## ON THE THIRD LAW OF MOTION.

By Professor W. H. H. Hudson.

The difficulty of understanding the third law of motion is, I think, in part attributable to the popular and unscientific personification of Force. A force is said to pull, to push, to act as if it were a person. This is wrong. That which pulls or pushes anything is another material thing, whether it be a person or something inanimate. In mechanics we only consider material things, we call them bodies. One body can and does act upon another body; a particular sort of action is contemplated in the third law of motion, that is to say, the body A *changes the motion* of the body B. If B is at rest, A sets it in motion; if B is moving, A alters its velocity in direction or magnitude or both. This change of motion of B is estimated by the rate per unit of time at which momentum is added to the body B. I do not stop to explain here what is meant by momentum, nor why it is measured by the product of the numbers that measure mass and velocity. This must be first understood if the meaning of Force is to be understood. I take for granted that the idea of momentum is familiar, and assert—following Newton—as a law of nature, that it is impossible for the body A to change the momentum of the body B in any given time, long or short, without B also reacting upon A, and in that same time causing an equal change in the momentum of A, equal, that is to say, in magnitude, but opposite in direction. The rate at which A changes B's momentum is equal—but opposite—to the rate at which B changes A's momentum. This is what is meant by saying that action and reaction are equal and opposite. This is what is meant by saying that to every force there is an equal and opposite anti-force. This is the third law of motion.

This equality and oppositeness of action and reaction is quite independent of the mode in which the bodies A and B act and react. If A pulls B, B pulls A; if A pushes B, B pushes A; if A attracts B—whatever attracts may mean—B must attract A equally.

Two difficulties now arise. The first is this: A and B may push one another without either of them experiencing any change of motion. How is this? The push is a force, and force is rate of change of momentum; and there is no change of momentum, and therefore no force. Let us look closely into this. Let us think first of B. Why does the action of A on B—say the push of A on B—not cause B to move? The only reason is this: something else, say C, is acting on B, and acting with a force that is exactly equal and opposite to the action of A on B. Now let us think of A. The only reason why A does not move is that something else, say D, is acting on A with a force exactly equal and opposite to the action of B on A.

An illustration may help to make this clear. A man, A, pushes a massive block of stone, B, horizontally on the ground. The stone does not move, neither does the man. Why not? Because the rough ground C underneath the stone pushes the stone with a force exactly equal and opposite to that with which the man A pushes. And the man does not move because another part, D, of the rough ground, under his boots, pushes him with a force equal and opposite to that of the action of the stone upon him.

Moreover, the force with which the part of the ground, C, pushes the stone horizontally is equal and opposite to the force with which the stone pushes the ground horizontally, and the force with which the part of the ground, D, pushes the man horizontally is equal and opposite to the force with which the man pushes the ground horizontally. There are thus three pairs of actions and reactions, one pair between the stone and the man, a second pair between the stone and the ground, and a third pair between the man and the ground. All these six forces are equal in magnitude, three of them are in one direction, three in the opposite direction; they are all horizontal, and as the result of their action, neither the stone, nor the man, nor the ground moves.

But still some one may say, this does not remove the difficulty: you are using force in two senses, you have been discussing the balance of statical forces, whereas you have defined force as the rate of change of momentum, and in your illustration there has been no momentum. The answer to this is to be found in the principle of superposition, whereby the resultant change of motion of a body due to several actions from several agents is obtained by combining the changes which would be due to the action of each body separately. In the above illustration, the whole change of momentum of the stone is zero, being compounded of the momentum that the push of the man would give if the ground were perfectly smooth, and of the equal and opposite momentum that the push of the ground would give if it could be supposed to act alone. The force of each push is estimated by the rate of change of momentum that would be due to it acting alone. There is no inconsistency in measuring pushes, pulls, &c.—so-called statical forces—when there is no motion, in exactly the same way that ordinary forces are measured. In fact, this is the way in which such forces are measured by those who maintain—if any are still to be found—the distinction between statical and dynamical forces. They actually do measure statical forces by the weight they would support. Now the weight of a body is nothing more or less than the rate at which its momentum changes when it is falling to the earth.

The next difficulty is this: An objector may say, if action and reaction are equal and opposite, why does anything ever change its motion? why does anything at rest ever move? The horse pulls the cart, the cart pulls the horse back with an equal force; how then can the cart get along?

The answer to this will be seen if we examine particularly not only how the cart but also how the horse gets along. We may take it as a fact that the horse does move. Suppose horse and cart at rest to begin with, after they are in motion there has been a change of momentum of the horse; the momentum was nothing, it is now something, so in accordance with the laws of motion some body must have acted with a force in the direction in which the horse is going. That body certainly was not the cart; the pull of the cart upon the horse tends in the opposite direction—it is backwards—so there must have been a body urging the horse forward with a force greater than the backward pull of the cart. This body is the ground, which pushes horizontally forwards on the horse's hoofs; a horse could not drag a cart upon a perfectly smooth ground. That which gives momentum to the horse, a body that previously had no momentum, is the difference between the push of the ground forwards and the pull of the cart backwards. If the traces were suddenly cut, the horse pushing the ground, and, therefore, by the third law of motion, the ground pushing him the same as before, his momentum would increase more rapidly, he would go faster. Again, that which gives momentum to the cart is the difference between the pull of the horse forwards and the frictional push of the ground upon the wheels of the cart backwards.

Let us further consider the motion of the horse and cart considered as a whole. Here it is true that the action and reaction—the mutual pull of the horse and cart—do neutralise each other, and no change of momentum is due to them. That which urges the system along is the external agency—the difference between the friction of the ground on the horse's hoofs forwards, and the friction of another part of the ground upon the wheels backwards.

The reason why a difficulty of this sort is felt is probably because the objector does not clearly present before his mind the body the motion of which he is considering. We may either consider the cart alone, in which case we have the action pulling the cart forward; or the horse alone, in which case we have the reaction pulling the horse backward; or we may consider the two together, and it is only in this last case that the action and reaction neutralise each other.

The objector may, however, perhaps assert that this does not so much answer his objection, but evades the difficulty. He is thinking, perhaps, neither of the horse nor the cart, nor the two together, but of something between them. Let us try and follow this home, and see where the difficulty may lurk, and whether it really vitiates the third law of motion.

Now we must have some definite body to think of and reason about. We will choose a particular short length P Q of one of the traces; P is the end nearer to the horse, Q is the end nearer to the cart. It was at rest, it is in motion; it has received momentum, something must have acted upon it with a force. So far so good; but says the objector, the action, the pull of the horse, is equal to the reaction, the pull of the cart, consequently the whole force upon it is zero, and therefore it ought not to acquire momentum. In order to see the error in this, we must remember that we have now three bodies to deal with, (1) the horse and all the trace up to P, (2) the link P Q, (3), all the trace from Q and the cart. The law of action and reaction does not say that the pull of the first body upon the link P Q at P is equal to the pull of the third body upon the link P Q at Q. What the law does say is that the pull of the first body—horse, &c.—upon the link at P is equal to the pull of the link P Q upon the first body; likewise, the law says that the pull of the link P Q upon the third body—cart, &c.—is equal to the pull of the third body upon P Q. There are two different pairs of actions and reactions in this case. It is not true that the two pulls upon the two ends of P Q are equal; on the contrary, it is the difference between these two pulls that gives momentum to P Q. But it is true that the difference between these two pulls will be very small if—as it is natural to suppose—the mass of P Q is very small, for then a considerable velocity will correspond to a very small momentum.

The above explanation has been written in the hope that it may help to remove the difficulties of those who have doubts about the third law of motion. The secret of clearness of ideas on this subject is, I repeat, to leave off thinking of force as an independent entity capable of acting, pushing, pulling of its own free will; to fix the mind clearly upon the body of which we are considering the motion; to attribute the change in its motion to the action of other bodies, and to measure the action of each of these by the rate at which the momentum of the body acted on would increase if that action were uncounteracted by the action of other bodies, and then to determine the actual change of motion by compounding these several changes. In this way, not only will no difficulty be found in appreciating the truth of the third law of motion; on the contrary, it will seem so axiomatic that it will appear absolutely impossible to build up a system of dynamics without employing it at every turn. W. H. H. H.

King's College, March 7th.

## THE INFLUENCE OF POSITION ON THE VALUE OF HEATING SURFACE.

The object of the present article is to endeavour to show the limit of the amount of forcing which steam boilers can bear, more particularly that class which is usually placed on board steam vessels where a high power is expected to be exerted for a considerable period of time. It is not proposed to treat the limit fixed by considerations of wear and tear or constructive details except incidentally. The amount of forcing of which any boiler is capable is mainly dependent on the goodness of the circulation, for as soon as the currents flowing along the heated surfaces are unequal to the task of quickly carrying away the globules of steam formed, priming takes place. Circulation is caused by the difference of density of water in various parts of the boiler; so, obviously, water spaces should be of sufficient size to favour a free current in the necessary directions. A mere difference in temperature is in itself of little or no use in causing these currents, the greater difference in density of a given column of water being caused by the honeycombing of the water by the formation of steam globules. The difference of densities is less as the pressure rises owing to the globules of steam being heavier, and their size reduced by the surrounding pressure; this may explain the tendency to priming usually shown by many types of high-pressure boilers, and especially where the water spaces are of insufficient size.

Grease and dirt, of course, largely influence priming very often; but the best makers are usually liberal in the matter of water spaces for high pressures. Circulation may be thus described: The highest part of the water area is the region of the greatest ebullition; as soon as the steam is disengaged the water which had enclosed it flows by gravity to the cooler parts; these possessing superior density by reason of the smaller amount of steam enclosed, displace the water in the hotter parts; the more rapidly the circuit is completed the better is the steam swept off the heated surfaces. The difference of densities of water in various parts of the boiler being the only influence worth mentioning that causes an active circulation, the importance of proper areas for descending, as well as for ascending currents, is apparent. These remarks are supported by examples in practice; the contractors' boiler is found a primer, the cylindrical fire-box being uniformly heated over its horizontal area; and taking any horizontal plane, the same is true with regard to the tubes, so, to be at all efficient, very large spaces require to be left at the sides of the tubes to favour the downward current. The boiler alluded to here is the upright cylindrical boiler, with vertical tubes. The fire engine boiler's circulation is much studied. The Field tube, too, affords an example of the circuit of the ascending and descending currents, being complete in themselves in each tube. Locomotive boilers present a striking example of excellent circulation, and will bear very heavy forcing; but their introduction afloat has not been so satisfactory in results as on land. It will be suggested later on that the circumstances are not nearly so similar as is sometimes thought in the two cases.

In the ordinary marine boiler with return tubes the direction of the currents will be probably as follows:—The principal ebullition being over the furnace crown, combustion chamber, and first length of the tubes, these parts will be in contact with water of smaller average density than that at the smoke-box end of boiler, and the upward current from the furnace crowns will be directed laterally towards the back of the boiler; the prominence over the top of combustion chamber and first part of the tubes impelling the water to smoke-box end or front of boiler, to repeat the circuit. The larger the tubes are, of course, the greater distance flame will travel in them before extinction, and the smaller will be the difference of temperatures at the two ends; so that ebullition may take place over the whole length of the tube. The best practice apparently recognises this circumstance, for the water spaces between the nests of tubes are made free enough to encourage a downward current independently of any that may take place between the tubes at the front end. Box boilers may sometimes be seen which are crowded with small tubes for purposes of surface, and have small water spaces, and yet show no great tendency to prime from bad circulation. The apparent anomaly may be thus explained:—The small tubes extinguish the flame very soon after its entry, especially when their areas are reduced by soot and ashes, and so cause, by the inferior heating power of hot gas as compared with flame, the difference of density in the water necessary to cause a fair amount of circulation, no great amount of steam being made at the chimney end of the tubes. Such a boiler will generally be found extravagant of fuel, and will have a tendency to flame, the extinguished gases, of course, igniting at the first opportunity.

In locomotive boilers the view generally accepted of the direction of the circulation is this:—The principal ebullition occurring over the fire box and tube plate heaps up the water—this may be observed in the water gauge—which, as soon as the steam leaves it, flows to the front of boiler, separates, and falls by the sides of the barrel and along the belly to the fire-box water spaces to repeat the circuit. The ordinary low boiler, used much in her Majesty's Navy, approximates very closely in its behaviour to that of the locomotive boiler, and to this owes its suitability for forced draught. Locomotive boilers, by their great length of tube, offer a considerable fall in temperature to favour circulation, and experiments made on this class of boiler with plates fitted, dividing the tubes off into compartments of so many feet each, do not fairly represent the facts of actual working; for, admitting that the first portion of the length of the tubes does the principal part of the tube duty, the remainder is required to raise the feed-water to the tolerably high temperature which is necessary for boiling at high pressures. Allowance also should be made for the circumstance mentioned by Rankine, viz.: "When the difference between the heat of the gases and the water is very great, the rate of conduction increases faster than the simple ratio of that difference, and is nearly proportional to the square of the difference of temperature.* An example may be taken of a locomotive working at a pressure of 140 lb., corresponding temperature of water being, say, 360, assuming the temperature of the flame entering the tubes at 1800 deg. Fah. and issuing at 800 deg. as gas, 1800 — 360 = 1440 deg., while 800 deg. — 360 deg. = 420 only; the proportion of the squares of these differences of temperature is about $11\frac{3}{4}$ to 1, and this leaves out of the case the inferior heating power of gas compared with flame. The advocates of short tubes will not find much support for their views in these figures.

Again, the total heat of steam of 140 lb. above the atmosphere is 1190 in round numbers, reckoning from 32 deg. Fah.; of this amount 860 heat units are concerned in making steam, and 330 units in raising the water to the boiling point agreeing with this pressure. If the feed-water enters at 60 deg. Fah., the total heat of steam from water of 60 deg. Fah. = 1190 – (60 – 32), which = 1162; of this 302 units are used in heating the water, and 860 in making steam. If the feed-water enters at 140 deg. Fah., as is the case usually in marine engines with surface condensers, 220 units are employed in raising water to boiling point, and 860 units in making steam. The inference from these figures, which are only approximate, as the alteration in the specific heat of the water at higher temperatures is not reckoned, seems to be that a certain

* Wilson on Steam Boilers, p. 283.

amount of the heating surface is performing two useful functions, although no great amount of evaporation may be taking place from it—first, heating the feed-water to the point necessary for the disengagement of steam from it by the more active parts of the boiler surface; and secondly, producing greater density of water in one portion of the boiler by the absence of actual evaporation at that part, so encouraging circulation, because the denser water displaces that which is, as it were, honeycombed by steam bubbles in suspension. A familiar example of the advantage of a difference of temperature is shown in a common pot, which will boil actively and regularly when the heat is applied on one side, but which boils over directly the heat is applied pretty much equally all over the bottom.

Although in locomotive boilers the length is given as the easiest dimension to increase, and long tubes are necessary to extract the heat from the flame and heated gases so powerfully drawn through by the blast, it yet remains to be proved that such boilers would steam even moderately well if the length of tubes were limited to that portion of their length which is actively engaged in steam making. In the boilers of torpedo vessels it is not unusual to see flames driven by the fan blast right through the tubes and up the chimney—not the flaming that occurs with bad air supply to the grate. These boilers are touchy at high powers as regards priming, and this may be expected when the whole of the length of tubes is giving off steam. Another and probably important difference of condition in working locomotive boilers afloat and ashore is that in the latter case the water is fresh to start with, and nearly all the steam from it is sent into the air, but afloat the water is only fresh to start with, and is continually passing through the condenser, so becoming almost, if not entirely, freed from air in suspension. The experiments of Sir William Grove communicated to the Royal Institution in his paper on "Boiling Water," many years ago, seem to prove that boiling, as generally understood, cannot occur regularly unless air be present. More attention may perhaps be with advantage directed to this circumstance than has been done as yet, and it may go a long way to explain the sometimes poor performance of locomotive type boilers when fitted in vessels intended for cruising purposes, especially as the tendency now is to prevent air entering boilers, some authorities considering corrosion to be much influenced by it. The influence of a vigorous circulation in preserving the more highly heated portions of the boiler from injury, and favouring a uniform supply of steam, is admitted generally, and it is certain that the boiler which, by its good arrangement of heating surface and water spaces, most encourages a good circulation, will in consequence be the least liable to disturbance in its action by the various incidents of every-day working, such as grease, dirty water, &c., and will bear a higher amount of forcing than a boiler wherein these points are not considered, and heating surface and grate area are present in abundance but cannot be used.

## THE BLAAUW KRANTZ BRIDGE IN CAPE COLONY.

By MAX AM ENDE, M. INST. C.E.

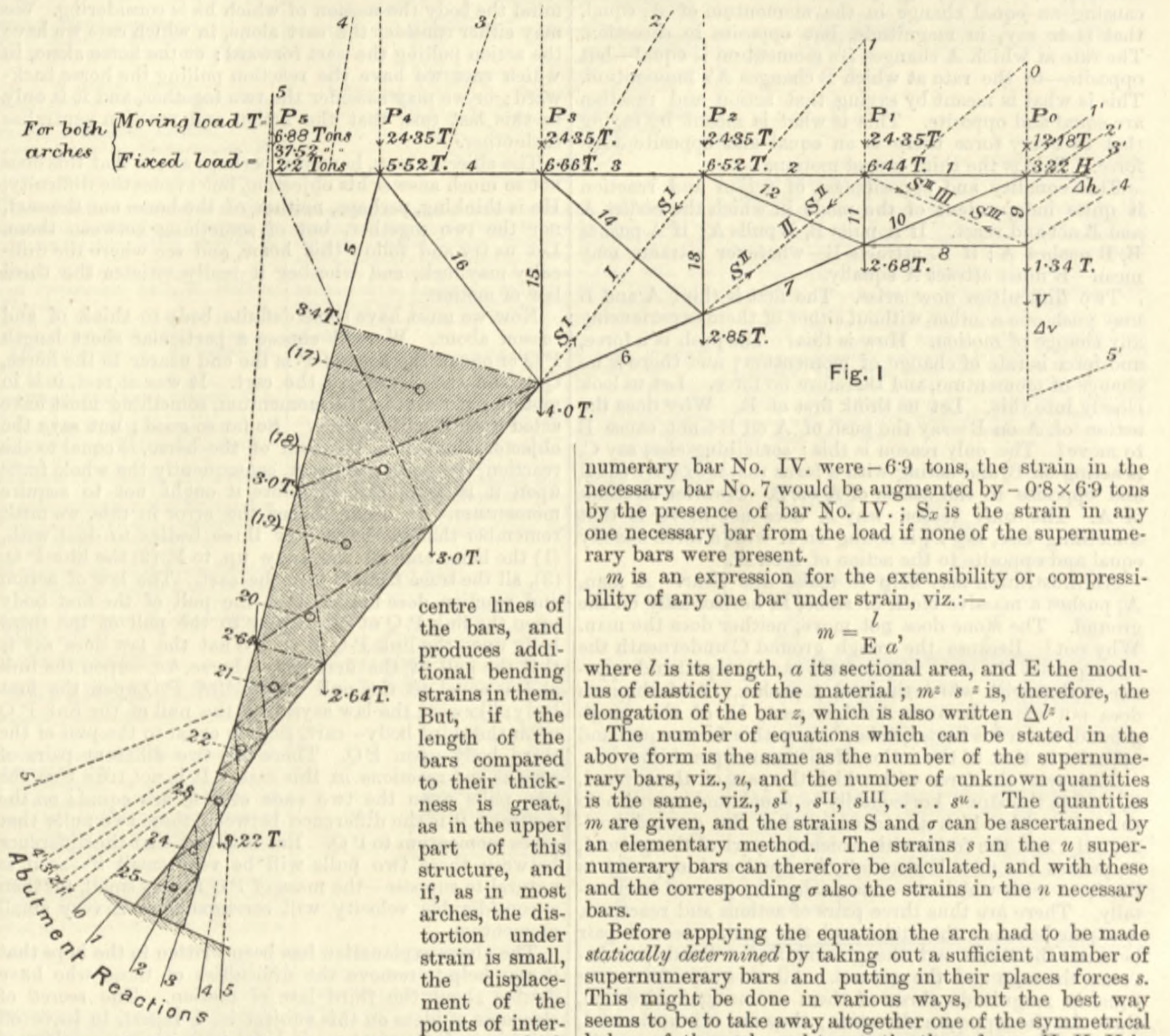
No. II.

THE girders on each side of the arch were used during the erection as cranes for lifting and erecting those parts of the arch, which are necessary to form a support for the overhanging ends of the girders. A connection was then effected by means of horizontal bolts with adjusting screws, and the remaining parts of the arch were erected according to the projecting method. A pivot was inserted at the crown, and there was also a pivot at each abutment of the arch, so that when the adjusting screws were loosened the central span became an arch with three hinges, and for the time being quite independent, as the girders did not press upon it either vertically or horizontally. The strains in the whole structure could now be determined, for although the arch was afterwards transformed into one without hinges, and the strains from loads subsequently brought upon it became dependent upon the elasticity of the structure, the usual uncertainty as to the strains in such cases could be entirely obviated, because the transformation was effected without adding any fresh strains—*i.e.*, the former condition did not transfer any uncertainty to the latter.

The calculation of strains was, accordingly, twofold, as there was the calculation of the hinged arch with the dead load, and any artificial load which may have been, and actually was, used for the purpose of adjusting strains, and the calculation of the fixed arch with the moving load. The two results were added together, and the sectional areas of the parts determined accordingly; but as these sectional areas had to be used as factors in the previous calculations of strains according to principles of elasticity, it was necessary to make this calculation twice. For the first time the ordinary method was used, in which it is assumed that the arch can be replaced by a single line, viz., its neutral fibre invested with varying moments of inertia, which resist bending in the same degree as the real arch. This method is shorter than the one subsequently applied; but, although the results did not differ much from those obtained by the latter, this must in some measure be ascribed to accident, and they could not be considered satisfactory in the present case of a somewhat novel structure.

This second calculation was made according to a method which takes into account the elastic alteration of length of every single member of the structure instead of the alteration of form of the various laminæ into which, according to the first method, it is usually divided at right angles with the neutral fibre. But as the method does not necessarily exclude the calculation with laminæ, it has been applied, with this simplifying modification, to those parts of the arch which are not immediately exposed to the action of the moving load, and which, on account of their form and position, justify this simplification.

In the application of this method to a system of bars it is assumed that they are joined in perfect hinges. This is never entirely and seldom approximately the case, for the junctions are either completely fixed by means of rivets, or to a great extent fixed by the friction of pin-connections. This has the effect of placing the points of intersection of the strain lines out of coincidence with the




centre lines of the bars, and produces additional bending strains in them. But, if the length of the bars compared to their thickness is great, as in the upper part of this structure, and if, as in most arches, the distortion under strain is small, the displacement of the points of intersection can be ignored while the bending strains, which would be inconsiderable, are objects of a separate calculation. If, on the other hand, the bars are short and thick—as near the base of the present structure—so as to make it almost solid, the calculation with laminæ will give as good results as that with hinged bars having regard to the effects of fixed junctions.

These remarks may be sufficient to explain why the different parts of the arch have been differently treated.

The calculation of strains is given here in a somewhat extensive form, because the method which was applied, is, judging by its usefulness, unquestionably one of the most remarkable achievements in the science of applying physical laws to engineering calculations, and is not yet so generally known as it should be.

The method here alluded to, the principles of which have been treated by Maxwell, Lamé, and Schulze, is generally known as Mohr's method of applying the *principle of work* to the calculation of statically undetermined structures. Although it does not require the use of higher mathematics, it is accurate, clear, and not difficult, except occasionally in the diagnosis of the case and in the arithmetical treatment if several unknown quantities have to be dealt with.

As the process of reasoning has already been explained by various writers, it may be sufficient to begin here by stating the conclusion in its most comprehensive form.

$$-m^z s^z = \sum_{x=1}^{x=n} m_x \sigma_x^z S_x + s^{I} \sum_{x=1}^{x=n} m_x \sigma_x^z \sigma_x^{I} + s^{II} \sum_{x=1}^{x=n} m_x \sigma_x^z \sigma_x^{II}$$
$$+ s^{III} \sum_{x=1}^{x=n} m_x \sigma_x^z \sigma_x^{III} + \ . \ . \ . \ + s^z \sum_{x=1}^{x=n} m_x (\sigma_x^z)^2$$
$$+ \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ + s^u \sum_{x=1}^{x=n} m_x \sigma_x^z \sigma_x^u$$

This equation applies to a system of $n + u$ elastic bars, $n$ being the number of bars *necessary* to make it *statically determined* and $u$ the number of those *supernumerary* bars, in consequence of whose presence the system is rendered *statically undetermined.*

$x$ is any one number between 1 and $n$, and $z$ is any one number between I and $u$;

$s^{I}$, $s^{II}$, $s^{III}$, . . . . $s^z$ . . . . $s^u$ are the strains in the supernumerary bars;

$\sigma_x^z$ is the strain in any *necessary* bar, produced by the strain unit in any *supernumerary* bar; for example, $\sigma_7^{IV} = 0·8$ would indicate that, if the strain in the supernumerary bar No. IV. were $-6·9$ tons, the strain in the necessary bar No. 7 would be augmented by $-0·8 \times 6·9$ tons by the presence of bar No. IV.; $S_x$ is the strain in any one necessary bar from the load if none of the supernumerary bars were present.

$m$ is an expression for the extensibility or compressibility of any one bar under strain, viz.:—

$$m = \frac{l}{E\,a},$$

where $l$ is its length, $a$ its sectional area, and E the modulus of elasticity of the material; $m^z s^z$ is, therefore, the elongation of the bar $z$, which is also written $\Delta l^z$.

The number of equations which can be stated in the above form is the same as the number of the supernumerary bars, viz., $u$, and the number of unknown quantities is the same, viz., $s^{I}$, $s^{II}$, $s^{III}$, . . . $s^u$. The quantities $m$ are given, and the strains S and $\sigma$ can be ascertained by an elementary method. The strains $s$ in the $u$ supernumerary bars can therefore be calculated, and with these and the corresponding $\sigma$ also the strains in the $n$ necessary bars.

