question. We have before us the official record of the vessels removed from the register during the month of September. It shows that there were in that month fourteen iron steamers removed from the registers of the United Kingdom. Out of these not fewer than five were sold foreign, one was sold to the Admiralty, one was converted to a hulk, and one was broken up, whilst collisions and losses were responsible for the removal of the remainder. As to the ages, the vessel converted to a hulk was built in 1863, and that broken up was built in 1853, so that they had seen very fair service. The vessels removed from causes such as collision, loss, &c., were respectively built in the years 1876, 1870, 1866, 1880, and 1885. There were four wooden steamers removed from the register; two built in 1852 and 1855 were broken up, one built in 1862 was lost, and the fourth was removed because of a collision, it having been built in 1861. A somewhat similar statement might be made as to the iron sailing vessels removed from the registry, whilst the wooden sailing vessels were in one or two cases built as far back as 1817. One was built in 1795, another in 1769, and another in 1762, whilst the youngest was built in 1873. It would thus appear that the vessels removed have on the whole attained a fair average age, and when it is added that above a score of those removed from the registry were broken up, it will be acknowledged that there is some evidence that the shipowners have not been unmindful of their duty to their crews, and it is clear that they have endeavoured to remove, at a loss to themselves, a not inconsiderable number of vessels, which from age or some other cause it was scarcely desirable to again send to sea.

THE STEEL SLEEPER QUESTION.

We have now something authoritative upon the matter which during the last week or two has been exercising steel makers, of the purchase by the Midland Railway of Belgian sleepers. It was early denied that the order was for 10,000 sleepers, but the company states that it was for half that quantity, which means a weight of some 250 tons. The reason which they assign for the purchase was the one which might have been expected—the lower price of the continental manufactnre. The reason for the difference in price is not far to seek. The Midland Company, in the communication which their general manager has addressed in reply to the Staffordshire Steel and Ingot Iron Company, and which is referred to by our Staffordshire correspondent, suggest, and, no doubt correctly, that the higher rates which home steelmakers asked represent expenditure which would be involved in putting down special plant, whereas the Belgian firm had the plant already erected. On the wages factor the company does not touch, but it is one which will have by-and-bye to be seriously taken into account. The Midland intimates indirectly that if it determines to adopt steel sleepers it will prefer to order of English makers, who will perhaps put down plant at their own expense to secure the extensive business which may be expected. Already, indeed, it is hinted that the company has issued second trial tenders to British steelmasters.

LITERATURE.

Draught. By William Philipson. London: John Kemp and Co. 1885.

This is a reprint of the essay for which the Coachmakers' Company awarded the author the first prize last year. The subject is one which had been dealt with at great length by many writers whose names are well known, including Edgeworth, Morin, Youatt, and the Royal Agricultural Society by its Reports on the Bedford experiments, and others. The author has, however, approached the subject from the more limited point of view of the coach and light carriage builder, but he has done his work in a systematic manner, and has compressed the whole into about thirty pages, including an appendix giving the result of some experiments on the power required to overcome the friction of wheels on their axles, and of wheels and axles running over ground. The author acknowledges the assistance of several well able to give him valuable aid. He treats first of the causes of draught, including the rolling friction considered as made up of a continual surmounting by the wheel of small articles, and as a cylinder rolling upon a plane surface; secondly, the axle friction; thirdly, influence of gravity on up or down gradients; and, fourthly, speed. The subject is further dealt with in reference to the angle of the trace, height of wheels, coupling and track of a carriage, dish of wheels and pitch of axle, form of tires, position of vehicle body, point of draught, comparison of and working two and four-wheel carriages, and springs. It need hardly be said that each item has not been treated at any length in a *brochure* of thirty pages, but the coachmaker will probably find what is supplied of much value. A mathematical treatment of axle friction is given, in which the author has apparently received the assistance of Professor Herschel; but the author does not make it quite clear, as he ought, why it is that, if friction is not affected by extent of surface, it is increased by increase of diameter of axle and not by increase of length, especially as the reader is reminded that "the surface in contact is merely the small portion on the underside of the axle that presses against the box." The three items—track, dish of wheels, and form of tire—are dismissed in twenty-four lines; but the position of the body on the wheels and the point of draught receive more attention. The strength, flexure, and construction of springs are not dealt with; but as it would be difficult to show in any useful way how draught is affected by the accuracy of formulæ, or of the mathematical aspect of these questions, it is not, perhaps, needful to touch upon these questions, solutions of which will be found in other places. As materials for experiments with full-size carriage-wheels and axles could be so easily obtained, it is a pity the experiments, of which results are given in the appendix, were made with very small wheels.

Treatise on Practical Astronomy as Applied to Geodesy and Navigation. By C. L. Doolittle, Professor of Mathematics, Lehigh University. New York: J. Wiley and Sons. London: Trubner.

This book is concise, and masters each question thoroughly and in a good shape. A good deal of it is taken apparently from Chauvenet, as acknowledged in the preface. There are excellent cuts—that is, the figures are well chosen. Each question is dealt with from its mathematical aspect, but examples are worked and tables for use furnished, and it is, therefore, practical also. The transit and zenith telescope receive much attention. The latter instrument we should have expected to find specially well dealt with in American books, excellent work having been done with it in America in notable instances, as, for example, in laying down the 39th parallel of latitude for the boundary line between the English and United States territories. The use of the transit instrument in the prime vertical is discussed. There is one branch of work, however, that we think now deserves attention in astronomical books, namely, the system of observing transits in the vertical of the pole star. This system is carried out, of course, with an instrument which has the movements of an altazimuth; the Russians use a broken transit thus mounted. The advantage is that good work may be done directly the instrument is erected—thus two stations in the same night may be taken by the same instrument in succession. It is, therefore, a capital system for rapid work of this kind. The evil is that the reduction of the observations is troublesome. It has been much followed by foreign astronomers, and Mr. Gill, the astronomer at the Cape, employed it when working with Lord Crawford—then Lord Lindsay—in his transit of Venus expedition of 1874. This will show that the subject ought to have been dealt with in books before now, yet hitherto we have not met with it. The work before us is no exception, therefore, in this respect. It is well got up and of much more manageable size than Chauvenet.

Tables and Diagrams of Switches and Crossings. By Thos. Summerson. New edition. Liverpool, G. J. Poore and Co., 1885.

This consists of a series of tables accompanied by six diagrams of arrangements of crossings and switches, all arranged in a very convenient form for reference, and evidently compiled by one thoroughly conversant with the wants of those practically engaged in general railway and siding work.

These tables are published in 9in. by 11in. folding boards, neatly bound and printed on the insides with their corresponding diagrams. The tables give the various dimensions—as the distance from spring of curve to heel of switches, the distance from heel of switches to nose of crossing, radius of curve, for angles of crossings ranging between 1 in $1\frac{3}{4}$ and 1 in 18. The diagrams to which the tables refer represent—(1) A simple junction or turn-out from a straight main line. (2) A junction with the main line curved. (3) Three-throws turning out both ways. (4) Three-throws turning out one way. (5) Through roads. (6) A junction with diamond or cross-over. They contain also information with regard to the proper length of switches, the shortest practicable curves, the elevation of the outer rail on curves, and the measurement of angles, with rules for bending rails.

Tables and Diagrams for Curving Tramway Rails, and for Making and Laying Railway Crossings. By W. T. Olive, C.E. Didsbury: W. T. Olive, C.E. 1885.

This comprises three tables mounted on the inside of a thick cover. The one contains the versed sines for chords of 12ft. and of 18ft., of curves from 30ft. to 500ft. radius, the versed sine being employed as the arc offset by which to guide the workmen in bending a rail. The other two tables give the various angles and tangents for switches, crossings, and leads for various curves and angles of entry. The tables are useful to those acquainted with the work.

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Malt and Malting. By H. Stopes. London: H. W. Lyon, *Brewers' Journal* office, Eastcheap-buildings. 1885.

Ancient Rome in 1885. By J. Henry Middleton. Edinburgh: Adam and Charles Black. 1885.

Mechanics of Materials, and of Beams, Columns, and Shafts. By Mansfield Merriman. New York: J. Wiley and Son. London: Trübner and Co. 1885.

Measurement of the Force of Gravity. Appendix to Memoir No. 5. Report by A. Tanakadate. Tokio: Published by Tokio Daigaku. 1885.

A Concise Dictionary of the English Language—Literary, Scientific, Etymological, and Pronouncing. By Chas. Anandale, M.A., LL.D. London: Blackie and Son. 1885.

TENDERS.

For sundry additions to brewing plant at the Lion Brewery, Broad-street, Golden-square, for Messrs. Huggins and Co., to the designs and under the superintendence of Messrs. Scamell and Colyer, civil engineers, Great George-street, Westminster.

Messrs. R. Moreland and Sons, London £2380
Messrs. Thornewill and Warham, Burton-on-Trent—accepted 1557

Quite a clever piece of work was accomplished by the Nuttall Machine Works, of Allegheny, Pa., not long since. It was drilling an inch hole lengthwise through a bar of steel $2\frac{1}{2}$in. in diameter and 9ft. 7in. in length. The job was refused by several shops, and pronounced impossible by others. The drill was started from both ends of the bar, and where the holes met in the centre not the slighest shoulder was visible. A second bar has been drilled with like results.—*American Manufacturer.*

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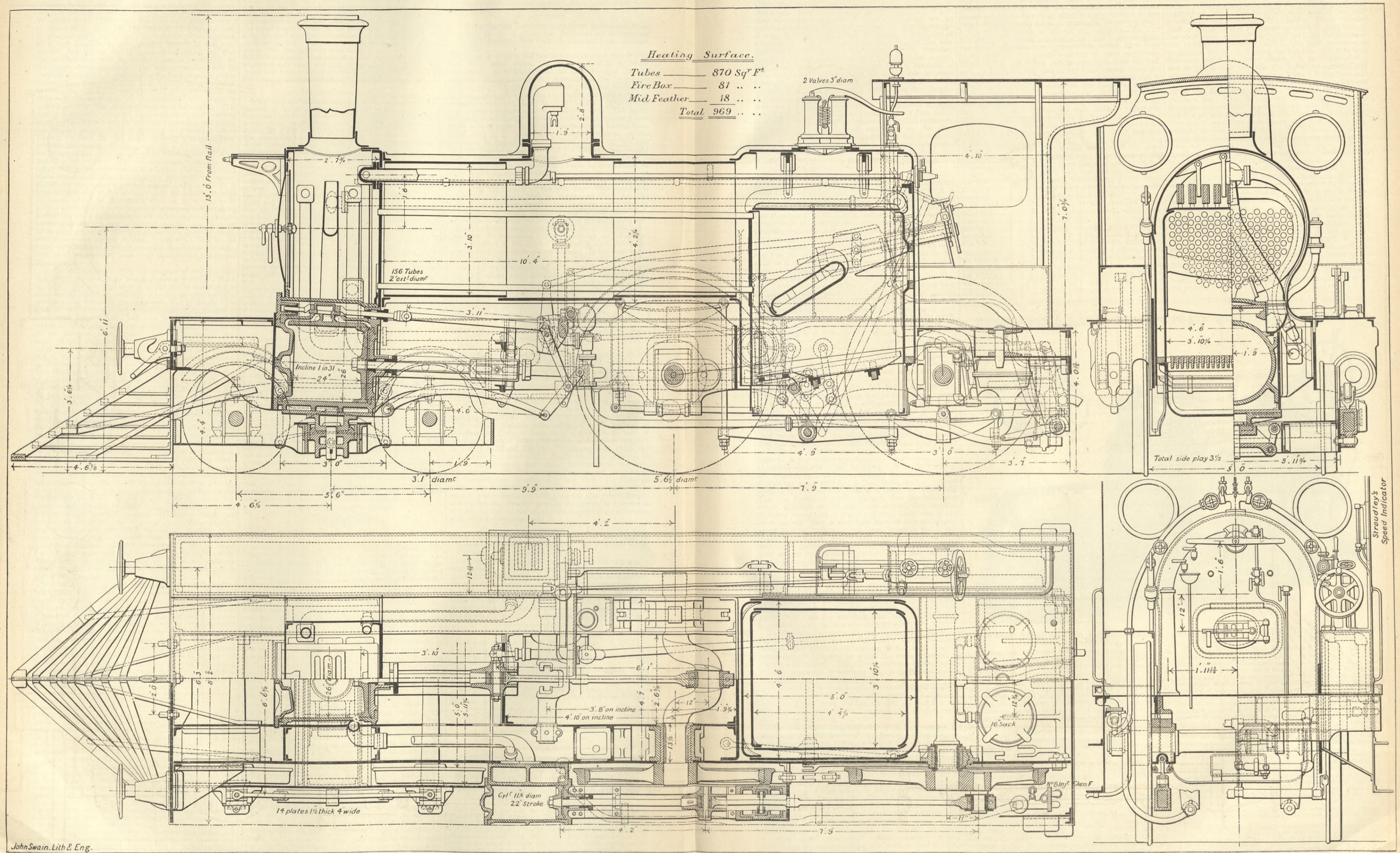
Politechniczna

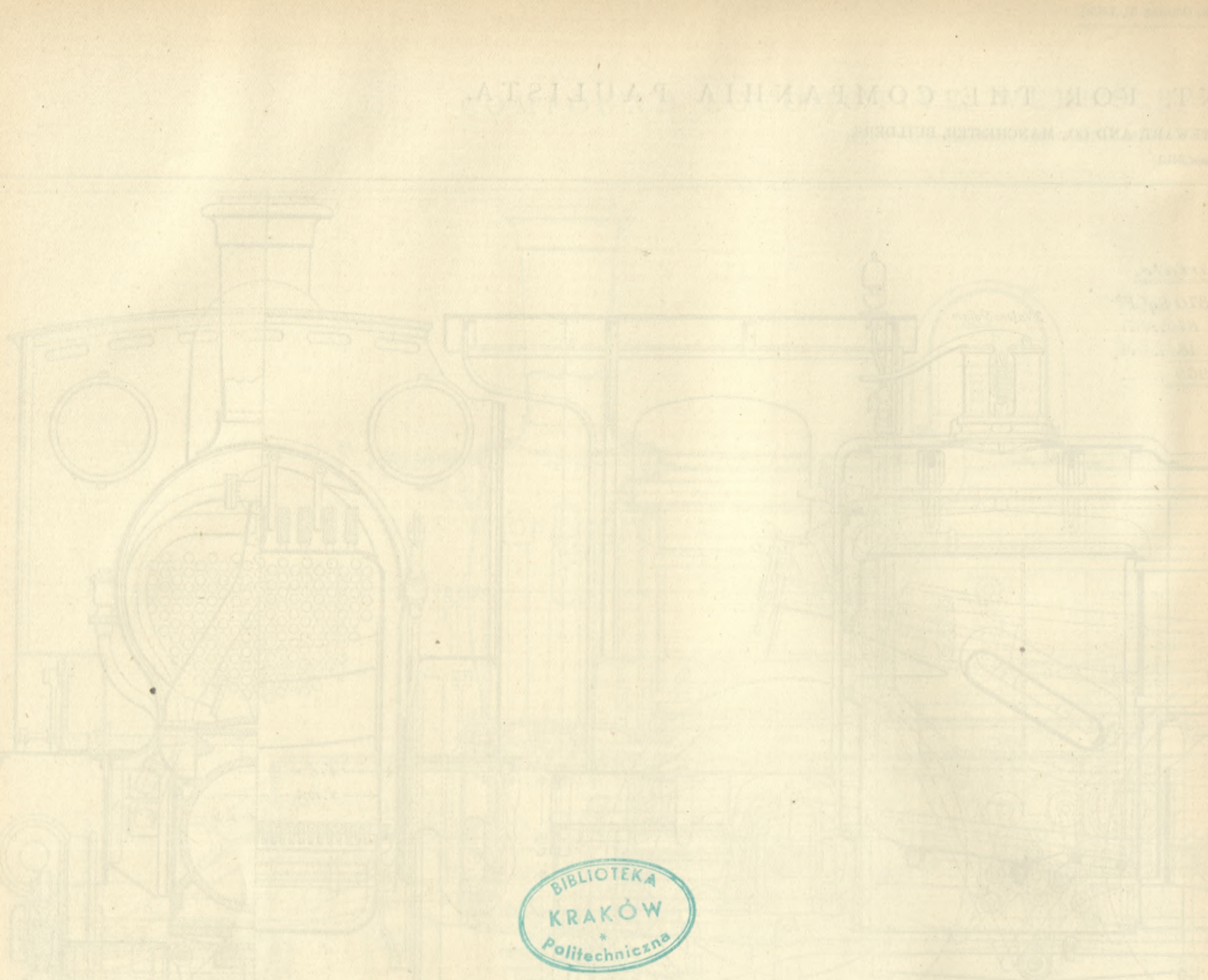
COMPOUND LOCOMOTIVE, WEBB'S PATENT, FOR THE COMPANHIA PAULISTA.

MR. W. J. HAMMOND, ENGINEER; MESSRS. SHARP, STEWART, AND CO., MANCHESTER, BUILDERS.

(*For description see page 341.*)



John Swain. Lith & Eng.



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THE ANTWERP EXHIBITION.

No. VIII.