Before applying the equation the arch had to be made *statically determined* by taking out a sufficient number of supernumerary bars and putting in their places forces $s$. This might be done in various ways, but the best way seems to be to take away altogether one of the symmetrical halves of the arch, and to put the three forces H, K, V in its place—see Fig. 1; it is also necessary to take out the bars marked I, II, III, and it would further be necessary to take out several bars in the cross-lined part, but, as already indicated, this part was divided into laminæ, each of which is represented by its length $\Delta x$, its moment of inertia J, and the modulus of elasticity of the material E. The flexibility of the laminæ can be stated by the expression $\frac{\Delta x}{E\,J}$, and it has been shown that this may be put for $m$ in the above equation, if at the same time $\mu^z{}_x$ the moment in any lamina $x$ produced by the force unit in the supernumerary bar $z$ is put in place of $\sigma_x{}^z$, and $M_x$ the moment in any lamina produced by the load in place of $S_x$. The system, Fig. 1, now consists of the bars 1 to 16, and of the laminæ 17 to 25; further, of three supernumerary bars and the unknown forces H, K, V. In the other half of the arch there are also three supernumerary bars and the same forces H, K, V in an opposite direction. This makes the number of unknown quantities nine, and if the movements of the points of attachment of the forces H, K, V, viz., $\Delta h$, $\Delta k$, $\Delta v$, are introduced for each half of the arch, the number of equations becomes fifteen, the number of unknown quantities being the same.

The equations are then as follows:—

For the left (loaded) half.

$$\Delta h = \Sigma m_x \sigma_x^{H} S_x + H \Sigma m_x (\sigma_x^{H})^2 + K \Sigma m_x \sigma_x^{H} \sigma_x^{K} + V \Sigma m_x \sigma_x^{H} \sigma_x^{v} + s^{I} \Sigma m_x \sigma_x^{H} \sigma_x^{I} + s^{II} \Sigma m_x \sigma_x^{H} \sigma_x^{II} + s^{III} \Sigma m_x \sigma_x^{H} \sigma_x^{III} \quad . \ . \ . \ . \ . \ . \ . \ . \quad (1)$$
$$\Delta k = \Sigma m_x \sigma_x^{K} S_x + H \Sigma m_x \sigma_x^{K} \sigma_x^{H} + K \Sigma m_x (\sigma_x^{K})^2 + V \Sigma m_x \sigma_x^{K} \sigma_x^{v} + s^{I} \Sigma m_x \sigma_x^{K} \sigma_x^{I} + s^{II} \Sigma m_x \sigma_x^{K} \sigma_x^{II} + s^{III} \Sigma m_x \sigma_x^{K} \sigma_x^{III} \quad . \ . \ . \ . \ . \ . \ . \ . \quad (2)$$
$$\Delta v = \Sigma m_x \sigma_x^{v} S_x + H \Sigma m_x \sigma_x^{v} \sigma_x^{H} + K \Sigma m_x \sigma_x^{v} \sigma_x^{K} + V \Sigma m_x (\sigma_x^{v})^2 + s^{I} \Sigma m_x \sigma_x^{v} \sigma_x^{I} + s^{II} \Sigma m_x \sigma_x^{v} \sigma_x^{II} + s^{III} \Sigma m_x \sigma_x^{v} \sigma_x^{III} \quad . \ . \ . \ . \ . \ . \ . \ . \quad (3)$$
$$-m^{I} s^{I} = \Sigma m_x \sigma_x^{I} S_x + H \Sigma m_x \sigma_x^{I} \sigma_x^{H} + K \Sigma m_x \sigma_x^{I} \sigma_x^{K} + V \Sigma m_x \sigma_x^{I} \sigma_x^{v} + s^{I} \Sigma m_x (\sigma_x^{I})^2 + s^{II} \Sigma m_x \sigma_x^{I} \sigma_x^{II} + s^{III} \Sigma m_x \sigma_x \sigma_x^{III} \quad . \ . \ . \ . \ . \ . \ . \ . \quad (4)$$
$$-m^{II} s^{II} = \Sigma m_x \sigma_x^{II} S_x + H \Sigma m_x \sigma_x^{II} \sigma_x^{H} + K \Sigma m_x \sigma_x^{II} \sigma_x^{K} + V \Sigma m_x \sigma_x^{II} \sigma_x^{v} + s^{I} \Sigma m_x \sigma_x^{II} \sigma_x^{I} + s^{II} \Sigma m_x (\sigma_x^{II})^2 + s^{III} \Sigma m_x \sigma_x^{II} \sigma_x^{III} \quad . \ . \ . \ . \ . \ . \ . \ . \quad (5)$$
$$-m^{III} s^{III} = \Sigma m_x \sigma_x^{III} S_x + H \Sigma m_x \sigma_x^{III} \sigma_x^{H} + K \Sigma m_x \sigma_x^{III} \sigma_x^{K} + V \Sigma m_x \sigma_x^{III} \sigma_x^{v} + s^{I} \Sigma m_x \sigma_x^{III} \sigma_x^{I} + s^{II} \Sigma m_x \sigma_x^{III} \sigma_x^{II} + s^{III} \Sigma m_x (\sigma_x^{III})_2 \quad . \ . \ . \ . \ . \ . \ . \ . \quad (6)$$

Further:

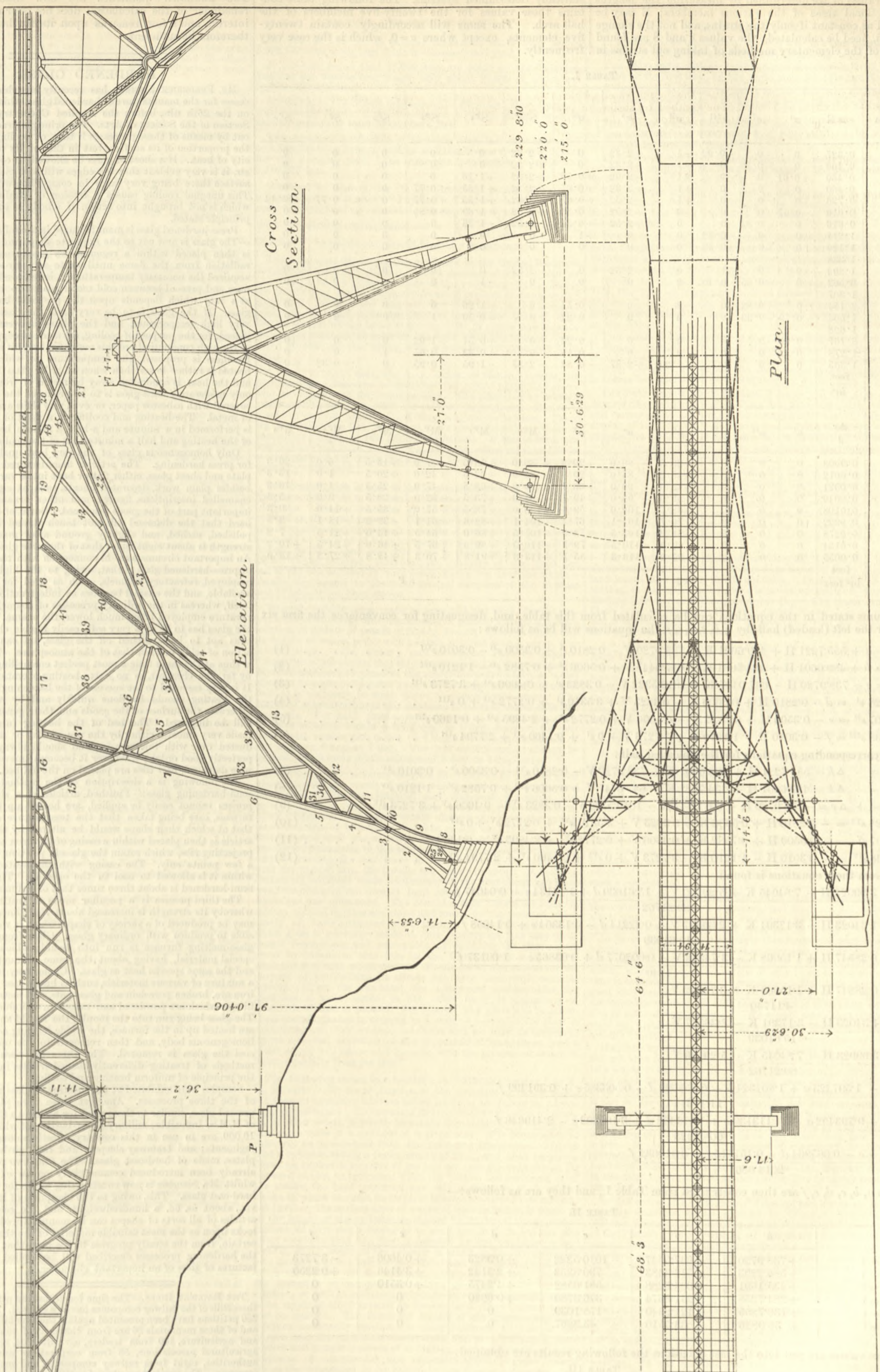
For the right (unloaded) half. { Six equations of a similar form, but with $-\Delta h^1$, $-\Delta k^1$, $+\Delta v^1$, instead of $\Delta h$, $\Delta k$, $\Delta v$; $m^{VI}$, $m^{V}$, $m^{IV}$, instead of $m^{I}$, $m^{II}$, $m^{III}$; $s^{VI}$, $s^{V}$, $s^{IV}$, instead of $s^{I}$, $s^{II}$, $s^{III}$; $S = 0$; $V^1 = -V$; $\sigma^{VI}$, $\sigma^{V}$, $\sigma^{IV}$, $= \sigma^{I}$, $\sigma^{II}$, $\sigma^{III}$. The values for $\sigma$ remain, therefore, as above . . } (7, 8, 9, 10, 11, 12)

Finally

$$-\Delta h^1 = \Delta h \quad . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \quad (13)$$
$$-\Delta k^1 = \Delta k \quad . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \quad (14)$$
$$+\Delta v^1 = \Delta v \quad . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \quad (15)$$

# THE BLAAUW KRANTZ BRIDGE.

MR. MAX AM ENDE, M.I.C.E., ENGINEER. MESSRS. HANDYSIDE AND CO., DERBY, CONSTRUCTORS.



The values $m$ are determined by measuring the lengths and sectional areas of the various members; E may be omitted as constant if only the strains, and not the change of form, need be calculated; the values $\sigma$ and S are found by one of the elementary methods of taking out strains in statically determined systems. The following table contains these values for the twenty-five members of the half arch. The sums will accordingly contain twenty-five elements, except where $\sigma = 0$, which is the case very frequently.

TABLE I.

| Bar or lamina No. | $m$ E | $\sigma^{I}$ | $\sigma^{II}$ | $\sigma^{III}$ | $\sigma^{H}$ | $\sigma^{v}$ | $\sigma^{K}$ | $S^{P_0}$ | $S^{P_1}$ | $S^{P_2}$ | $S^{P_3}$ | $S^{P_4}$ | $S^{P_5}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0·327 | 0 | 0 | −0·92 | +1 | −2·32 | 0 | +2·32 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0·460 | 0 | −0·76 | 0 | +1 | −2·32 | 0 | +2·32 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0·460 | −0·61 | 0 | 0 | +1 | −2·32 | +0·50 | +2·32 | +1·16 | 0 | 0 | 0 | 0 |
| 4 | 0·460 | 0 | 0 | 0 | +1 | −2·32 | +0·67 | +2·32 | +1·55 | +0·77 | 0 | 0 | 0 |
| 5 | 0·730 | 0 | 0 | 0 | +1 | −2·32 | +0·67 | +2·32 | +1·55 | +0·77 | 0 | −0·77 | −0·42 |
| 6 | 0·616 | −0·67 | 0 | 0 | 0 | +2·52 | +0·36 | −2·52 | −1·69 | −0·85 | 0 | 0 | 0 |
| 7 | 0·616 | 0 | −0·82 | 0 | 0 | +2·52 | +0·54 | −2·52 | −1·26 | 0 | 0 | 0 | 0 |
| 8 | 1·218 | 0 | 0 | −0·92 | 0 | 0 | +1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 1·120 | 0 | 0 | −0·40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| III. | 1·338 | | | | | | | | | | | | |
| 10 | 1·202 | 0 | 0 | +1 | 0 | +2·52 | 0 | −2·52 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0·562 | 0 | −0·65 | −0·40 | 0 | 0 | 0 | 0 | −1 | 0 | 0 | 0 | 0 |
| II. | 1·307 | | | | | | | | | | | | |
| 12 | 2·154 | 0 | +0·82 | 0 | 0 | 0 | +0·51 | 0 | +1·26 | 0 | 0 | 0 | 0 |
| 13 | 1·063 | −0·79 | −0·33 | 0 | 0 | 0 | −0·22 | 0 | −0·50 | −1 | 0 | 0 | 0 |
| I. | 1·628 | | | | | | | | | | | | |
| 14 | 3·167 | +0·81 | 0 | 0 | 0 | 0 | +0·22 | 0 | +0·51 | +1·02 | 0 | 0 | 0 |
| 15 | 1·278 | −0·52 | 0 | 0 | 0 | 0 | −0·15 | 0 | −0·33 | −0·67 | −1 | 0 | 0 |
| 16 | 1·335 | 0 | 0 | 0 | −1·22 | +2·87 | −0·82 | −2·87 | −1·95 | −0·95 | 0 | −0·32 | +0·51 |
| | feet / in² | | | | | | | | | | | | |
| | $\frac{\Delta x}{J}$ | $\mu^{I}$ | $\mu^{II}$ | $\mu^{III}$ | $\mu^{H}$ | $\mu^{v}$ | $\mu^{K}$ | $M^{P_0}$ | $M^{P_1}$ | $M^{P_2}$ | $M^{P_3}$ | $M^{P_4}$ | $M^{P_5}$ |
| 17 | 0·0008 | 0 | 0 | 0 | +29·5 | − 80·0 | +20·2 | + 80·0 | +58·5 | +37·0 | +15·5 | − 6·0 | −20·3 |
| 18 | 0·0012 | 0 | 0 | 0 | +39·2 | − 85·0 | +29·9 | + 85·0 | +63·5 | +42·0 | +20·5 | − 1·0 | −15·3 |
| 19 | 0·0021 | 0 | 0 | 0 | +49·0 | − 90·0 | +39·7 | + 90·0 | +68·5 | +47·0 | +25·5 | + 4·0 | −10·3 |
| 20 | 0·0040 | 0 | 0 | 0 | +59·0 | − 95·0 | +49·7 | + 95·0 | +73·5 | +52·0 | +30·5 | + 9·0 | − 5·3 |
| 21 | 0·0108 | 0 | 0 | 0 | +68·7 | −100·0 | +59·4 | +100·0 | +78·5 | +57·0 | +35·5 | +14·0 | − 0·3 |
| 22 | 0·0222 | 0 | 0 | 0 | +76·7 | −104·1 | +67·4 | +104·1 | +82·6 | +61·1 | +39·6 | +18·1 | + 3·8 |
| 23 | 0·0278 | 0 | 0 | 0 | +83·2 | −107·5 | +73·9 | +107·5 | +86·0 | +64·5 | +43·0 | +21·5 | + 7·2 |
| 24 | 0·0134 | 0 | 0 | 0 | +89·0 | −110·5 | +79·7 | +110·5 | +89·0 | +67·5 | +46·0 | +24·5 | +10·2 |
| 25 | 0·0055 | 0 | 0 | 0 | +95·0 | −113·3 | +85·7 | +113·3 | +91·8 | +70·3 | +48·8 | +27·3 | +13·0 |
| | feet / in² feet² | ×1 | | | | | | ×P | | | | | |

The sums stated in the equations can be calculated from this table, and, designating for convenience the first six sums for the left (loaded) half, by $a, b, c, d, e, f$, the equations will be as follows:—

$$\Delta h = a + 555·7221\,H + 489·6601\,K - 738·9720\,V - 0·2810\,s^{I} - 0·3500\,s^{II} - 0·3010\,s^{III} \quad (1)$$
$$\Delta k = b + 489·6601\,H + 434·7681\,K - 647·0447\,V + 0·5606\,s^{I} + 0·7582\,s^{II} - 1·1210\,s^{III} \quad (2)$$
$$\Delta v = c - 738·9720\,H - 647·0447\,K + 1010·5322\,V - 0·3823\,s^{I} - 0·4606\,s^{II} + 3·7273\,s^{III} \quad (3)$$
$$-1·628\,s^{I} = d - 0·2810\,H + 0·5606\,K - 0·3823\,V + 3·5310\,s^{I} + 0·2772\,s^{II} + 0\,s^{III} \quad (4)$$
$$-1·307\,s^{II} = e - 0·3500\,H + 0·7582\,K - 0·4606\,V + 0·2772\,s^{I} + 2·4895\,s^{II} + 0·1460\,s^{III} \quad (5)$$
$$-1·338\,s^{III} = f - 0·3010\,H - 1·1210\,K + 3·7273\,V + 0\,s^{I} + 0·1460\,s^{II} + 2·7794\,s^{III} \quad (6)$$

and the corresponding equations for the unloaded half:

$$\Delta h' = -\Delta h = 555·7221\,H + 489·6601\,K + 738·9720\,V - 0·2810\,s^{VI} - 0·3500\,s^{V} - 0·3010\,s^{IV} \quad (7)$$
$$\Delta k' = -\Delta k = 489·6601\,H + 434·7681\,K + 647·0447\,V + 0·5606\,s^{VI} + 0·7582\,s^{V} - 1·1210\,s^{IV} \quad (8)$$
$$\Delta v' = +\Delta v = -738·9720\,H - 647·0447\,K - 1010·5322\,V - 0·3823\,s^{VI} - 0·4606\,s^{V} + 3·7273\,s^{IV} \quad (9)$$
$$-1·628\,s^{VI} = -0·2810\,H + 0·5606\,K + 0·3823\,V + 3·5310\,s^{VI} + 0·2772\,s^{V} + 0\,s^{IV} \quad (10)$$
$$-1·307\,s^{V} = -0·3500\,H + 0·7582\,K + 0·4606\,V + 0·2772\,s^{VI} + 2·4895\,s^{V} + 0·1460\,s^{IV} \quad (11)$$
$$-1·338\,s^{IV} = -0·3010\,H - 1·1210\,K - 3·7273\,V + 0\,s^{VI} + 0·1460\,s^{V} + 2·7794\,s^{IV} \quad (12)$$

From these equations is found—

$$S^{I} = \frac{3·99923\,H - 7·84045\,K + 5·29130\,V - 15·61039\,d + 1·14134\,e - 0·04047\,f}{80·21762}$$

$$S^{II} = \frac{1·34023\,H - 3·17391\,K + 2·36537\,V + 0·22214\,d - 4·13364\,e + 0·14658\,f}{15·61039}$$

$$S^{III} = \frac{0·28847\,H + 1·15068\,K - 3·74942\,V - 0·002077\,d + 0·03865\,e - 1·00137\,f}{4·11740}$$

$$S^{IV} = \frac{0·28847\,H + 1·15068\,K + 3·74942\,V}{4·11740}$$

$$S^{V} = \frac{1·34023\,H - 3·17391\,K - 2·36537\,V}{15·61039}$$

$$S^{VI} = \frac{3·99923\,H - 7·84045\,K - 5·29130\,V}{80·21762}$$

$$H = \frac{-1·597423\,a + 1·801324\,b - 0·255699\,d - 0·503385\,e + 0·391499\,f}{11·11314}$$

$$K = \frac{+9·793492\,a - 11·113139\,b + 1·574438\,d + 3·100302\,e - 2·419646\,f}{60·42023}$$

$$V = \frac{-c - 0·065964\,d - 0·151515\,e + 0·910632\,f}{2014·086}$$

The sums $a, b, c, d, e, f$ are then constructed from Table I., and they are as follows:—

TABLE II.

| | $a$ | $b$ | $c$ | $d$ | $e$ | $f$ |
|---|---|---|---|---|---|---|
| $P_0 = 1$ | +738·9720 | +647·0447 | −1010·5322 | +0·3823 | +0·4606 | −3·7273 |
| $P_1 = 1$ | +586·2293 | +517·3483 | − 790·3353 | +2·3142 | +3·4146 | +0·2250 |
| $P_2 = 1$ | +435·1691 | +384·6288 | − 581·6582 | +4·2475 | +0·3510 | 0 |
| $P_3 = 1$ | +284·7358 | +251·8674 | − 376·3780 | +0·6640 | 0 | 0 |
| $P_4 = 1$ | +136·7255 | +121·2340 | − 178·1039 | 0 | 0 | 0 |
| $P_5 = 1$ | + 36·9826 | + 33·5510 | − 43·3867 | 0 | 0 | 0 |

When these values are put into the last equations the following results are obtained:—

TABLE III.

| | H | K | V | $s^{I}$ | $s^{II}$ | $s^{III}$ | $s^{IV}$ | $s^{V}$ | $s^{VI}$ |
|---|---|---|---|---|---|---|---|---|---|
| $P_0 = 1$ | −1·5030 | +0·9511 | 0·5000 | −0·2009 | −0·3982 | +0·6158 | +0·6158 | −0·3982 | −0·2009 |
| $P_1 = 1$ | −0·6089 | +0·0919 | +0·3922 | −0·4153 | −0·8808 | −0·3979 | +0·3401 | −0·1304 | −0·0652 |
| $P_2 = 1$ | −0·3213 | −0·0800 | +0·2886 | −0·8107 | −0·0001 | −0·3065 | +0·2180 | −0·0551 | −0·0272 |
| $P_3 = 1$ | −0·1186 | −0·1561 | +0·1868 | −0·1075 | +0·0593 | −0·2224 | +0·1182 | −0·0067 | −0·0030 |
| $P_4 = 1$ | −0·0024 | −0·1369 | +0·0884 | +0·0191 | +0·0410 | −0·1189 | +0·0421 | +0·0142 | +0·0074 |
| $P_5 = 1$ | +0·1223 | −0·1766 | +0·0215 | +0·0248 | +0·0497 | −0·0604 | −0·0212 | +0·04314 | +0·0219 |

The unknown quantities are now determined; the remainder of the calculation does not offer much general interest, and a few remarks upon its further course will therefore be sufficient.

## HARDENED GLASS.

MR. FREDERICK SIEMENS has recently introduced some processes for the manufacture of hardened glass, which he described on the 26th ult., before the Applied Chemistry and Physics Section of the Society of Arts. The principle practically carried out by means of these processes is that of cooling glass, not in the proportion of its surface, but in that of its volume or capacity of heat. If a sheet of glass be allowed to cool in the open air, it is very evident that the edges will cool most quickly, the surface there being very large in comparison with the volume. This unequal cooling causes a tension or strain in the glass, which is not brought into action if a body is cooled upon the principle stated.

Press-hardened glass is manufactured in the following manner:—The glass is first cut to the requisite shape and dimensions, it is then placed within a regenerative gas furnace heated by radiation from the flame until quite soft; as soon as it has acquired the necessary temperature it is removed from the furnace and pressed between cold metal plates to be cooled down at a rate which depends upon the proposed hardness of the glass. If the glass is to be very hard the glass is raised to a very high temperature, and the plates between which it is placed, for the purpose of cooling, are made of copper, on account of the high conductivity of this metal for heat; if a less degree of hardness is proposed, the temperature to which the glass is heated is rather lower than when a harder glass is to be made, and the heat is conducted away by means of iron plates; when only moderately hard glass is to be produced the iron plates are covered with asbestos paper, or even clay slabs are used in place of metal. The heating and cooling of a sheet of ordinary glass is performed in a minute and a-half, a minute being the length of the heating and half a minute that of the cooling operation.

Only homogeneous glass of the very best quality is suitable for press hardening. The articles manufactured are mainly of plate and sheet glass, either flat or bent into a variety of shapes; besides plain work, decorated sheets, such as sign-boards with enamelled inscriptions, figures, and other ornaments form an important part of the goods produced. Some of the glass is so hard that the diamond will not touch it, and it can only be polished, etched, and slightly ground after manufacture; its strength is about eight times that of the same glass unhardened. An important circumstance in connection with the manufacture of press-hardened glass is that, owing to the high temperature employed, refractory enamels, such as used for porcelain, are available, and the enamel becomes as indestructible as the glass itself, whereas in the ordinary processes of enamelling, the temperature employed being much lower, the enamel to be fixed on the glass has to be of a very soft, easily fusible character; it is thus apt to be scratched off the glass, and cannot resist the action of acids, or even that of the atmosphere. The hardening is thus at the same time a most perfect enamelling process, and by far the cheapest, as no extra heating operation is required. It is very essential to the success of the hardening operation that the heating should be done quickly and by radiation only, otherwise the surface of the goods and their general appearance will be impaired. The bed of the heating furnace must be made very smooth, either by the use of clay or sandstone tiles, dusted over with talc powder, and should always be kept in perfectly good order; whenever it becomes uneven, or is otherwise damaged, new tiles are placed on the old bed.

The following is a description of the method employed for semi-hardening glass:—Finished articles, of a shape to which presses cannot easily be applied, are heated up in a radiation furnace, care being taken that the temperature shall be below that at which their shape would be altered by the heat; each article is then placed within a casing of cast iron having internal projecting ribs, which retain the glass in position, touching it at a few points only. The casing with the heated glass article within it is allowed to cool in the open air. The strength of semi-hardened is about three times that of ordinary glass.

The third process is a peculiar mode of casting hard glass, whereby its strength is increased about four times, and articles may be produced of a variety of shapes which it would be impossible to produce with ordinary glass. Glass from a continuous glass-melting furnace is run into moulds, which are made of special material, having about the same conductivity for heat and the same specific heat as glass. Choice may be made from a mixture of various materials, such as heavy spar and magnetic iron ore, broken porcelain and glass pots, and metal turning and filings, which are powdered and mixed in suitable proportions. The glass being run into the mould, the mould and its contents are heated up in the furnace, the whole forming as it were one homogeneous body, and then removed to the open air; when cool the glass is removed. The three processes are different methods of treating differently shaped articles in carrying out the principle of uniform heating and cooling.