In our first article on the Antwerp Exhibition we spoke fully and freely on the extreme beauty of design, finish, and material of the steam engines exhibited. It will be remembered that our statements evoked a correspondence and some criticism. We were taken to task for making it known that foreign engine builders could turn out first-class work. Now we hold that the worst policy it is possible to adopt is that of the ostrich. Nothing can be more useful to English engineers than a precise knowledge of what is being done abroad. Nothing is exhibited at Antwerp to excel a Corliss compound engine by Mr. Van den Kerchove, of Ghent. We applied to Mr. Van den Kerchove for information not only concerning his engine, but his methods, and his views, and he has favoured us with a statement which cannot we think fail to prove interesting and valuable to our readers. It is not every day that they can learn precisely what an eminent Belgian engineer thinks about engine building. Mr. Van den Kerchove is very cosmopolitan. He attaches a large value to engineering for its own sake; and we have failed to find in him the slightest antagonism to English engineers. He is proud of his own work, and justly so. In what follows we give as far as possible in Mr. Van den Kerchove's own words the information which he has courteously supplied to us, concerning, as we have said, his methods and his views. His engine we shall illustrate in another impression, and fully describe.

The excellent qualities of the engine are not apparent, perhaps, to the casual observer. But Mr. Van den Kerchove holds that they are of such value to the buyer that it is not astonishing that he can obtain with perfect ease prices considerably higher than those usually charged. Mr. Van den Kerchove's experience in this respect may be compared with that of English engineers, many of whom maintain that they cannot get a price which will pay them for first-class design, workmanship, and materials. This is a very important point, and the Belgian engineer's testimony on the subject is valuable. The principle he has gone on is to make an engine as perfect as possible, and to trust to the machine itself to make its way.

As is easily seen by the separate pieces which Mr. Van den Kerchove exhibits beside his engine, his aim has been to perform each operation in the most perfect possible manner—that is to say, instead of turning out ordinary and therefore imperfect work, to make the production of each detail the object of special study. To arrive at this result, he has first of all striven to realise the main object he had in view regardless of prime cost; content with examining afterwards the price at which such work could be sold, and whether the customer would find it to his advantage to pay it. These are, we think, the points most subject to controversy, and which should decide how far the line pursued by this clever Belgian engineer may be followed in this country.

On these important points he holds the following opinion:—Work may be either well or badly done, according to the spirit in which it is undertaken and carried out, and also according to the means employed for arriving at the result desired. Thus, if bad materials and imperfect tools are used, it naturally becomes impossible to turn out good work; but, on the other hand, to insure success it does not suffice to use the best materials and most perfect tools, for the mode of working and the method to be followed in the various operations are conditions of success at least as essential as the foregoing. If, on the contrary, the engineer succeeds in combining the three principal conditions—good material, perfect tools, and a rational method of working—he obtains a result on which Mr. Van den Kerchove insists, namely, that the work produced, although almost absolutely correct, *costs less than if it had been sought to produce it at a cheap rate by any other method.* That is to say, we have an able and experienced Belgian engineer, with great practice and a continental reputation, maintaining that by going the right way about it first-class work can be done more cheaply than second or third-rate work. With this we fully agree, and so, no doubt, will many of our readers, while others have the truth yet to learn. In proof of what he advances, and with a view to meet the criticisms of those who, not having succeeded in attaining this desideratum, might accuse him of having finished his engine too highly, he has thought fit to exhibit a series of pieces, by means of which it will not be difficult for him to prove how correct his ideas are and how much superior his method of working is to that but too often adopted.

These pieces illustrate all the operations which are regularly performed in an engineer's works, beginning with planing, which, with turning, is the most frequent and important operation to which the various parts of an engine is submitted. The object exhibited by the builder for this purpose is a cast iron face plate, 3ft. 3in. by 3ft. 3in., presenting a surface of 10½ square feet. This plate was finished in three cuts upon an excellent planing machine, from the works of Sir J. Whitworth, of Manchester; and here, before going farther, we may say that Mr. Van den Kerchove speaks in the very highest possible terms of this veteran engineer.

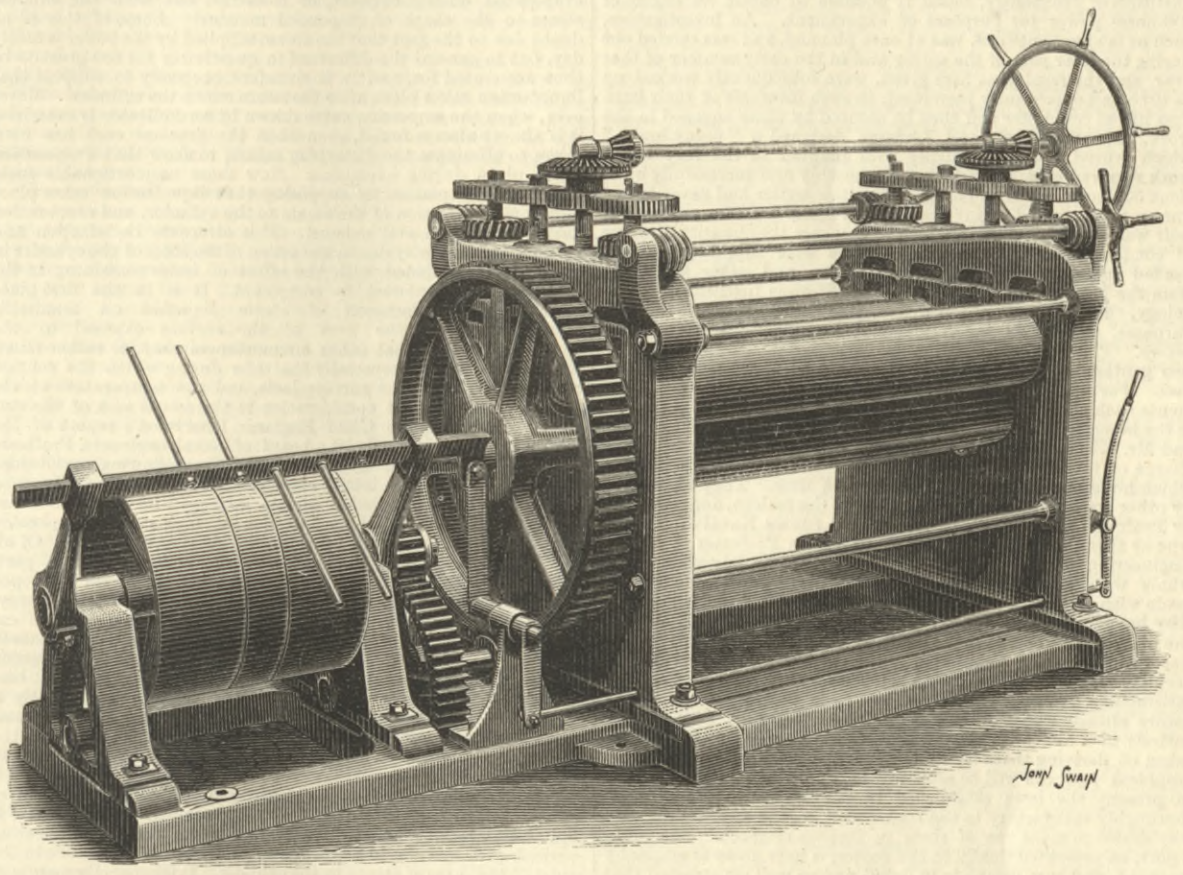
The first cut—a roughing cut—took four hours; the second cut also took four hours, and the third, or finishing cut, took fifteen minutes, making a total of 8 hours 15 minutes. This time is certainly not so short as to lead anyone who knows anything about engine work to doubt for an instant the figures given by the builder, and which may be read upon the card affixed to the object in question; nor did he, according to his own statement, seek to do this work in the minimum of time which he might possibly be able to do it in. What he aimed at was to produce this surface as perfect as the best planing machine could make it, without forcing its speed or the feed, and without even employing a machine with revolving tools, as he could easily have done, had he wished to obtain a more rapid production. He contented himself with using a planing machine, not with a view to obtain rapid production, but simply to produce a surface as true as possible by proceeding methodically, and by means which alone can insure this result. A simple inspection of the planed surface shows us that it would be difficult to obtain better results. Moreover, the exhibitor assures us that he has tested this plate with a Whitworth surface plate, and that without wishing to say it is as correct as the latter, he was nevertheless unable to find the slightest inperfection in it. The fact that such a surface can be planed in eight and a-quarter hours is, in our opinion, a positive proof that it is not impossible to produce an almost perfect surface in as short a time—in fact, in less time—than is usually taken to produce an imperfect one.

The same principle is followed and applied in Mr. Van den Kerchove's works to turned work; and to demonstrate this he has exhibited two Corliss valves, which have been turned with a very coarse feed, but to great perfection. These valves are shown just as they came from the tool, and, according to the maker, are more perfect than the plate just described. We have next several examples of milled work entirely finished on the machine, amongst them a cylinder for a small steam engine, which is deserving special notice; this is as perfect as it can possibly be. By the side of this we find another interesting specimen of good workmanship in the form of a connecting rod, of which the butt, strap, keyways, and keys have been entirely finished upon the machine and fitted together without being touched with the file. The body of this rod is turned bellied in a special lathe, with the same facility as an ordinary straight rod. The object of the builder in doing this was to show that with good tools and expert workmen this result can easily be obtained; and the cost of fitting up by hand, which fitting is very detrimental to the correctness of work carefully executed with a machine tool, up to a certain point avoided.

To complete our notice of the various detached pieces exhibited, we must return to the lathe work, some specimens of which are really remarkable. We may mention, first of all, that in a small glass case are shown several unhardened steel pins, used in the construction of engines, also two crank pins which, the builder asserts, differ only $\frac{1}{8400}$ part of an inch from a perfect cylinder. Here, again, we have work produced without any after finish, and by means of the tools usually employed; the time required for turning these pieces has not been given us, but we were assured that it did not exceed that required for the most ordinary work. All this means, of course, that with first-class machine tools properly used, perfect work can be done just as quickly as bad work can be turned out under other conditions. It does not take any more time to turn a rod round than it does to turn it an irregular shape.

There can be no doubt but that the specimens to which we refer, and which we have carefully examined, are of a perfection which has, we think, rarely been attained in an engine works, or even in a machine tool works; and realising this, the maker is, we think, perfectly justified in boasting of being able to attain such results, not only practically, but commercially. Lastly, there remains another set of almost absolutely cylindrical pins, true to less than $\frac{1}{250000}$ part of an inch; but these are hardened and rectified by methods used in the finer branches of mechanical work. It is none the less true that it is rare that such results have been achieved in an engine works, and to find a man who has the knowledge, energy, and perseverance requisite to produce them. It has been said that the engines shown at Antwerp have been specially got up for the Exhibition, and that they are too showy for ordinary use. This is not the fact. Mr. Van den Kerchove has excellent reasons for all that he has done, and it is natural that he should like to make an engine all the parts of which are constructed with minute accuracy, pleasant to the sight as well. Mr. Van den Kerchove asserts that the beautiful polish he produces costs him no more—in fact, less—than that which engine builders usually put on; in proof of this he says:—"Look carefully into the smallest detail in any ordinary construction, either polished or filed, and you will neither find plane surfaces nor square corners, and if in many instances the polishing were pushed a little further, the work would be so defective as to be scarcely presentable; in my work, however, neither of these defects is found, the surfaces are perfect, and the angles so sharp that they require taking off, so as not to cut in handling. What conclusion is to be drawn from this? Either that my process of polishing has been quicker, since it has left the surfaces perfect and the corners sharp, or that I have a method which is more practical and rational, and by which I can obtain economically results which it would be impossible to arrive at by ordinary means." What, some of our readers may say, is the value of all this polish? On this point Mr. Van den Kerchove has a good deal to say which we must reserve for the present.

RUSHWORTH'S SEVEN ROLLER PLATE FLATTENING MACHINE.



RUSHWORTH'S SEVEN ROLLER PLATE FLATTENING MACHINE.

The machine illustrated by the accompanying engraving is made by Messrs. Rushworth and Co., Sowerby Bridge, for flattening, stretching, and taking the buckles out of plates. The machine is arranged with a double set of rolls powerfully geared, between which the plates pass. The lower surfaces of the top rolls are arranged to come slightly below the top of the lower rolls, this adjustment being done by the large hand wheel by gear and screws as shown in illustration. By this adjustment the plates can be made to pass in a serpentine manner to take out the buckles, and then brought out perfectly straight without buckles or hammer marks. The machine illustrated is designed to stretch plates from, say, ¼in. to ⅝in. in thickness and 5ft. in width, and is self-contained on a strong foundation plate requiring little or no masonry. All the arrangements for adjusting the rolls and for reversing the machine are at one end, within easy reach of workman. The driving roll is of steel, and the pinions on the roller ends steel. The approximate weight is ten tons, the machine being very strong and well proportioned.

COMPOUND LOCOMOTIVE, PAULISTA RAILWAY.

We publish this week a two-page engraving of the compound locomotive, an external view of which we gave on page 280 of our impression for October 9th, with a description on page 283. It will suffice to say here that the gauge is 5ft. 3in., the stroke of the high-pressure cylinder is 1ft. 10in., diameter 11½in.; the stroke of the low-pressure cylinders is 2ft., diameter 26in.; the driving wheels are 5ft. 6½in. diameter.

CYLINDER CONDENSATION IN STEAM ENGINES. AN EXPERIMENTAL INVESTIGATION.*

By Chas. L. Gately, M.E., and Alvin P. Kletzsch, M.E.

Introduction.—In a paper read by the writer before the New York Academy of Sciences, several years ago,† the remark was made, referring to the nature of that function which determines the waste by "cylinder condensation:" "The function is evidently determined by the area of cylinder surface, time of exposure, variation of temperature of surfaces, and quantity and character of the working steam." The writer was compelled to assume the form of this function, and, after studying existing records of experiments, concluded that it was practically correct to take the amount of loss due to the cause above referred to as varying as the square root of the ratio of expansion. But, as remarked later,‡ "a comparison of the quantities of steam demanded to supply an engine thermodynamically 'perfect' with the actual quantities required by even the best of engines exhibits so wide a difference that it becomes obvious that the determination of the efficiency of an engine, and the solution of the questions involving those of expenditure of heat, are not problems in thermodynamics simply. The mathematical theory of the steam engine is not yet in so satisfactory a state—and cannot be until the correct theory of this transfer of waste heat can be introduced into it—that the engineer can often use it in every-day office work with much confidence, unless checked by direct experiment." It had been the

* Presented to the American Association for Advancement of Science; Ann Arbor Meeting, 1885, with an Introduction by Professor R. H. Thurston.

† "On the Behaviour of Steam in the Steam Engine Cylinder, and on Curves of Efficiency;" *Journal of the Franklin Institute*, February, 1882.

‡ "On the Several Efficiencies of the Steam Engine, and on the Conditions of Maximum Economy." "Trans." Am. Soc. of Mechanical Engineers, April, 1882; *Journal of the Franklin Institute*, May, 1882.

intention of the writer, for a long time previous to the publication of the paper referred to above, and of several other papers published at other dates, bearing upon the same general subject, to seek an opportunity to make a systematic investigation of this whole subject, and to determine, if possible, the laws governing the variation and the amount of cylinder condensation in steam engines, the speed of piston, the area of exposed surfaces, the ratio of expansion and the pressure of steam and its temperatures, varying within the range of familiar practice. It is not unusual to find steam engines in common use in which the speeds of piston vary from 200ft. up to 600ft., or more, per minute, and 1000ft. is becoming a not very unusual speed. Steam pressures range from 25 lb. to 250 lb. per square inch in this country, and from two to ten atmospheres in Europe, while in exceptional cases the pressures are vastly higher than the larger of the figures just given. The ratio of expansion varies from about two, in low pressure and the simpler kinds of engines, to ten, or even twenty, with high steam and superheating in machines designed with the intention of securing the utmost possible efficiency of fluid. In the latter also it is usual to find condensers in which a vacuum of 20in.—two-thirds of one atmosphere—is maintained, in utter disregard of the fact that high temperatures of steam should be accompanied by a restricted amount of vacuum, and a warm condenser. The area of surface presented to the steam varies from about one square inch per pound of water per hour, in very small engines, to perhaps one quarter as much in very large marine engines. Before the date of the research to be described in the following paper, much had been done in this line of investigation, and some facts had been settled with a practically satisfactory degree of certainty. The work of Messrs. Clark, in England, and Hirn, in France, had shown the importance of this phenomenon of cylinder condensation, in the economy of the engine, and had given us some knowledge of the extent to which it affected the efficiency of certain classes of engine. The investigations of Isherwood had shown very clearly the extent, and the method of variation, of this waste, with varying ratios of expansion, in the marine engine of which that of the United States steamship Michigan is the type. The studies of Escher had indicated the method of variation with change of speed of piston; and other investigators had added something to the existing stock of knowledge. The writer, however, in common with many others in the profession, was desirous of securing an opportunity to investigate the matter more completely and more systematically than it had yet been possible, and sought to find a means of carrying out a plan which he had long before laid out. It was his desire to make an investigation upon an engine of fair size, of ordinary commercial construction, and under the usual conditions of every-day operation, first determining upon some one condition which should be made variable, all others being retained constant, then making this first condition constant and another variable, and thus one by one determining the influences which together determine the total effect, measuring the extent of that effect, and learning the law of its variation. Thus it would be possible to ascertain the effect of variation of each of the determining conditions, as above, and to ascertain and to express the law of such variations, and the final resultant of all. To do this work properly required, evidently, great care, skill, patience, and familiarity with the steam engine and its management, and demanded a corresponding familiarity with the use of the apparatus of exact measurement to be applied in the work. Such an opportunity finally offered, in the spring of 1884, when Messrs. Gately and Kletzsch, two young men who were attached to the Stevens Institute of Technology, found it possible to obtain an engine of 250-horse power for purposes of experiment. An investigation, such as is above outlined, was at once planned, and was carried out during the later part of the spring and in the early summer of that year, and the results, as here given, were subsequently worked up as time and opportunity permitted, in such intervals of their business life as could now and then be secured by those engaged in the work. Messrs. Gately and Kletzsch designed a "prony brake," which proved to be thoroughly well adapted to the very heavy work required of it, and which ran smoothly and successfully up to some 300-horse power, a power which the writer had never before known to be applied to any brake controlling a steam engine. A weir was constructed, with which to measure the quantity of water of condensation, and the investigators were supplied with all needed indicators, meters, thermometers, and other apparatus from the Mechanical Laboratory of the Stevens Institute of Technology, then in charge of the writer, who had organised it for such purposes, as well as for commercial investigations, some years before. The work of investigation was performed mainly by the two gentlemen, who had assumed charge of this very important task. Fortunately, both had had experience in the use of instruments such as were required in the work, both having been trained in the laboratories and the experimental departments of the college, and Mr. Kletzsch having prepared himself with a view to taking charge of the mechanical laboratory of the institute, a position which he has occupied up to the present time. They were aided by other trained assistants detailed from the college, and especially by Professor C. A. Carr, of the United States Naval Engineers, who at that time was on duty at Hoboken, as Professor of Marine Engineering and as Assistant Professor of Mathematics. The whole work was very carefully planned, the observations were made with great care and abundant skill, and the manner in which they have been worked up is evidence equally of the reliability of the observations and of the ability with which the whole research was conducted and completed. The results will be found of peculiar value and interest. In some cases they confirm, in a very satisfactory manner, work previously done by the earlier investigators already referred to, and, in other instances, they give us entirely new and strikingly important deductions. The method taken of deriving these results by a union of mathematical and graphical methods will be seen to give great certainty, as well as to present the laws established in a manner which is most thoroughly satisfactory to the reader and to the investigator who may desire to make use of them in further research. The whole report, as presented finally to the writer, is here given as originally prepared, and is so complete in detail and so well constructed that it is unnecessary here to go into explanation, or to give a *résumé* of its conclusions. It will be observed that the method of variation of cylinder condensation, with variation of the ratio of expansion, is found to be precisely that indicated in earlier papers presented by the writer, and assumed in the theory of efficiency developed by him. The variations of condensation, with changes of pressure and temperature, under usual conditions of practice is found to be very moderate, and to follow a very simple law, so far as it can be traced. The waste with varying speed of engine is found, also, to be nearly as indicated by earlier writers; but the law is less exactly determined than in the case of varying expansion. Since, however, in all ordinary cases, in practice, the speed of engine and the boiler pressure are practically constant in the regular operation of the engine, the most important part of the investigation is that relating to the ratio of expansion, which part of the work is most satisfactorily fruitful of result. The next most important matter is the determination of the variation of loss with varying speed of engine, and the results here reached are sufficiently exact to be very useful, both to the designer and the owner of engines; while the last investigation, that relating to variation with change of pressures, is very interesting as bearing upon the future of the now progressing advance in the direction of increasing pressures. The last two lines of research demand still further and corroboratory exploration. The results here reached must be regarded as applicable, in the theory of the steam engine only provisionally, and as to be accepted finally, only after repeated experiment with other sizes and kinds of engine. This investigation, although most complete in plan and systematic in its prosecution, is but a single step in the work. R. H. Thurston.

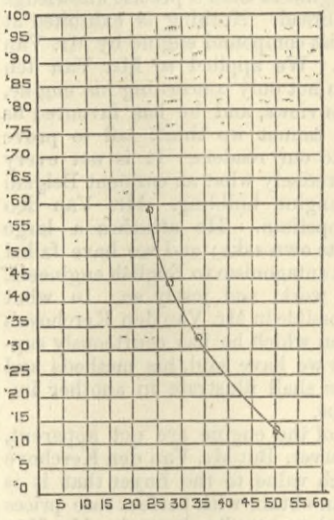
Sibley College, Cornell University, Ithaca, N.Y., July 1, 1885.

Object of this research.—The loss of waste, known as cylinder condensation, which occurs in the working of all steam engines, has been recognised by engineers as a more or less important factor, entering into the design of an engine ever since the time of Watt. The solution of the problem of the method of variation of this condensation was suggested to the writers in the spring of 1884, by Professor R. H. Thurston, then of the Stevens Institute of Technology, Hoboken, N.J., as a most promising field for investigation in the department of steam engineering, not only from the fact of its vast importance to steam consumers at large, but also because the best data existing on the subject were very incomplete and unsatisfactory. Up to that time, although the general method of action was fairly well understood, the amount of loss which would occur from this cause with any given set of conditions could not be predicted with that certainty which is essential in the designing of an engine. Thus we were led to the consideration of this question, and to attempt its experimental investigation. Our principal object was to furnish to the engineering profession a complete set of data, obtained from a good factory engine, running under conditions which were completely under our control, and such as to enable us to vary at pleasure the three most important factors entering into this question, viz., the ratio of expansion, the pressure, and the piston speed. Further than this, we desired to deduce the laws affecting this loss from a series of careful observations of the conditions governing each particular case of initial condensation. Our limited time has rendered it necessary that several of the parts into which the subject might be subdivided should be left untouched, hence it is that we have given in considerable detail the construction of the special apparatus used, its arrangement when in use, a description of the engine, and the manner in which the trials were conducted, so that any one who may see fit to use the data here furnished, can satisfy himself as to its true value, with a better knowledge of all the details attending the trials, than he could get by simply an examination of the records of the observations.

(1) *Cylinder condensation defined—its method of action.*—As some difference of opinion still exists as to just how condensation takes place within the cylinder, and as to its causes, we may quote from several well-known authorities on the subject, in order that the different opinions of eminent engineers may be compared with results obtained by us, and which will be found summarised later. Professor Rankine, in his "Steam Engine and other Prime Movers," pages 395-396, writes: "That liquefaction does not, when it first takes place, directly constitute a waste of heat or of energy; for it is accompanied by a corresponding performance of work. It does, however, afterwards, by an indirect processs, diminish the efficiency of the engine; for the water which becomes liquid in the cylinder, probably in the form of mist and spray, acts as a distributor of heat, and equaliser of temperature, abstracting heat from the hot and dense steam during its admisson into the cylinder, and communicating that heat to the cool and rarefied steam which is on the point of being discharged, and thus lowering the initial pressure and increasing the final pressure of the steam, but lowering the initial pressure much more than the final pressure is increased; and so producing a loss of energy, which cannot be estimated theoretically." Professor Jas. H. Cotterill, in his treatise on "The Steam Engine Considered as a Heat Engine," page 246, says:—"When the volume of steam actually delivered from a steam cylinder at release is compared with the volume of dry steam at the terminal pressure, corresponding to the amount of feed water used, it is always, or nearly always, found that the first is far less than the second, showing that at the end of the stroke the steam discharged from the cylinder must contain more or less water, which is either re-evaporated during exhaust, or is carried out with the exhaust steam in the shape of suspended moisture. Some of this is no doubt due to the fact that the steam supplied by the boiler is rarely dry, but in general the difference in question is far too great to be thus accounted for, and it is therefore necessary to suppose that liquefaction takes place after the steam enters the cylinder. Moreover, when the expansion curve drawn by an indicator is examined it is almost always found, even when the greatest care has been taken to eliminate the disturbing causes, to show that evaporation takes place during expansion. Now these unquestionable facts can only be explained by supposing that liquefaction takes place during the admission of the steam to the cylinder, and evaporation during expansion and exhaust. This alternate liquefaction and evaporation is chiefly due to the action of the sides of the cylinder in many cases combined with the effect of water remaining in the cylinder after exhaust is completed. It is in the first place clear that the amount of steam liquefied on admission must depend on the area of the surface exposed to the steam. It is true that other circumstances may, or rather must, have influence, and especially the time during which the contact of the steam with the surface lasts, and the temperature of the surface; but the first consideration is the actual area of the surface." Referring to Chief Engineer Isherwood's report of the marine engine trial made by a board of naval engineers, Professor Cotterill continues: "We may draw the following conclusions from them:—(1) The initial condensation and the heat absorbed per square foot of admission surface increase with the ratio of expansion. (2) The initial condensation at high rates of expansion may exceed fifty per cent." Professor Thurston writes*:—"Of all the heat furnished to the engine by the boiler, a certain part, definite in amount and easily calculated when the power developed is known, is expended by transformation into mechanical energy, another part, equally definite and easily calculated also, is expended as the necessarily occurring waste which must take place in all such transformations, at ordinary temperatures of reception and rejection of heat; still another portion is lost by conduction and radiation to surrounding bodies; and finally a part, often very large in comparison with even the first and most important of these quantities, is wasted by transfer within the engine from the induction to the eduction side, or from 'steam to exhaust,' without any useful effect being derived therefrom. This last transformation is what is properly known as cylinder condensation. The amount of this loss increases with wet steam, and is diminished by any expedient—as steam jacketing, or superheating—which prevents the introduction or production of moisture in the midst of the mass of steam in the cylinder. It is generally assumed, in the usual theory of the engine, that the expansion of the working fluid takes place in a cylinder having walls impermeable to heat, and in which no losses by conduction or radiation can occur; but it is impossible in practice, so far as is known, to secure a working cylinder whose material will fulfil these conditions. The consequence is that, since the steam or other working fluid enters at a high temperature, and is discharged at a comparatively low temperature, the surfaces of the cylinder, cylinder heads, and piston are one moment charged with heat of a high temperature, and at the next instant exposed to lower temperatures, are drained of their surplus heat, which heat is then rejected from the cylinder through the exhaust, and wasted. In the steam engine the loss by the method here referred to is rarely less than one-fourth in unjacketted cylinders, and is often more than equal to the whole quantity of heat transformed into mechanical energy. As the range of temperature worked through in the engine increases as the quantity of steam worked per stroke diminishes, and as the time allowed for transfer of heat to and from the sides and ends of the cylinder and piston is increased, the magnitude of this loss increases. Hence the use of high steam of a high ratio of expansion and of low piston speed, tends to increase the amount of this waste."

(2) *Influence of cylinder condensation upon efficiency—Method of securing economy—Influence on the ratio of expansion at maximum efficiency.*—By reference to Table I., line 31, it will be seen that, of all the steam that passed into the cylinder from the boilers, from 22 to 50 per cent. absolutely passed through the engine to the exhaust without producing any useful dynamical effect upon the piston. From this it can readily be understood at what point the engine of the present day fails, and why so small a percentage of the energy stored in the fuel consumed by the boilers is realised in giving motion to the machinery of our mills. Any saving effected in this direction would be felt throughout the world in the cheapening of the manufactured products, and he who accomplishes it will be considered as great a public benefactor as he who first conceived the idea of utilising the steam itself. In considering the theory of the steam engine thermodynamically, expansive working of the steam is found to produce economy, but the effect produced by cylinder condensation is not considered; hence it is that the extent to which expansion should in theory be carried is found to be greatly in excess of that found to give the best results in practice. This can readily be understood by referring to Fig. 1, when it will be seen that, as the ratio of expansion increases, or as the fraction of the stroke completed up to cut-off diminishes, the percentage of condensation rapidly increases, the angle made by the curve representing the variation with the axis of X, on which the percentage of condensation is laid off, becoming less and less as the cut-off is earlier. Therefore a point must exist at which, expansion being carried beyond it, the loss due to condensation will exceed the gain of work done by the expanding fluid. Professor Thurston, in a paper on the "Several Efficiencies of the Steam Engine," read before the American Society of Mechanical Engineers, Philadelphia, 1882,* writes "The efficiency of engine has been often studied by authorities considered as standard, but almost invariably as a problem in thermodynamics simply, and the losses of heat occurring in consequence of the working of steam in a cylinder composed of a good conductor of heat have been left unnoted, although frequently the most important of all the expenditures of heat taking place in the engine. In a non-conducting cylinder, the maximum efficiency of fluid would be secured if the ratio of expansion were made nearly the quotient of initial by back pressure; while the efficiency of the engine would be made a maximum when the ratio is made nearly equal to the quotient of initial pressure by the sum of all useless resistances. When, however, as is always the case in practice, the steam is worked in a metallic cylinder, the best ratio of expansion is made very much smaller, and the efficiency of the engine is greatly reduced by cylinder condensation and re-evaporation, which produce a serious waste of heat. The total loss of efficiency of work, or of pressure, due to cylinder condensation, may be allowed for by taking for its value the expansion $a\,r^m$, in which a is a constant dependent upon the state of the steam before expansion, r is the rate of expansion, and m is an exponent dependent upon the method of variation of the properties of the mixture of steam and water as expansion progresses. The useful work per stroke is a maximum, and the ratio of expansion at maximum efficiency of engine is found, when the latter is of such value as to satisfy the equation:

FIG. 1



$$r^{-n} - a\,r^{m-n} = \frac{p_b}{p_1},$$

nearly, and when, if c is the 'cut-off,'

$$c^{n} - a\,c^{n-m} = \frac{p_b}{p_1}$$

nearly. The value of the constant a varies from 0·1 to 0·2, in good engines, according to the quality of steam supplied, and m may be taken at o in the best class of well-designed compound engines, and as rising to 0·5 in unjacketted single-cylinder engines; n is the exponent in the equation of the expansion line." Reference will be made later to the "curve of efficiency," described by Professor Thurston in the paper referred to, by which he represents graphically the general effect produced by condensation at varying ratios of expansion.

(3) *Historical, &c.*—In order to be brief, and at the same time not wishing to under-rate the work done by physicists and engineers previous to our time, we will quote, from Dr. R. H. Thurston's "Theory of the Steam Engine,"† the following historical outline:—"The limitations of the thermodynamic theory of the heat engines, and of its application in the design and operation of such engines, were first discovered by James Watt a hundred years ago and more. They were systematically and experimentally investigated by Isherwood in 1855 to 1865, were observed and correctly interpreted by Clark in 1855 and earlier, and were revealed again by the experiments of Hirn, and by those of Emery and many other recent investigators on both sides of the Atlantic. These limitations are due to the fact that losses occur in the operation of steam engines which are not taken into account by the hitherto accepted theory of the engine, and have no place in the thermodynamic treatment of the case. James Watt discovered this cause of the limitation of the efficiency of the steam engine. He not only discovered the fact of the existence of this method of waste, but experimentally determined its amount in the first engine ever placed in his hands. It was in 1763 that he was called upon to repair the little model of the Newcomen engine, then and still in the cabinets of the University of Glasgow. Making a new boiler, he set up the machine and began his experiments. He found, to his surprise, that the little steam cylinder demanded four times its own volume at every stroke, thus wasting, as he says, three-fourths of the steam applied, and requiring four times as much 'injection water' as should suffice to condense a cylinder full of steam. It was in the course of this investigation that he discovered the existence of so-called 'latent heat.' All of Watt's first inventions were directed toward the reduction of this immense waste. He proposed to himself the problem of keeping the cylinder 'as hot as the steam that entered it.' He solved this problem by the invention of the separate condenser and the steam jacket, and thus the discovery of the limitation of the thermodynamic theory here noted was the source of Watt's fame and fortune. John Smeaton, a distinguished contemporary of Watt, and perhaps the most distinguished engineer of his time, seems to have been not only well aware of this defect of the steam engine, but was possibly even in advance of Watt in attempting to remedy it. He built a large number of Newcomen engines between 1765 and 1780, in some, if not many, of which, he attempted to check loss by this now familiar 'cylinder condensation' in engines, some of which were 5ft. and 6ft. in diameter of cylinder, by lining pistons and heads with wood. This practice may not be practicable with the temperatures now usual; but no attempt has been made, so far as is known to the writer, to follow Smeaton in his thoroughly philosophical plan of improvement. Cylinder condensation remains to-day, as in the time of Smeaton and Watt, the chief source of waste in all well-designed and well-constructed heat engines. It is a curious fact, and one of great interest as illustrating the gulf formerly separating the philosopher studying the steam engine and working out its theory, from the practitioner engaged in its construction and operation in the earlier days of engineering, that, notwithstanding the fact that this waste was familiar to all intelli-

* "On the Several Efficiencies of the Steam Engine." "Transactions" of the American Society of Mechanical Engineers; *Journal of the Franklin Institute*, 1882.

* "Transactions" of the American Society of Mechanical Engineers, 1884; *Journal of the Franklin Institute*, 1882.

† Report of British Association for Advancement of Science, Montreal meeting, 1884; printed in extenso, p. 569.

gent engineers, from the time of the invention of the modern steam engine, and was recorded in all treatises on engine construction and management, the writers on the theory of the machine have apparently never been aware that it gives rise to the production, in the working cylinder, of a large amount of water mingled with the steam. In fact, it has often been assumed by engineers themselves that this water is always due to 'priming' at the boiler. Even Rankine, writing in 1849-50, while correctly describing the phenomenon of cylinder condensation, made the mistake of attributing the presence of the water in steam cylinders to the fact of condensation of dry steam doing work by expansion, apparently not having noted the fact, that this would only account for a very insignificant proportion of the moisture actually present in the average steam engine. He considers incomplete expansion the principal source of loss, as do usually other writers on thermodynamics.

(*To be continued.*)

SOUTHAMPTON NEW WATERWORKS.