Samples were exhibited at the meeting of glass made by each of the three processes. Amongst these were plates of hard-pressed glass, similar to those used for fitting up the chart-room of H.M.S. Inflexible; military water-bottles, of which more than 10,000 are in use in this country, mostly amongst volunteer regiments; and tramway sleepers and rails, girders and floor-plates, made of hard-cast glass. The first two processes have already been introduced commercially on an extensive scale, whilst Mr. Siemens is now constructing works for the supply of hard-cast glass. This, owing to the cheapness of its production, viz., about 5s. 6d. a hundredweight, and the ease with which articles of all sorts of shapes can be manufactured, its inventor looks upon as the most valuable material of the three. He feels certain, from the steady progress in the past, that in the future the hardening processes described will be applied to all manufactures of glass of an important character.

THE RAILWAY BILLS.—The time for depositing petitions against these Bills of the railway companies has now elapsed. No fewer than 280 petitions have been presented against the nine bills in question, and of these memorials 86 are from chambers of commerce, trade, and agriculture, 100 from traders, agriculturists, and trade and agricultural associations, 85 from corporations and other local authorities, eight from railway companies, and one from a canal company. The greatest number of petitions is directed against the London and North-Western Railway Company's Bill, to which there are 55 opponents. Fifty-four petitions have been lodged against the Midland Bill, 52 against the Great Western, 33 against the Great Northern, 32 against the North-Eastern, 18 against the Great Eastern, 17 against the London, Brighton, and South Coast, 10 against the London and South-Western, and nine against the London, Chatham and Dover. All the above petitions pray to be heard before Committee, and, in addition, there are a great many bodies who have by petition recorded their objection to these measures without seeking to appear against them.

## RAILWAY MATTERS.

THE record of train accidents in America published by the *Railroad Gazette* from month to month during the past year has contained mention of 445 collisions, 681 derailments, and 65 other accidents—a total of 1191 accidents, in which 389 persons were killed and 8760 injured.

THE *Times* said yesterday that the railway companies which have lately introduced Bills for the regulation of rates and charges were believed to be about to abandon their measures in deference to the opposition they have encountered. The chairman of the London and North-Western, however, repudiated this at yesterday's meeting of the company.

AT the recent meeting of the Great Northern Railway, the chairman, Lord Colville, said:—"I should regret the entire abolition of the second-class carriages. But I am inclined to think that though the second class may be, and ought to be retained for the suburban traffic, still it will no longer pay to haul second-class carriages on long journeys in our fast trains throughout the country."

THE London and North-Western Railway Company is now running on the express trains between Wolverhampton, Birmingham and London carriages of an improved type. Each carriage is 42ft. long, and has eight wheels, the front and rear pair of wheels working on radial base axles, which causes the train to run smoothly and pass easily over curves and crossings. The compartments are lofty, being 7ft. 6in. high.

THE Wolverhampton Chamber of Commerce are determined to continue their strenuous opposition to the new railway Bills. And the more so since the shares of the three railways in which South Staffordshire is interested—the London and North-Western, Great Western, and Midland—stand at from over 30 to over 60 per cent. premium, and the companies have suffered less from the depression than any other class of the community.

TWO instances of car-heaters exploding have been lately, the *Railroad Gazette* says, brought under our notice. "In one case two train hands were scalded, and the sleeping passengers, badly scared, rushed on the platform in scanty night attire. In the other, the car was considerably damaged, one end being almost completely blown out. Both explosions were probably caused by the safety valve sticking fast." The heating arrangements of American cars can hardly be considered safe.

THE railways of New South Wales are rapidly increasing in length, the total mileage having reached 1438¾ miles, which, with 772 miles remaining to be finished, will bring the total up to 2210¾ miles. Besides this extension, the Colonial Parliament has sanctioned the construction of 1197 miles. During 1883, 17,271 tons of railway material were imported, of the value of £275,149. The gross earnings of 1883 were £1,931,464; the working expenses, £1,177,788; and the net earnings, £753,676.

A PROPOSAL for the construction of the Suakim-Berber Railway was long since made by M. Louis Vossion, who for several years down to 1882 was French Vice-Consul at Khartoum. He was well acquainted with the route which it is now proposed should be followed, prepared plans and drew up prospectuses showing how advantageous it would be to commerce that the line should be made, thus, the *Times* says, forestalling the recent utterances of Mr. Stanley. The plans and all information upon them are in the archives of the French Foreign-office.

THE report of the Great North of Scotland Railway Company, to be read on the 19th inst., gives the total cost of maintenance of way and works for the half-year ending 31st January at £19,697; of the locomotive power at £19,811; of repairs and renewals of carriages and wagons, £8348; traffic expenses, £22,307; general charges, £3531; miles worked by engines, 302¼; train mileage, passenger, 400,148; goods and minerals, 330,212; total, 730,361. The locomotive power charges include £6922 for coke, coal, and firewood, the cost of fuel per train mile being thus 4·12d.

OUR Birmingham correspondent says: Traders hereabouts are awaiting with interest the result of the claim against the London and North-Western Railway Company, which has been preferred by the Great Western Company of £40,000 as compensation for loss of traffic. The Great Western is supreme along the whole of the Severn Valley from Worcester to Shrewsbury, since there is no competing railway, and the only opposition is from the Shropshire Union Canal Company. As the railway rates are high the greater portion of the goods are going by canal. The Great Western allege that the canal in reality belongs to the North-Western Company, and they urge that according to certain agreements this company have no power to compete by water.

ONE way to meet an accident is thus given by "Remus," in the *St. Albans (Vt.) Messenger*:—"'Did I ever tell you my experience in the accident at ——?' said a railroad man to Remus the other day. 'No; let's have it.' 'Well, it was when I was conducting on a passenger train. We were going south at a pretty fair pace, and just as we got over the hill at —— we discovered a freight train in our way. There was no help for it, and the collision had to come. One of the trainmen who stood by me left in a hurry for the next car. I sat down on the car floor, and when she struck I went the length of that car in a sitting posture at the rate of about twenty-five miles an hour. I wasn't hurt much; but the wear and tear of that part of my apparel on which I was sitting was something remarkable. I never realised before what it was to sit down and be in a hurry at the same time.'"

MR. J. S. FORBES has been explaining the objects and the probable working value of the Regent's, City, and Docks Railway, a Bill for which is again before Parliament. According to Mr. Forbes, this railway, which, running along the line of the Regent's canal from a little north-west of Paddington to the Albert Docks, and having branch or subsidiary lines between the Great Northern goods stations, Islington and the City, will cost, as a metropolitan railway of twelve miles in length, a comparatively small sum, viz., a little over six millions sterling, exclusive of the sum paid for the Regent's Canal, which is £1,500,000. The canal is to be improved, and the railway could be started at once, but the House of Lords last year threw out the Bill because it is proposed to pay interest on capital during construction. Unless this interest can be paid, capital, he says, will not be obtained, and he mentions the Suez Canal, Great Northern Railway, and other works which were constructed on these terms.

MAJOR-GENERAL C. S. HUTCHINSON has presented to the Board of Trade his report on the accident which occurred on the 29th of December at Crow's Nest Junction, near Wigan, on the Lancashire and Yorkshire Railway, when a passenger train from Liverpool to Bolton was turned into an up goods loop line, Crow's Nest Junction, where it came into collision with a pilot engine at the tail of a coal train, which had a few minutes before been turned into the loop line to allow the passenger train to pass. Forty-two passengers and five officials were all more or less injured, and the rolling stock of both trains was much damaged. This very serious collision, General Hutchinson concludes, was caused by the failure of a joint in the point rod connecting the loop facing-points with the signal cabin, in consequence of which failure the Crow's Nest Junction signalman was unaware, when he lowered the junction signals for the up passenger train, that the facing points were standing open for the goods loop, into which he had just turned an up coal train to get it out of the way of the passenger train. The report recommends an improved method of securing the joints of all facing-point rods, and the abandonment of the practice of covering over rods in troughs. Moreover, General Hutchinson thinks that had the passenger train been fitted with a good, quickly-acting continuous brake the collision would have been avoided, or its results have been very much mitigated, as the train had to travel about two hundred yards after the driver saw he was on the loop line. If these points were worked electrically, the signals might be made to remain up until the points were as intended.

## NOTES AND MEMORANDA.

AS far as can be at present estimated, there were about 3,572,155 tons of pig iron made in Germany last year.

IT has been found that 17,000 stops are made on the Brighton Railway per twenty-four hours, only about 10,000 of which are regular station stops.

BY means of the Gillett telephone, the *Electrical World* says, it was recently shown that conversation could be carried on with ease by persons at least 1000 miles apart.

THE American production of Bessemer steel last year amounted to 1,538,355 tons, being a decline of 116,272 tons from the figures for the previous year. The American production of rails was 1,140,932 tons.

WRITING to *Nature*, Mr. E. D. Archibald points out an old standing error in Ganot's "Physics." The formula which represents the weight of air saturated with vapour occurs on page 325 of the tenth edition, and is printed:—$P = \frac{0{\cdot}31 \times V F}{(1 + \alpha t)\ 760} (H - \frac{3}{8} F)$. The first F, he points out, should obviously be expunged.

THE total quantity of pig iron produced in the United Kingdom during 1884 was 7,528,966 tons, being a decrease of 961,258 tons, or 11 per cent. on the quantity made in the preceding year. This is the second year during which a decrease of production has occurred since 1879. In 1883 the decrease was 3063 tons on the make of 1882. In 1879 the make was 290,566 tons below that of 1878. But on comparing the latter year with 1884, it comes out that the increase of make in the interval has been 1,519,532 tons, or 25 per cent.; so that, on the whole, very substantial progress has been made.

A CONTEMPORARY says, Mr. A. A. Luber, of Macon, Georgia, has succeeded in endeavours to hybridise the cotton plant that grows wild in Florida with the common okra. The plant has an average height of 2ft., and each plant has only one large bloom. Each boll is said to produce about 2 lb. of very long-stapled cotton. There are no seeds in the lint, from four to six seeds, resembling those of persimmon, being at the bottom of the boll. If this is true, the new cotton will need no ginning, and the effect must be felt in several parts of the cotton industry if the new plant can be commercially cultivated.

THE consumption of coal in the iron manufacture of the United Kingdom, relatively to the total production of pig iron, as compiled from the "Mineral Statistics of the United Kingdom" has been reduced in the past few years. The figures, so far as they go, would appear to show that the average quantity of coal consumed per ton of pig made in the United Kingdom as given in the British Iron Trade Report, by Mr. Jeans, was 2·08 tons in 1883, against 2·55 tons in 1874. In the interval, therefore, the quantity of coal used per ton of pig was reduced by very nearly half a ton over the whole—thanks very largely to the more general adoption of the Cowper and Whitwell hot blast stoves.

TO apply soluble glass made as described last week, for the preservation of buildings and monuments of porous materials, take a solution of silicate of potash of 35 deg. Baume, dilute it with twice its weight of water, paint with a brush or inject with a pump, give several coats. The *Pottery and Glassware Reporter* says:—"Experience has shown that three coats applied on three successive days are sufficient to preserve the materials indefinitely, at a cost of about 15 cents per square yard. When applied upon old materials, it is necessary to wash them thoroughly with water. The degree of concentration of the solutions to be used varies with the materials. For hard stones, such as sand and freestones, rock, &c., the solution should mark 7 deg. to 9 deg. Baume; for soft stones with coarse grit, 5 deg. to 7 deg.; for calcareous stones of soft texture, 6 deg. to 7 deg. The last coating should always be applied with a more dilute solution of 3 deg. to 4 deg. only."

AMERICAN manufacturers of glass have striven to produce glass which, for strength, purity of colour, and general lustre would equal that made in France, England and European countries, but have been unable to manufacture glass that would retain its colour. After a time the best made would darken and show the unmistakeable traces of iron presence. For a long time it was thought that the sand used was so mixed with ferric oxide that the colour was directly traceable to this source, but after repeated trials with acids to remove the last trace of iron, and then cast into plates with the utmost care, the trouble was nearly as great. A building containing windows made exclusively of the best American plate was found to give the poorest light after a time in those portions where gas was most used. The *Steel Age* says "the most common colours noticed in glass are violet and green, for the cause of which nearly all have advanced some theory. The materials out of which glass is generally made in this country are to a very great extent ferruginous, and susceptible of colouring the glass a deep green by means of this iron in the form of protoxide, a form generally met with when present. Protoxide of manganese for the purpose of neutralising its effects has been used with variable success. If, on the one hand, the manganese predominates, the glass has a violet shade; on the other hand, if a quantity of protoxide of iron is present, the cast of the glass will be green. If all the manganese is reduced to a state of protoxide the glass is colourless, and the influence of light and air may determine at length a partial oxidation of the protoxide of manganese, and a violet colour will ensue and increase with the protracted action of light, especially from gas jets."

THE following occurs in a *brochure* on "The Gas Engine," by E. H. Thwaite:—By the application of the principle of compressing the gaseous explosive mixture before ignition, the following advantages are obtained: An increased density of the explosive mixture, or, in other words, a greatly increased accumulation of calorific or oxidisable units in a cylinder of a given size. The importance of this will be understood from the following illustration:—Given that a cylinder having a piston stroke of 18in., and that its piston draws an explosive mixture of gas and air into the cylinder on its outward stroke, to be ignited when the piston has traversed $\frac{4}{10}$ of the stroke, the heat produced has only a distance of $\frac{6}{10}$ of the stroke in which to exert its force, or become converted into motion; but further, the surface area of wasteful heat radiation is equal to $\frac{4}{10}$ the length of the cylinder multiplied by $2\pi$, but if the explosive gaseous mixture was compressed to even one half its volume, the effect would be that the heat generated by the explosion would have $\frac{8}{10}$ of the length of the cylinder in which to become converted into motion, and but half the superficial area for wasteful radiation, or $\frac{2}{10}$ the length of the cylinder multiplied by $2\pi$. Further, the principle of compression allows gas and air in extreme dilution, or with an enormous preponderance of the quantity of air, to be mechanically increased in density until they become explosive on ignition. The increased density of the gaseous explosive mixture necessarily produces a more intimate mixture of the oxygen with the oxidisable constituents, and thus induces a more perfect and complete action of oxidation. An examination of the diagrams of compression and non-compression engines clearly shows the advantage to be gained by the former principle. The diagram of the compressed gas explosion indicates a more gradual inflammation than the other, which exhibits an instantaneous production of heat, the dynamic effect of which is so neutralised, owing to the larger superficial area by which it is rapidly and wastefully absorbed, that the indicator diagram presents an instantaneous rise and a correspondingly rapid depression in only a fractional part of the length of the piston stroke. The advantage of a more intimate diffusion of the gases, caused by the mechanically produced density, permits the use of a dilute mixture of the new explosive charge with a portion of the products of former explosions, and also permits the use of pure carbon monoxide or water gas produced from anthracite coal.

## MISCELLANEA.

IT is stated that two millions sterling has just been subscribed in Geneva to expedite the piercing of the Simplon.

THE Alexandra Palace International Exhibition, 1885, will be opened on the 31st inst., by the Right Hon. Lord George Hamilton.

A TERRIBLE explosion occurred on the 6th inst. at Karwin, in the Johann Schachte shaft of the mines belonging to Count Larisch; 147 miners were buried.

THE Crystal Palace District Gas Company will reduce the price of gas to 2s. 10d. per 1000 cubic feet, from and after the date of the Lady-day quarter's accounts.

THE Town Council of Glastonbury have under consideration a scheme for supplying the town with water. The cost is estimated by Mr. Newton, C.E., at £6000.

THE contract for the wire and cables required this year by the Commissioners for the lighting of the International Inventions Exhibitions has been placed in the hands of Messrs. Walter T. Glover and Co.

THE Town Council of Basingstoke have resolved to apply to the Local Government Board for permission to borrow £4000, in order to provide additional reservoir accommodation, and for other works connected with the water supply of the town.

OWING to the success of the Yarrow boats, Lotus and Water Lily, the War-office authorities have entered into a contract with Messrs. Yarrow and Co. for the immediate construction of two similar stern wheelers, but of considerably larger size, for service on the Nile.

THE whole of the property of the Caloric Engine and Fog Signals Company, including Professor Holmes' siren fog signal and the Bucket caloric engine, has been bought by the Pulsometer Engineering Company, by whom the siren apparatus and engines will in future be constructed at its engineering works, Nine Elms.

THE Bath and West of England Society will this year hold its Annual Show at Brighton on June 8th, 9th, 10th, 11th, and 12th, and money prizes amounting to nearly £2500 are offered. The display of implements, machinery, and articles of general utility is expected to be large. Prize lists can be obtained of the secretary—Mr. Thos. F. Plowman, Bath—and further particulars will be found in our advertisement columns.

IN the House, on the 18th inst., Mr. Carbutt asked whether it was true that the Maxim Company had offered to send six guns to Egypt, capable of firing 500 shots per minute automatically by using the recoil, so that the gunner had only to direct the gun, and not to work it, as machine guns had hitherto been, and Mr. Brand said he had not received the offer referred to, and he was informed that the first service gun on this system had not yet been made.

THE area of Sydney Harbour including all its bays and inlets, is about twelve square miles. It has deep water in every part, and is land-locked and secure in all weathers. The shipping is chiefly berthed at the public and private wharves which line Sydney Cove, Darling Harbour, and Woolloomooloo Bay. The Government Dry Dock is on an island of the Parramatta River, close to the city, and is capable of taking in the largest ships that go to the port, its length being 485ft., breadth 86ft., and depth 26ft.

AT the annual meeting of the Engine, Boiler, and Employers' Liability Insurance Company, on February 26th, Mr. R. B. Longridge, the managing director, said, there had been no explosion of any boiler insured by the company, but the damage from breakdown of engines had been considerably heavier than in the previous year. Damages to engines do not, however, seem to have much serious effect, for a dividend, at the rate of 15 per cent. on the paid-up capital for the half year ending 31st December, 1884, was declared, making—with the interim dividends paid on June 30th last, 10 per cent. for the year.

MESSRS. J. BIRCH AND CO., of Liverpool, have published a rather remarkable quarto catalogue of 205 pages, illustrated with engravings of almost every known tool employed in engineering, manufacturing, and other works and outside them, and a large quantity of machinery, materials, appliances, and stores of very diverse kinds. The machines alone are too numerous to particularise. They are by very numerous makers, are briefly described, and prices given. A telegraph code, and some remarks on the quality and characteristics of iron and steel, with results of tests, open the book, which appears to be intended for the use of foreign merchants, as it contains various information on the strength and weight of materials and other tabular matter not often found in such a connection.

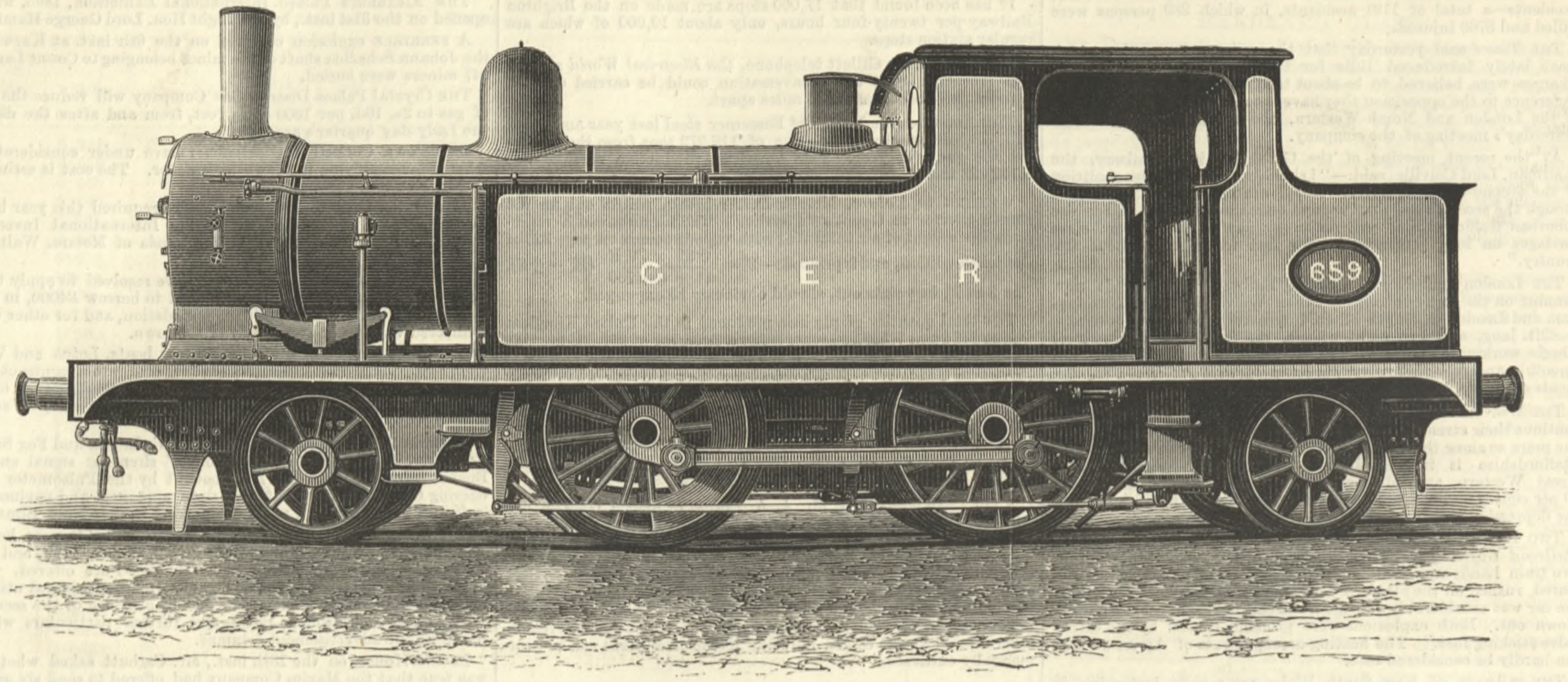
ANCIENT mariners bewail the decay of seamanship consequent upon the introduction of steamers, and they are apt to look with alarm and disgust on every appliance which relieves the A. B. of some of his responsibilities. But the *Electrical World* says:—"An invention has now been made that must well-nigh break their hearts. It is an electric automatic compass, the needle of which, by opening and closing the circuit, keeps a ship on the course laid down, without the intervention of any 'man-at-the-wheel.' All that is necessary is to set the compass—so the story goes—and the good ship makes a bee line for port. Such an invention might diminish the number of able seamen, but it would also be preventive of a lot of bad steering." We should think that it might also steer ships regardless of icebergs and other temporary occupants of a ship's course.

HEATING by electricity is frequently spoken of. Currents have not yet been found like natural gas, and even if they had it would be a waste to use them for heating, but, assuming steam engines to be used for generating in the first case, only one-ninth of the heat of the coal is recovered; then, say, 25 per cent. of power is lost in the dynamo; and finally, 25 per cent. or more lost on conversion of the current into heat. Thus we get $0{\cdot}1 \times 0{\cdot}75 \times 0{\cdot}75$ of the heat of the coal $= 0{\cdot}05625$, or say, at best, $\frac{1}{20}$ only. Even when coal is burnt in an open fireplace, not more than half the heat is lost. In short, taking the expense of machinery, &c., into consideration, it is fair to assume that heating by electricity is at least fifty or sixty times more expensive than burning coal direct in the most approved stoves, and twenty-five to thirty times dearer than coal burnt in an open fire.

IN the course of a lecture on "Flexural and Torsional Rigidity," recently delivered to his students in Glasgow University, Sir William Thomson made reference to the breaking of the screw-shaft of the Poonah. The breaking of this shaft was about the most serious accident that could happen to a ship; and yet, on an average, two mishaps of that kind took place every year. This, he said, could only be set down to the ignorance of engineers in general, who did not know the greatest amount of torque a screw-shaft ought to bear, and who had not yet endeavoured to discover it. Some of the remarks of Sir William are full of the lecture-room egotism of text-book engineers, whose want of real practical experience leads them to characterise as ignorant those who may be much the better informed on many subjects. The lecturer said:—"In every case of fracture it was almost certain that the accident had occurred through a flaw in the metal or imperfection in the welding. It was not because the torque had been too great, but because in the great forging there had been a crack from the beginning. He did not blame the manufacturers of iron, who, indeed, did their best to ensure perfection in these huge blocks, but he did complain, and complain most bitterly, that mechanical engineers and civil engineers had not, up to the present time, devised a satisfactory test for the torsion of these shafts, and had, year after year, allowed this state of uncertainty to continue without trying to remedy it. If engineers did not take the matter into serious consideration the general public must at length turn upon them. It was impossible that great ships and numerous lives should be allowed to continue in jeopardy year after year, and passage after passage, for want of certainty as to whether there was or was not a crack in the screw-shaft."

# TANK ENGINE FOR METROPOLITAN TRAFFIC, GREAT EASTERN RAILWAY.

DESIGNED AND CONSTRUCTED BY MR. T. W. WORSDELL, LOCOMOTIVE SUPERINTENDENT.




THESE engines, one of which is illustrated above and by our supplement, were built at the company's works at Stratford, from the plans of Mr. T. W. Worsdell, locomotive superintendent of the Great Eastern Railway, and are specially designed to work the heavy suburban passenger traffic, the ordinary trains in this particular service being composed of fifteen and the early or workmen's trains of twenty close coupled carriages. The line they run over has some heavy gradients and sharp curves, and the engines, as will be seen from our engraving, are provided with a radial box at each end, to enable them to take the curves with ease when running either end first. One essential point about the engines for this service is that they should be able to start promptly, as the time allowed for running between stations is very limited. One case may be mentioned where the distance to be travelled is 10¾ miles, with fifteen stopping stations; time allowed, 41 minutes for the journey, which, allowing about 1½ minutes per stop and start, would give an average speed of about 35 miles per hour between stations. It should be noted that every stop is made by the Westinghouse brake.