The ceremony of turning the first sod at the new Southampton Waterworks at Otterbourne-hill was performed by the Mayor (Mr. James Bishop) on the 15th inst. The works at Otterbourne-hill comprise, shortly, a circular tank 150ft. in diameter, with a capacity of a little over one million gallons, the depth of water being 10ft. 6in. The exterior wall will be of concrete, in the making of which the material obtained from the excavations will be utilised. Between the outer wall and the centre will be concentric rows of brick piers, supporting five concentric rings of brick arches, the spandrils of which will be filled in with concrete. This will form the roof of the reservoir, and the surface of the common will be restored to its original state. The only feature that will appear above the surface will be a small circular tower from 10ft. to 12ft. diameter, and built of Portland stone, of the Norman style of architecture, which will serve for the double purpose of an entrance to the reservoir and a ventilating medium. The wells and pumping station will be some distance from the reservoir—in the valley of the Itchen—between Otterbourne-hill and Shawford station. Two wells and borings 100ft. deep will be sunk into the chalk, brick-lined 20ft. down and then 6ft. borings the remainder of the depth. The water, after being softened, will be pumped up to the reservoir by two powerful engines of the most modern construction, passing along 1⅛ mile of 24in. piping to the reservoir. A by-pass will be constructed here so as to allow the water supply to continue to Southampton while the reservoir is being cleaned. The supply pipes to Southampton will be 4½ miles in length, and 16in. in diameter. They will proceed partly along the high road and partly across country—the most direct route to the reservoirs on the common—where they will discharge their contents. The water gravitates from Otterbourne-hill, and at one point it almost descends to sea level, and then rises again.

Mr. Matthews, water engineer, said the idea of Otterbourne affording a source of water supply to Southampton was not a new one. So far back as 1851 it was proposed to get their water pretty well at the same site they had now obtained. But violent opposition was raised to the project, and this was carried so far that the then vicar of Otterbourne urged the people to protect themselves against the Southampton people, who were coming to rob them of their water. The proposal was then abandoned. If the works had been carried out in those days they would have been of a very different character to those now proposed. The expenditure which was about to be entered into was the largest single expenditure ever undertaken by the Corporation. The largest loan raised hitherto was one of £30,000, but the amount now to be raised was between £50,000 and £60,000. The works, if carried out some years ago, would have cost much more than they would now. The manufacture of concrete had been brought to such a state of perfection that now it was a comparatively cheap material. The works there were to cost less than £5000, but thirty years ago they would have cost from £7000 to £8000. The reservoir to be there excavated was not intended as a large storage place. They had on the Southampton-common reservoirs which would hold over five million gallons, so that together they would have a capacity of about six million gallons. When the water consumption in Southampton had been reduced to the quantity they hoped it might be, that would give them three days' supply, which, as they were going to erect duplicate machinery at the pumping station, was ample. The reservoir would be covered in, and in three years' time the inhabitants of Otterbourne would be able to again enjoy their recreation ground. These works would displace some 18,000 cubic yards of earth. They would replace between 2000 and 2500 cubic yards of concrete, about 800 cubic feet of stone, and something like 320,000 bricks. The work comprised in the laying of the pipes from the pumping-station to the reservoir and thence to Southampton would be something between 13,000 and 14,000 cubic yards of earthwork, and about 2000 tons of piping would be required, which would have about 3000 joints. The two borings at the pumping-station were, he believed, the largest borings ever undertaken, and special tools would have to be made for the work. The two pumping-engines were to be of the most modern construction, The two boilers were to be of steel. They proposed to lay down softening works in connection with the pumping station—the largest, so far as he knew, that had ever been attempted. He believed the largest quantity of water which it had been attempted to deal with hitherto was 500,000 or 600,000 gallons at once. They proposed to deal with 2,000,000 gallons. The works at the pumping station would comprise a series of buildings for slacking the lime—the chalk being raised on the spot—and making lime water. This lime water was mixed with the water pumped from the well, and then allowed to subside. After that it was passed through a series of filters by a patent process, and the water pumped up, by the same engine which raised it from the well, to the reservoir on Otterbourne-hill. Cottages would also be erected for the staff. It was almost certain now that the Corporation would obtain a railway siding at the pumping works. The only thing necessary to do with the reservoirs on Southampton-common was to alter the inlets so that the water should not overflow. He hoped at some future time the Corporation would have those reservoirs covered over.

Mr. Whitaker, F.G.S., said they could not perhaps get to chalk at Southampton, and past experiments on the common did not encourage them to spend more money in that direction. They *might* get water near Southampton, but it was very doubtful, whereas in Otterbourne district the presence of chalk streams and springs and other signs left very little doubt that a plentiful supply was to be obtained.

Water from the Chalk Formations. — The numerous artesian wells sunk in the metropolis are causing a gradual lowering of the chalk springs, or of the underground water level; this is now steadily going on at the rate of about 18in. per annum. The depression in central districts has reduced the head of the chalk springs to more than 80ft. below Ordnance datum line; the effect, however, is at present local, and it would appear that great as is the cone of depression already, the outlying portions of the chalk formation have as yet not been affected to any notable extent. Last week an artesian well was completed at Yewsley, near West Drayton, by Messrs. Le Grand and Sutcliff, of London, where immediately upon the chalk being struck at 152ft. the water rose to over 8ft. above the surface, and continues to overflow with increased force. The level of the ground at the site of this well is about 100ft. above Ordnance datum, thus demonstrating a difference of nearly 200ft. in the levels of the chalk springs between this spot and the centre of London, the distance from Yewsley being fifteen miles.

AMERICAN NOTES.

(*From our own Correspondent.*)

New York, October 17th.

The commercial situation has not materially changed during the past week, excepting in the disposition of jobbers and retailers in certain lines of trade to place orders for fall requirements with more freedom and confidence. The week's business in steel rails is reported at 20,000 tons, at 30 to 31 dols.; in bridge iron, 5000 tons for bridges across the Missouri, Mississippi, and two or three other smaller streams. One thousand tons of plate iron have been ordered in Pennsylvania mills for delivery in November and December.

Heavy orders are crowding the Eastern nailmakers, and prices are likely to be advanced 10 cents per keg, owing in part to the resolution this week of the western nailmakers, representing 4000 machines, to not yield to the demand of their workmen in any event. Fortunately for manufacturers and buyers, the bulk of the demand is over, and it is regarded as probable now that the capacity employed will be sufficient to meet actual requirements of the market, but not the speculative requirements, which a good many are presenting in view of the possibilities of a further advance.

Quotations range as follows:—No. 1 foundry, American, 17·50 to 19 dols.—stocks of good material light; No. 2, 16 to 17 dols.; Bessemer, 19 to 20·50 dols.; gray forge, 14·50 to 15·50 dols.; southern forge, 14 to 15 dols.; muck bars, 27 to 28 dols. at mill; merchant iron, 1·50 to 1·80 dols. at mill; nails, 2·40 to 2·50 dols. at store; nail slabs, 29 to 31 dols. at mill; plate iron, 1·90 to 2 cents in large lots; tank iron, 2·10 to 2·15; shell iron, 2·50; beams and channels, 3 cents; sheet iron, 3·25 to 3·50, according to gauge. No shading in discount prices on wrought pipe is to be had in any department, owing to the heavy demand. Offers are made for steel rails at less than 30 dols., but are declined. Old rails are wanted at 17 to 18 dols., and supplies are behind demand. Cargo scrap is quoted at 14 to 16 dols.; selected scrap, 17 to 18 dols. Scotch pig iron is in moderate demand. The exports of copper continue heavy, but prices are slightly weaker. A good demand is in progress for lead, zinc, and antimony, and prices are steady.

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

(*From our own Correspondent.*)

The reports brought to 'Change yesterday in Wolverhampton and this afternoon—Thursday—in Birmingham did not generally indicate an increase of business upon the week. In other than the sheet branch trade is again beginning to assume the hand-to-mouth character with which we are only too familiar. Merchants do not seem disposed to place orders of a large size for export, and home consumers have not that demand for their manufactured products which calls for any considerable buying on their part.

In sheets, however, plenty of activity is still maintained in the execution of orders booked a few weeks ago. Specifications are not in all cases arriving as promptly as could be desired, and makers thus situated find difficulty in keeping the works steadily going, but generally speaking the mills are mostly active upon sheets for galvanising purposes. Singles are quoted £6 10s. upwards; doubles, £6 15s. upwards; and trebles, £7 17s. 6d.

It is satisfactory that this week the extensive Osier Bed Ironworks, Wolverhampton, which have been standing idle for over fifteen months, have been restarted under the new proprietary of Messrs. John Lysaght. The works will be employed on the production of sheets for galvanising. By next week two forges and three mills will be running, and in a month's time five mills will be on. When completely ready and in full swing, the works will employ 400 ironworkers, who will receive £600 a week in wages. These works will be carried on by Messrs. Lysaght in addition to their present Swan Garden Works, where their output of sheets is already very large.

The leading galvanisers keep full of work; there is a heavy outturn on account of the colonies; much of the tonnage is being sent out on consignment rather than on actual order, some makers being prepared to sell at the market price in Sydney or Melbourne at the time of the arrival of the goods in the colonies without waiting for better terms. I hear that one large firm has accepted instructions from one Australian importing house to send out regularly 1000 tons per month under consignment.

The price lists of the galvanised sheet makers still set out the 5s. per ton advance declared a couple of months ago. Morewood's Red Star corrugated sheets are quoted at date £11 10s. for 18 g. and 20 g., £12 for 24 g., £13 10s. for 26 g., £14 10s. for 28 g., and £16 10s. for 30 g. Their Lion brand is £12 for 20 g., £12 10s. for 24 g., £14 for 26 g., £15 for 28 g., and £17 for 30 g. The Wheatsheaf brand of galvanised flat sheets, in cases, are quoted £13, £13 10s., £15 10s., and £16 10s., according to gauge; Woodford Crown brand, £14 10s., £15, £16, and £18 respectively; the Anchor brand of galvanised tin sheets, £17, £18, £20, and £21, according to gauge; and the Lion brand of best quality sheets, £20 for 18 g. and 20 g., £21 for 24 g., £23 for 26 g., and £24 for 28 g.

Plates are quiet, in much part because of the competition from other districts, and prices range from £7 10s. to £8 10s.

Prices of marked bars continue on the Quarter-day quotations, namely, £7 10s.; medium qualities range from £6 10s. to £6, and common sorts may be purchased at from £5 2s. 6d. upwards. It is in the two latter qualities that most business is doing at date, since buyers are unprepared to give the higher prices except for special uses.

Hoops are in pretty good demand. Rounds and squares of large size for engineering purposes display a better demand, and sales of small sizes are about the same as for some few months past.

The demand for nail and wire rods continues dull, and little or no improvement is noticeable in the number of current orders in those departments. Rivet iron has also shown a restricted business of late. Cable and chain iron is in limited request. Hoops are in moderate sale at £5 10s. for common and £6 for superior sorts. Tube strip is £5 5s. upwards.

It was made known on 'Change in Wolverhampton that the chairman of the Staffordshire Steel and Ingot Iron Company, Mr. Alfred Hickman, had received from Mr. John Noble, the general manager of the Midland Railway Company, an important communication touching the recent purchase by the company of steel sleepers from Belgium. Mr. Hickman wrote to the company, stating that he should be glad if, when the company were again buying sleepers, they would allow Staffordshire steel works to tender, and pointing out the desirability of the Midlant Company encouraging and assisting its own customers rather than of sending orders abroad. Mr. Hickman did not ask for any preference over the foreigner, but that an opportunity should be given of competing on equal terms. To this Mr. Noble has replied that it is quite true that his company have purchased 5000 sleepers from Belgium, weighing about 250 tons, and for trial only. The company applied to several English houses for tenders, but found that they had not at present the necessary plant, and they "naturally asked a sufficiently high price to cover the cost of new plant." The Belgian firm, however, had the plant ready, and were willing to supply at a price very much below that of the English makers.

The Midland Company protest that they do not like sending orders out of the country, and they express their confidence that if they should determine upon adopting steel sleepers there will then be plenty of English makers who would be willing to put down the necessary plant at their own cost without increasing the ordinary price, seeing that the consumption of the Midland Company would be large. It was reported upon 'Change that already the Midland people have issued a second tender to home firms. If the report is correct the Staffordshire Steel Company will doubtless make an attempt to get some of the work.

Ironmasters and engineers commented with much satisfaction to-day upon the intention of the Admiralty to spend nearly two millions more money upon shipbuilding and machinery to be built by contract in 1885-6 than in 1884-5. This new high-class work, it was held, will give a very pleasant fillip to the iron and steel industries. Though the iron and steel masters in the districts where the contracts will be executed will most largely benefit, requirements will yet be needed from all the metal manipulating centres.

New bookings in all-mine and part-mine pig are only moderate, but regular contract consignments are going forward. Quotations are fairly strong, and stand at about 55s. to 57s. 6d. per ton for all-mine iron, 45s. for best part-mine, and 35s. for common iron, with minimum qualities selling at 32s. 6d. Foundry pigs are in better request at date than forge sorts.

A meeting called by circulars was held this—Thursday—afternoon at the Queen's Hotel, Birmingham, to consider the wages question. It was stated that in consequence of the higher wages paid in the North of England, the competition from ironmasters in that part of the kingdom is increasing severely, and that a reduction in Staffordshire wages has become imperative. Ultimately, it was determined to postpone definite action till a month hence.

The South Staffordshire colliers are proceeding with their arrangements for taking a ballot upon the question of stopping the works at a given date, to obtain the 15 per cent. in wages which has been agitated by the Manchester Conference. On Wednesday a meeting of delegates was held at Great Bridge, at which the different Staffordshire districts were represented, and the mode of taking the ballot previous to the adjourned conference on the 4th November was decided upon.

Manufacturers in this district are trying to secure the order from the Great Peninsula Railway Company for the supply of brass and iron screws, wrought nails, copper plates and rods, telegraph material, and other hardwares.

The Anglo-American Tin Stamping Company has issued circulars announcing a reduction in discounts of 5 per cent. upon tinned hollowwares. The firm is understood to be exceedingly busy, and the advance is the outcome of the large demand and of the rise in tin-plates.

The Staffordshire Chamber of Commerce, replying to the questions submitted by the Royal Commission on Trade Depression, suggest as measures to improve the existing state of things the freeing of canals from the control of railway companies, the development of the resources of India, close commercial alliance with the colonies, and the opening out of new markets, particularly in Western China. The members of the Chamber were divided upon fair-trade proposals.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—The weight of business doing in the iron trade of this district continues extremely small, and the general tone throughout the market is weak. This is especially the case as regards pig iron; although there is no quotable reduction in price, and in some instances makers still hold firmly to their full list rates, these are purely nominal, as they are not being got on ordinary business transactions. In fact, there is so little buying going on, that prices in any case are scarcely being tested, and although there are sellers prepared to come considerably under current quoted rates, even low prices do not bring forward buyers. The general prospects of trade are so unsatisfactory that there is no inducement for consumers to enter into anything like speculative transactions, and any actual requirements that have not already been covered by purchases a month or so back are extremely small. The general disposition is rather to wait, and this is strengthened by the unsettlement caused by the approaching elections. Consequently the orders given out are confined chiefly to small hand-to-mouth lots; and to secure even these small orders prices are being cut very low. Finished iron is perhaps not in quite so depressed a condition. At any rate, it is not suffering from the same reaction as is the case with pig iron; but business is coming in only very slowly to manufacturers, and at the best they are only with difficulty able to keep their works going from hand to mouth.

There was again but a very dull iron market at Manchester on Tuesday. Pig iron makers reported a continued absence of inquiry, and although in some instances 39s. to 39s. 6d., less 2½, is still adhered to as the quoted list price for local and district brands delivered equal to Manchester, there are sellers quite ready to take 1s. per ton under these figures, and even where prices are quoted on this reduced basis, sellers are very indifferent about giving out orders. Outside brands are also weaker in price, and good named brands of Middlesbrough foundry are to be got at under 41s. net cash, delivered equal to Manchester.

Hematites still meet with only a very poor demand, and good foundry qualities are to be got at about 51s. 6d. to 52s., less 2½, delivered into the Manchester district.

For manufactured iron the minimum basis of quoted prices remains at £5 5s. for bars, £5 15s. for hoops, and £6 15s. for local made sheets, but there is only a small weight of business giving out, which is barely sufficient to keep works going from hand to mouth, and in some cases a disposition is being shown to give way a little to secure orders, although not to such an extent as to have any appreciable effect upon prices generally.

The condition of the engineering trades is without improvement, the position of various branches remaining practically the same as I last reported.

Messrs. R. and J. Dempster and Co., who at the commencement of the present year introduced the construction of gas works plant on a large scale to this district, have since they started their works at Newton Heath had no less than twenty gasholders in hand, their last order being for Ballynahinch, Ireland.