Among the special features of these engines are the following:—The copper fire-box roof is supported by eight cast steel roof bars of a girder section; the wheels are of cast steel; the frames are made each of a single steel plate, 1in. thick, as are also the buffer and cross stay plates in front of the fire-box; the motion plate and the trailing diagonal stay are both steel castings, the latter being arranged so as to take the draw-bar, and also to give additional weight at the trailing end. The valve gear, as will be noticed, is on Joy's principle, it having given such satisfaction on the express engines—lately designed and built at Stratford—and now running on this line, that Mr. Worsdell decided to apply it to this class also.

The engines are fitted with the Westinghouse brake, the air pump for which is conveniently placed in a box at the back of the tank on the left-hand side, so as to be within easy reach of the driver; the air reservoirs are fixed under the platform at the trailing end of the engine. The boiler is fed by two injectors, one No. 8 and one No. 10, fixed on each side of the engine. Our engravings show everything so very clearly that further description is scarcely needed. Thirty of these engines are now being built at the Stratford works.

The following is a tabular statement giving the principal dimensions:—

| | ft. | in. |
|---|---|---|
| Cylinders:— | | |
| Diameter of cylinder | 1 | 6 |
| Stroke | 2 | 0 |
| Length of ports | 0 | 11½ |
| Width of steam ports | 0 | 1¾ |
| Width of exhaust ports | 0 | 4⅛ |
| Distance apart of cylinders centre to centre | 2 | 0 |
| Distance of centre line of cylinders to valve face | 1 | 1 |
| Distance of centres of valve spindles | 2 | 0 |
| Lap of slide valve | 0 | 1⅛ |
| Maximum travel of valve | 0 | 5 |
| Lead of slide valve | 0 | 0 3/16 |
| Motion, Joy's patent:— | | |
| Diameter of piston-rod (steel) | 0 | 3 |
| Length of slide blocks | 1 | 3 |
| Length of connecting rod between centres | 5 | 11 |
| Length of radius rod | 3 | 2½ |
| Wheels and axles:— | | |
| Diameter of driving wheel (cast steel) | 5 | 4 |
| Diameter of intermediate wheel (cast steel) | 5 | 4 |
| Diameter of trailing wheel (cast steel) | 3 | 9 |
| Diameter of leading wheel (cast steel) | 3 | 9 |
| Distance from centre of leading to centre of driving | 7 | 6 |
| Distance from centre of driving to centre of intermediate | 8 | 0 |
| Distance from centre of intermediate to centre of trailing | 7 | 6 |
| Distance from driving to front of fire-box | 1 | 10 |
| Distance from leading to front of buffer plate | 5 | 3 |
| Distance from trailing to back of buffer plate | 3 | 6 |
| Crank axle:— | | |
| Diameter at wheel seat | 0 | 8½ |
| Diameter at bearings | 0 | 7 |
| Diameter at centre | 0 | 6¾ |
| Distance between centres of bearings | 3 | 10 |
| Length of wheel seat | 0 | 7¼ |
| Length of bearing | 0 | 9 |
| Section of crank arms: Inner web, 12in. × 4¾in.; outer, 12in. × 4¼in. | | |
| Intermediate axle:— | | |
| Diameter at wheel seat | 0 | 8½ |
| Diameter at bearings | 0 | 7 |
| Diameter at the centre | 0 | 6¾ |
| Length of wheel seat | 0 | 7¼ |
| Length of bearings | 0 | 9 |
| Centres of bearings | 3 | 10 |
| Diameter of outside crank pins | 0 | 3¾ |
| Length of outside crank pins | 0 | 4 |
| Throw of outside crank pins | 0 | 11 |
| Trailing axle:— | | |
| Diameter at wheel seat | 0 | 8 |
| Diameter at bearings | 0 | 6½ |
| Diameter at centre | 0 | 6 |
| Length of wheel seat | 0 | 6¾ |
| Length of bearings | 0 | 11 |
| Centres of bearings | 3 | 8 |
| Thickness of all tires on the tread | 0 | 3 |
| Width of all tires on the tread | 0 | 5⅜ |
| Leading axle:— | | |
| Diameter at wheel seat | 0 | 8 |
| Diameter at bearings | 0 | 6½ |
| Diameter at centre | 0 | 6 |
| Length of wheel seat | 0 | 6¾ |
| Length of bearings | 0 | 11 |
| Centres of bearings | 3 | 8 |
| Frames:— | | |
| Distance apart of main frames | 4 | 0 |
| Thickness of frame (steel) | 0 | 1 |
| Boiler:— | | |
| Centre of boiler from rails | 7 | 3½ |
| Length of barrel | 10 | 2½ |
| Diameter of boiler outside | 4 | 2 |
| Thickness of plates (steel) | 0 | 0 7/16 |
| Thickness of smoke-box tube plate | 0 | 0¾ |
| Lap of plates | 0 | 2½ |
| Pitch of rivets | 0 | 1 13/16 |
| Diameter of rivets | 0 | 0 13/16 |
| Fire-box shell (steel):— | | |
| Length outside | 5 | 5 |
| Breadth outside at bottom | 3 | 11 |
| Depth below centre line of boiler | 5 | 0 |
| Thickness of front plate | 0 | 0½ |
| Thickness of back plate | 0 | 0½ |
| Thickness of side plate | 0 | 0½ |
| Distance of copper stays apart | 0 | 4 |
| Diameter of copper stays | 0 | 1 |
| Inside fire-box (copper) | | |
| Length at bottom inside | 4 | 9 |
| Breadth at bottom inside | 3 | 3 |
| Top of box to inside of shell | 1 | 4 |
| Depth of box inside | 5 | 8½ |
| Tubes:— | | |
| Number of tubes | | 198 |
| Length of tubes between tube plates | 10 | 6½ |
| Diameter outside | 0 | 1¾ |
| Thickness | No. 11 and 13 w.g. | |
| Diameter of exhaust nozzle | 0 | 4¾ |
| Height from top row of tubes | 0 | 2 |
| Height of chimney from rail | 12 | 11 |
| Heating surface:— | | |
| Of tubes | 955·7 | |
| Of fire-box | 98·4 | |
| Total | 1054·1 | |
| Total | 1054·1 sq. ft. | |
| Grate area | 15·43 sq. ft. | |

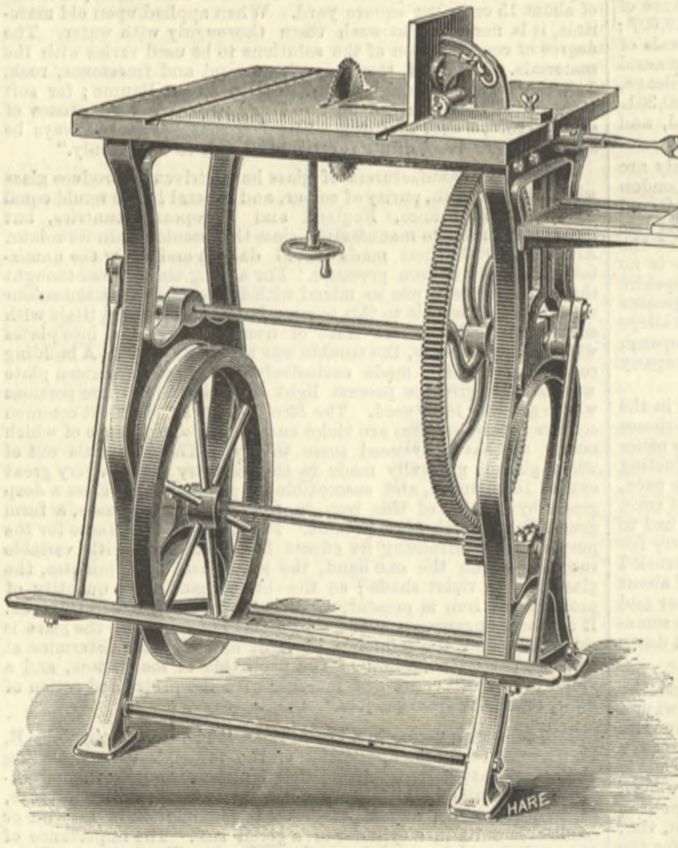
| Weight of engine in working order:— | tons. | cwt. | qr. | lb. |
|---|---|---|---|---|
| Leading wheels | 12 | 16 | 1 | 0 |
| Driving wheels | 15 | 13 | 0 | 0 |
| Intermediate wheels | 13 | 9 | 3 | 0 |
| Trailing wheels | 9 | 19 | 1 | 0 |
| Total | 51 | 18 | 1 | 0 |

| Weight of engine empty:— | tons. | cwt. | qr. | lb. |
|---|---|---|---|---|
| Leading wheels | 11 | 4 | 0 | 0 |
| Driving wheels | 13 | 6 | 3 | 0 |
| Intermediate wheels | 11 | 5 | 2 | 0 |
| Trailing wheels | 5 | 17 | 2 | 0 |
| Total | 41 | 13 | 3 | 0 |

Tanks hold 1200 gallons of water. Coal bunker, 2¼ tons of coal.

## NEW FOOT POWER SAW.

THE accompanying engraving represents a new arrangement of treadle saw made by the Britannia Company, Colchester, and exhibited at the Architectural and Building Exhibition. It is made for and will be found very useful in the pattern and joinery shops, as it is not only an efficient circular saw, but can be used for fret saw work, groove, dovetail cutting, dowelling and drilling. The saw runs at about 1500 revolutions per minute, or the fret saw makes that number of strokes. The leading peculiarity of the machine is the arrangement of a fly-wheel upon a secondary spindle driven at a very high speed from the treadle-crank. A very high velocity of fly-wheel and considerable weight are used in such a way that the wheel is a very effective accumulator of energy, and a user of the saw finds that very heavy cuts may be made, as the moment the work begins to be a little in excess of that done on the treadle, the fly-wheel comes into play, and having a large store of accumulated energy, the saw is easily carried through what would easily stop it if the fly-wheel were in the usual way fixed upon the crank-shaft. Some idea of this may be gathered from the statement that, after getting the saw up to full speed by the treadle and then removing the foot, 3ft. 8in. of 1in. mahogany has been cut through. For fret cutting the machine is provided with a separate appliance, the upper arm is suspended from the wall or ceiling, and only let down when wanted, thus leaving the table quite clear for work of any size. Grooving is done by a thick saw, and dowelling is done on the adjustable table which is shown at the side of the machine.




THE BRITANNIA COMPANY'S TREADLE SAW.

## DIRECT-ACTING PUMPING MACHINERY.

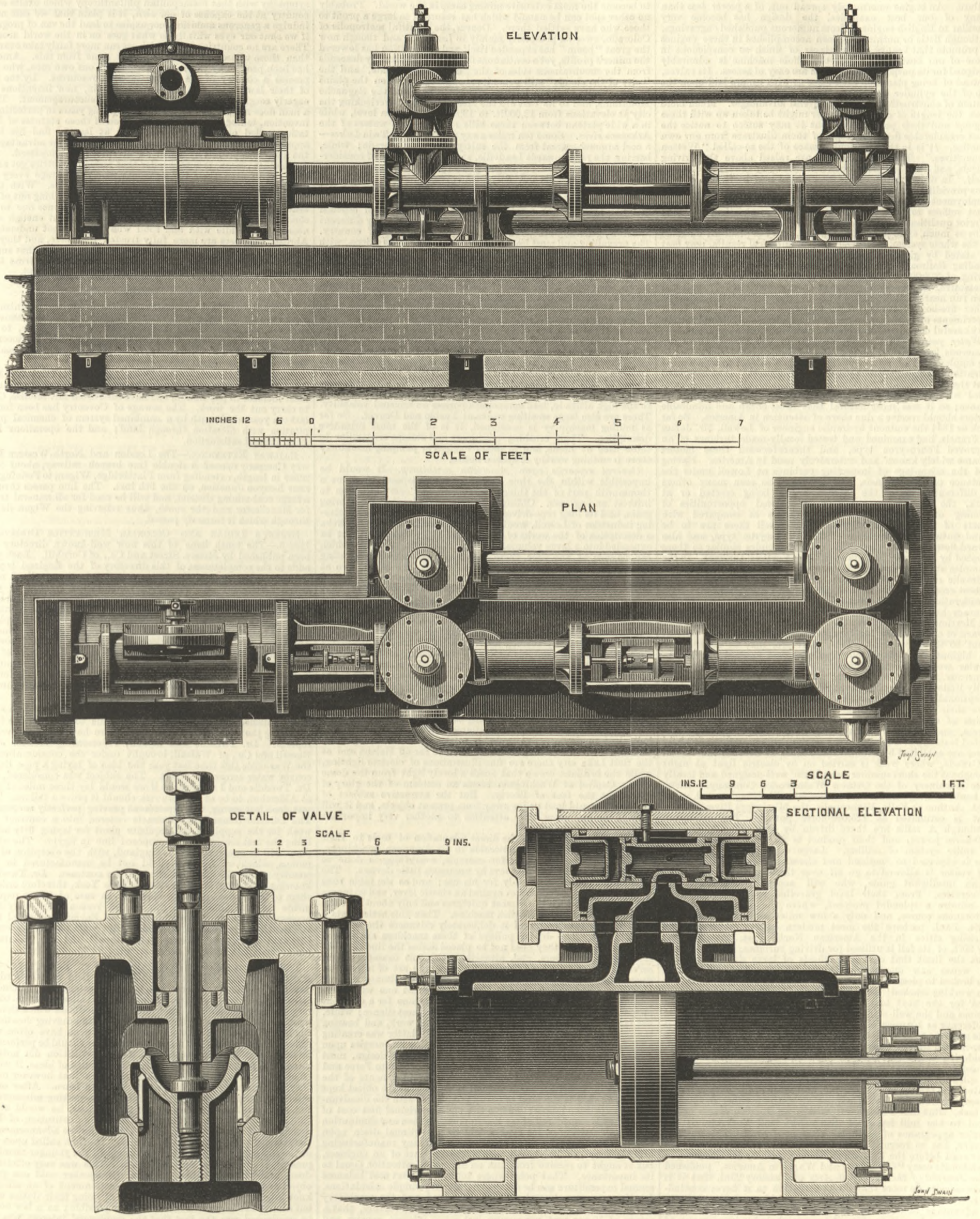
JUST at the present time when the public mind has been excited and somewhat irritated by our Government having placed an order for direct-acting steam pumping machinery for the Suakim-Berber Railway with an American company, an account of what has already been done by an English firm, who have made this class of machinery a speciality, will, we think, be of interest to most of our readers. The name of Hayward Tyler and Co. has been associated with direct-acting steam pumps for the last sixteen years, during which period some thousands of pumps, adapted to almost every imaginable duty, have been constructed by them, but as the interest for the moment is centred on the particular duty of pumping through mains many miles in length, and at considerable pressures we have chosen for illustration pumps of a class which has been employed for that purpose for some years.

The illustrations represent one of a number of pumps made by this firm, used in forcing sugar juice from outlying stations to the central refineries—distant in some cases eight miles, and in one ten miles—at the large sugar beet factories situated in the north of Europe, and also for various duties in the manufacture involving still heavier work, such as pumping at high pressures into the filters. This duty is peculiarly trying to any pump, as the work is suddenly thrown off when the maximum pressure is attained and the pump must be so constructed as not to run away.

The pump in question has a steam cylinder 15in. in diameter, and a double-acting plunger pump 5in. in diameter, with a stroke of 36in. Pumps of an almost similar type have been made by the firm with steam cylinders of 33in. and 40in. diameter. We may mention, by the way, that the great length of stroke is one of the features in the pumps now made by Messrs. Hayward Tyler and Co., when pumping against high

# HIGH-PRESSURE PUMPING MACHINERY.

MESSRS. HAYWARD TYLER AND CO., LONDON, ENGINEERS.




pressures, the number of reversals being fewer, and hence less wear and tear upon the pump valves occurs. Before every reversal the speed of the piston is greatly reduced; in fact the piston can be made to pause at the end of each stroke, allowing the pump valves to close without shock. The slide valve is, as will be seen by reference to the sectional view, of cylindrical construction, and is moved entirely by the action of the steam without the intervention of any mechanism—a manifest advantage where machinery is at a distance from a repairing shop, or if exposed to sand and grit. Pumps of this construction have been for many years largely used in coal pits, and frequently are left for many hours working without attention. In the pump we have chosen for illustration, which is specially used for the heavy duty of pumping into the filters, the pump valves are of the class known as double beat or equilibrium, the pressure on the seats of the valve being thus reduced. Some of the pumps supplied to the sugar companies have had ordinary mushroom valves, and for lower lifts valves of india-rubber. Pumping at high pressures through long lengths of pipes seems, up to the present time, not to be in use in this country. But, practically, the same result has been arrived at by a class of pumps introduced by Messrs. Hayward Tyler and Co., and named by them the Accumulator pump, for the supply of water, under a pressure of from 3000 lb. to 5000 lb. per square inch to hydraulic presses without the intervention of an accumulator.

So long ago as 1871 Messrs. Hayward Tyler and Co. made a pump for the Dee Mineral Oil Company at Chester, and also one for Messrs. Prockter and Bevington, the well-known glue and size manufacturers, of Bermondsey, to work their hydraulic presses at a pressure of over 3000 lb. per square inch, and we may state of the latter that though the pump has been almost in daily use for fifteen years it is still doing its work well, and up to the present time has cost but little for repairs. Messrs. Bass and Co., of Burton, work their hop presses with pumps of this description at a pressure of about 1000 lb. per square inch, and Messrs. Perry and Co., Government contractors, of Bow, are using presses worked in a similar manner at over 4000 lb. per square inch. It will therefore be seen that this class of work presents no difficulty of any kind to English firms, such as the one mentioned, whose experience is probably quite as wide as that of any in America. With regard to the rapidity with which English contractors can supply work when required, it will be remembered that in 1878 Messrs. Hayward Tyler and Co. delivered to Woolwich the largest hay pressing plant ever constructed, made to entirely new designs of the Government, in about twenty-one working days from the receipt of the order, the whole being erected and set to work in some fourteen days more.

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SOUTH KENSINGTON MUSEUM.—Visitors during the week ending March 7th, 1885:—On Monday, Tuesday, and Saturday, free, from 10 a.m. to 10 p.m., Museum, 11,469; mercantile marine, Indian section, and other collections, 2849. On Wednesday, Thursday, and Friday, admission 6d., from 10 a.m. to 4 p.m., Museum, 1433; mercantile marine, Indian section, and other collections, 97. Total, 15,848. Average of corresponding week in former years, 15,326. Total from the opening of the Museum, 23,789,929.

## THE SOCIETY OF ENGINEERS.

### AMERICAN ENGINEERING ENTERPRISE.

(*Concluded from p.* 182.)

*American locomotives.*—So far as the American type of locomotive be looked upon from an æsthetic point of view, it is a manifest failure. An engine enormously spread out, of a power less than many of our best examples, the design has become very familiar to English engineers from numerous published engravings. Although little or nothing has been accomplished in these engines to promote that beauty and neatness of finish so conspicuous in those of our best makers, yet the whole machine is admirably designed for its purpose, and all parts are easy of access. Its valves, instead of being placed on their sides as with us, are laid upon the top of the cylinder and driven by an overhanging weigh shaft, a system of construction possessing several advantages. Much more than the length of our entire paper might be taken up with these engines and their peculiarities, but it may suffice to notice the most considerable departure some of them illustrate from our own practice. It is in the capacious furnace of the so-called "Wotton locomotives." Their furnace bars are raised above the driving wheels, and thus are only limited in width by that of the engine itself. In width they measure 8ft., and in length 8ft. 6in. or 9ft., thus providing so much as 72 square feet fire-grate area. By the employment of so large an area for combustion, a very gentle blast suffices to produce the needful slow combustion, and such inferior qualities of coal as lignite can be used. This material contains as much as 20 per cent. of water, and the practical outcome of the whole system, measured by its economical results, may best be stated by giving the 1883 return of the Philadelphia and Reading Railroad. For this year there is stated to have been a saving of 378,000 dols.—£78,432—to the credit of this class of locomotive. Moreover, the first of them started in 1877, and had then run nearly 184,000 miles without appreciable deterioration in either fire-box or furnace bars, therefore one cannot but think experiments of this class, so original and successful, should receive very careful consideration from our own locomotive engineers.

*Water power.*—In Canada, as also in the States, there are numerous large rivers, having falls of considerable elevation; so the employment of water power has been a subject to which great attention has been devoted by American engineers. It so happened that the era of great expansion in their commercial progress coincided with the time when turbines had just been developed in France; so it was most natural that these cheap and admirable motors should receive a due share of attention in America. So far back as 1844 the eminent hydraulic engineer of Lowell, Mr. James B. Francis, had examined and tested locally-made turbines of an improved Fourneyron type, and thenceforward these motors became widely known and extensively used in America. Having had the advantage of inspecting turbines at Lowell under the guidance of Mr. Francis, and having also seen many others in different parts of the country either being erected or at work, the writer has enjoyed exceptional opportunities of forming an opinion upon those motors as compared with others of English manufacture. At Lowell there are to be found outward-flow turbines of the Fourneyron type, and also inward-flow turbines constructed upon principles similar to those adopted by Professor Thompson in his "Vortex" turbines. In the examples at Lowell both classes are designed by the most skilful hydraulic engineers in America, and constructed for giving the highest economical use of a scanty water supply, and not from considerations of first cost. Impartial tests of the greatest accuracy have been conducted by Mr. Francis, who is engineer of the Merrimack Water Power Company, and it is found that either inward or outward flow turbines give practically the same duty at about 80 to 82 per cent. This, therefore, may be regarded as the highest duty obtainable from the best finished turbines in regular work. We are, however, all well aware that there are numerous turbines extensively advertised, cheaply made, and really little else than rough castings bolted together, and for these exceptionally high duties are claimed. Such claims, however, have their origin in nothing more substantial than the imagination of sanguine manufacturers or the wishes of credulous buyers, and it is unfortunate that no reliable, impartially conducted tests are ever known to the public. Fine examples of water power are exhibited by extensive saw mills at Ottawa, the capital of Canada, where work is carried on by electric light at night throughout the short summer; also in the well-designed and locally made machinery of the Ottawa Waterworks Company. Along the banks of Niagara there are numerous mills being erected, while at St. Anthony's Falls, Minneapolis, the Mississippi River supplies what is estimated at 125,000-horse power. The celebrated Pittsburgh A mills are there driven by two turbines, each of 1200-horse power, and their product is 25,000 bushels daily, by the roller system of milling. Large quantities of their best flour is exported to Scotland and elsewhere all over the world. Any visitor is allowed to go all over these mills, accompanied by an intelligent guide, who will accept no gratuity for his services. From their level gravelled roof he can survey and admire a splendid prospect, where the great river winds its tortuous course, and only a few miles away stands the city of St. Paul, perhaps the most modern and most flourishing of rising cities in the American North-West. At Niagara, only 80ft. of its fall is utilised for driving turbines, and this seems about the limit that cast iron wheels of large size can endure. The writer saw one turbine in which the first wheel had been broken to pieces by the current; a second stronger wheel was then working cracked; and a third, still stronger, was already provided for the next breakdown. Between these rough Niagara turbines and the well-made machinery at Lowell there is as great a difference as between similar classes of English work, and it is quite an error to suppose that American work must necessarily be cheaper than that of equal quality made in this country. Indeed, considering wages and cost of material, the thing is altogether impossible. Adequately to describe the vast industries of Lowell, the splendid engines by which their deficient water power is supplemented, the system of belt driving, and method for extinguishing or escaping from fire, would require an entire evening devoted to the task. But that which most strikes an English visitor accustomed to the mill hands of Lancashire and Yorkshire is the superior appearance of a similar class at Lowell. This subject, however, has so recently been treated by Mr. J. S. Jeans, in a paper read before the Statistical Society, and by Mr. Pidgeon, in his elaborate essay "On Labour and Wages in America," published in the *Journal of the Society of Arts* of January 23rd, that it is unnecessary to do more than direct attention to it here; concluding, however, with the reflection that it would conduce greatly to the advantage of our own people if the high tone which still lingers around Lowell, in spite of an overwhelming immigration of French and Irish labour, could in some degree become acclimatised at home.

*Mines and mining.*—The wealth of mineral deposits in the mountain areas of Canada and of the United States can hardly be exaggerated, and although disastrous results have followed the hopes of some sanguine speculators, yet very many fortunes have been made by successful operations in those regions. All along the Rocky Mountains range there are spots where abundant minerals of a profitable description are to be found, nearly all those who were early in the field have become prosperous, and such once rough mining camps as Butte, in Idaho, and Leadville, in Colorado, have developed into considerable towns. Helena, the capital of Montana, is actually built upon worked-out *debris* of a valuable gold mine, and in the mountains some twenty miles further north the writer had an opportunity of visiting the Montana gold mines, better known there as the "Drumlummon." It is situated at the upper end of a long gulch, in which every stone of the mountain stream seems to have been overturned in search of gold, and has recently been provided with new stamping machinery and powerful engines made in California. But as the usual process for extracting gold by amalgamation with mercury is followed, there is nothing special to notice. But of more interest than any single place can possess is the crowded assembly of mining enterprises which centre around the lofty city of Leadville, in Colorado. Standing at an elevation of 10,150ft. above sea level, in an atmosphere of the utmost purity, having an average pressure of no more than ten pounds per square inch, this city has grown from five-and-twenty log cabins in 1878, to become the most extensive mining camp in the world. Probably no other spot can be named which has returned so large a profit to those who have settled there. Denver, the beautiful metropolis of Colorado, owes its prosperity mainly to Leadville, and though now the great "boom" has expended itself and competition has lowered the miner's profits, yet a continuous flow of wealth steadily descends from the mountainous sides of the "continental divide," and the "city of the clouds" still pours its abounding riches on the plains below. To its west are lofty snow-covered peaks of the Saguache Mountains, and to its east are the Mosquito range, overlooking the city at elevations from 12,000ft. to 13,500ft. above sea level, while in a wide plateau between these hills run the quiet waters of the Arkansas river. Some ten miles away are the lovely Twin Lakes—a cool summer retreat from the sultry plains of Colorado; while, barring the road towards Leadville, stand a succession of considerable hills, which form the largest glacial moraine known to exist. This country abounds not only with opportunities of sport to the hunter or profit to the adventurer, but also with scientific interest to the geologist and student of nature. The number and varieties of its ores renders the neighbourhood of Leadville one of especial interest to both classes, for there are concentrated many different minerals, generally scattered over far wider stretches of country. The prevailing and most important ore is argentiferous galena, with its secondary products, cerussite—carbonate of lead—and keragyrite—or chloride of silver. Lead is also found as anglesite—or sulphite and pyrmorphite—or phosphate—and occasionally as oxide. Silver occurs frequently in the form of chloro-bromide, sometimes chloro-iodide sulphuret or in a native state. Gold, zinc, arsenic, antimony copper, bismuth and iron, are also found in Leadville, over a total area of ore-producing districts of about 225,000,000 square feet, and some of these ores are of extraordinary richness. For example, much sulphide ore found in "Seller's mine" has a thickness of 135ft. and contains 200 ounces of silver to the ton. The writer spent two hours down this mine, and no sight can be more impressive than is seen in a walk along tunnels cut in every direction through dazzling masses of this vast mineral deposit. Smelting to a considerable extent is carried on at Leadville, and it has been noticed that owing to the high altitude, lead compounds possess an unusual volatility. There are also large smelting works at Pueblo and Denver. So far as mining machinery is concerned, it is of the most primitive description. Their crushing machinery and stamps are similar to those used at home, and in steam engines or pumping machinery there is nothing worthy of special notice.

*General remarks upon American machinery.*—It would be impossible within the time at our present disposal to name a thousandth part of the things that abound in every direction to interest an engineer. Chicago, with its vast elevators for storing grain, and its long rope-driven tramways, or the vast manufacturing industries of Lowell, would each repay weeks of study. Even a description of the works of Mr. Corliss, at Providence, might be expanded into a large volume. But apart from these things, which can be seen at any time, there were last year several interesting exhibitions of mechanical appliances—one at New York, two at Boston, and one at Denver—besides a superb show of electrical machinery at Philadelphia. To see the marble streets of that splendid city, light as day during the sultry nights, while an unceasing tinkling of tram bells went on for 168 hours every week without a moment's pause. To see the crowds that thronged its busy avenues, and the numbers that lined its wharves or filled its ferry boats, the city seemed a very centre of life and unresting activity. Then it contains extensive engineering establishments, such as the Baldwin Locomotive Works, or Messrs. Seller's well-known tool manufactory, and the Southworks Works, there is the original home from whence came high-speed engines. Time fails for more than a mere mention of these sights, but a few words on the employment of electricity may be given. It is most noticeable how much better all electric lighting is managed in America than here; one never sees those utter failures which so many companies have had to deplore, due probably to their interests being more absorbed with shares than science. Even in far-off Helena and at the Salt Lake city there are fine illustrations of electric lighting, while the brilliant crown that sheds a lovely light from the dome of the Capitol at Washington seems an emblem of the glory of science at the feet of liberty. But the attractive subject of electricity would lead us far away from present objects, and it will be well to pay some little attention to another very important subject, that of the general

*Design of machinery.*—The direct adaptation of tools to their intended purpose is very noticeable in all American machinery. In their planing machines, for example, everything is done to facilitate the attendant's labours by numerous little devices. The handles are arranged already for his use; and as the table runs quickly back, its catch strikes against an elastic lever, and so moves the narrow belt with the utmost quietness and only about half the distance needed for an English machine. Then this action puts a friction pawl into gear, and it deliberately advances the tool for another cut. The driving pulleys of these machines are ranged along the side, so they need not be placed across the line of main shafting as with ours, and, altogether, this one example might serve as a text for a long dissertation upon the art of intelligent design, more particularly as contrasted with the clumsy planing machines which satisfy people here. Indeed, at one works the proprietor showed the writer an American machine for a different purpose, that was working well and with the utmost silence; while, not far away, was another doing corresponding work, and bearing the name of a large firm in this country. This latter was creating a deafening noise, and seemed as if concentrating its energies upon self-destruction every few minutes. A barbarous design, most appropriately named by its owner, as we left it, "Brute Force and Ignorance." In setting out manufacturing establishments of the best class in America, one cannot fail to notice that the object kept steadily in view is the need of cheap production with the disadvantage of expensive labour; and to this end the original first cost of machinery is considered of far less importance than any diminution of its productiveness, for that would be a continual drain upon profits. Settling the commercial aspects of any manufacturing concern may not lie strictly within the province of an engineer, but it ought to receive from him an amount of attention equal to its importance. That point where interest on first cost balances annual expenditure can be determined by very simple calculations, for if we assume capital all to be borrowed, and the machinery constantly in full work for fifty hours a week; and further, that a return of 10 per cent. per annum just covers interest, repairs, and depreciation, then it follows that unless an investment gives more than 10 per cent. it is not worth making. All excess over such interest becomes clear profit, and is frequently found enough to justify an opinion that no investment yields so high a return as first-rate machinery fully employed; and this is further illustrated by the old Lancashire saying that it is always worth investing £1000 to save the annual cost of one man's labour. Those who commence doing everything which imperfect knowledge considers cheap are little aware how wide-spreading are the consequences of such an opinion being entertained by themselves and communicated to their workpeople. That idea not only saps the foundations of permanent success, but also poisons the springs of all honest dealing. It acts by the force of an evil example, and constantly depreciates the quality of manufactures. Many of our goods are already nearly driven out of foreign markets in spite of our immeasurable advantages, and are being replaced by the productions of America and other foreign countries. If there is much to see and admire in Canada and the United States, there is nothing more worthy of imitation than the system which prevails there to so large an extent, of having the best of everything, whatever it may seem to cost—a system which ensures prosperity to trade, self-respect to the manufacturer, and one that is consonant not only with the sound principles of political economy, but also with ordinary common sense. Some people seem imbued with an idea that anything said in praise of either American or of foreign workmanship involves an unpatriotic distinction of what we produce at home. This is a very narrow view of things, for without having any sympathy with that cosmopolitan philanthropy which exalts every country at the expense of our own, it is plain that we can never indulge a generous ambition, nor aspire to lead the van of progress, if we shut our eyes wilfully to what goes on in the world around. There are no countries from which we can more fairly take example than those whose original inhabitants came from this. America has been peopled by the more energetic of our own race, who now possess a country of marvellous internal resources. By the help of their laws, and to their enormous gain, new inventions are eagerly sought after, and talent meets great encouragement. There a man does not need to labour for many long years in perfecting an invention, taking the doubtful protection of those statutes of limitation, called our Patent Laws, only at last to find his ideas appropriated by another—a pirate who takes undue advantage of the numerous pitfalls by which an inventor is encompassed. And for another reason, it is no wonder that foreign countries get ahead of us, when even their Governments wisely encourage every new departure, every improvement in existing methods. With them there is little of that nervous timidity about anything out of the beaten track, and none of that provoking interference due to the conceited half-knowledge of those who have learnt enough engineering to meddle with and spoil what they cannot understand. Abroad, engineers are more fully trusted than here, and they are therefore more free to obey the sound maxims—Make first sure of those general principles you intend to apply; then trust them implicitly; and, finally, never be afraid to carry them out.

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NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—William H. Meadus, assistant engineer, to the Crocodile; Andrew Watt, chief engineer, to the Pembroke, for service in the Hydra; Alfred Palmer, engineer, to the Mariner; and F. M. D. Spry, assistant engineer, additional, to the Raleigh.

COVENTRY SEWAGE.—The Town Council of Coventry have decided to considerably enlarge the sewage works of their city to meet increase in population, and have instructed Mr. Melliss, C.E., to carry out the work. The sewage of Coventry has been for the last ten years dealt with by a combined system of chemical precipitation with filtration through land; and the operations have given general satisfaction.

RAILWAY EXTENSION.—The London and North-Western Railway Company opened a double line branch railway, about eight miles in length, extending from Plattbridge, Wigan, to Pennington, near Kenyon Junction, on the 9th inst. The line passes through a large coal-mining district, and will be used for all mineral traffic for Manchester and the south, thus relieving the Wigan depôt, through which it formerly passed.

STREET'S INDIAN AND COLONIAL MERCANTILE DIRECTORY, 1884-5.—The tenth issue of this now well-known directory has been published by Messrs. Street and Co., of Cornhill. Each year adds to the completeness of this directory of the England beyond our shores, not only in the letterpress, but in the excellent maps which accompany it. Preceding the directory section of each colony is a concise account of the features, geographical and commercial, and in fact it is now so complete a directory that it enables us to feel as much at home in these wide world-separated places as when looking up a name or address in the Directory of London. The topographical and statistical information given, and revised each year, adds the character of a gazetteer to the claims of the book, and makes it not only of great value to all having commercial relations with India, and all the small and the large colonies, but to others who for any purpose require recent information under any of the many heads.

SUAKIM AND BERBER WATER PIPE.—The following letter has been published:—"Sir,—Will you allow me to send you the facts regarding the above line, about which there have appeared varied reports? Dr. Tweddle and myself, representing Messrs. John Russell and Co., of Walsall, brought under the consideration of the War-office this time last year the idea of laying a pipe line to convey water across the desert. The subject was considered, and Dr. Tweddle and I were asked if we would lay three miles of pipe at Aldershot, to be at our own risk should it prove a failure. This was done last spring, the experiment proving perfectly successful. The Director-General of Contracts entered into a contract last week for the supply of the requisite plant for laying fifty miles, being the first section of the proposed line in Egypt. The whole plant will be manufactured in England, with the exception of six pumps, which we believed could not be manufactured in this country within the time specified in the contract. Dr. Tweddle, knowing the pumps were in stock in New York, therefore ordered them to be shipped at once. However, in case of future requirements for this line, there can be no reason why everything necessary should not be manufactured in England, provided that sufficient time is allowed. I remain, Sir, your obedient servant, CHARLES EDWARDS. Messrs. John Russell and Co. (Limited), head offices, 145, Queen Victoria-street, E.C."

THE INSTITUTION OF PERMANENT WAY INSPECTORS.—A sectional meeting of this Institution was held at Bradford on Saturday evening. There was a good attendance, including visitors from various centres. The chairman called attention to the importance of a thorough knowledge of the duties which devolve upon persons in their particular profession, and having mentioned the fact that persons who fill similar situations have often very different ideas of how and when various duties should be performed, he said it was his impression that if the Institution did nothing more than promote and facilitate an interchange of ideas, it would be of great value, and would teach members that however much they might know, they had much more to learn. After other interesting remarks, he said although he was getting advanced in life, and would soon have to put off the armour, he would at all times be pleased to assist any object like the Institution of Permanent Way Inspectors which had for its aim the advancement of the younger portion of the community. He then called upon one of the founders to explain, for the benefit of the younger members present, the purpose of the Institution. This was very efficiently done, and amongst other remarks the speaker said one great object as regards this life should be the attainment of an efficient knowledge of the best means not only of doing their duties well, but also in the most economical manner possible; as a law not to be overlooked was the fact that the employers' interest was the employés' also, for unless the one succeeded, the other could not expect to attain the amount of success he would otherwise attain. He also wished to impress upon each member the obligation he was under to convey any special technical knowledge he might possess to his fellow members if required, and concluded by remarking that it was no use any person endeavouring to become a member thinking it was a trades union, or in any way similar to one, as it was in most respects quite the reverse. In fact the great aim of each member should be to make himself a better servant to his employers, and to put more technical training into his work; and they who might join with the thought that they were joining an institution which had for its objects agitation, &c., would find themselves greatly deceived. The following persons were then elected:—Mr. Alfred Ivins, inspector, Great Western Railway, Dorchester, as Member; Mr. Clarke White, inspector, Midland Railway, Hellifield, as Member; and Mr. H. Elliott, inspector, Great Southern and Western of Ireland, Tipperary, as Associate. A considerable amount of other business was then gone through, and the meeting concluded with the usual votes of thanks.

FOREIGN AGENTS FOR THE SALE OF THE ENGINEER.

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

## PUBLISHER'S NOTICE.

*** *With this week's number is issued as a Supplement, a Two-page Engraving of Tank Locomotive for Metropolitan Traffic, Great Eastern Railway. 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.*

*** *In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must, in all cases, be accompanied by a large envelope legibly directed by the writer to himself, and bearing a* 1d. *postage stamp, in order that answers received by us may be forwarded to their destination.*

B. H —*Cannot answer the question.*
PRESTISSIMO.—*We think that your idea is quite impracticable.*
CONSTANT SUBSCRIBER.—*You have forgotten to enclose the sketch referred to in your letter.*
SUBSCRIBER (Ballina).—*Address the Secretary,* 9, *Conduit-street, London, W.*
M. A.—*As action and reaction are equal and opposite, the total effort on the cylinder cover is precisely equal to the total effort on the piston. If the effort on the latter is* 30,000 *lb., the effort on the former will be the same.*

### SCREW MIXTURE.

(*To the Editor of The Engineer.*)

SIR,—Can any reader give me the address of a firm supplying an article called the Astbury screwing mixture? VULCAN.

### PACKING GROCERIES.

(*To the Editor of The Engineer.*)

SIR,—Can any reader give me the names of makers of machinery for packing groceries, such as tea, coffee, sugar, and such like, automatically into paper, and also gumming these packages at the same time?
Manchester, March 11th. ENQUIRER.

### THE HEATING POWER OF ELECTRICAL CURRENTS.

(*To the Editor of The Engineer.*)

SIR,—Will any correspondent tell me where I can find a formula for the temperature due to a given current under the following conditions? I have a wire whose resistance is $x$; I transmit a given current $y$, and I get a temperature $t$. But as $t$ rises, $x$ is augmented, and becomes, let us say, $x_1$. This augments $t$, which in turn augments $x$, and at last a point must be reached when $y$ is diminished. We shall then have equilibrium. I want to be able to calculate the conditions of equilibrium. Let me suppose that $x = 3$ ohms, that $y = 14$ ampères with a potential of 50 volts, the maximum temperature is not to exceed 800 deg. Fah. in a German silver wire resistance, what is the smallest resistance coil I can use in safety?

I cannot find any information of service on this point, all books on electricity dealing with conditions where the temperature has to be kept low. Now I want to heat certain coils to 800 deg. under the conditions stated. They will be exposed to currents of gas, which they are intended to heat; but to simplify matters, it may be assumed that the coils stand on a table in a laboratory the temperature of which is 60 deg. CALORIC.
London, March 11th.

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## MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, March 17th, at 8 p.m.: Ordinary meeting. Paper to be further discussed, "The Construction of Locomotive Engines, and some Results of their Working on the London, Brighton, and South Coast Railway," by Mr. Wm. Stroudley, M. Inst. C.E. Thursday, March 19th, at 8 p.m.: Special meeting. Fourth lecture "On the Theory and Practice of Hydromechanics"—Subject: "Inland Navigation," by Sir Chas. A. Hartley, K.C.M.G., F.R.S.E., M. Inst. C.E.

INSTITUTION OF MECHANICAL ENGINEERS.—Friday, March 20th, at 7.30 p.m.: Ordinary general meeting. The following papers will be read and discussed:—"On Recent Improvements in Wood-cutting Machinery," by Mr. George Richards, of Manchester—adjourned discussion. "Description of the Tower Spherical Engine," by Mr. R. Hammersley Heenan, of Manchester. "On the History of Paddle-wheel Steam Navigation," by Mr. Henry Sandham, of London.

ROYAL METEOROLOGICAL SOCIETY.—Wednesday, March 18th, at 7 p.m.: Ordinary meeting. Papers to be read:—"Notes on Sunshine Records," by Mr. Robert H. Scott, M.A., F.R.S., President. "Results of Meteorological Observations made at San Paulo, Brazil, 1879-1883," by the late Mr. Henry B. Joyner, M. Inst. C.E., F.R. Met. Soc. Exhibition of Sunshine recorders and radiation instruments, and of such new instruments as have been invented and first constructed since the last exhibition.

SOCIETY OF ARTS.—Monday, March 16th, at 8 p.m.: Cantor Lectures. "Carving and Furniture," by Mr. J. Hungerford Pollen. Lecture II. The renaissance. Tuesday, March 17th, at 8 p.m.: Foreign and Colonial Section. "The Congo and the Conference, in Reference to Commercial Geography," by Commander Cameron, R.N., C.B. Wednesday, March 18th, at 8 p.m.: Fifteenth ordinary meeting. "The Rivers Pollution Bill," by Mr. J. Willis-Bund. Lord Alfred S. Churchill, Vice-President of the Society, will preside.

## DEATH.

On the 5th March, 1885, at his residence, Southfield Villas, Middlesbrough, JOHN GUNNING, C.E., aged 58 years.

# THE ENGINEER.

*MARCH 13, 1885.*

### THE SUAKIM-BERBER RAILWAY.

SEVERAL questions begin to crop up concerning the Suakim-Berber Railway—questions of much more importance than the puerile interrogations put to the Government concerning the status of Mr. Bagnall and his politics, intended to ascertain whether he was a fit and proper person to be entrusted with the construction of five 18in. gauge locomotives. The first point that presents itself for consideration is why is the Suakim-Berber Railway going to be made. The only answer to this has been supplied by Lord Hartington, who said on Monday night, in moving the supplementary army estimates:—"It will be undertaken as a military work, and in aid of a military object. In the event of a combined operation by way of the Nile and by Suakim and Berber on Khartoum, the construction of the railway if possible as far as Berber would be an enormous advantage. If it were constructed I think it would go very far to insure the absolute success of such an operation. If that is not possible under the conditions in which we are placed, the construction for a smaller distance will be, I admit, a less, but still a distinct and substantial advantage. The country which intervenes between Suakim and Berber, although it contains a certain number of wells, is a desert. The first portion of it is a mountainous and rocky country; the last portion of it—at least 100 miles of it—is sandy; but through the whole length of the route it is but indifferently supplied with water, and affords no provision or supply for an army marching through it. Lord Wolseley has recently estimated the loss of camels in desert marching at 5 per cent. for every 100 miles. It is obvious, therefore, I think, that every mile this railway is constructed from Suakim will be of immense advantage to any force that is advancing from Suakim in the direction of the Nile. Even in the event of the Suakim route to Berber not being used at all, still for the purposes of supplying troops which will have to occupy positions in this portion of the country to prevent the renewed concentration of troops under Osman Digna, it will be of the greatest possible advantage, and, in my opinion, almost of absolute necessity. The terms of the agreement which has been made with the contractors, Messrs. Lucas and Aird, are before the Committee. From them the Committee will see that the character of this work is purely military. It is to be carried on for military purposes, under military supervision, in accordance with and in subordination to military requirements."

Now for the object in view a line 4ft. 8½in. gauge is altogether too wide. The railway is intended to convey troops and stores into the heart of Africa; and it is of the utmost importance that it should be laid with the greatest despatch. The larger the various parts are, and the greater the weight for any given distance, the more troublesome will it be to get materials up to the front and to lay them. In the matter of sleepers alone the difference in quantity between a line 2ft. 6in. wide and a line 4ft. 8½in. wide is about three to one; for the sleepers are in the wide railway nearly twice as long as in the narrow, while their weight per foot run is much greater. We have heard it argued that it is quite as easy to lay the wide as the narrow gauge, provided there are hands enough available for the work. This proposition will not commend itself to engineers. We have already explained what could be done with a narrow-gauge road, and we have shown that the difference between such a light railway as we suggest and no railway at all is practically infinitely in favour of the railway; and we may add that the difference between a broad gauge and a narrow gauge, when there are no heavy guns to be carried, is virtually so small that it may be neglected. If the railway is intended to be permanent and not wanted at once, then by all means let it be broad gauge. If it is wanted in a hurry for purely military purposes, let it be narrow gauge.

So much for the question why it is to be made and what the gauge of the Suakim-Berber Railway should be. Now let us consider whether it will be made at all. On this point we have the gravest doubts. Let the reader imagine the construction of a railway from London to Holyhead, over a route which has never been properly surveyed, in the face of a vigorous and determined enemy, and under a tropical sun. Is it for a moment likely that such a road can be laid at the rate of more than one mile a day—is it likely it can be made at that rate? There can be no section work. The line cannot be begun in several places at once, because there are no means of getting stones and supplies save the line itself. At one mile a day, 260 days, or at least eight months, will be occupied; but the road will be wanted certainly in the early autumn for military purposes—that is to say in August. The question is, Will it be worth having in eight months for military purposes? There may be two opinions on this point. It seems clear, however, that by adopting a broad gauge the Government have done all in their power to retard the construction of the road on which they apparently depend for ultimate success. The railway ought to have been made long ago. At the very outbreak of the war it ought to have been seen that the construction of a railway would have saved an expenditure of millions, besides hosts of lives. It was not made, and the conclusion is forced on us that it is to be made now not because the Government or their military advisers have any great faith in it, but on a "something-had-to-be-done-you-know" policy.

Another important question is, How is the line to be made? It is proposed to employ native labour. This is wise; indeed, it seems that it would be absolutely impossible to dispense with it. When the temperature rises to 120 deg. in tents, it is quite out of the question for white men to think of working in the sun. Not many persons have, we think, quite realised what the heat in the Soudan is. Let it be remembered that it is within the tropics—that Suakim is on the Red Sea, proverbial for its high temperature—and then imagine what an arid glowing desert must be. We confess we regard with the utmost doubt the feasibility of constructing the line at any but an extremely slow pace during the summer; and if it is not made at once, events move so rapidly in Egypt that it is not easy to believe that it will be made at all. It appears to us that the Government are throwing away a substance for a shadow. The great obstacle to movement across the desert is that wheeled vehicles cannot be used. But with a railway, 2ft. 6in. gauge, laid on the sand, the difficulty would be at once overcome. Let it even be supposed that the road thus laid was so rough and so light that a steam engine could not be used on it; it would still be possible to run cars on it which could contain stores and ammunition, which cars could be pushed by native labour, or even by the soldiers. As we have already shown, that must be a bad road indeed on which a specially constructed engine would not work; but, putting this on one side, it is enough to imagine the advantages possessed by troops marching with all their stores, invalided men, &c., in wheeled vehicles, and men compelled to carry on camels everything down to the smallest necessaries of life. The difference is so great that we would even now urge on the Government the prudence of abandoning, for the present at all events, the broad-gauge road, and extending the 18in. road which is to be laid down in the immediate neighbourhood of Suakim. Although such a road is too narrow, it would still be wide enough to render a march possible, which without it could not be undertaken. The theory is, of course, that as the march will not take place until the autumn, there is plenty of time to make a broad-gauge road. This is another point on which we believe the Government are in error. They have been too late throughout the whole Egyptian muddle, and the Suakim-Berber Railway promises to add another to the long list of mistakes they have committed. Engineers and contractors can do wonders, but they cannot work miracles; and it will be little short of a miracle if a broad gauge line from Suakim to Berber is completed this year.

### THE SHELL EXPLOSION AT SHOEBURYNESS.

SIR CHARLES ARBUTHNOT'S Committee have not, we understand, quite concluded their inquiry as to the cause of the accident at Shoeburyness, but so much has now been brought out on the inquest that there seems no reason to delay anything that need be said on the matter. The subject is specially painful, but in justice to those concerned directly, as well as to all who may be indirectly interested in such questions from being at times engaged in gunnery exercises, it is necessary that it should be fairly discussed. It should be understood that Colonel Lyon, who had been Superintendent of the Royal Laboratory for five years, had designed a fuse intended to act on graze, and therefore of a quick, sensitive description. Having completed the term of his appointment, he had received a command at Portsmouth; and before proceeding thither, he went to Shoeburyness to complete some trials with his fuse. The fuse acted well with certain muzzle-loading guns, and it was thought desirable to try it, screwed in the base of a common shell, for a 6in. breech-loading gun. Hence it came that the shell was standing vertically on its apex, and Colonel Lyon, Captain Goold Adams, Mr. Lowe, the assistant manager of the Royal Laboratory, Sergeant-Major Daykin, and Gunner Allen were close round the shell; Colonel Fox-Strangways, Mr. Rance, and others a little further away. When the shell exploded, therefore, it acted in the most fatal manner possible; for those standing round it were brought into the closest proximity, and the fuse was not merely put in action by the displacement of the pellet, as would be the case were the shell base down, but caused to explode, firing instantly the bursting charge of 9 lb. of powder. Mr. Lowe, in a wonderful way, escaped all serious injury, and his evidence as an expert is naturally very much more valuable than any that can generally be obtained in such a case. He states that he screwed the fuse in, and that Captain Goold Adams placed a lead disc over it, and directed Sergeant-Major Daykin to tap it very gently all round; then the explosion took place. He added that he thought that there was no blame attributable to any one; that it took some time for a new fuse "to develope all its excentricities." The fuse itself may be described as containing a pellet, which moved like a piston in the body of the fuse, and on its advance to one end brought a needle and patch of percussion powder in contact with one another, and so exploded the bursting charge of the shell. This pellet was suspended by means of nine balls, which were situated in holes drilled radially through the side of the fuse and into the pellet for a short distance—that is, sufficiently far to allow the balls to enter about half way into the pellet, while moving in the opposite direction they may roll into the fuse body entirely. Any ball remaining at the pellet end of the hole half in pellet and half in fuse body prevents all motion. This can not take place with all of the balls at the same time; but the intention of the fuse is that in every possible position some balls should be thus home in the pellet. This end is secured as follows:—Considering the fuse as standing vertically, three of the radial holes are inclined downwards into the pellet, so that in these the balls—in the position assumed—would be half in pellet and half in fuse wall; three are horizontal, and in these the balls might be in any position; while three incline upwards from fuse wall into pellet. In these the balls would roll clear of the pellet, and in this position they would not prevent the pellet from moving, which would therefore depend on its hold on the other balls. If the fuse were reversed, of course the condition of the balls would also be reversed, and the balls we have described as away in fuse body would be home on the pellet. It was found that these balls acted so completely that Colonel Lyon was able to throw the fuses violently on to the floor or use any test that occurred to him without displacing the pellet, because some balls were always home in every position. Directly the shell rotated, however, at its high velocity in flight, centrifugal force threw all the pellets well into the sides of the fuse, and the pellet was free to act on the slightest check. Mr. Lowe observed that the fuse was in the position above contemplated, when the three balls in horizontal channels and three in inclined ones might act, and he thought the former had probably been moved outwards by the rotation of screwing in the fuse, and that the tapping must have caused the three remaining balls to jump sufficiently to free the pellet, which descended and exploded the shell. For service we believe a safety pin would have been fitted to this fuse. Such a pin, if removed only as the shell enters the bore, may be made to afford great security, and in sensitive fuses is a most desirable addition. In the case before us the fuses had been just completed, and it was thought safe to fire them experimentally as they stood.