At the usual fortnightly meeting of the Manchester Association of Employers and Foremen, held on Saturday, several interesting short papers reviewing different sections of the Inventions Exhibition were read. The President (Mr. W. H. Bailey), in opening the proceedings, made a few pertinent remarks respecting exhibitions in general. There were, he said, very different views as to whether exhibitions were useful or not to manufacturers in this country. He had himself very definite views as to whether it was advisable for an Englishman to exhibit in exhibitions abroad where the tariffs were intended to be of a prohibitive character. For instance, in the United States he considered that it was foolish for a man to exhibit unless he had a strong monopoly as a patentee or something of that sort, which would enable him to command sufficient profit to pay the extraordinary duties which were levied on English manufactures. Of course there was a great deal to be said on both sides; he thought Englishmen were giving the foreigner too much chance for copying our designs—on the other hand, it was just possible that the greater publicity given to our manufactures might enable our countrymen to get a footing abroad before the foreigners themselves had time to copy our designs. Mr. S. Boswell afterwards gave a short review of the land boilers shown at the exhibition, and in regard to these, remarked that in most cases the exhibits presented no feature of special novelty, the only boiler which he found calling for any special mention being Moy's patent non-priming boiler, which was certainly a decided departure from the beaten track of ages. Mr. Thomas Daniels, in the locomotive section, found very little that was new or any invention likely to come into general use, or to be of any practical value beyond Mr. Webb's compound locomotive, which he considered to be the greatest departure from the ordinary practice of modern times, and entitled to be regarded as a real invention. The several types of stationary engines shown at the exhibition were briefly described by Mr. Joseph Nasmith, who also dealt shortly with the textile machinery, with regard to which he did not consider there was any decided novelty either in spinning or looms. Other sections of the exhibition are to be dealt with at another meeting of the Society.

In the coal trade the usual extra demand for winter requirements is producing increased activity, but any improvement in the demand is still confined chiefly to the better qualities for house

fire consumption. General trade requirements show no tendency towards enlargement, and common round coals continue in very poor demand for iron making and steam purposes, whilst engine fuel, although not being pressed quite so much as it was during the Oldham strike, still hangs in the market, and the common sorts are a drug. In the Manchester district the usual winter advance in prices which was only partially put into operation at the commencement of the present month is, with the commencement of November, being made general to the extent of 10d. on house coals and 5d. to 10d. on other sorts, both at the pits and wharves, and delivered with this advance in prices there will also be an advance in wages. In other Lancashire districts where an advance of 6d. per ton upon round coals has been generally established during the past month, there is no announcement at present of any further upward movement, but the action taken in the Manchester district will necessarily tend to harden prices.

The shipping trade, except where coals are being shipped for house fire purposes, is very quiet, and for steam coals prices continue very low both at Garston and Liverpool.

Barrow.—The dull trade in hematite pig iron still continues, and there are no signs of improvement on any hand. There is a quiet demand from home consumers as well as from foreign, colonial, and continental buyers. Indeed, there is no new life to record from any quarter. Stocks remain very large, and delivery engagements, especially to foreign consumers, are inextensive. Prices show no variation, mixed Bessemer parcels being quoted at 42s. 6d. per ton net at makers' works, prompt delivery, or f.o.b., and No. 3 forge and foundry iron at 42s. per ton, forward deliveries 1s. per ton extra. Steel makers are in rather fuller employ, but the weight of trade doing is immeasurably inferior to the capabilities of the works in the direction of production. The rail mills and the plate mills are in some cases idle, and in others only half employed. The production of tin bars, which a month or two ago was reported to be one of the best features of the local steel trade has somewhat declined lately in harmony with the diminution which has taken place in the production of the tin-plate works of Wales, to which place large consignments of material were sent from this district. Practically no new trade is offering to the steel makers of the district, and the future of the trade is on the one hand uncertain, but on the other presenting undoubted evidences of erratic movements, requiring much less in the way of production than the mills are capable of. Shipbuilders have booked no new orders. Engineers remain busier, as previously reported. Ironfounders are doing a poor trade. It is expected in the course of a few months a new development will take place in the boiler making trade by the introduction of a mill, already described in THE ENGINEER, for the manufacture of circumferential seamless boiler plates, the patent of Mr. Windle. It has been determined by the Barrow Tramways Company to lay lines of tramway early next spring from Duke-street, the centre of the town, across the High Level Bridge on to old Barrow Island, and down to Ramsden Dock passenger station, alongside the steamboat pier.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

MY anticipation that there was another side to the story about the Midland Railway Company ordering 10,000 steel sleepers from the Cockerill Company, Belgium, turns out to be correct. Steel sleepers have long been a speciality of continental firms, and the Midland Company, having decided to give them a trial, have ordered a few by way of experiment. If they become a railway requirement in England, home firms will no doubt be equal to supplying the home demand. I notice that the order is written about as 10,000 tons of steel sleepers. This exaggerates the statement still further; 10,000 steel sleepers and 10,000 tons of steel sleepers are two widely different things; 10,000 steel sleepers would only mean about 500 tons. It is difficult to see how railway companies can economise much by the substitution of steel for wood in sleepers, if the figures given to me by an expert be true. A wooden sleeper, he says, costs half-a-crown to start with, lasts for thirty years, and at the end is worth 9d. A steel sleeper cannot do much better than that.

Mr. C. E. Hall, of the Standard Ironworks, Washford-road, Sheffield, has been the successful tenderer for the four dredger elevators for the sewage works now being constructed at Blackburn Meadows for the Sheffield Corporation. Mr. Hall has despatched to Columbia, Central America, a sectional crusher for mountain districts, along with a patent elevator for use on the Andes. There is also a good demand for his Noria pump, used in India and Egypt for irrigation and similar purposes, as well as for his Victor bone mill, with pulverising roller, for home and colonial markets.

I hear most gratifying accounts of the continued success of English manufacturers at the world's trial of agricultural implements at Adelaide, Australia. The well-known Grantham firm, Messrs. Richard Hornsby and Sons, have again carried off the premier honours with their patent reaper and binder, beating the McCormick, Howard, Wood, Johnston, Osborn, Deering, and Esterley. Prior to Messrs. Hornsby entering upon the manufacture of these special implements, the American houses — notably the McCormick and the Wood — had the control of the markets. In 1882, however, in open competition, the Grantham firm carried off the £100 first prize of the Highland and Agricultural Society of Scotland. In 1884 Messrs. Hornsby were again to the front, securing the first prize of £100 at Shrewsbury; no prizes were offered by the Royal Agricultural Society in 1883. In addition to this they followed up their successes in Australia by taking eleven first prizes in field trials alone, in every case winning the Government trials which were held in the various colonies. Similar results may, and are likely to be accomplished in a branch of trade in which Sheffield is still more deeply interested. The Americans have long held "the thick end" of the stick in the spade and shovel trade, but the energy which is being exhibited by our local manufacturers is not unlikely to secure to the town a goodly portion of the work, for the production of which it is so admirably situated.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THE Cleveland pig iron trade continues in a gloomy and unsatisfactory condition. Very little business is being done, and prices are somewhat weaker than they were. There was a fair attendance at the market held at Middlesbrough on Tuesday last, but the sales made were for small quantities only. Some holders, anxious to sell before the end of the month, pressed their iron on the market, and prices fell in consequence. Several small lots of No. 3 g.m.b. were sold at 31s. 9d. to 31s. 10½d. per ton; but most of the merchants refuse to take less than 32s. per ton. Some will accept the latter figure for delivery into next year; but, as a rule, no sellers are eager to commit themselves so far ahead. Makers have sufficient orders to last some weeks, and do not quote less than 33s. per ton. Forge iron is somewhat firmer than No. 3, and the price is maintained at 31s. 3d. per ton.

Warrants are in poor request. Some sales have been made at 32s. 3d., but there are not many holders who will accept so low a figure.

The stock of pig iron in Connal and Co.'s Middlesbrough store is still steadily increasing. On Monday last the quantity held was 109,981 tons, being an addition of 2751 tons during the week.

The continued bad weather has impeded the shipping trade considerably. Up to Monday last only 67,152 tons had been exported from the Tees since the 1st of October, that being about 10,000 tons less than during the corresponding portion of September.

Nothing new has occurred in the finished iron trade. Owing to scarcity of specifications the mills are not working much more than half time. No change has taken place in prices. Dr. Watson's award in respect of ironworkers' wages has not yet been announced.

Messrs. Raylton, Dixon, and Co. have received an order for a new steamer from the Union Steamship Company. The leading dimensions of the vessel are:—Length, 253ft.; breadth, 33ft.; depth, 24ft. 7in.; and her gross tonnage will be 1300. The hull is to be built of steel under Lloyd's special survey; but all the plates and frames are to be of the same thickness as would be required by Lloyd's for iron. This is the first instance where this has been done, and shows that in the opinion of the advisers of the Union Company the reduction of 20 per cent. for steel permitted by Lloyd's is undesirable, at all events, where the rough seas of the Southern Ocean have to be encountered. The vessel will be fitted with triple expansion engines of the type designed by Mr. Wyllie, and manufactured by Thos. Richardson and Sons, of Hartlepool. There are three cylinders side by side, the steam entering the forward one, then passing to the after one, and then to the middle one. The pistons work successively on to a three-throw crank shaft.

The prospects of employment for the industrial classes in the large towns on the north-east coast, during the ensuing winter, are daily becoming worse. All who have full work, at wages no matter how low, are well off—better off, indeed, than they were two years ago; for 15s. is as good now as regards purchasing power as 20s. was then. But for those operatives—and their number is increasing day by day—who cannot get full work, and who wander about, spending their limited strength and means in trying to obtain it, the situation is almost appalling. Already in Newcastle and elsewhere the benevolent are talking of organising relief funds to mitigate to some extent the widespread distress which is approaching; and the sooner these arrangements are matured the better, for the cold weather, with all its accompanying hardships, is almost upon us. Some persons are confident that as soon as the elections are over a better state of things will ensue. This may or may not be the case, but it is certain that until they are over an immense amount of thought and energy will be diverted from business and expended on politics. Not only so, but those who alone have power to give an impetus to the wheels of trade, namely, those who have accumulations of wealth, are not likely to embark in new enterprises until the nation has given its decision as to how, and by whom, it will be governed in the immediate future. The only gleam of hope which is at present apparent comes from the undoubtedly improved state of trade which exists in the United States. All accounts agree that the better tone and increased activity which has arisen there is real and substantial.

As yet, however, no other country has shared in this beneficial influence, not even the Dominion of Canada, and Great Britain is unable to respond in the smallest degree. Nevertheless, it is impossible to believe that the United States can continue to prosper without sooner or later affecting us. Its railways and other public works are largely held by English capitalists, who will benefit by better dividends. If the demand for labour increases it will lead to increased emigration, and in that way relieve our glutted labour market; and fewer mouths means more to put into them here. Besides, better trade in America will lead to renewed purchase of some of our products, and to a relaxation of American competition in certain neutral markets. And in many other ways it is certain that the cup of American prosperity cannot fill up without a beneficial overflow in other directions. Whether or not, American producers contemplate that result.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

LOOKING at the iron and steel trade as a whole, it is evident that there is a large amount of business passing, but the pig iron department, unfortunately, remains in a depressed condition. The shipments of pigs have been smaller than before, amounting to 7210 tons, as compared with 8223 in the preceding week, and 10,806 in the corresponding week of 1884. Warrants have fluctuated about 5d. a ton, and the market has been much depressed, while ironmasters and merchants report that the inquiry for shipping iron continues poor. There are ninety-one furnaces in blast, against ninety-five at the same date last year. Stocks are still on the increase, and the week's addition in Messrs. Connal and Co.'s stores is about 1200 tons.

Business was done in the warrant market on Friday at 41s. 10½d. cash. The tone on Monday was depressed, when prices receded to 41s. 7d. On Tuesday forenoon transactions occurred at from 41s. 6½d. to 41s. 7d. cash, the business of the afternoon being at 41s. 7½d. to 41s. 6½d. cash. Business was done on Wednesday at 41s. 5d. to 41s. 3d. cash. To-day—Thursday—the market was depressed, with business at 41s. 3½d. to 41s. 2½d., closing at the latter.

The market values of makers' pig iron are as follow:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 46s.; No. 3, 43s.; Coltness, 48s. 9d. and 45s. 6d.; Langloan, 47s. 6d. and 45s.; Summerlee, 47s. 6d. and 43s. 6d.; Calder, 51s. 6d. and 43s. 6d.; Carnbroe, 45s. 6d. and 43s.; Clyde, 45s. 9d. and 41s. 9d.; Monkland, 42s. and 40s.; Quarter, 41s. 6d. and 39s. 6d.; Govan, at Broomielaw, 42s. and 40s.; Shotts, at Leith, 47s. and 46s. 6d.; Carron, at Grangemouth, 51s. and 47s.; Kinneil, at Bo'ness, 43s. 6d. and 43s.; Glengarnock, at Ardrossan, 45s. 6d. and 42s.; Eglinton, 41s. 9d. and 38s. 9d.; Dalmellington, 43s. and 40s.

The total shipments from Christmas to date are 375,751 tons, as against 463,543 in the same period of last year.

The exports of iron and steel goods from Glasgow in the past week included six locomotive engines and tenders, valued at £18,400, for Bombay, and four at £9000 for Japan; an iron steam barge, at £500, for Bombay; £6200 worth of machinery, £1329 sewing machines, £2500 steel goods, and £30,500 general iron manufactures, the latter embracing large quantities of sleepers, pipes, bars, sheets, &c., for India and Australia.

The coal trade is still fairly active in the shipping department. The quantity sent off in the course of the week from Glasgow was 22,234 tons; Ayr, 7800; Irvine, 2271; Troon, 5800; Grangemouth, 9279; Leith, 2550; and Greenock, 2829 tons. For steam coals there is a steady inquiry, and household sorts are in request, but no increase in prices has been obtained.

Considerable discussion is taking place just now among those engaged in the coal trade with reference to the inequality of the supply of railway wagons at the collieries. It is alleged that certain influential traders obtain advantages in this matter, and that the wants of other firms are neglected, causing the latter no little inconvenience and loss. In cases where a district is served by two competing railways, both companies keep a larger supply than is required, in order to prevent customers taking offence, and transferring their traffic from the one to the other. The result of this is that wagons are frequently standing idle in certain districts, whilst in others they cannot be obtained when required. An appeal to the Railway Commissioners, who meet only in London, involves so much trouble and expense that the firms aggrieved have practically no redress. Just now candidates for election in the mining districts are being plied with questions on the subject, and some of them have promised to use their influence, if elected, to get the Railway Commissioners to hold at least two meetings in the year in Scotland for hearing and adjudicating on the complaints of traders. At present neither boards of directors nor railway managers will afford them any satisfaction.

Messrs. William Baird and Co., Gartsherrie, have secured a contract from the London and North-Western Railway Company for the supply of a large quantity of creosote oil, one of the bye products they now obtain under their ammonia recovery process from the gases that used to go to waste from their blast furnaces. The creosote is to be employed for the purpose of preserving timber.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

NOTICES have been posted up at Dowlais, Blaenavon, and principal iron and steel works, to the effect that on and after the 31st of October, all workmen will be employed from day to day. This abolishes the monthly notice system, and shows that the iron and steel trades are getting into a still more precarious condition than they have yet been. Not only will a reduction be enforced, but every man that can be dispensed with will be discharged. At the same time, should trade revive, there is no doubt that the ironmasters will gladly return to former arrangements.

Newport showed a small total of iron consignments last week, only 510 tons of rails being sent away. Cardiff figured better, 3300 tons having been exported. This, however, represented accumulations. Trade is greatly depressed, and the few orders coming in could be worked off in half the time taken.

At Cyfarthfa the proprietors have gone to considerable expense in building storing places for rails, and at the rate they are stocking thousands of tons will be placed before the winter is out. From personal examination, I should say that the rail, which is one of ordinary section, is of most creditable manufacture.

The decadence of Plymouth Ironworks is the subject of much regret in the district, especially as the dismantling is going on. It now transpires that previous to the purchase by Mr. Fothergill, Mr. Clark, of the Dowlais Works, was in treaty for it, and had offered £90,000 for the whole establishment. Mr. Fothergill offered £110,000, and at this figure a sale was effected.

The coming winter promises to try the strength of Welsh ironmasters, and the rumour is becoming stronger that one or more of the works will be closed, *pro tem.*, unless a change takes place.

Coal shows in some places an upward tendency, and the exports to foreign destinations of Cardiff and Swansea indicate an increase. Thus, at Cardiff, close upon 155,000 tons left for foreign ports, being an increase of 27,000 tons over the preceding week, and Swansea shows an increase of 7000 tons. Newport, Mon., on the other hand, still flags behind, and last week they were 6000 tons to the bad. This is rather remarkable considering the steady improvement setting in with the house coal trade, but Newport coals figure in the commercial world more than the steam of Cardiff or the anthracite of Swansea, and until the commercial depression is removed the port returns cannot be expected to look up in any great degree.

Patent fuel is in better favour than it has been for some time. Swansea exports amounted to over 6000 tons, a decided increase on the past. Newport trade in this article, though only lately started, is showing life. Last week 1550 tons left for Civita Vecchia. Cardiff shipment was 2090 tons.

Colliers in greater part of the district are only half employed, and at many collieries not only will the reduction be enforced, but hands will be weeded out. Great privation has existed in the Rhondda, but is moderating a little.

I am sorry to see that the stokers and enginemen do not take kindly to the proposed reduction. A meeting is to be held in a day or two, when a strong protest will be formulated.

They are clearly not well advised, as their condition is much better than that of the colliers, who lose many a day when they only suffer a proportionate loss.

The Gwerna men resumed work this week at Maesycwmmer.

It has been a subject of surprise that the Welsh wire works, which, though fitted with best machinery, are in some places stagnant, do not make a start. The answer has been given this week by the import to our ports of wire from Antwerp. It is evident that the article is manufactured more cheaply abroad.