The cause of this fatal accident, then, is not difficult to trace. It is most desirable, however, to point out that the experiment was quite an exceptional one, and the danger not one which accompanies artillery practice under ordinary service conditions. Men who are investigating in any branch of science frequently incur risks beyond those of ordinary men, because operations performed for the first time are always liable to unexpected contingencies. We have the case of an adaptation suggested on the spot to complete a series of trials, and this is exactly the sort of incident that draws men who are keenly interested in their work into unforeseen danger. When the danger is over it is often easy to see how to prevent it for the future, and this case is no exception. With wooden time fuses small blowing charges have frequently been employed in shells to show when the fuse acted without bursting the shell at all. Percussion fuses screwed into shells in the ordinary manner, however, cannot be ejected by a blowing charge. Hence full bursting charges have been employed, and the shells themselves burst as on service. It is, however, now thought feasible to prepare shells specially for experimental purposes by weakening them in the region of the fuse hole, and opening them by a comparatively insignificant charge of powder. It may be confidently said then, that experimental practice may for the future be guaranteed against such an accident as that which we now have to deplore, even should a fuse of new construction behave in some unexpected way. Ordinary service firing is not, or certainly ought not, as we have said, to be liable to this class of accident, for everything experimental ought to be thoroughly tried before it is introduced into the service.

With regard to the danger besetting the use of percussion fuses generally, General Boxer has written a letter to the *Times*, which appeared on Friday last, which deserves careful consideration. General Boxer, on this subject, is, of course, as high an authority as can be quoted. Indeed, he may be called the very highest, being celebrated both as an inventor and as the superintendent of the Royal Laboratory, which he did more to mould than any other man. On the other hand, we may observe that, like many other able inventors, he is apt to be a severe critic of the designs of others. General Boxer contends that all fuses containing detonating powder are too dangerous to be admissible in the service, and that the danger attending their use has greatly increased with the adoption of new type guns. This, briefly, is what we understand to be General Boxer's point. He himself had one time fuse which for use in a breech-loading gun was fitted with a hammer acting on detonating composition, because there was not sufficient windage to ignite the fuse by means of the flash of discharge. This detonator, however, was rather an unwilling expedient adopted by him to meet a case which he would never have allowed to arise had he had his own way, for, as he says in the letter we refer to, he holds that "no gun except those exclusively required for armour piercing ought to be introduced into the service in which provision is not made for lighting the fuse by the flash of discharge." The fuse, however, which he thus made, as it were, under protest, had a suspending wire twelve times as strong as some since employed. The powder in those days burnt rapidly, and the projectile at once bounded forward with a velocity sufficient to enable the inertia of the suspended striker to shear a comparatively thick wire —such a wire as gave tolerable safety in handling the fuse. With slow burning powder the shell moves much more gradually, hence in the fuses of earlier construction the strikers have no power to shear their suspending pins, and the fuses are not put in action, and so cannot fire the shells on impact. This, we believe, was the cause of many of the failures at Alexandria. It is easy to see, then, how much more difficult the problem is to deal with now, than when General Boxer was in the service. His plea that this should make us give fuses lit by flash a fresh trial is a reasonable one; at the same time there are many objections, and we must decline to join with him in his conclusion "that grave doubts must be entertained as to the ability of the gunnery authorities to deal with these matters." The question is difficult, and undoubtedly all the skill that can be brought to bear on the subject should be invited. Any design of a fuse lit by flash or percussion submitted by General Boxer would deserve special attention, and we hope would command it. At the same time, it cannot be conceded that this fatal loss of seven lives proves the necessity of vetoing percussion powder in fuses. Curiously enough, about the same number of lives have been sacrificed in two former laboratory accidents. About 1846 seven men, in a building now replaced by the brass foundry, were killed by the ignition of fuse composition, when breaking up old fuses, made in about the year 1700, we believe. These were the simplest form of wooden fuse. In 1867 nearly the same number of boys—that is, six, or perhaps seven—were killed in making up the Boxer small-arm cartridge, since which time happily no accident approaching the present one in its disastrous results has occurred. The two last have undoubtedly owed their origin to the use of percussion powder. The first, of course, did not; nor was this element in any way connected with the great explosion of rockets in the marshes in the autumn of 1883.

In 1867 there was evidence that a boy fired a cap thoughtlessly, and it would be monstrous to hold General Boxer to blame for the occurrence, but nevertheless it was easy to make arrangements for the future that put it out of the power of every thoughtless boy to explode a whole store of powder and destroy life on a large scale, and obviously such arrangements were equally possible before the accident. It would have been fairly logical, however, to argue that it was intolerable that thirty or forty lives should hang on the whim that might enter the head of any thoughtless lad, and hence to insist that the caps should never be brought into contact with the powder. General Boxer, however, devised arrangements to enable central fire cartridges containing cap and powder to be made without the liability to the danger that had caused the loss of so many lives. Percussion fuses also may be dealt with, we trust, satisfactorily. They have been in the service in considerable numbers since about 1860, now nearly a quarter of a century, and before that time in small numbers. Hitherto they have caused very few accidents, and there is no sufficient reason to conclude that the difficulty now caused by slow burning of the powder is insuperable. As above noticed, there is much to be worked out in connection with fuses. Some of the requirements are new, and others were thought of and yet not met in General Boxer's day; for example, abroad, in firing at overhead cover it has been found that against hard materials shells rebound slightly and lose much of their effect before any known percussion fuse can act; hitherto a fuse of sufficiently quick action has been sought in vain. On the other hand, a trustworthy deferred action fuse to enable a shell to pass through thick armour before it explodes is one of the objects to which much attention has long been directed. As no one has fully met these wants in any country, it may in a sense be held that the gunnery authorities throughout the world are unable to deal with these matters. General Boxer can best support his strictures, however, by designing fuses for the various purposes himself. He has never, we believe, designed a fuse that would meet the need Colonel Lyon sought to supply, and this and the armour deferred action fuse have been wants felt for many years.

We trust that every possible lesson may be learned from this accident which has cost us so much, but we do not think that General Boxer shows us the proper light in which to regard it.

## THE TEACHING OF DYNAMICS.

OUR criticisms on the modern system, or want of system, of teaching dynamics have appeared in our pages in various ways for years. They have at last evoked a reply, which may almost be termed a defence, from a gentleman well fitted to represent teachers of dynamics as a body. His position as professor of mathematics in King's College is sufficient guarantee that he represents at least one phase of modern thought as set forth in text books of dynamics, and we have great pleasure in directing the attention of our readers to a paper "On the Third Law of Motion," which will be found on page 199. This article, we may explain, has been written as a commentary on an article on the same subject which appeared in our issue of February 13th. Professor Hudson is no doubt aware that what he has written is liable to be criticised, and we have no reason to think that to honest criticism he can have any objection. The noblest object of science is the pursuit of truth; and discussion properly conducted does much to place truths before the world. We make no apology, therefore, to Professor Hudson for expressing our opinions concerning his very freely.

To begin at the beginning, Professor Hudson holds that "the difficulty met with in understanding the third law of motion is to be found in the popular and unscientific personification of Force." In the first place, we may remark, that we, at all events, never stated that there was any difficulty in understanding the third law of motion, which says that action and reaction are equal and opposite. Professor Hudson combines Clerk-Maxwell's definition of force with Professor Tait's. With the first he holds that anything that changes motion is a Force, while with the latter he holds that Force is a rate. It will not escape our readers, however, that Professor Hudson has introduced a new and very subtle definition. Eluding the word Force, he says: "A body, A, *changes* the motion of a body, B." The italics are ours. He does not at first say how it changes the motion of B. Returning, however, to his opening statement, it will be seen that he apparently holds that Force is not a push or a pull. That, he says, is the popular and erroneous notion of it. No doubt the popular notion of Force is that the words Force and Stress are very nearly, if not quite, synonymous; and we will go so far as to say that, until a comparatively recent date, Force never was regarded in any other light than as a push, pull, effort, or stress. However, it is a matter of very small moment for our present purpose what anyone but Newton considered it, and to Newton, beyond all question, a force was a stress, effort, pull, or push. On this subject Newton was explicit. Lest any doubt should exist as to what he intended to convey by his third law, he explained it in the following words:—"If a horse draw a body by means of a rope, the horse also is drawn, so to speak, towards the body; for the rope being *strained* equally in both directions, draws the horse toward the body as well as the body toward the horse." Epigrammatically he laid it down, *ut tensio si vis.* Newton never for one moment regarded force as a rate. No one ever did before Professor Tait, to whom the credit, whatever it may be, of the definition is due. We have advanced over and over again in these pages the proposition that Force alone cannot be the cause of motion, using the word Force in the sense of stress or tension; and it was, perhaps, because Clerk-Maxwell recognised this truth that he declined to regard Force as the cause of motion; and Tait, with the same idea, gave up Force altogether in any received sense, and started an entirely new definition of the word. Why he retained the word at all, indeed, it is difficult to say. We are then face to face with the fact that Newton, whatever else he meant, held that force was an effort, stress, pull, push, or draw, for, as we have seen, he speaks of the "draw" of a horse on a body. But it is evident that if the stresses at work be equal and opposite, that no motion can take place by virtue of the stress; and accordingly people have jumped to the conclusion that Newton's third law is wrong, or that he meant something else; and very little has been said about the law in text-books of dynamics, because it was felt that it involved difficulties which were best slurred over or let alone; and finally, the law has been evaded, as we have seen. Thus, then, we join issue at the outset with Professor Hudson, and maintain that what he condemns as the popular notion of Force was Newton's notion, and that Newton's third law applies to stresses as well as to momentum. We have no exception to take to Professor Hudson's statement concerning momentum. It is all quite true. Newton dealt with momentum; but he superadded it to what he had already said about the equality of pull, push, or draw. For after he has finished with his horse and body, he goes on: "Again, if any body impinge on another, whatever quantity of motion it communicates to that other it loses itself." Professor Hudson wants, apparently, to limit Newton's third law in its application to momentum, and to this we cannot for an instant consent. Newton held, not only that the momentum of a body was changed by the impact of another body, but that stresses were equal and opposite. In fact, the momentum proposition can only be true because the equality of stress proposition is true. Professor Hudson enunciates the momentum proposition, and says, "this is the third law of motion." So it is; but not the whole of it.

Professor Hudson having stated early in his paper that it is erroneous to regard force as a push, in his third paragraph uses the words, "the push is a force." Are we to assume that although a push may be a force, yet a force is not a push? Moreover, we are told in the next line that a force is the rate of change of momentum. Therefore a push is the rate of change of momentum. But let us take the whole passage. It illustrates the inextricable confusion of ideas inseparable from the modern system of teaching dynamics. "Two difficulties," says Professor Hudson, "now arise. The first is, A and B may push one another without either of them experiencing any change of motion. How is this? The push is a force, and force is rate of change of momentum, and there is no change of momentum, and therefore no force." We add the legitimate deduction which Professor Hudson has omitted, there is no push. Is not this a pretty syllogism? An arch pushes against its abutments, and this push is, says Professor Hudson, a force. But force is the rate of change of momentum, and inasmuch as the abutment does not move, there is no rate of change, and therefore no force, and consequently, to be logical, there is no push on the abutments. Professor Hudson does not, we suppose, mean this, but this is what his words mean, and no other deduction can be drawn than that which he has drawn from the idea that force has no existence save as a rate. Why not follow Tait to the bitter end, and say that force is but a name?

It is quite unnecessary to follow Professor Hudson step by step as he combats manfully with his difficulties—difficulties which are not of his making. But we cannot help calling attention to the statement beginning, "The answer to this is found in the principle of superposition. The whole change of momentum is zero, being compounded of the momentum that the push of the man would give if the ground were perfectly smooth, and of the equal and opposite momentum that the push of the ground would give if it could be supposed to act alone." Does not reasoning such as this go on all fours with that which goes to prove that space is in certain regions curved, while four or more dimensions are possible in it?

We come finally to the last difficulty. If action and reaction are equal and opposite, why does anything ever change its motion? We confess we have read with great pleasure what Professor Hudson has written on this subject. We find in his words the fullest and most ample justification for all that we have ever written concerning the way in which dynamics are taught. Newton's third law is too much for Professor Hudson, as it has been for scores of others. Let us take his own illustration—the horse and cart. Nothing could be happier, because it is Newton's. If, says Professor Hudson, the cart pulls the horse as much as the horse pulls the cart, why should the cart move? and he gives us the reason why. This is it. The ground pushes the horse along, and the cart being fastened to him, must follow him. This, be it observed, is written in sober seriousness by a professor; and again we say that the blame must not be laid on him, but on his teachers. But even with the aid of ground which does that which all the experience of mankind shows that it does not do, Professor Hudson cannot extricate himself from the muddle in which he is involved. Tying the horse and cart together, he says that the ground pushes the cart one way and pushes the horse the other way; but it pushes the horse one way more than it pushes the cart the other way. Hence motion. But by Newton's third law action and reaction are equal and opposite all round, and the horse pushes the ground just as much as the ground pushes him, so that the horse ought not to be able to advance. Lest it may be said that we have forgotten the part played by the cart, we shall eliminate that vehicle altogether, and put the horse, minus cart and harness, on the road. Now by Newton's third law the ground pushes the horse no more than the horse pushes the ground. Therefore the horse must remain a fixture. But if Professor Hudson is right, if we fasten a cart to him, he can immediately proceed. There is no possible escape from this deduction. It would seem, however, that the push of the ground is not, after all, sufficient to account for the motion of the horse and cart. Professor Hudson is actually driven to assert that the pull at one end of a trace must be greater than the pull at the other end, or no motion could take place. We find as much difficulty in attempting to combat this astounding statement as we should in arguing with a man who asserted that two and two made five, Shall we ask Professor Hudson the old schoolboy puzzle? If two horses are fastened one at each end of a rope, and are driven in opposite directions, will the pull be that due to two horses or to one horse? A correspondent asked us this week if the pressure in a cylinder being sustained by the piston as well as the cylinder cover, he was to consider the strain one-half on each. It is not more erroneous to assume that the pull at one end of a rope can be greater than the pull at the other. It is, indeed, practically impossible to argue about such a point at all. Let us, however, put the proposition, as we understand it, in another form. We have three sections of trace. The first next the horse; the horse pulls this with a force $x$, and it resists with a force $y$, and $x = y$. Then we have the length of trace next the cart, and this pulls the cart with a force $a$, and the cart pulls it with the force $b$, and $a = b$; but, says Professor Hudson, it does not follow that $x = a$. There is a link intervening between them which has at one end a pull $= x$, and at the other end a pull $= a$. May we ask Professor Hudson to plot a curve showing what his notion is as to the dying away of the strain between the $x$ end and the $a$ end of this curve? and to simplify matters, we shall eliminate momentum altogether, by assuming that the horse and cart are yet at rest, the horse simply leaning forward steadily against the collar, as railway horses do when they are starting a coach. It must not be forgotten that if a pull greater at one end of the rope or link than at the other be needed to maintain the motion of the cart, it is yet more necessary to initiate that motion.

Nothing about the third law of Newton is, perhaps, more remarkable than the difficulties in which it has involved men who really ought to hold in their hands the key to the whole problem. At the proper time we shall say more on this point. For the present it must suffice to say that Newton spoke of what we now conveniently term stresses when he dealt with action and reaction. Stresses alone cannot produce motion, and are always equal and opposite. Force alone, whether a stress or a rate, cannot cause motion, yet stress is a necessary concomitant of motion. Although a train could not follow an engine, or a cart follow a horse, without the aid of a drawbar or a trace, yet neither the drawbar nor the trace is the cause of motion. *The only cause of motion is motion.* The motion of the horse is not to be sought in the ground, which is a passive agent, the fulcrum of a lever, but in the vital energy of the horse; and as nothing can cause motion but motion, the vital energy of the horse is a mode of motion. The trace is but a means of establishing the equivalent of cohesion between the horse and the cart. The whole perplexity and difficulty and complication arise from the notion that stress causes motion. Let us go behind the stress, and ask ourselves what causes it.

### THE YORKSHIRE COAL TRADE.

At Rotherham on Monday the miners of South Yorkshire and West Yorkshire held a most important conference to decide the action to be taken in regard to the reduction of wages proposed by the employers. There were present 136 delegates representing no fewer than 41,391 miners in all the different districts of the Yorkshire coal-field. Both sides have now spoken, and it is clear that unless some powerful third party succeeds in inducing the adoption of more moderate counsels, the beginning of April will find forty to fifty thousand pit-hands idle, and the raising of the famous Yorkshire coal suspended. This misfortune would be keenly felt in all the colliery villages as well as in the towns of the South Riding, for the evil effects of a conflict between capital and labour extend far beyond the persons immediately concerned. The village merchant is unable to get money from his customers, and he in turn cannot pay his wholesale merchant, who is crippled by the drying up of the small rivulets of cash which make up his river of capital. Children are either withdrawn from school or are sent there at the public expense. Those frugal miners who have saved against a rainy day find their little hoard exhausted; those who have nothing are immediately destitute, and swell the paupers' roll, as well as increase the crowd of mendicants on the highway and in the street. The position of the coalowners and the colliers is sharply defined, and as facts at present exist, there seems no common ground for any arrangement to be come to. Concession on either side might lead to a settlement; but in the present temper of the disputants, those who engage in compromise would engage in work as thankless as that of interfering in matrimonial squabbles. For the coalowners it is urged that the condition of the coal trade in 1882 did not justify an advance of 10 per cent., that affairs have become worse ever since, and that while the price has steadily decreased the business has also declined. Mr. Arthur M. Chambers, of the Thorncliffe Collieries, points to the monetary column of the *Times*, where it is stated that the output of coal in 1884 is 3,700,000 tons less than in 1883. The employers add that the reduction need not necessarily be permanent. Once conceded, they express their willingness to meet the men and arrange a scheme for the settlement of wages by means of a sliding scale, the miners' remuneration to rise and fall with the market value of the coal. The colliers—or rather their officials—contend that the present depressed condition of trade is largely due to the coalowners themselves, as by their extreme competition they have forced the price of their commodity far below its real value. They deny that reductions of wages are the cure for bad business. In every instance during the last ten or fifteen years they state that a reduction had meant worse and not better work. The colliery owners would not benefit by the reduction of 10 per cent., which, according to their estimate, meant about 3½d. a ton. The only people who would benefit by it were such large consumers as railway companies, manufacturing firms, steam shipping companies, and gas companies. Mr. Pickard thinks 10 per cent. would not exceed 2d. per ton, and he did not see how the coalowners were going to reduce the cost of coal to meet that. The gas companies, Mr. Pickard contends, are paying standing dividends of about 12½ per cent., and many coalowners were interested in having cheap coal to make gas. "The railway companies, added Mr. Pickard, had been going to the dogs all the year, but the North-Eastern had only paid 1 per cent. less—they paid 7 per cent.; the Midland Company were paying 6 or 6¼ per cent.; all the mills paid good dividends, and the collieries paid on the average 5 to 7½ per cent. Messrs. John Brown and Co., Messrs. Charles Cammell and Co., and the Thorncliffe Company did not lessen their dividend. They had honestly earned it, and they paid it; but they did not think that the men had a right to continue receiving their dividends." The union officials express themselves strongly against the coalowners for not first "stating their case to labour" before putting "the pistol to the head." The coalowners warmly repudiate any "pistol-to-your-head policy," and the prospect of a peaceful settlement is not improved by the tone which is being adopted in the discussion. After passing the resolution of resistance, a suggestion was made that the secretary of the Coalowners' Association should be asked to arrange an interview with a view to a frank interchange of opinion, and an amicable arrangement arrived at if possible. This suggestion was sharply rejected, it being pointed out that the owners had ignored the association, and that such a course would be ill-advised. After luncheon, however, the colliers' delegates appear to have been in a less belligerent mood, for they appointed a deputation of twenty-three of their number, including the five officials of the South Yorkshire Miners' Association, and Mr. W. Chappell, of the South Yorkshire and North Derbyshire Miners' Association, to meet the owners, should the latter express a desire to that effect.

### OUR FRIEND THE FOREIGNER AND HIS WARES.

The Cutlers' Company of Sheffield do a great deal of work which is not seen or heard of, but occasionally the exigencies of the public service bring it to light. An instance in point has a universal interest to traders over the country. At the present time it is an offence in countries abroad to mark a fictitious indication of a place of origin upon goods provided that this is joined to a fictitious business name, or to a business name assumed for the purposes of deceit. If a manufacturer abroad strikes the word "Sheffield" upon goods, and adds to that a fictitious business name, it is a breach of international law, but if he confines himself to marking the word "Sheffield" alone, and his own name, which is not fictitious, he escapes scot free. This is the point which the Cutlers' Company have taken up with the view of having the international law altered. Under the English law—Merchandise Marks Act—it is an offence in England to put a false indication of a place in which goods are made upon English goods. No such law exists in Germany, and although a law similar in its character to the Merchandise Marks Act exists in France, still, as pointed out by a memorandum of M. Jules Ferry, "that in accordance with French jurisprudence, foreign manufacturers cannot invoke the privilege of this law unless reciprocity has been established by treaty." There seems no reason in the case of France why reciprocity should not be established. Both countries have laws bearing upon the matter. There is machinery already in existence by means of which concord of international law may be secured, viz., the Industrial Property Convention, to which the Powers of Europe are parties. Much good work has been done by the Convention, and it is owing to their resolution that the international law does provide against the placing of a false indication of origin upon the goods when coupled with a fictitious business name; and as the Cutlers' Company very fairly point out, it is not a very long step from this resolution to a resolution making it an offence to place a false indication of origin alone upon goods. The position taken up by the Cutlers' Company seems reasonable, practicable, and on the side of honesty in commerce. Taking this view of the matter, the Sheffield Town Council on Wednesday decided to appoint a deputation to accompany representatives of the Cutlers' Company and Chamber of Commerce to wait upon Lord Granville and urge energetic action.

### RAILWAY AND SEA-BORNE COAL.

The competition between sea-borne and railway-borne goods seems likely to settle the question of the rates that shall prevail for their carriage; and in nothing is this more exemplified than in the coal trade. The low freights for coal cargoes during the past few months have begun to affect the quantities of coal carried on the railways, and the Midland Railway has taken a step which will probably be followed up in other directions. It has decided to lower the cost of the carriage of coal sold at less than 2s. per ton at the pit by giving a rebate of 15 per cent. from the 15th inst. This reduction in the cost of carriage of the small coal or smudge will affect the price to the manufacturers and to one or two other classes who use it largely. This is that class of coal which is often most embarrassing to the coalowners—so embarrassing, indeed, that at one large northern colliery it was a few months ago proposed to sell it at nominal prices in large quantities to steamers going long distances in order to enable them to use what was possible, and if the remainder were unsaleable, to "throw it overboard" at the end of the voyage. During the past month the imports of coal into the metropolitan district were increased by nearly 57,000 tons over those for the corresponding period of the past year, whilst the quantity brought in by rail was 32,000 tons in excess of the corresponding quantity. For the first two months of the present year the proportion of the increase of the sea-borne coal is the most marked, and it is to meet that, in all probability, that the reduction to which we refer has been made. It is a concession to a change in the position of the coal trade that will be acceptable to those coalowners who have a large production of small coal, and who supply any part of it to the metropolis by rail. If this spirit of concession to the changing aspect of trade were more frequent on the part of the railways we should hear less of the attempts to alter the whole basis of the rates, and there would be less of the bitterness that there is now between the chief companies and many of their customers. In the passenger traffic it is shown that low rates are the most productive, and it may be that the tentative and partial reduction in the coal trade will lead to similar results.

### GROWTH IN GAS PRODUCTION.

Some facts that are officially vouched for will illustrate the changes that have taken place in the gas manufacture during the last few years. At Newcastle and Gateshead the production of gas in round numbers was 1,368,000,000 cubic feet—an increase of 10 per cent. on the quantity for the previous year, in spite of the great dulness in trade. In one week, about the middle of December, not less than 44 millions of cubic feet were made. In 1875 the price of gas was 3s.; now it is 1s. 10½d.; and the result of the change is seen in the fact that whilst in the earlier year 81,000 tons of coal were needed to supply the demand for gas, last year about 124,000 tons of coal were needed. The supply is still in the hands of a company, and it declared for the last half of last year a dividend at the rate of 4½ per cent.—a very excellent result. It is proved that there is a large demand for gas, and that with cheapness in the production that demand is capable of almost indefinite growth, for until last year only the demand for lighting had been satisfied. There is now the commencement of the demand for warming and cooking purposes, as well as for power; and these should give a continuance of the increase, if even there should be a check to the rapidity of the growth in the demand for lighting purposes. Cheaper coal and lessened prices received for residuals are also amongst the special characteristics of the year; but they are not confined to Tyneside, and need not be much reverted to. The growth of production is accompanied by a larger yield from a given quantity of coal; and thus it is evident that in this, as in other manufactures, lower prices entail economy. The ultimate amount of the economy it is as yet impossible to discern; but it seems to be clear that there will be a longer life for the gas manufacture than some had expected a year or two ago.