Of only two of our industries can I write with any amount of hopefulness—patent fuel and tin-plate. The latter is still doing well. In the Monmouthshire district business is good, and quotations firm, and at Swansea, now regarded as head-quarters, the activity in all branches is continued, and would have been still greater had there been more vessels to hand. One only was loaded last week, the Suffolk, with 2100 tons for the United States. Present prices are:—Wasters, 13s. 6d. to 14s.; coke, 14s. 6d. to 15s.; Bessemers, 15s. to 15s. 6d.; Siemens, 15s. 9d. to 16s.

The exports of tin-plate during the nine months ended September, have amounted, I see by the Board of Trade returns, to 112,000 tons. The improvement in the trade has visibly affected imports in the matter of tin bars, chemicals, &c.

Mr. W. T. Lewis is arranging for an additional timber float at Cardiff.

There are two old tin-plate works still in the market for sale; but until requirements are in great excess of make, the prospect of a start is not good.

LAUNCHES AND TRIAL TRIPS.

ON the 24th inst. the new screw steamer Norden, length 180ft., by 27ft. 2in. beam, by 14ft. 6in. depth of hold, recently launched from the shipbuilding yard of Messrs. Boolds, Sharer, and Co., Pallion, and built for the Svenska Lloyd's, Gothenburg, had her trial trip at sea. The owners having stipulated that the vessel should carry so much deadweight with Lloyd's new freeboard, she was loaded and found to do so. In this loaded condition she put out to sea for trial, and was run to Hartlepool and back without stopping, and, in spite of a heavy sea which was running at the time, the results obtained were highly satisfactory. The dead weight trim, when loaded, the speed, 10 knots, and the consumption of coal, 9 tons per day, were all guaranteed, and the result of the trial of each was, we are informed, as desired. The vessel was supplied with a horizontal donkey boiler and steam winches and windlass by Messrs. Clarke, Chapman, and Parsons, of Gateshead; midship steering gear and after screw gear by Messrs. John Lynn and Co., of Pallion; and a fire-engine by J. Stone and Co., London. The engines, which are from the works of Messrs. Carr and Co., are of the direct-acting compound surface-condensing type, having cylinders 27in. and 50in. diameter, with a stroke of 36in., and an extra large steel boiler. After the trial the Norden left for Gothenburg to take up her station. She has been specially constructed and arranged for the company's cargo and passenger trade between Hamburg and Gothenburg. The rooms are heated by means of steam pipes and stoves, and the comfort of the passengers provided for in ways usual now on board large ocean steamers.

The new steamer Heliades, the latest addition to the Houston Line of steamers between Liverpool and the River Plate, has had a successful trial trip, and returned to Hartlepool to take in her bunker coal. The Heliades, which has been built by Messrs. Richardson, Duck, and Co., of Stockton, is a fine vessel of 1921 tons net register, with spar deck and all the latest appliances and improvements, including Sir W. Thompson's compasses, Harrison's steam steering gear, Blake's donkey boiler of 150 lb. working pressure, &c. This is the first boiler of this description which has been made for such a high pressure; but it has been turned out in the most satisfactory manner, and to the entire approval of the Board of Trade and Lloyd's surveyors. It is 14ft. 9in. high, 6ft. 6in. diam., and has 450ft. of heating surface. The engines are by Messrs. T. Richardson and Sons, of Hartlepool, on the triple expansion principle, with 150 lb. working pressure. They are of 350-horse power nominal, and on the trial trip indicated over 1600-horse power, the vessel attaining a speed of 14½ knots per hour. The trial was a very lengthy and exhaustive one, the steamer having been under full steam over sixteen hours, during which time everything about the engines and ship worked in a satisfactory manner. She is fitted up for a number of first-class passengers, the state rooms being unusually airy and commodious. Several of the berths are already engaged, and it is expected she will become one of the most favourite boats in the trade. She will leave the Mersey as the Houston Line packet on Saturday, November 7th. She is commanded by the commodore of the line, Captain W. Taylor.

NEW COMPANIES.

The following companies have just been registered:—

British Pulveriser Company, Limited.

Upon terms of an agreement of 28th ult. this company proposes to purchase from Mr. Lyman Franklin Holman and Mr. F. A. Luckenbach, both of New York, the British letters patent No. 5104, A.D. 1880, and No. 1849, A.D. 1884, relating to pulverisation by means of opposing currents of superheated steam. It was registered on the 16th inst. with a capital of £60,000, divided into 4000 £6 per cent. accumulative preference shares of £5 each, and 40,000 deferred shares of £1 each. The purchase consideration is £10,000 in cash and £20,000 in fully-paid shares. The subscribers are:—

	Shares.
W. L. Williams, 2, Westminster-chambers, engineer	1
Herbert Evans, 32, Great Ormond-street, W.C., merchant	1
W. Agnew Pope, 113, Cannon-street, newspaper proprietor	1
J. N. Buck, J.P., Fairlie, N.B.	1
R. A. P. Forrester, Moffatt, N.B.	1
R. H. Weight, M.D., 168, Haverstock-hill	1
R. Varley, Lytham, Lancashire	1

The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first; qualification, 20 preferred or 100 deferred shares; remuneration, £500 per annum, and 10 per cent. on the surplus net profits remaining after payment of 10 per cent. dividend.

Callington Waterworks Company, Limited.

This company was registered on the 21st inst. with a capital of £1000, in £1 shares, to construct waterworks for supplying the town and parish of Callington, Cornwall. The subscribers are:—

	Shares.
John Venning, Callington, printer	1
Hy. Davis, Callington, surgeon	10
W. Bond, Callington, innkeeper	5
J. Roskelly, Gunnislake, builder	1
S. Brown, Callington, draper	5
J. P. Blight, Callington, solicitor	1
M. Dymond, Callington, ironmonger	1
J. G. Spear, Callington, auctioneer	5
J. Higgins, Callington, grocer	1
J. Brendon, jun., Callington, ironmonger	1

Registered without special articles.

Duchy Tinworks, Limited.

This company was registered on the 16th inst. with a capital of £30,000, in £1 shares, to purchase and work certain mineral property referred to in an unregistered agreement of 9th inst. between Albert Bliss and John Coleman. The subscribers are:—

	Shares.
F. W. Robinson, 40, Fenchurch-street, goldsmith	1
F. D. Collingwood, 35, Tetley-street, Poplar, messenger	1
J. Nolan, 104, Elsley-road, Wandsworth, retired officer	1
E. Mark, 49, Parkholme-road, Dalston, lithographer	1
G. Carter, 180, Vauxhall-street, Kennington	1
D. Jenkins, Canonbury-square, engineer	1
E. Thomson, Brand-street, W.C.	1

The number of directors is not to be less than three nor more than five; qualification, £100 in shares or stock. Most of the regulations of Table A are adopted.

Howden Water Company, Limited.

Registered on the 21st inst. with a capital of £5000, in £5 shares, to carry on the usual business of a waterworks company at Howden, in the East Riding of Yorks. The subscribers are:—

	Shares.
Philip Saltmarshe, J.P., Saltmarshe, York	1
T. S. Clarke, J.P., Howden	1
Rev. W. Hutchinson, Howden, vicar	1
G. Wyland, Goole, solicitor	1
Rev. J. Butler, Howden	1
R. S. Schofield, Howden	1
E. Stony, Howden, bank manager	1

The number of directors is not to be less than two nor more than five. Most of the articles of Table A are adopted.

Midland of Western Australia Land and Railway Syndicate, Limited.

This company proposes to acquire upon such terms as may be arranged, the benefit of a contract or concession about to be granted by the Government of Western Australia to Mr. John Wadding, for the construction of a railway from Guildford to the Greenough Flats, in the said colony; power is also taken to construct public works and conveniences of all kinds in the colony, and to promote emigration. The company was registered on the 20th inst. with a capital of £15,000, divided into 60 shares of £250 each. The subscribers are:—

	Shares.
John Ewart, 4, Fenchurch-street, merchant	2
Col. Sir Wm. Crossman, K.C.M.G, Cheswick, Bent, Northumberland	1
G. Buchanan, 25, Bucklersbury, engineer	1
Col. E. C. Sim, 32, James-street, Buckingham-gate	1
G. Bethell, 110, Fenchurch-street, shipowner	1
C. J. Trinder, Leadenhall-chambers, shipowner	1
Cyrus Legg, Rochfort Tower, South Norwood, wool stapler	1
J. R. Morrison, 102, Redcliffe-gardens, S.W., merchant	1

The subscribers are to appoint the first directors; qualification, one share; the company in general meeting will determine remuneration.

Talyclyn Colliery and Fire-brick Company, Limited.

This company was registered on the 21st inst. with a capital of £2000, in 80 shares of £25 each. It proposes to purchase the business carried on at the Talyclyn Colliery and Fire-brick Works, in the parish of Llanedy, Carmarthen. The subscribers are:—

	Shares.
David Griffith, Pontardulais, surgeon	2
D. White, Glyncaeran, farmer	4
D. Rees, Llangenech, butcher	4
Wm. Thomas, Pontardulais, farmer	4
John White, 52, St. Helen's-road, Swansea, draper	4
W. H. White, Pontardulais, brickworks manager	2
John White, Caercerrig, farmer	2

The number of directors is not to exceed seven; the subscribers are to appoint the first and act *ad interim*; the company in general meeting will determine remuneration.

The North of England Peat Moss Litter Company, Limited.

This company was registered on the 15th inst. with a capital of £10,000, in £5 shares, to manufacture and supply peat moss for litter for horses and cattle as a substitute for straw, sawdust, &c., and to manufacture and supply peat for fuel, paper-making, linoleum and oilcloth, covering steam boilers, fire-lighters, deadening sound, mixing with plaster and mortar instead of hair, for horticultural uses, and other purposes. The subscribers are:—

	Shares.
*Charles Arnison, Stanhope, Darlington, physician and surgeon	10
J. Smith, Willington-on-Tyne	50
*R. Richards, 64, Fawcett-street, Sunderland, iron merchant	10
*A. D. Carr, 1, Collingwood-street, Newcastle-on-Tyne, land agent	1
E. T. Reid, Newcastle-on-Tyne, merchant	10
*J. V. Walton, Wilton-le-Weor, lead manufacturer	10
*W. B. Campbell, C.E., 34, Grey-street, Newcastle	1

The number of directors is not to be less than five nor more than twelve; the first are the subscribers denoted by an asterisk and Mr. Thos. Smith, of Wallsend; qualification, £50 in shares or stock; the company in general meeting will determine rumuneration.

A Boiler-iron Gaol.—The appended account of a novel lock-up—and a pretty secure and cheap one withal—is well worth reading. It is from the Omaha *Bee*:—"The peculiar feature of the gaol, which marks it as different from any other, is that the cells are arranged in a great iron cylinder, which revolves, so that only one cell is at the opening at any one time. This cylinder is three storeys high, and there are ten cells on each floor. Its weight is 45 tons, and is hung from above. The great cylinder can be turned by a simple crank with very little force, one man moving it readily. When all is complete, it is the intention to have a little water motor in the basement, and then, by simply moving a lever, the cylinder will be set to rotating. It is suggested that when there are prisoners who may be trying to get out, the cylinder can, by a motor, be easily kept moving slowly all night, so that the prisoners do not remain long enough in one place to do any mischief, or even to crawl out if they had made a partial break. A cage of iron bars completely surrounds the cylinder in which the cells are. The entrance on each floor is guarded by two doors. The officer standing outside does not have to unlock even the first door, but can swing the cylinder around until a cell appears in which is the desired prisoner, and then by a simple movement the inner door is open and the prisoner can step out of h cell. Then the officer can open the other door and let the man out, but the other prisoners are beyond reach of the officer, and it is impossible for them to reach him while he is taking a man out or putting one in. He can handle any number of men in the same way, and they cannot get within reach of him until he chooses to let them."

Does the Buyer Build the Engine?—English engine builders are just now somewhat exercised by reason of the discovery that their customers are looking to other countries for their engines—notably Belgium and Germany—to the injury of their trade. Various excuses are offered for this defection on the part of buyers, but the naked fact is that better engines can be bought abroad than in England. This is tacitly admitted, nay, expressly stated, by the London Engineer, and while some of its readers take it to task for telling the truth, others see the value of the information, and give the causes for the loss of trade to English engine builders. In a few words, the price paid is too low to admit of honest work and proper construction. The buyer builds the engine, in so far that he names the price which he intends to pay, and the actual builder of the machine gives as much as he can, or as little as he dares, for the money. This is an unfortunate condition of things for the development of steam engineering, but the question seems to be one which is not easily settled, since more than mere buying and selling and building engines is involved. One condition which enters is the relative wages paid in England and in foreign countries. Of this no mention is made in our contemporary. Continental builders obtain workmen and material for considerably less than English engine builders do, and in this respect alone have a very great advantage. Our caption is a question—"Does the buyer build the engine?"—and we may answer it affirmatively, for this and for all other countries. The buyer does build it, with the qualification previously made, that he forces the market price to the lowest possible point; so low, in fact, that there is no profit, and consequently very little interest in the product. Engineers look upon the steam engine as a scientific apparatus, and split hairs upon this or that merit or defect, but the buyer does not care for economy as a rule. He looks upon the engine only as a machine, and if by chance, or for some whim of the moment, he is led to buy a really good and well-made engine, he treats it precisely as he would a rough affair. So far as economy is concerned, he might as well have bought the cheapest to be had. We know of instances not a few where Corliss engines have actually been gagged, so that they could not drop their valves, the wear of the detaching gear being the reason for gagging. Fuel is not yet so scarce in this country that buyers are willing to go to the trouble and expense of regularly indicating their engines, and keeping them up to their work. Objection is made to repairs and the cost of the same, and the result is that the buyer or steam user, in a majority of instances, pays a great deal more for power than he should. Those who may dissent from our views must remember that the steam economy of any country is not represented by the comparatively few well-managed and high-powered engines, but the mass, large and small, automatic and plain slide valve engines, everywhere. If these are considered, it will be found that the great obstacle to higher economy and advanced engineering is the unwillingness of the buyer to pay for the machines which will obtain these ends.—*Mechanical Engineer.*

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

Applications for Letters Patent.

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

20th October, 1885.

12,494. Circular Knitting Machines, E. Newton and A. C. Smith, London.
12,495. Prevention of Casks from Becoming Impaired, T. Hall, Burton-on-Trent.
12,496. Ice Machines, H. J. Allison.—(*O. Vezin, U.S.*)
12,497. Pulverising Machines, H. J. Allison.—(*J. B. Waring, United States.*)
12,498. Cabs, C. Thomas, London.
12,499. Telephone Switch Boards, W. E. Heys.—(*C. C. Sonne, China.*)
12,500. Securing Handles to Brooms, S. Pickersgill, Derby.
12,501. Working Light Scrap Iron, J. W. Summers and T. Sharp, Stalybridge.
12,502. Wheels, &c., H. Hazleton and A. Young, West Smethwick.
12,503. Carriage Axle-boxes, R. Grindle, Birmingham.
12,504. Let-off Valves, J. H. Heaton, Milnsbridge.
12,505. Use of Earthenware, W. T. Allen, Erdington.
12,506. Fencing-in Animals, C. Bennett, Braunston.
12,507. Bolt for Lavatories, H. C. Lory, Liverpool.
12,508. Water-closet Cisterns, A. Kerr, Blackburn.
12,509. Weighing Machines, W. B. Avery, Birmingham.
12,510. Window Frames, R. Mason, Birmingham.
12,511. Atmospheric Apparatus, J. E. Thorpe and J. H. Strudwicke, London.
12,512. Hull of a Ship, W. Smith, London.
12,513. Water Filters, P. Parker, Keighley.
12,514. Penholders, &c., T. Harrison, Halifax.
12,515. Shedding Motion for Looms, D. Bailey and S. Stead, Halifax.
12,516. Forming Temporary Screens for the Roofs of Tramcars, &c., G. R. Smith, jun., Aston-juxta-Birmingham.
12,517. Forming Temporary Coverings for Seats, G. R. Smith, jun., Aston-juxta-Birmingham
12,518. Lemon Squeezers, W. B. Browne, Bristol.
12,519. Adjustable Wrench or Spanner, A. H. Bishop, Birmingham.
12,520. Velocipede Lamp, H. Lucas, Birmingham.
12,521. Finger and Scarf Rings, E. T. Pendleton, Birmingham.
12,522. Watches, R. Fennell, Coventry.
12,523. Calcining Flints, &c., H. H. Redfern, Hanley.
12,524. Storing up Force, T. R. H. Fisken, London.
12,525. Floorings, &c., W. H. Scrymgour, London.
12,526. Projecting Advertisements upon Side Walks, &c., F. G. Chapman, London.
12,527. Tinder-box, T. Harbeck, London.
12,528. Discs and Hoes, W. Wilkinson, Kempston.
12,529. Regulating the Angle of Opening of Fanlights, &c., J. Collier, London.
12,530. Throstles, R. Patterson, London.
12,531. Preserving Fish, A. Egestorff and L. Hermann, London.
12,532. Electro-magnetic Motor, S. W. Maquay, London.
12,533. Refrigerators, W. P. Thompson.—(*J. F. Hanrahan, Canada.*)
12,534. Dyeing, Scouring, &c., J. H. Ashwell, Liverpool.
12,535. Memorial Tablets, J. Smith and A. Proudlock, Liverpool.
12,536. Feeding Apparatus for Nail Machines, F. Myers, Liverpool.
12,537. Coverings for Propeller Blades, R. Morrin, Liverpool.
12,538. Envelopes or Wrappers, T. Kauffmann, Liverpool.
12,539. Indicating when Closets, &c., are Occupied, W. Merryweather, London.
12,540. Pulverising Fuel, H. M. Morrison.—(*J. G. Hathaway, U.S.*)
12,541. Bolts for Securing Doors, &c., G. Heinsius, London.
12,542. Ladders, E. Ferrari, London.
12,543. Extinguishing Fires, A. Thompson, R. O. Ritchie, and W. E. Irish, London.
12,544. Electrical Communication in Mines, A. Thompson, R. O. Ritchie, and W. E. Irish, London.
12,545. Porous Cells, &c., A. W. Armstrong, Lewisham.
12,546. Copper Printing Plates, A. F. Wenger, London.
12,547. Opening, &c., Fanlights, E. Verity and B. Banks, London.
12,548. Parasols, &c., W. Corder, London.
12,549. Folding Chairs and Perambulators, W. H. Dunkley, London.
12,550. Austin Antiseptic Basin for Closets, &c., F. J. Austin, London.
12,551. Regulating Apparatus for Electric Arc Lamps, G. E. Vaughan.—(*The Austrian Small Arms Manufacturing Company, Austria.*)
12,552. Drying Skeins of Yarn, H. J. Haddan.—(*J. R. Dearden, United States.*)
12,553. Water-meter, H. J. Haddan.—(*F. W. Tuerk, jun., United States.*)
12,554 Fire-escapes, G. Martin, London.
12,555. Lawn-tennis Balls, B. Birnbaum, London.
12,556. Thrashing Machines, P. A. Newton.—(*Messieurs Garrett, Smith, and Co., Germany.*)
12,557. Swinging Parts of Thrashing Machines, P. A. Newton.—(*Messieurs Garrett, Smith, and Co., Germany.*)
12,558. Gas Engines, C. M. Sombart, London.
12,559. Binder or Holder suitable for Periodicals, &c., T. Crowther, London.
12,560. Double Arc Lamps, A. Duffin, London.
12,561. Casks or Barrels, W. Keable, London.
12,562. Battery Plates, J. Rettie and J. B. Garnham, London.
12,563. Cement, T. Castle, London.
12,564. Sewing Machines, W. R. Lake.—(*C. E. Tibbles, United States.*)
12,565. Pianofortes, &c., W. R. Lake.—(*B. B. Bradbury, United States.*)
12,566. Horseshoes, L. H. Bellamy, London.
12,567. Inserting, &c., Metallic Staples, W. R. Lake.—(*W. J. Brown, jun., United States.*)
12,568. Pigments, &c., W. R. Lake.—(*L. Brown, United States.*)
12,569. Bottle Rinsers, R. White, London.
12,570. Permanent Way of Railways, W. Saunders, Glasgow.
12,571. Brakes for Railway Carriages, &c., A. McDonald, London.
12,572. Portable Hydraulic Drill, M. B. Fontaine, London.
12,573. Cleaning Malt or Grain, H. J. Worssam, London.
12,574. Steam Hoists, H. J. Worssam, London.
12,575. Metallic and other Packing Boxes, J. G. Claude-Mantle, London.
12,576. Machines for Indicating Lifting Power, R. W. Page, London.
12,577. Folding Live-bait Can, J. Hamley and N. Aspray, London.
12,578. Determining the Positions of Passages of Valves in Relation to the Ports of Cylinders of Steam Engines, C. H. Tricker, London.