### THE PALL MALL PAVEMENT.

The condition of the wood paving which was laid down in this much-used thoroughfare some four years back offers us very strong evidence of the inadvisability of attempting to economise too far in the first laying of such roadways. In spite of very extensive repairs—amounting, indeed, to almost entire renewal of the central portion of the street—executed some twelve months back, the present state of the paving is unsatisfactory to the last degree, and it affords a striking contrast to the well-preserved and level appearance presented by the Strand, Regent-street, and Oxford-street pavements, all of which have to carry a much heavier description of traffic than falls to the share of their more aristocratic neighbour. We recollect perfectly well observing the hasty and careless manner in which the blocks were "jerked" into place when the work was in progress. No attempt was made to ensure uniformity of line, and, as the natural result, the blocks have never borne fairly against one another, and they have, therefore, been exposed to constant shocks tending to their displacement. The reply given to the objections we at the time raised was that the price tendered for was exceedingly low, and that the light character of the traffic, which was principally of carriages and cabs, would guarantee the stability of the road. The fears we expressed to the contrary have been fully verified, and the result of what we cannot but term to have been "cheap and nasty work" are now fully apparent. It is not only for the sake of uniformity to the eye that careful alignment in laying the blocks is a necessity, but for the avoidance of their angular movement under shocks which all solidarity in spacing is otherwise unable to prevent.

### NORTH BRITISH BORNEO.

We have on a previous occasion referred to what is really an extension of British territory in the acquirement of vast tracts of country in the island of Borneo by the North British Borneo Company, pointing out when we did so that such acquirement held out an extended field for the employment of our engineers abroad, a field much to be desired, considering the increase in their number, and the more than corresponding curtailment of the limit afforded for their employment within the British Isles. Any further extension of that field will, therefore, of course have interest for those who seek scope for their energies, and we may call attention to the fact that very recently, under a convention with the Sultan of Borneo, the North British Borneo Company has secured an accession of territory amounting to 4000 square miles, which includes sixty miles of coast line and two rivers, one of these last being navigable for 100 miles. From information privately reaching us, we learn that many engineering works—at first, of course, only of a pioneering character—are to be shortly undertaken within this newly-acquired territory, and an early attempt is to be made to develope the trade up the navigable river by small steamers. Vessels of a large tonnage are now being attracted from Australia to take up the carrying of the varied export trade which is springing up, and the favourable results which attended Rajah Brooke's experiment at Sarawak within the same island of Borneo seem likely to be more than surpassed by those which the development of the extensive and fertile country, under the auspices of the North British Borneo Company, is likely to bring about.

### THE OUTPUT OF COAL.

Now that there is every probability of a prolonged strike in the Yorkshire coalfield, it is interesting to note that the output of coal in Yorkshire last year was 19,220,144 tons, being 347,526 less than 1883. Every colliery district shows a decrease. Northumberland raised 7,516,005 tons, a decrease of 11,050; Durham, 28,552,303, decrease 1,326,132; South Wales and Monmouthshire, 24,838,562, decrease 136,871; Derbyshire, 8,581,001, decrease 206,966; Nottinghamshire, 5,091,603, decrease 224,277; Leicestershire, 1,152,930, decrease 172,457; Scotland, 21,186,688, decrease 39,109. The total tonnage raised in 1884 was 160,044,175, being 3,693,152 less than in 1883. The quantity of coal exported, and the quantity of coal sent abroad for the use of steamers on the foreign trade shows an increase in 1884 over 1883, whilst the aggregate quantity of coal sent to the London market was nearly the same as in 1883, only about 30,000 tons less. Though every district shows a decrease, Durham has the largest drop, owing to the slackness of the iron trade in that county. In Northumberland and in Scotland the diminution has been small, but in the great Midland coalfield, including Yorkshire, Derbyshire, Nottinghamshire, and Leicestershire, the total diminution is about 1,000,000 tons. It is therefore pretty clear that the diminution in 1884 of nearly 3,700,000 tons is attributable chiefly to the lessened demand in the iron and kindred industries.

## LITERATURE.

*Treatise on Valve Gears*, by Dr. Gustave Zeuner, translated from the fourth German edition by Professor J. F. Klein Lehigh University, Pa. 1884. E. and F. N. Spon, London and New York.

The book which we are about to review is an English or American version of Zeuner's well-known work on Valve Gears, translated from the fourth German edition by Professor Klein, of Lehigh University, Pa. In his preface Zeuner remarks that he now regards his book as exhaustive and complete. But, since Zeuner wrote, valve gears have grown apace, and to us it is strange and disappointing to find no mention whatever of the modern development of radial gears. It was, however, not till after the issue of Zeuner's latest edition that Charles Brown, of Winterthur, began, about the year 1876, to apply his radial gears to locomotives, and only still later that the Joy arrangement appeared in this country; so that, although Zeuner was a near neighbour of Brown's, and might therefore have easily become acquainted with his system, it is probable that, at the time when Zeuner was issuing his fourth edition, radial gears had not taken such definite shape as to admit of rigorous and systematic treatment. So far as we are aware, the first, and in fact the only geometric construction of a radial system yet published was given in a series of papers contributed to this journal, beginning in the issue of February 23rd, 1883, in which also was embodied an account of the application of Zeuner's polar diagram to Brown's form of gear. Those who are acquainted with Zeuner's book will not have failed to observe that he contrives, sometimes cleverly and directly, but frequently by very ingenious and tortuous ways, to reduce every form of valve gear to one and the same expression, namely, A cos. $w$ ± B sin. $w$, which is the analytical expression of his polar diagram. Now, much as we admire Zeuner's book, we cannot help regarding this unswerving adherence to one system of exposition as defective, and suggestive of a want of elasticity of method. This is especially noticeable in cases where the problem obviously admits of a simpler and more direct graphic solution. On these occasions we are called upon to sacrifice time and wade through lines upon lines of symbols, every now and then casting out some troublesome and inconvenient term, before the analysis can be so bent and shaped as to fit exactly into Zeuner's iron shoe—the polar diagram. At the same time we must express our great admiration of Zeuner's work, the fulness and perspicuity of his language, the unquestionable originality of his methods, and last, but not least, the undoubted skill and ingenuity with which he wields that unique and powerful weapon which is of his own creation. But, as we have already stated, at times the too exclusive use of this instrument has led him to adopt very roundabout and provokingly tiresome methods, where the problem could have been very simply, and often more correctly, solved, by choosing another form of diagram. A noteworthy illustration of this statement appears in the fact that, as a rule, Zeuner finds it more convenient to assume the angle of advance as a condition to determine the lead; whereas in practice it is the lead which is given to find the angle of advance. Take, for instance, the statement of the problem on page 33:—"In a simple slide valve gear let the eccentricity $r$ = 0·060m.—2·3in.—and the angle of advance $\delta$ = 30 deg. Let the admission of steam take place whilst the piston travels 0·8 of its stroke, and let the exhaust begin when the piston has still 0·04 of its stroke to travel. It is required to find the inside and outside lap, the inside and outside lead, the greatest opening of the steam ports, &c. &c."

The peculiar nature of the polar diagram has led Zeuner astray in two directions. If he had chosen a more direct graphic construction, he would have found that, not only has he inverted the natural order of the data and unknown quantities, as far as regards lead and advance, but, further, has assumed the superfluous condition of a given eccentricity or travel. There is a very simple graphic method of determining all the unknown quantities of this problem, without presupposing a given travel. In fact, owing to its intimate and inseparable correlation with the piston stroke, the valve travel is derived from a ratio in the very construction of the diagram. We believe that M. J. Valet was the first, years ago, to introduce this method, or, more truly, the fundamental idea upon which it is capable of being built up and developed; seeing that Valet's construction was crippled by the exclusion of the lead. Mr. W. H. Maw, in his contribution on "Valve Gears" to Zerah Colburn's "Locomotive Engineering," states the same problem in the right order as regards lead and advance, but, as usual, assumes the unnecessary condition of a given travel. His statement runs thus:—"Lead and travel being fixed, to determine the amount of outside lap and inside lap or clearance necessary to effect the cut-off and release of steam at certain points in the stroke of the piston."

If Zeuner's statement of this problem already given be compared with Maw's, it will be seen that, where the former assumes the angle of advance, the latter presupposes the lead; so that Maw's statement is more practical but at the same time less complete than Zeuner's; because he pretends to determine only two unknown quantities—namely, the inside and outside laps—whereas, as Zeuner had shown long before, the diagram is capable of much more than that—to wit, of fixing not only the two laps, but also the two leads, or, what is equivalent on Maw's assumptions, the angle of advance. In this respect there is room for improvement in existing treatises on valve gears.

Coming now to Professor Klein's part in the work, we may state unhesitatingly that he has succeeded in rendering the original into clear and readable, if not always grammatically correct, English. Indeed, Professor Klein's language cannot, under any pretext, pretend to be pure or classical; but it is in an eminent degree lucid, which amply compensates for its lack of other qualities. To take an instance or two: English purists would probably object to Professor Klein's substitution of the term "swing back and forth" for "move to and fro;" and many of his readers will not at first understand the phrase "when the link is way down," page 90, meaning, when the lever is in the last notch. The term "medium," page 92, cannot be used as an equivalent for "mean," or "average." "Vertical movement," page 115, should read "versinal movement," which is not the same thing. The circumlocution "the centre of motion of the movement of the valve," page 122, is tautological. Further, there cannot be "the three following," page 131, or "the four principal," page 235; though there may be "the following three," or the "principal four." Again, on page 159 it is stated that "their centres—of the valve circles—are situated above each other," which cannot be true of any, and least of all of the top centre. The term "shuts," page 175, is written for "opens." "Hurtful space," page 177, is rendered too literally from the German; "clearance" is the genuine English term. We can also imagine that the British engine driver would resent being called a "locomotive runner," as the term might suggest unpleasant association with another class of runners, now defunct, who "followed the track" under the shadow of Bow-street. The expression "from zero on," page 231, is certainly shorter than "from zero upwards," but presumably not so correct. All these, however, are mere punctilios, which are easily excused in the presence of what is certainly a clear interpretation of the original text. Other errors of a more serious nature have either slipped into the translation, or have been transcribed from the original text. We can afford space to mention only a few of this class. Thus in equation 63, page 125, the factor $\frac{r^2}{4cl}$ is omitted before the last bracket. On page 156 we find $2\rho$ cos. $\phi$ as the denominator of a fraction, instead of $2\rho\cos.^3\phi$. The statement, page 182, that "from position 6 to 1 steam is again admitted," is incorrect. The true account is that from position 6 to 4 steam is admitted into the inner valve chest, but not into the cylinder; and from position 4 to 5'—5' being a point diametrically opposite to 5, but not shown—steam is again admitted into the cylinder. There are also several misprints in the figure-letters and references; thus Y O X, page 201, should read Y O D $x$; $\delta$, page 232, should be $\delta_0$; at the foot of page 239 we have $+\alpha_0$ instead of $-\alpha_0$; and on page 240, A X instead of A B. It is also worthy of remark that a valve gear system must be designed for the engine in its heated state, a fact which Zeuner nowhere expressly mentions. It is, indeed, easy to see that a valve gear might be a perfect geometric fit on a cold engine, and yet would work excentrically when the parts had acquired their normal heat. The boiler, cylinder and its appendages, would expand forward independently of the axle, excentric, and valve gear; whereby the lead and admission would be increased on one and diminished on the other stroke. In spite, however, of these few blemishes, the book before us is to be recommended as a worthy reproduction of Zeuner's valuable work.

## BOOKS RECEIVED.

*Street's Indian and Colonial Directory*, 1884-5. Tenth issue. London: Street and Co., Cornhill. 1884.

*Laxton's Builders' Price Book for* 1885. Comprising above 72,000 prices. Originally compiled by W. Laxton. Sixty-eighth edition. London: Kelly and Co. 1885.

*Practical Physics.* By R. T. Glazebrook, M.A., F.R.S., and W. N. Shaw, M.A. London: Longmans, Green, and Co. 1885. Text-book of Science Series.

*A Catechism of the Steam Engine in its Various Applications in the Arts, with new Chapter on Gas Engines, and another of Useful Tables and Memoranda.* By John Bourne, C.E. New edition, enlarged, and mostly re-written. London: Longmans, Green, and Co. 1885.

*Die Steuerungen der Dampfmaschinen.* Von Emil Blaha. Berlin: J. Springer; London: David Nutt. 1885.

*Our Gold Supply: its Effects on Finance, Trade, Commerce, and Industry.* By Thomas Cornish, M.E. London: E. Fisher and Co. 1884.

*Modern Shipbuilding, and the Men Engaged in it.* By David Pollock, M.A. London: E. and F. N. Spon. 1884.

*L'Année Electrique.* Par Ph. Delahaye. Première année. Paris: Baudry et Cie. 1885.

*Zeitschrift des Architekten und Ingenieur.* Vereins zu Hannover. Band XXXI., Heft 1. 1885. Hannover: Schmorl and von Seefeld. 1885.

*Men of Invention and Industry.* By Samuel Smiles, LL.D. London: John Murray. 1884.

*Stationary Steam Engines, Especially as Adapted for Electric Lighting Purposes.* By Robert H. Thurston, A.M.C.E. London: Trübner and Co.; New York: J. Wiley and Sons. 1884.

*The Engineers', Millwrights', and Machinists' Practical Assistant.* By W. Templeton. Seventh edition, revised. London: Crosby Lockwood and Co. 1885.

*Physical Arithmetic.* By A. Macfarlane, M.A., D.Sc. London: Macmillan and Co. 1885.

## CITY OF WINCHESTER: COST OF SEWAGE PUMPING.

THE tabular information published below should be of considerable interest to many of our readers, both from the sanitary and engine and pump building points of view. For these figures and facts we are indebted to Mr. J. Ashcroft, the resident engineer, and we should like to receive similar reports from other engineers in his position.

*Sewage Pumping Account for the year February* 1st, 1884, *to January* 31st, 1885, *inclusive.*

| | Coal used. | Gals. pumped. | Gals. pumped. | Hours working. | Revs. of engines. |
|---|---|---|---|---|---|
| 1884. | cwts. | Day. | Night. | | |
| February .. .. | 806¼ | 14,871,790 | 8,760,100 | 671¼ | 521,641 |
| March.. .. .. | 1007¾ | 18,383,740 | 12,305,500 | 672 | 651,423 |
| April .. .. .. | 976¾ | 16,177,060 | 10,515,460 | 665½ | 598,399 |
| May .. .. .. | 999 | 18,540,330 | 10,192,770 | 824¾ | 660,456 |
| June .. .. .. | 728¾ | 13,905,150 | 7,239,320 | 656 | 496,045 |
| July .. .. .. | 832¼ | 18,416,110 | 9,331,800 | 833½ | 630,748 |
| August .. .. | 639¼ | 12,873,160 | 6,440,100 | 653½ | 450,184 |
| September .. | 687½ | 13,441,990 | 5,666,790 | 651 | 455,142 |
| October .. .. | 872½ | 16,281,960 | 6,364,250 | 783¾ | 540,684 |
| November.. .. | 641¼ | 12,524,120 | 4,775,500 | 593¼ | 410,521 |
| December .. .. | 604½ | 13,829,250 | 5,996,930 | 624¾ | 460,740 |
| 1885. | | | | | |
| January .. .. | 831½ | 17,837,930 | 7,225,460 | 788¼ | 582,799 |
| Totals.. .. | 9627¾ | 187,082,590 | 94,813,980 | 8417½ | 6,458,762 |

| | |
|---|---|
| Total quantity of coal used in pumping .. | 481 tons 7 cwt. 3 qr. |
| Total quantity of sewage pumped .. .. .. | 281,896,570 gals. |
| Decrease in total quantity of sewage pumped since 1883 .. .. .. .. .. .. .. .. .. | 7,727,374 gals. |
| Decrease in total quantity of coal used in pumping since 1883.. .. .. .. .. .. | 15 tons 13 cwt. 2 qr. |
| Coal used in pumping 1000 gals. sewage .. | 3·825 lb. |
| Cost of pumping 1000 gals. sewage (coal only) | 0·416d. |
| Height to which the sewage is pumped .. | 100-150ft. |
| Population .. .. .. .. .. .. .. .. | 19,000 |
| Number of houses connected to sewers .. | 3000 |
| Average daily amount pumped, 24 hours .. | 770,209·2 gals. |
| Average daily amount pumped per head of population .. .. .. .. .. .. .. .. | 40·537 gals. |
| Total working expenses of pumping station | £946 11s. 7½d. |
| Total cost of pumping 1000 gals. sewage .. | 0·8d. |

## TENDERS.

### FINCHLEY MAIN DRAINAGE.

CONTRACT No. 1.—Mr. Geo. W. Brumell, engineer.

| | £ |
|---|---|
| Neave.. .. .. .. .. .. .. .. .. .. .. | 33,812 |
| Nowell and Robson .. .. .. .. .. .. .. | 30,853 |
| Mowlem and Co. .. .. .. .. .. .. .. .. | 30,330 |
| Bottoms Bros. .. .. .. .. .. .. .. .. | 29,809 |
| Pearson and Son .. .. .. .. .. .. .. .. | 27,990 |
| Kellett and Bentley .. .. .. .. .. .. .. | 27,350 |
| Botterill .. .. .. .. .. .. .. .. .. | 26,897 |
| Peill .. .. .. .. .. .. .. .. .. .. | 26,666 |
| Godfrey .. .. .. .. .. .. .. .. .. | 26,160 |
| Pizzey .. .. .. .. .. .. .. .. .. | 25,776 |
| Mears .. .. .. .. .. .. .. .. .. | 25,300 |
| Beadle Bros. .. .. .. .. .. .. .. .. | 24,978 |
| Dickson .. .. .. .. .. .. .. .. .. | 22,840 |
| Cooke and Co.. .. .. .. .. .. .. .. | 22,788 |
| Killingback .. .. .. .. .. .. .. .. | 22,327 |
| Everett—accepted .. .. .. .. .. .. .. | 20,950 |
| Hill and Co. .. .. .. .. .. .. .. .. | 19,301 |
| Ditto, revised tender .. .. .. .. .. .. | 21,301 |

## CONTRACTS OPEN.

THE following are the conditions for the delivery and manufacturing of rails and fastenings for the Danish State Railways in Jutland and Funen. The Administration for the Danish State Railways in Jutland and Funen ask for tenders for the supply of—

*Steel Rails.*

| | | Weight per yard. | Length. |
|---|---|---|---|
| A | 3400 tons (English).. .. | 63 lb. (English) .. | 24ft. (English) |
| | 100 tons ,, .. .. | 63 lb. ,, .. | 18ft. ,, |
| B | 1300 tons ,, .. .. | 45 lb. ,, .. | 21ft. ,, |

*Fastenings.*

| | | |
|---|---|---|
| C | 8,000 pieces of sole-plates for 63 lb. rails .. | 18 tons |
| D | 10,000 pairs of fish-plates for ,, ,, .. | 118 tons |
| E | 30,000 pieces of bolts and nuts for 45 lb. rails .. | 12 tons |
| F | 8,000 ,, ,, ,, 35 lb. ,, .. | 2 tons |
| | Total | 150 tons (English) |

To be delivered before September, 1885.

1.—The rails and fastenings to be produced in precise accordance with the conditions given below, and the annexed drawings, and must be of the very best quality, carefully manufactured of the very best materials.

2.—The Railway Administration reserves the right to control the manufacturing of the materials and to undertake tests and examinations at the works at the expense of the contractor. Each acceptable rail will be stamped with the mark of the inspector at the works, who will also give a certificate about the acceptance of the fastenings when these are being sent off from the works. The materials which have been accepted by the Control at the works will only be rejected at the receipt at the place of delivery in case they have got damaged—after the Control has accepted them—during transit from the works to the vessel, or on board the vessel, or by overloading, which may have caused fracture, bending, or other damage. Provided that the Railway Administration do not wish to control the manufacturing of the fastenings, the contractor will have, before commencing the manufacturing, to send the Administration specimen of the fastenings, that they may be approved. If the materials after this on receipt prove to be wholly or partly unacceptable—consequently out of harmony with the approved specimen—the receiver shall have full power to reject them, all or that part of them which he deems unacceptable.

3.—Provided that the delivery is executed by sea, the materials to be delivered free in railway wagons at the station at Aarhus. The railway between the harbour and the station of Aarhus may be used according to the common taxes of 1 krone per wagon with c. 6 tons. The loading in railway wagons at the harbour is to be done by the railway at the expense of the contractor. If the delivery is executed per railway, it must be delivered free in wagons at Vamdrup station, yet the Railway Administration reserves the right to demand the materials being delivered at any other railway station in Jutland or Funen on condition that the difference in the freight is re-paid to the contractor. In the event of the date specified for the delivery not being kept, the contractor to be liable to a penalty of 1 per cent. of the value of the wanting quantity for every week the delivery is delayed, and the Administration of the Railways shall then have the power to procure, without any notice to the contractor, all the materials not delivered, at his expense, and shall be free from any obligation to him.

4.—As security for the accurate fulfilment of the deliveries, the contractor must deposit a sum of money equal to 10 per cent. of the aggregate amount of the contract in such effects as the Railway Administration may consider good. The Railway Administration do not require that the contractor shall guarantee for the soundness of the delivered materials, but if he is willing to do it, the tender must include necessary explanations about that. When the deliveries are fulfilled and if the materials are unguaranteed, the contractor will receive the sum deposited by him—eventually with deduction of fines or other sums due. In case of the materials are guaranteed, the contractor, when the deliveries are fulfilled, will only receive half the amount of the sum deposited by him, also with deduction of eventual fines or other sums due; the remaining half will be paid when all his obligations are fulfilled. In case of the contractor not having fulfilled his obligations, the Administration of the Railways shall have the power to retain the deposit furnished by him or the amounts which may have been deducted from the payments made before.

5.—The payment for the materials will be paid by the Railway Administration when the whole delivery has been received by the same. At the same time, in case the delivery is accomplished in several parts, payment on account, less 10 per cent. below the price, will be remitted for each part received, and liquidation will then take place after the Railway Administration has received the remaining part of the delivery.

6.—The tenders for the undertaking of the deliveries must include:—(*a*) Explanation about which part of the delivery of the materials the contractor wishes to contract for; (*b*) quotations of the prices, including all charges of freight, packing up, &c., with the exception of duties; (*c*) the names of the manufacturers, and the works; (*d*) explanations about the materials and the process which is proposed to be used, besides all other explanations, which may be considered necessary to judge of the manufacturing of the articles; (*e*) proposals of the tests which the different materials must undergo; (*f*) statement whether the delivery will be executed by sea at Aarhus Station, or per railway at Vamdrup Station. In case of the tender comprising more of the above by the letters *a* to *f* marked parts of the deliveries, the bidder shall have to submit to, that the Railway Administration only accept his tender for one or more of the offered parts, suppose that the tender do not include an express reservation against it. The tenders further to include an express recognition of the present conditions. Tenders for undertaking of the deliveries are to be handed to the Directorate of the Danish State Railways in Jutland and Funen before the 24th March, 1885. They are to be marked "Tender for delivery of rails and fastenings," and will be opened the said day, twelve o'clock at noon, in the Secretariat of the Railways in Aarhus in the presence of the bidders.

7.—The Railway Administration does not bind itself to accept the lowest or any tender. For the examination of the tenders a term of eight days is reserved, in which time every one shall abide by his tender. The necessary communication will, before the expiration of this term, be made only to him whose tender has been accepted.

8.—After the acceptance of the tender the contract will be concluded. The deliveries not to be transferred to other works without the sanction of the Railway Administration.

9.—The contractor, residing in a foreign country, to have a representative in Denmark, who in every respect can represent the seller, so that all transactions can be arranged with this representative; the payment to be made to him, and all eventual disputes can be addressed to him as the contractors' agent.

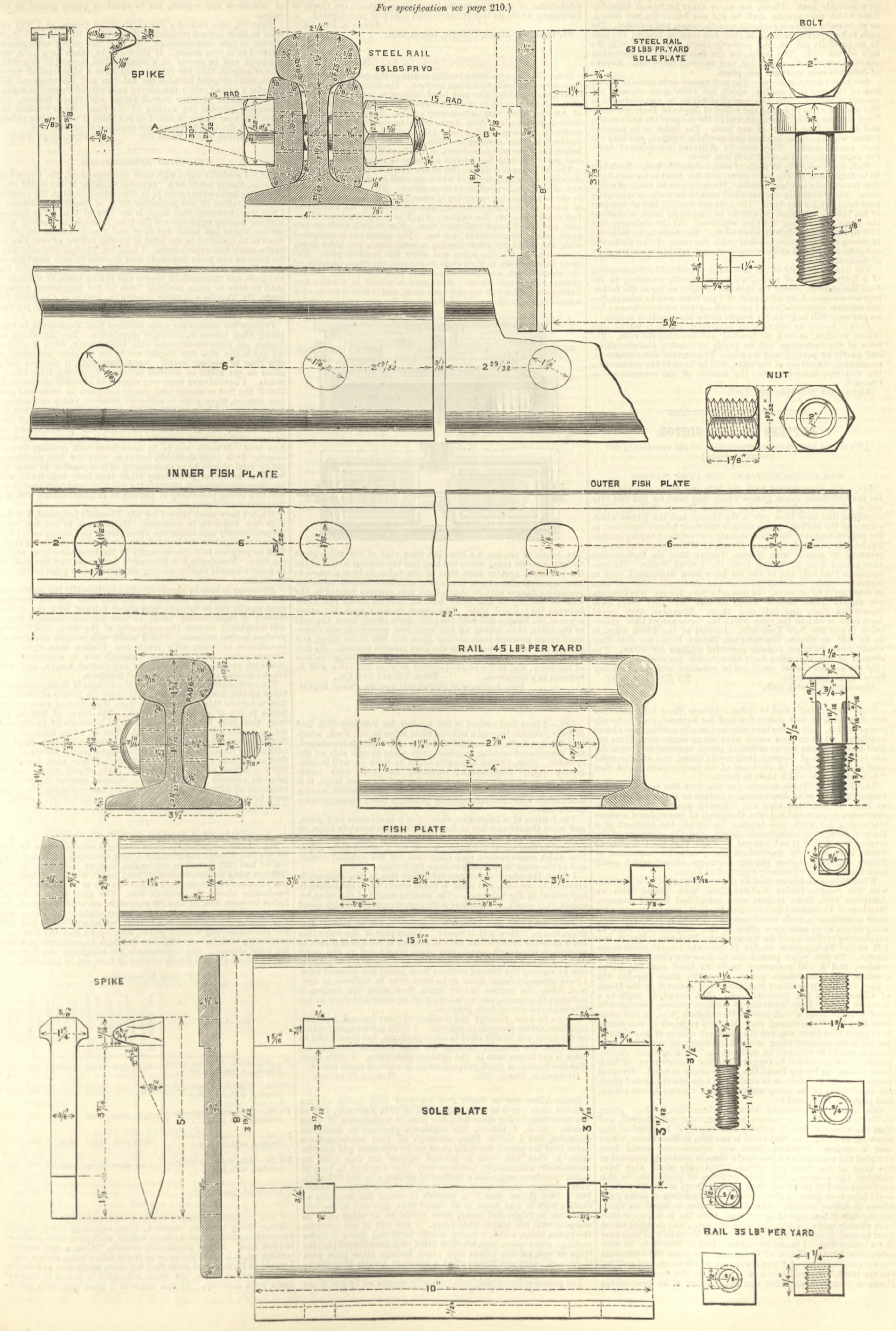
10.—In case of action the contractor shall be liable by his representative to appear before the Arbitration Court and the Ordinary Court of the place where the materials are to be delivered, and to be subjected to the administration of justice, which is authorised by the law of the 25th of January, 1828.