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12,579. Machines for Making Traversed Nets, J. Carver, London.
12,580. Flushing Closets, &c., S. W. Smith, near Coventry.
12,581. Milk Cans, &c., F. H. Freeth and S. J. Pocock, London.
12,582. Hydrometers, Thermometers, &c., W. Chadwick, Manchester.
12,583. Pipe-holder, G. H. Busch, London.
12,584. Imitation Inlaid Work, A. Gunn and T. Caisley, Newcastle-on-Tyne.
12,585. Carboy Hampers and Fireproof Ceiling Laths, R. Leigh, Bolton.
12,586. Screw-down Valve, J. P. and W. F. Phillips, London.
12,587. Water Skate, W. S. Goodwin, Southampton.
12,588. Tab for Marking Drapery Goods, E. H. Ledger, Shrewsbury.
12,589. Flat Carding Engines, E. Tweedale, Halifax.
12,590. Revolver Pistols and Rifles, W. G. Tranter, Birmingham.
12,591. Suction Fastener for Artificial Teeth, T. Marston, Burslem.
12,592. Collar Studs, W. J. Tanner, London.
12,593. Stopping Runaway Horses, J. H. Johnson.—(*H. Ernst, Germany.*)
12,594. Fire Extinguishers, J. H. and J. W. Galloway, London.
12,595. Driving Belts, F. Bosshardt.—(*E. A. Creton, France.*)
12,596. Type Writing, M. Hearn, London.
12,597. Toy Spinning Tops, A. A. Leech, Manchester.
12,598. Fixing Open the Jaws of Pike, A. G. Jardine, London.
12,599. Rendering Coal Smokeless, F. V. Hadlow, Buxted.
12,600. Telephonic Apparatus, D. J. Smith and D. Sinclair, Glasgow.
12,601. Cutting Almond Tablet Cakes, R. Morton, Glasgow.
12,602. Regulating the Supply of Gas, H. Harrison, London.
12,603. Automatically Balanced Cranes, R. Pirie, London.
12,604. Horseshoes, M. Amos, London.
12,605. Door Silencer, G. B. Thornton, London.
12,606. Regulating Electric Currents, W. H. Scott and E. A. Paris, London.
12,607. Washing Machines, D. Towler.—(*Walter and Echberg, Australia.*)
12,608. Force Pumps for Soda-water Machines, J. G. Chapman and R. Foote, Liverpool.
12,609. Fire and Thief-proof Safe, &c., W. Diaper, London.
12,610. Pulp, Millboard, and Brown Paper, F. G. Morton and N. Salamon, London.
12,611. Testing Electrical Resistances, W. J. Murphy, Kent.
12,612. Taps and Valves, E. J. Jones and T. Johnson, London.
12,613. Signalling at Sea, G. Stavers, London.
12,614. Piston Valves for Steam Engines, R. Matthews, London.
12,615. Producing Ingots, G. Allan and T. Turner, London.
12,616. Manufacturing Variegated Metal, G. Allan and T. Turner, London.
12,617. Covered Dustpan, R. G. Owen, London.
12,618. Saddle-trees, H. H. Lake.—(*H. Leckel, Austria.*)
12,619. Velocipedes, J. M. Taylor, London.
12,620. Securing Sliding Sashes, F. S. Morris and J. H. Fox, London.
12,621. Type-casting Machines, O. Titchener, London.
12,622. Lamps for Chandeliers, &c., J. Russell and J. Ruthrie, London.
12,623. Telegraph Posts, S. and F. G. Sharrock, London.
12,624. Photographic Cameras, J. Sturrock and Marion and Co., London.
12,625. Means of Advertising, P. H. Baily.—(*G. Meyer, France.*)
12,626. Shirts, A. Linney, London.
12,627. Working steam Engines, A. M. Clark.—(*Wirth and Co., Germany.*)
12,628. Toe Tips for Boots and Shoes, G. S. Clarke, London.

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12,629. Suspenders for Pictures, C. Priestland, jun., Aston.
12,630. Mustard Pots, J. Mallol, Birmingham.
12,631. Apparatus for Cutting Vegetables, &c., W. J. Moodey, London.
12,632. Pictorial Transparent Calqueur, A. Quehen, Waterloo.
12,633. Bearings of Gates, &c., R. J. Worrall, Liverpool.
12,634. Window Sash Fasteners, I. E. Higginbotham and H. J. B. Holland, Blackburn.
12,635. Boxes to Contain Thread for Sewing, &c., G. K. Cooke, Manchester.
12,636. Stripping Carding Engine Cylinders, P. Müller, Manchester.
12,637. Water Fittings, J. M. McMurtrie, Glasgow.
12,638. Purification of Gas, H. Harris, London.
12,639. Strengthening Metallic Rings, H. P. Fenby, Leeds.
12,640. Utilising the Action of the Tides in Estuaries, J. Mason, Manchester.
12,641. Carriers for Tramcar Life Guards, &c., W. C. Edwards, and J. Record, London.
12,642. Roller Curling Stone, H. MacKenzie, Kirn.
12,643. Fire-grates, H. J. B. Holland, Blackburn.
12,644. Combustion of Gases in Furnaces, &c., F. J. Jones, London.
12,645. Clips for Stocking Suspenders, G. Twigg, Birmingham.
12,646. Attaching the Lenses to the Instantaneous Shutters of Photographic Cameras, E. Marlow, Birmingham.
12,647. Concealed Appliance for Carrying Hand Bags, C. E. and A. H. Arnold, Portsmouth.
12,648. Drawing Curtains, J. S. Orton, Birmingham.
12,649. Metallic Sleepers for Railways, R. A. Harucastle, London.
12,650. Fencing, Z. Uzac, London.
12,651. Fish-bolts and Tie-bars for Railways and Tramways, W. Bayliss and R. Howarth, London.
12,652. Diaphragms of Dry Gas Meters, J. Somers, Glasgow.
12,653. Self-acting Window Blind Apparatus, W. H. Nisbet and W. W. Virtue, Glasgow.
12,654. Feeding Bees, J. P. Hopkins, Milverton.
12,655. Machine for Brushing Lawn Tennis Balls, S. Morrison, London.
12,656. Forming Designs upon Glass, A. Martyn, Hammersmith.
12,657. Picks, J. Bownes, London.
12,658. Bird Cages, A. Laurie and C. T. Bishop, London.
12,659. Fire Extinguishers, H. Defty, London.
12,660. Securing Travelling Rugs, C. G. E. Terraneau, London.
12,661. Oil Lamps, M. Sugar and M. Merichenski, London.
12,662. Automatic Disinfecting Apparatus, J. Greenwood, London.
12,663. Rising and Falling Back Centre, J. Dyer and H. Redman, Birmingham.
12,664. Cleaning Slates and Blackboards, G. Macdonald, London.
12,665. Pencil-case, P. Lawrence, London.
12,666. Discharge Fittings of Syphon Vessels, J. M. Durafort, London.
12,667. Cutting Out Gloves, L. A. Groth.—(*B. Uhle and A. von Wagner, Germany.*)
12,668. Ruling, L. A. Groth.—(*J. Tarrés y Puigsech, Spain.*)
12,669. Velocipedes, A. C. Sterry and J. Sterry, London.
12,670. Combined Scarf Pin and Shirt Stud, J. W Tiptaft, Birmingham.
12,671. Automatic Safety Railway Coupling, C. M. Stahl, J. Weber, and R. Hoffmann, London.
12,672. Tiles, J. J. Cornish, London.
12,673. Stoves, J. Watson, London.
12,674. Disposal of Sewage, H. N. Crellin, London.
12,675. Expanding the Packing Rings of Pistons, J. Reid, London.

12,676. Attaching Knobs to Bedsteads, H. S. Whitehouse, London.
12,677. Metallic Bedsteads and Cots, H. S. Whitehouse, London.
12,678. Tricycles, &c., J. Starley, London.
12,679. Preserving Brewers' Grains, A. M. Clark.—(*W. Thne, United States.*)
12,680. Smoothing Irons, R. W. Thomas and P. C. Smith, London.
12,681. Arc Lamps, J. Brockie and B. Pell, London.
12,682. Lubricators, W. R. Lake.—(*H. Piron, Belgium.*)
12,683. Measuring, &c., Differences of Levels, &c., A. E. Adlard, London.
12,684. Grinding Apparatus, H. H. Lake.—(*Wirth and Co., Germany.*)

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12,685. Knife-cleaning Machine, &c., W. Norman, London.
12,686. Carrying off the Products of Combustion from Gas, S. F. Smith, London.
12,687. Fixing, &c., Pipes, &c., J. Brindle, London.
12,688. Fastening for Driving Belts, &c., A. Morton, Sheffield.
12,689. Envelopes, W. and J. S. Hughes, Portmadoc.
12,690. Looping Yarn during Weaving, A. Broadbent, Halifax.
12,691. Mowing and Reaping Machines, J. Hornsby and J. Innocent, Grantham.
12,692. Breech-loading Small-arms, W. Bentley, Birmingham.
12,693. Toasting Forks, H. A. Hill, Birmingham.
12,694. Device for Locking Screw Nuts, D. D. McLellan, Glasgow.
12,695. Device for Locking Screw Nuts, J. McLellan, Glasgow.
12,696. Fuel Economisers, J. S. Sutcliffe and G. Stonehouse, Manchester.
12,697. Spring Latch for Doors of Vans, T. Andrew, Tranent.
12,698. Clock and Carillon Machinery, J. Eshelby, Dublin.
12,699. Measuring and Indicating Liquids, L. Hanson, Halifax.
12,700. Ventilating Buildings, &c., J. Westmoreland, Liverpool.
12,701. Stand for Holding Matches, &c., R. Mahony, Birmingham.
12,702. Yarn Beaming Machines, &c., A. Hitchon, Accrington.
12,703. Anchors, W. P. Strawson, Birmingham.
12,704. Set Squares, H. Marle, Birmingham.
12,705. Locomotive Clack Boxes and Check Valves, C. S. Madan, Manchester.
12,706. Kitchen Grates, J., W. R., and R. Green, Ecclesfield.
12,707. Judging the Size of Angles at Sight, T. R. Ablett, Blackheath.
12,708. Metallic Handles for Gimlets, C. Barnard, Oldham.
12,709. Bottle Stoppers, W. Hazlehurst and J. Lyon, Rochdale.
12,710. Merry-go-rounds, J. and H. McLaren, London.
12,711. Gas Governors, W. and W. H. Cowan, London.
12,712. Heel Trimming Machines, H. J. Allison.—(*P. P. Sherry, H. Robinson, and H. F. Hurlburt, U.S.*)
12,713. Bit for Horses, H. Andrews, London.
12,714. Cans, H. P. Humphrey, London.
12,715. Boring and Air Coursing Machine, R. Stanley, London.
12,716. Working Ventilators, R. Brough, London.
12,717. Mules for Spinning, &c., W. Heaton and J. Catterall, London.
12,718. Holding the Reins of Horses, T. H. Heard, Sheffield.
12,719. Toys, E. G. Smith.—(*E. Smith, France.*)
12,720. Fire Shovel, A. Langdon.
12,721. Illuminating Gas, &c., J. L. Balfour and J. Lane, London.
12,722. Type Writing Machines, E. Howard, London.
12,723. Treating Antimonial Ores, T. C. Huntingdon and M. Chiapponi, London.
12,724. Galvanic or Primary Batteries, J. E. Liardet, London.
12,725. Bricks, H. Blythe, London.
12,726. Watch Keys, F. McIlvenna and W. Thompson, Liverpool.
12,727. Argand Burners, &c., E. L. Coninck and A. Rolland, London.
12,728. Advertising, J. Morley, London.
12,729. Mounting for a Quick-firing Gun, R. T. Brankston, London.
12,730. Gun Carriages, A. Noble, London.
12,731. Steam Boilers, R. Penman, Glasgow.
12,732. Shutting Doors for Lift Shafts, L. Hopmann, London.
12,733. Cultivating Land, J. Braby, London.
12,734. Filtering Materials, A. G. Salamon, London.
12,735. Cigarette Lighter, C. Hill and W. Reid, London.
12,736. Mineral Oil Lamps, E. Sundborg, London.
12,737. Window and Door Fasteners, E. T. Horsley, London.
12,738. Steering Gear for Cycles, &c., S. C. Maguire, London.
12,739. Altering the Throw of the Crank for Cycles, &c., S. C. Maguire, London.
12,740. Driving Gear of Velocipedes, E. Smith, London.
12,741. Bearings for Bicycles, &c., G. Singer, London.
12,742. Polishing Compound for Painted Iron, &c., F. B. Bale, London.
12,743. Steam Boilers, H. Heaton, London.
12,744. Driving Belts and Bands, W. R. Lake.—(*G. Ebell, Germany.*)
12,745. Ammonium Chloride, W. R. Lake.—(*T. Schmidtborn and D. Jarves, United States.*)
12,746. Connection Frames for Hand-bags, &c., F. Weintraud, London.

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12,747. Fastening Tubes, J. Stewart and F. H. Hallard, Manchester.
12,748. Printing Photographic Vignettes, W. Brookes, Manchester.
12,749. Castrating Lambs, J. A. Douglas, Manchester.
12,750. Castors for Chairs, &c., G. Wakeman, Birmingham.
12,751. Heads and Necks for Velocipedes, W. Hasted, Coventry.
12,752. Cues for Billiards, &c., W. H. Blackwell and J. Ridyard, Ashton-under-Lyne.
12,753. Balance Ropes, J. Farrar and E. H. Birley, Barnsley.
12,754. Floor Springs for Swing Doors, G. F. Newman, Birmingham.
12,755. Coupling, &c., Railway Wagons, C. B. Phillips, Chester.
12,756. Regenerative Steel-making Furnaces, J. Riley, Glasgow.
12,757. Railway Brakes, E. J. Duff, Glasgow.
12,758. Dredger Buckets, A. W. Robinson, Glasgow.
12,759. Railway Fastenings, G. and J. Bell, Glasgow.
12,760. Furnaces, J. Riley and W. Crossley, Glasgow.
12,761. Pumping, &c., Liquids, J. H. Kidd, Manchester.
12,762. Furnace, J. C. Belfield, Prestonpans.
12,763. Measuring, &c., Speed of Locomotives, R. H. Ridout, London.
12,764. Hollow Wooden Spells, H. B. Andrews, Halifax.
12,765. Fire-iron Tongs, T. Gold, Birmingham.
12,766. Buoyant Fabrics, C. Moseley, Manchester.
12,767. Practising Shooting, J. Grimshaw, Manchester.
12,768. Turnip Cutters, M. A. Thompson, Berwick-upon-Tweed.
12,769. Lace and other Fabrics, H. S. Cropper and W. Birks, London.
12,770. Knee Caps, R. S. Moss, London.
12,771. Heating Liquids, T. F. Wood, Bristol.
12,772. Rendering Paper Impervious, J. R. Thame, London.
12,773. Yeast Press, A. F. Vuylsteke, London.
12,774. Engine, &c., Packing, J. Holland and J. Lever, Manchester.
12,775. Cutting Wood for Matches, &c., E. Schooling, London.
12,776. Facilitating Composition of Type Formes, J. A. Taylor, London.
12,777. Compound Types, J. A. Taylor, London.
12,778. Granular Nitro Cellulose, O. Imray.—(*R. Bernstein, Germany.*)
12,779. Fringe Ribbons, C. D. Abel.—(*F. Watzlawik, Austria.*)
12,780. Non-conducting Material for Covering Steam Boilers, &c., J. C. Mewburn.—(*J. L. Martiny et Cie., France.*)
12,781. Velocipedes, &c., H. Fawcett, London.
12,782. Finishing Lace, W. Jennings, London.
12,783. Engraving Roller Plates, &c., A. J. Boult.—(*W. Pohl, Austria.*)
12,784. Shoes for Car Brakes, W. P. Thompson.—(*C. F. Wohlfarth United States.*)
12,785. Cutting Cotton, &c., C. T. Scowen, London.
12,786. Auxiliary Air Vacuum Motor, J. Ogden, sen., and J. Ogden, jun., Liverpool.
12,787. Rivetting Machines, W. F. Gilmer, London.
12,788. Private Locking Straps or Buckles, W. W. Ives and T. I. Cammell, London.
12,789. Valves for Casks, A. Clayton, London.
12,790. Checking Tickets at Theatres, J. W. Longley, London.
12,791. Knitting Machines, Seyfert and Donner, London.
12,792. Connecting Gear for Looms, W. H. Beck.—(*J. A. Lateux, France.*)
12,793. Blotter Baths, L. Bailey, London.
12 794. Marking Wind Gauge on Back Sights of Rifles, A. E. Cuttle, London.
12,795. Moulds for Casting Ingots, T. Turner, London.
12,796. Corking Bottles, F. Foster and J. H. Hamilton, London.

26th October, 1885.

12,797. Band Brake for Horse Vehicles, J. Ashdown, Preston.
12,798. Domestic Washing Appliances, G. A. Clough, Norton.
12,799. Aerated Water Pumps, F. G. Riley, London.
12,800. Fixing Winches to Fishing Rods, W. Phillips, Redditch.
12,801. Stench Traps, S. B. Bamford, Uttoxeter.
12,802. Strengthening Metallic Rings, H. P. Fenby, Leeds.
12,803. Water Pressure Engines for Working Organ Bellows, &c., J. Earsdon, London.
12,804. Pitch Chain Gearing, J. and H. Steele, and J. Lees, Manchester.
12,805. Securing Knobs to Spindles, W. Green, near Birmingham.
12,806. Photographic Washing Apparatus, J. McGhie, Glasgow.
12,807. Postal and Letter Balance, W. Dornan, Hull.
12,808. Railway and Tramway Chairs, J. Johnson, Spennymoor.
12,809. Mounts for Photographs, W. H. Tuck, London.
12,810. Purifying Water for Steam Boilers, H. J. A. Bowers, Acton.
12,811. Shower Baths, D. Grove, London.
12,812. Feather Sorting and Cleaning Machine, T. and A. T. Small, London.
12,813. Securing Papers, H. Steer, Derby.
12,814. Preparing Fire-clay for Potters' Use, J. Wilson, Glasgow.
12,815. Bands for Binding Gloves, &c., O. A. Thaege, London.
12,816. Electrical Fusible Cut-out, A. P. Lundberg, London.
12,817. Furnaces for Tubular, &c., Boilers, W. Noble and A. Mackie, Sutton.
12,818. Bottles for Sediment Liquids, W. Lowrie, London.
12,819. Screw Stoppers for Bottles, &c., W. Lowrie, London.
12,820. Buffers, A. Spencer, London.
12,821. Affixing Letters, &c., T. Gardner and W. J. Hall, London.
12,822. Obstetric Soap, J. Thomson, London.
12,823. Tubes and Ordnance of Steel and Iron, W. C. Stiff and H. B. S. Bennett, London.
12,824. Lifts, Hoists, &c., T. Thomas, London.
12,825. Hauling and Hoisting Apparatus, T. D. Hollick, London.
12,826. Steering Apparatus, T. D. Hollick, London.
12,827. Bottles or Pots for Liquids, J. Heinicke London.
12,828. Furnace Bars, T. Lockerbie, London.
12,829. Cartridge Filler, H. A. A. Thorn, London.
12,830. Chalk Holder and Protector, G. F. Redfern.—(*C. Devienne, France.*)
12,831. Steering Tricycles, G. Singer, London.
12,832. Self-acting Window Fastener, B. G. Skipworth, London.
12,833. Valve Apparatus for Casks, W. W. Druce, London.
12,834. Automatically Steering Bicycles, &c., J. Harrington and J. Hopper, London.
12,835. Springs for Carriages, &c., J. Harrington, London.
12,836. Single-acting Steam Engine, F. Klimsch, London.
12,837. Explosive Compound, H. Imray.—(*H. Dulitz, Germany.*)
12,838. Employing Glass in Metallic Bedsteads, R. G. V. van Avezathe, Wolverhampton.
12,839. Flushing Cisterns and Water-waste Preventors, G. C. Wickham, London.
12,840. Plates for Batteries, G. A. Mason, W. Weise, O. Romanze, and F. Thornton, London.
12,841. Brakes, M. Schleifer, London.
12,842. Taps for Beer Barrels, J. E. Minnitt and J. H. Vickers, London.
12,843. Cutting Corrugated Spiral Bars, &c., T. W. Duffy, Liverpool.
12,844. Impregnating Wood with Fluids, W. R. Lake.—(*J. P. E. Durst and L. Vidric, Hungary.*)
12,845. Wheels for Travelling on Rails, &c., F. King, New South Wales.

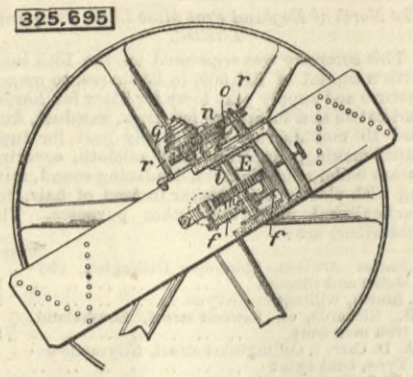
SELECTED AMERICAN PATENTS

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

325,695. Key Seating Machine, *David W. Porter, Pittsburg, Pa.—Filed April 27th*, 1885.

Claim.—(1) The combination, with the rack bar *a*, bearing the cutter head, of the pinion *d*, and movable shaft C, upon which it is mounted, and means, substantially as described, for automatically withdrawing the carriage upon which the shaft C is mounted. (2) The combination, with the rack bar *a*, pinion *d*, and shaft C, of the movable carriage F, in which said shaft is mounted, the spring *i* for withdrawing the carriage, and the lever *f*, provided with pin *e* for holding the carriage, as set forth. (3) The combination of the rack bar *a*, pinion *d*, shaft C, and movable carriage F, in which said shaft is mounted, with the spring *i*, for withdrawing the carriage, and the lever *f*, upon which the pin *e* is mounted, with the opposite end of which lever the bar *a* comes in contact at the end of its forward movement. (4) The combination of the rack bar *a*, pinion *d*, and movable shaft, with the spring for withdrawing the carriage upon which shaft is mounted, and the lever *k* for throwing it back into engagement, as set forth. (5) The combination of the rack bar *a*, the movable shaft and pinion, the spring for withdrawing the shaft, and the second pinion for withdrawing or moving the rack bar backward mounted upon another shaft. (6) The combination, with the shaft C, pulley *q*, and gear *r*, loose thereupon, and gear C*, fast thereon, of the gears S and *u* and the gears *v* and *n*, the latter being loose on shaft *l*, and the friction clutch *o* also on said shaft *l*, and pinion *m*, all arranged to operate as set forth. (7) The

325,695

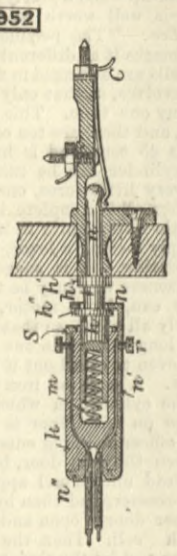


combination of the rack bar *a*, pinion *m*, and shaft *l*, with the carriage E, and set screw *x*, as and for the purpose set forth.

325,952. Telephone Switch Board Plug, *Chester K. Mead, Des Moines, Iowa.—Filed December 20th*, 1884.

Claim.—(1) An improved plug for telephone switch boards, composed of a tubular insulator and handle having a metal conductor fixed to its front end extended over the opposite end, and a conducting wire combined therewith to extend to a transmitting strip on the board, a conductor fixed to the rear end, and a wire combined therewith to extend to a battery, a

325,952

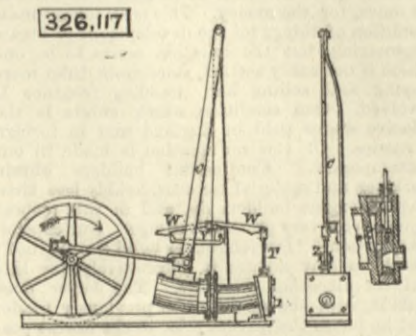


plug adapted to slide in the tubular handle and provided with two flanges or projections to alternately engage the two distinct conductors on the handle, and a spring to press the plug outward relative to the tubular handle, for the purposes specified. (2) The plug *h*, having flanges h^{1} and h^{11}, and a tubular extension, h^{111}, the tubular insulator and handle *k*, having a spring, *m*, enclosed, the fixed conductor *n* n^{1} n^{11}, having a wire *r* attached, and the fixed conductor S, having a wire attached, constructed, arranged, and combined to operate in the manner set forth, for the purposes specified.

326,117. Motor, *Hilon R. Horton, St. Louis, Mo.—Filed July 10th*, 1885.

Claim.—(1) A cylinder supported on an oscillatory rod or frame, and working over a fixed plunger, substantially as set forth. (2) The combination of an oscillating hanger-rod, a cylinder supported on the same and curved concentrically with the axis of oscillation, and a fixed plunger on which the cylinder works, and which has a passage through it for the entrance and exit of fluid, for the purpose set forth. (3) The combination of a fixed plunger having a passage extending through it, an oscillating cylinder working over it, and a slide-valve constructed to operate substantially as described and actuated by connection with the oscillating parts. (4) The combination of an oscillating hanger-rod, a cylinder attached to said rod

326,117

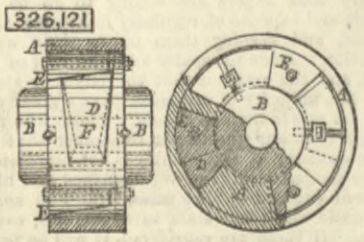


and working over a fixed plunger having a passage through it, a slide-valve governing the current of fluid through said passage, and having a working bar or lever connected to the valve stem, and actuated by a bar or frame attached to a pitman which connects the hanger-rod to the crank of a balance wheel. (5) The combination of the oscillating hanger-rod C, the pitman Z, with bar Y attached to it, and the working bar or lever W, having connection with the valve stem T, substantially as and for the purpose set forth.

326,121. Roll for Roller-mills, *James W. Jackson, Denver, Colo.—Filed March 16th*, 1885.

Claim.—(1) A roll consisting of a hub permanently secured to the axle and formed with circumferential recesses in its periphery, said recesses being provided with transverse openings therein, and an outer portion or shell formed in a single piece and provided internally with circumferential keys registering with the recesses

326,121

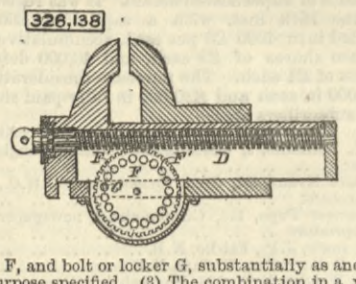


in the hub, and adjusting-blocks fitting the transverse openings in the recesses in the hub, substantially as set forth. (2) The combination of the hub B, having depressions *d*, and side wings D, with the shell A, formed with the wedge-shaped keys F, adapted to enter the said recesses *d*, and the wedge-shaped blocks E, and means, substantially as described, for adjusting said blocks. (3) The combination, with the recessed hub B, of the shell A, formed with keys registering with the recesses in the hub, the adjusting screws P, and blocks for insertion behind the keys F, substantially as described.

326,138. Vice, *V. Mumford Moore, Chicago, Ill.—Filed August 6th*, 1885.

Claim.—(1) The combination, with the adjusting-screw of a vice, of a cogged wheel adapted and arranged for engagement with the said screw and a locker for temporarily preventing the rotation of the said wheel. (2) The combination in a vice of the screw D, the

326,138

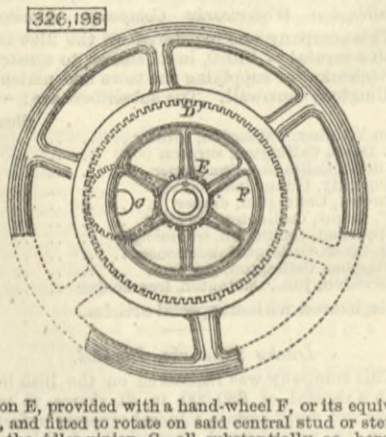


wheel F, and bolt or locker G, substantially as and for the purpose specified. (3) The combination in a vice, of the screw D, wheel F, having holes F^{1} F^{1} therein, and yielding bolt or locker G, substantially as and for the purposes specified.

326,196. Mechanism for Operating Valves, *James H. Blessing, Albany, N.Y.—Filed June 30th*, 1885.

Claim.—In a mechanism for operating stop valves or cocks, the combination, with a central stem or stud having an internal gear-wheel D, fixed thereon, of a

326,196

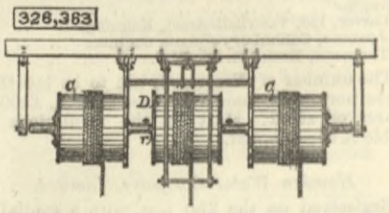


pinion E, provided with a hand-wheel F, or its equivalent, and fitted to rotate on said central stud or stem, and the idler-pinion G, all substantially as herein specified.

326,363. Electric Lamp Hanger, *William S. Weston, Chicago, Ill.—Filed February 16th*, 1885.

Claim.—(1) The combination in an electric lamp hanger of the cylinders C C with the cylinder D, for the purpose substantially set forth. (2) In an electric lamp hanger, the combination of the spring *f* with the cylinder D, and the shaft *r* substantially as

326,383

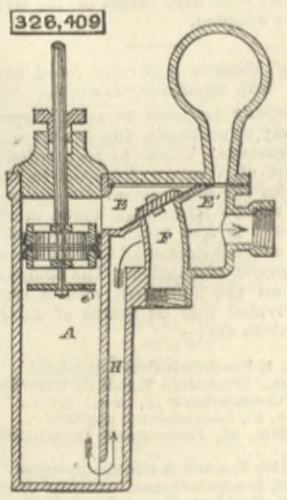


described. (3) In an electric lamp hanger the combination of the bar *g* with the cylinder D, and the shaft *r* substantially as set forth. (4) In an electric lamp hanger the combination of the bar *g*, and the lugs *n n* with the spring backed ratchets *k k* and the ratchet-wheel *i*, all for the purpose substantially as specified.

326,409. Single-acting Pump, *William H. De Valin, San Rafael, Cal.—Filed February 1st*, 1884.

Claim.—A single-acting pump consisting of the piston chamber or cylinder A, having the water passage H, connected with the base thereof and formed integral therewith, and extending up and connected with the eduction port E^{1}, the induction port E, connected with

326,409



the top of the cylinder A, and the passage F, connecting the induction port E with the exterior of a suitable pipe, said passage F lying in the eduction port, an inclined partition, as described, dividing the induction and eduction ports provided with the opening *e* over the mouth of passage F, and the valve described fitting over said opening, and the open piston and upwardly-acting valve under it, all constructed and combined to operate as set forth.

The Production of Lead and Zinc in the United States.—In 1884, the production of lead was 139,897 short tons; total value, at an average price of 75·32 dols. per ton on the Atlantic sea board, 10,537,042 dols. The production was 4069 tons less than that of 1883, while the decrease in value was 1,785,677 dols. The production of white lead (carbonate) is estimated at about 65,000 short tons, worth, at 4¼c. per lb., 6,337,500 dols., almost all of which was made from pig lead. The production of litharge and red lead has not been ascertained. Of metallic zinc, the production was 38,544 short tons; worth, at an average price of 4·44c. per lb. in New York City, 3,422,707 dols. The output was 1672 tons greater than in 1883, and the value increased 111,601 dols. Besides the spelter and sheet zinc, about 13,000 short tons of zinc white (oxide) were made directly from the ore, the total value of which, at 3¼c. per lb., was 910,000 dols.