11.—The contractor shall, for no reasons whatever, be entitled to insist upon any additional payment or compensation beyond the stipulated sum.

12.—The following are the conditions for the manufacturing of the materials:—The rails to be in their full lengths, exactly according to the prescribed section and the prescribed weight, which is given in pounds English per running yard English. From the standard weight there will only be allowed a deviation of 2 per cent. on the single rail, and 1 per cent. on the whole delivery. No payment will be given for weight above the standard weight. The deviations from the prescribed lengths not to exceed ⅛in. for each rail. The rails to be stamped with the name of the works and period of manufacture. The quantities that are delivered in short lengths to be marked with oil paint at both ends, for dis-

# CONTRACTS OPEN—RAILS AND FASTENINGS FOR DANISH STATE RAILWAYS.

(For specification see page 210.)



tinction from the other rails. The rails to be free from faults of any kind. They must be manufactured according to the Bessemer or Siemens process, and be of uniform quality and equal hardness throughout. The steel ingots shall, before the rolling, be forged at a suitable heat. Flaws, cracks, or other faults and imperfections which may appear, shall be cut out before the last rolling, so as to make the rails perfectly smooth, clean, and compact. The rails to be perfectly straight in their full running length; the ends to be carefully cut off, and perfectly sharp and square with the axis of the rail. The holes for the fish-bolts to be accurately placed, have the fixed opening, and be clean bored out. Repairs of defective rails must not take place.

*Sole-plates and fish-plates.*—The first named to be made of fibrous iron of the very best quality, which has twice gone through the process of rolling. The last named either to be manufactured in like manner or to be forged and rolled of blocks of Bessemer steel. They must be perfectly straight, and fit the shape of the rail exactly, and be free from faults of any kind. The holes to be punched square with the sides, be clean and carefully finished, and may not have caused cracks. They must be delivered in bundles of ten—five pairs each—well secured with iron wire.

*Bolts and nuts.*—To be made of soft, extensible iron. Each bolt to be forged out of one solid piece, and the head to be sound and free from cracks and laminations. The nuts may be made of rolled iron. The threads in the bolts and nuts to be made so accurately that each nut fits any bolt. The nuts not to stick fast at any part of the thread, but must be able to be turned by hand, without at the same time having any play whatever. At the delivery, each bolt to have its nut lightly screwed on. The bolts to be delivered in strong wooden boxes, marked with the name of the works and complete description of their contents, and marked with the place of destination.

*The standard weight* of the fastenings to be fixed by the weighing of a large number of pieces, which are exactly according to the fixed dimensions. From the standard weight, as far as the fastenings are concerned, an allowance of 2 per cent. will be tolerated on the separate deliveries, and 1 per cent. on the whole delivery; but no payment will be given for weight above the standard weight.

*Tests.*—As far as the rails are concerned, the tests will be with falling weights, as well as bending and breaking the rails. The tests of the fastenings will be partly by bending and stretching, and partly by heating and forging. The further determinations, concerning the nature of the tests, will be fixed in the contract for the delivery, according to the tender of the contractor—see Clause 6.

Aarhus, the 28th February, 1885.

## LETTERS TO THE EDITOR.

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

### THE GOVERNMENT AND THE PUMP MAKERS.

SIR,—The Government have got into hot water over the order for the half-dozen steam pumps which they need for the first fifty miles of water piping on the Suakim-Berber Railway. The questions that have been put in the House, and the letters which certain of the Midland pump makers and their friends have sent to the papers, together show how warmly Government buying outside England is resented. Messrs. Evans, of Wolverhampton, are unprepared to concur with Messrs. Tangye that the Government have gained time by buying from the United States. The contention is that only two of the six have been despatched, each in separate vessels; and that therefore the assumption that all were in stock must be an error. In less time than Messrs. Worthington can deliver them, Messrs. Evans declare that they could have themselves made and delivered them. Moreover, they would have done so at half the price which the Government have undertaken to pay the New York firm. Instead of the £4000 which is to be paid to Messrs. Worthington, Messrs. Evans say that they would have built six equally powerful engines for £2000. The officials at the War-office have been much too ready to assume that the engines needed could not be obtained with equal celerity from engineers at home. AN ENGLISH PUMP.

Birmingham, March 10th.

SIR,—From Land's End to John o' Groats there is an universal cry that trade is bad, orders few and far between, and so keenly competed for, that profits have assumed an airy nothingness almost appalling. It is an open secret that many engineering firms are glad when they can secure orders at prices covering bare cost; for the sole purpose of keeping their works going and their regular staff of men together, in the hope of an early experience of that "turn of the tide which leads to fortune."

The Board of Trade returns for the first two months of the present year are of so discouraging a nature as to cause the nation at large to feel that they are "hoping against hope." With decreasing exports and imports, thousands of unemployed artisans clamouring for work, and begging for bread—the prospect of a Budget showing a considerable deficit, and the certainty of increased taxation, it is but natural to think that the Government would have carefully ascertained the productive capacities of British engineers, before placing contracts abroad which could have been quite as effectively executed at home.

When it became known that an order for pumps, in connection with the Suakim-Berber Railway, had been placed with an American firm, home makers were astonished beyond measure. Members of Parliament endeavoured to elicit some information for their constituents, with scant success. Doubt as to the authenticity of the news soon gave place to dire despondency, when no satisfactory replies could be drawn from Ministers. But it was left to the Birmingham oracles to give the *coup de grâce* to the matter. To this point permit me to draw the attention of your readers, and I will endeavour to be as brief and concise as possible. In yesterday's papers generally there appears the report of an extraordinary incident which occurred in the House of Commons on the previous night. Mr. Brand, in reply to a question by Mr. Broadhurst anent Suakim pumps, proceeded to read a letter from a well-known Birmingham firm, to the effect that they had "ascertained that the duty required of the pumps is so great that there was not the slightest chance of any suitable for the work required being in stock in England, and that many months would be required to make them." Under these circumstances, they proceeded to congratulate the Government on their good fortune in having found the pumps ready to hand. By what inspiration the said firm were enabled to take the stocks and gauge the capabilities of the pump makers of this country is not stated, and probably never will be.

One mode of obtaining sound information, before giving publicity to such an autocratic assertion, was not adopted, and that the common one of making due inquiry. In proof of this allow me to assure you that there is one firm in Manchester, whose card I enclose—doubtless there are others—who could have accepted the contract at a less figure than is currently reported as the price of the American article. Not only could they have accepted the contract, but their facilities of production in this particular class of pump are such that delivery of the first pump could have been given in about two weeks from date of order; the others to follow weekly. That this assertion is based on trustworthy data is best proved by the fact that the firm in question have already made the identical type of pump, and supplied one at least to work in connection with one of Dr. Tweddle's oil lines near the Caspian Sea. Lancashire makers feel it keenly to be thus calumniated in the House of Commons, for were the statement the very embodiment of "the truth, the whole truth, and nothing but the truth," the publication of it through the medium of the House of Commons, at a time when the record of its proceedings must naturally be the cynosure of all nations, is one of questionable propriety. I trust other makers were in the same favourable position as the one referred to, and that they will come forward with a more able pen than mine, and so assist in bringing about a retractation of the unfortunate Birmingham letter in the House of Commons, where its unjust conclusions were first promulgated.

JAMES S. DEWAR.

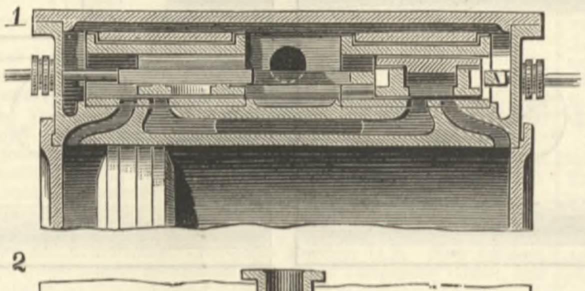
61, Broadway-street, Oldham, March 10th.

### THE FRICTION OF SLIDE VALVES.

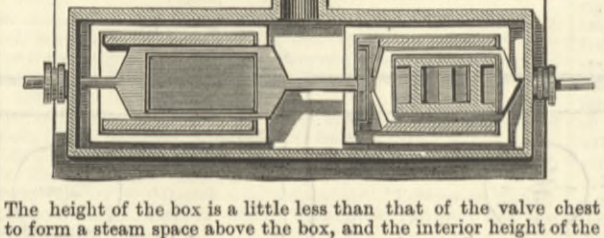
SIR,—We have read your leading article on this subject and letters from correspondents with much interest. The annexed drawing and description of slide valve may be of interest to your readers. The slide valve is already in successful operation in the United States of America with very satisfactory results. Messrs. Cassidy and Adder, ironfounders, New York, write to say that a slide valve under this system applied to a 14in. cylinder steam engine has resulted in their running at 60 lb. on boiler compared to 80 lb. before the valve was introduced, saving from 3000 lb. to 3500 lb. of coal per week, with less friction and wear of valve and connection.

The following is a description of the valve as shown in annexed drawing, a working model of which we shall be pleased to show to any of your readers calling at these offices:—The slide valve shown in the accompanying engraving is constructed in such a manner as to lessen the friction and wear, thereby lessening the amount of fuel required to run the engine. Fig. 1 is a sectional side elevation, and Fig. 2 a sectional plan view. The valve is made in two parts, which are connected by a bar. The piston-rod is connected with the parts by yokes passing around them, the sides being recessed to receive the yokes and allow the requisite play. The parts have recesses in their ends to increase the steam capacity of the steam chest, and have recesses in their lower sides for the passage of exhaust steam. Each part is placed in a valve box having close sides and top and open ends, and which is made of a length equal to the combined length of the part and its stroke.

1



2



The height of the box is a little less than that of the valve chest to form a steam space above the box, and the interior height of the box is a little greater than that of the valve, to form a space to receive a steel plate, upon the ends of which are formed upwardly projecting flanges that fit steam-tight into recesses formed in the ends of the top of the valve box, so that no steam can enter between the top and plate. The steam pressure upon the upper edges of the flanges will hold the plate down closely upon the part of the valve, thus taking up the wear and preventing any downward steam pressure from coming upon the top of the valve, and causing the valve to work with the least possible friction. By this construction there will be very little wear upon the rubbing surfaces of the valve, and so the power required to work the valve will be reduced to a minimum. THOS. VEASEY AND CO.,

Sole Assignees of British and Foreign Patent Rights.

Wool Exchange-buildings, Coleman-street, E.C.,

March 4th.

SIR,—I have just noticed in the number for February 27th last of your valuable journal a relieved slide valve by Mr. Peck, which is, I think, a move in the right direction. The valve is fan-shaped, and the exhaust opening is taken quite away to one side of the cylinder. Now, I think this valve ought to work in well in locomotive engine construction, especially for those with inside cylinders, as in such engines, when the cylinders are large, it is very difficult to find space for a good exhaust port without making this unduly wide, and consequently putting a heavy steam pressure on the valve.

The friction of a locomotive slide valve is in all cases very great, and when the exhaust has to be made disproportionately large on account of the small space left between the cylinders for the exhaust to pass across the barrel, any device deserves close attention which seems to open up a clear road for the exhaust steam, and at the same time clearly reduces the friction.

I think the above mentioned valve does this, as the exhaust is removed to one side, and what is worth more still, is not moved to any extent by the valve-rod. The moving weight of the valve becomes very small, and this is of some consequence in all high speed engines.

The point about this valve which seems to me to require consideration is, "How will it wear?" Every part of the valve face has a different speed—from next to nothing at the exhaust part to apparently one-fourth or one-fifth more than usual at the outer edge. I should anticipate unequal wear, and should try to prevent this by making the bearing surfaces large round the exhaust pipe. I have generally found there to be more wear in surfaces in contact, when the motion is very small, than when the motion is sufficient to overrun, and so to lap up oil or water and draw in the lubricant—on the oil-bath principle.

I hope to hear, through the medium of your journal, how this ingenious device succeeds in practice. I must not trespass further on the space you kindly allot to correspondents, but should like to hear from the inventor whether the total exhaust cavity in his valve is not larger than in the ordinary slide valve. I quite agree that the friction is much reduced owing to reduced mean travel.

Greenwich, March 10th. MARINE ENGINEER.

SIR,—Allow me to thank you for your kind notice of my relieved slide valve in your impression of 27th February, and at the same time to beg space for a few lines in explanation of some points. It is, I believe, the engineer's province to surmount obstacles, but I notice that, although all your correspondents agree that the reason our valve gears are so expensive and troublesome is that the slide is pressed against the face with an enormously unnecessary pressure over that required to keep it tight, none have suggested a method of getting over the difficulty. This enormous unnecessary pressure on the valve is unavoidable, but I have shown that it is possible to escape the necessity of dealing with it, and there is no doubt that, provided its one *bête noir* can be frightened away, there would be no other valve to compare with the simple slide valve. I put out of the question the piston valve, which is heavy, entails large and heavy cylinder castings, great space, and, whether fitted with complicated packing rings or not, no one knows how much leakage takes place with them, and every one knows what a constant trouble they are to keep in an efficient state.

The patent relieved slide valve recently illustrated by you is not a balanced slide, it is one of the simplest possible form, which does not require balancing, and may thus be driven with at most one-fourth the power required to move the ordinary valve. This means a great deal in light gear, freedom from heating, and saving of lubricants and repairs, not to speak of power gained to the engine.

You, Sir, have noticed a few of its other points, so I will not refer to them beyond explaining, if possible, a little more fully, in answer to your correspondent "S. W.," the second arrangement referred to in your notice. If the valve be taken as a lever, and the outer end be moved in a straight line, instead of describing part of a circle, then the fulcrum will have a slight radial movement, and any point between the fulcrum and the outer end will describe a curved path; this curved path will, of course, be crossed by any number of other curved paths, and this, I believe, will effectually prevent any cutting of the face. As to whether the valve will wear evenly or not, I do not think it will matter so long as it keeps tight, and I cannot see anything to prevent this.

Old Charlton, Kent, March 8th. EDWARD C. PECK.

### FLOATING BREAKWATERS.

SIR,—I cordially agree with your correspondent, Mr. Greenway Thomas, that it would be a "national calamity if the whole class of floating breakwaters were to be discredited, through the possible or partial failure of one particular form of floating breakwater." I feel now, however, that there is no fear of this. The opinion that the floating breakwater is the true principle of dealing with surface waves has taken too deep and firm a hold on the public mind to be uprooted by the total or partial failure of one, two, or half-a-dozen first experiments. I hope Mr. Thomas may soon have his fears on this point dispelled; and whether he ever sees his own special form of breakwater sheltering from the raging storms the hundreds and thousands of vessels and fishing boats, or whether it shall be done by some modified form of the suggestions already made, Mr. Thomas will richly deserve the thanks of the public for his early and very earnest labours in creating this strong popular feeling in favour of floating breakwaters.

Perhaps few persons are more cautious than Englishmen in venturing their money on an entire speculation. The Americans or French are more venturesome with their money, when they have it; but in this case the English are by far the most interested in this class of harbour works. Notwithstanding, it requires some effort to get £5000 or £10,000 advanced for trying these experiments. I have always been very careful to advocate the principle that if the first or second trial should not prove an entire and perfect success, there must be sufficient reserved power and courage to try again. I feel entirely certain that floating breakwaters represent the true principle for constructing these much-needed harbour works; but it would be a little too presumptuous to assume that we were going to arrive at perfection at the very first trial. It would not be in accordance with ordinary human events. It is most desirable, however, that the first prominent public trial should be as encouraging as it is possible to make it. With the numerous preliminary trials that have been made, and the thorough discussion amongst the most eminent engineers, there will be a strong probability of arriving at excellent results with the first considerable trial.

While I have much respect for Mr. Thomas's judgment, I differ with him decisively in principle. He proposes to cut the wave perpendicularly into numerous short pieces, and divert each piece horizontally against the diverted current of the neighbouring piece. This he proposes to do theoretically by the least amount of resisting force. Practically it is impossible to reverse the direction of so great a mass of rapidly-moving water without a great amount of resistance.

My theory is that by simply dividing horizontally the portions of the wave moving at different velocities, that portion moving most rapidly can be brought into direct contact with the slower moving or regurgitating parts, so that the counteracting forces will completely destroy the continuity of the wave, and thereby produce perfect stillness. This I claim will produce the desired smoothness of water with much less friction than upon Mr. Thomas's plan. The horizontal principle can be constructed to deal with portions of the wave of any desired length, and will require moving at much less frequent intervals.

The enthusiastic manner in which the citizens of Eastbourne have taken up this matter bids fair to give them the honour of being the first to remove this great problem from the region of mere speculation to one of accomplished facts. The hopes of looking off from this gaily thronged promenade to hundreds of yachts and fishing vessels riding calmly behind a line of white foam-covered floating breakwaters should be sufficient to send such a thrill of enthusiasm through every true Briton that a partial failure of the first experiment should have but little influence upon him, but, like the failure of the first Atlantic cable, should simply act to give him renewed energy and the exercise of greater ingenuity to overcome all difficulties in the way of his accomplishing the great work he had undertaken. LEWIS W. LEEDS.

38, Old Jewry, London, E.C., March 11th.

### TRIAL OF A CORLISS ENGINE AT CREUSOT.

SIR,—In investigating the three examples commented on by you for the loss through condensation during admission, it appears that No. 12 had ·224 loss when condensing without jacket, No. 51 had ·109 loss when non-condensing without jacket, and No. 60 had ·112 loss when non-condensing with jacket—as was to be expected, when condensing shows the greatest loss. The gain through use of jacket between Nos. 51 and 60 cannot be so well compared, the pressures differing so much; but it is very slight. So taking, say, Nos. 53 and 64 as on more equal terms, we have:—No. 53 had ·025 loss non-condensing without jacket, and No. 64 had ·017 loss non-condensing with jacket. The loss in these experiments is below the usual average. The experiments are altogether very interesting, and from the full data a number of facts can be gathered.

*Creusot Experiments.*

| No. of trial. | lb. steam per revolution. | Cub. content. Inches per revolution. | Wt. lb. of one cub. ft. steam. | Cub. inches steam consumed. | Steam consumed. Cub. content. | Loss through condensation |
|---|---|---|---|---|---|---|
| No. 12.—62 lb. steam, condensing, without jacket .. | ·7648 | 5895 | ·1804 | 7326 | 1·224 | ·244 |
| No. 51.—78 lb. steam, non-condensing, without jacket .. | 1·217 | 8797 | ·2155 | 9757 | 1·109 | ·109 |
| No. 60.—110 lb. steam, non-condensing, with jacket .. .. | 1·352 | 7392 | ·2845 | 8215 | 1·112 | ·112 |
| No. 53.—50 lb. steam, non-condensing, without jacket .. | ·8026 | 8797 | ·1538 | 9026 | 1·025 | ·025 |
| No. 64.—50 lb. steam, non-condensing, with jacket .. .. | ·7538 | 8329 | ·1538 | 8469 | 1·017 | ·017 |

Liverpool, March 9th. W. S.

### STREET MAINTENANCE AND SUBWAYS.

SIR,—Every tramway engineer, more especially every London tramway engineer, must heartily concur with your able leader of the 6th inst. As you pertinently remark, "Once a new roadway is taken up, it is never the same as it was before being broken into." I would go further, and state that the more costly and substantial the road broken into is, the more impossible it is ever to repair it again even decently. At this moment I have tramways laid in streets where the parish authorities, thinking doubtless to get a substantial road at the expense of the tramway company, have compelled them to put down granite cubes 7in. deep upon no less than 11in. of concrete.

Hardly a day passes that some part of these streets is not destroyed—I use the word advisedly—by either the gas, water, or Post-office people, who, after having spoilt the continuity of a really fine street, call upon the tramway company to reinstate it at their expense. The tramway engineer then does his best, not to reinstate—for that is impossible—but to make as good a patch as he can. As is frequently the case, a few minutes after the repairs are finished, along comes a heavy van, and down go the setts, and the deeper the concrete the more likely is the road to sink. Next comes a letter from the parish authorities, stating that the road in such-and-such a place is out of repair, and the whole patch has to be taken up and relaid, this time at the expense of the tramway shareholders. The loss and inconvenience to the public consequent upon the stoppage of traffic resulting from these frequent repairs is of necessity very great, and the whole of this loss might be saved by the adoption of a well designed system of subways laid in the centre of the street with cellarage on each side, through which the gas and water supply pipes might be taken to each house from the mains in the subway. Access might be obtained in the case of any given supply pipe through the house to which such supply pipe would lead, while access to the main could be got through a movable covering laid at the safety refuges now so common in London; and if this were insufficient, there should be no difficulty in designing a suitable covering which would provide a good foothold for horses, and which could be laid where necessary.

Such an arrangement would, of course, be costly—possibly impracticable for existing streets; but in contemplated subways, and for new streets, it is worthy of consideration. There may be practical difficulties, such as keeping the joints of the pipes, and the possible bursting of water mains. The idea is not a new one, but it would be interesting to have the opinion of engineers who have studied the question, and who are in a position to state what the practical difficulties would be. The astonishing increase of London traffic will no doubt eventually compel the adoption of some alteration of the present system, and the sooner the better, not only for the public generally, but, as I believe time will show, for the ratepayer himself. J. GURDON L. STEPHENSON.

6, Draper's-gardens, London, E.C., March 9th.

NEWTON'S THIRD LAW.

SIR,—The letter of your correspondent, "An Old Student," in your issue of the 6th, illustrates the wisdom of the Chinese sage Ho Ho Ha Ha, when he remarked, "Schooling can be got by any man, but sense is the gift of the lord of the moon." If your correspondent will think a little perhaps, even he will see that the strain in question does not end with the ends of the rope. It is transmitted by the rope to the crane barrel and by the crane barrel to its axle, and the real static action and reaction takes place between that axle and its bearings, and that axle slides upon these bearings, and at the point where the stress is taken, the "angular velocity"—is that the correct phrase?—of the axle is "tangential to a plane"—is that the correct phrase?—which plane is at right angles to the direction of the strain on the rope. To answer fully your correspondent's loosely worded question would take ten and a-half columns of THE ENGINEER small print; and I am not inclined to go to that trouble. But perhaps you will let me ask him—When you lift up a rope by one end, why is it that the parts of the rope that are above lift those that are beneath them? Surely at any cross section of the rope that you please to take you will find that action and reaction are equal. Why then does the rope suffer itself to be lifted at all? Surely the reply to this question should blow the action and reaction chimera as applied to dynamics, misbegotten by bad metaphysics or worse nomenclature, to the four winds. WM. MUIR.

9, Angel-place, Edmonton, March 7th.

RAILWAY SIGNALS.

SIR,—In reply to your correspondent "Express Driver," page 187, permit us to explain that our patent, as applied to the locomotive Winsford at the Haydock Colliery, is designed to prevent the danger and inconvenience caused by foggy and thick weather in the working of railways, and the patentees claim that the signals against a driver shall be as clear to him in such weather as though there was no fog. Boxes are placed in the permanent way in advance of the present signals, carrying a block which is raised or lowered by the action of the same lever that works the present signals. When the block is raised the signals are on; when it is lowered the signals are off. Levers are suspended underneath the platform of the locomotive, which are caught by the raised block and knocked over. The motion thus given is carried by rods and levers to a dial on the weather-board, which registers by different coloured lights, as well as by semaphores, whether the signal is a home or a distance one. The motion is carried on to the whistle, which it causes to sound until the driver pulls the signals off by simply lifting a handle placed in a convenient position. The signals are thus brought under the driver's notice by sound and sight, and it is impossible for him to pass signals against him without being notified of them. When the blocks are down, the suspended levers pass over them and are not affected.

March 11th. S. A. CROFT.

MILLER'S COUPLED BUFFERS.

SIR,—In his paper on "American Engineering Enterprise," recently read before the Society of Engineers, Mr. Arthur Rigg, C.E., as reported in your columns, says:—"Accidents do occasionally happen; but as Miller's system of coupled buffer is now used on all the trains, it prevents that secondary disaster of the carriages telescoping which used at one period to be the invariable sequel to a collision." From this brief reference I must assume that the Miller system has been well known amongst engineers for a considerable time. I shall be glad to know where I may look for such information as has been already published in respect to what appears to be so important an invention. Are there any Miller's buffers in use in this country, and what has prevented their general adoption? ASSOC. M.I.C.E.

March 12th.

LATIMER BRIDGE SAFETY GUARDS.

SIR,—I and no doubt others should be glad of further description of these, including detail drawings and information as to their percentage of efficiency, as ascertained from actual experiments, or known cases of derailment under various speeds.

March 12th. ASSOC. M.I.C.E.

## BOILER FURNACES.

AN interesting and practical paper on the above subject was read by Mr. Samuel Boswell, of Manchester, at the meeting of the Manchester Association of Employers and Foremen, held on Saturday week.

The President—Alderman W. H. Bailey—introduced the lecturer by observing that Mr. Boswell had had considerable experience in the construction and working of boilers both at the well-known works of Messrs. Galloway and by his connection with the Manchester Steam Users' Association. To his mind, Lancashire people, and the North of England generally, were largely indebted to such men as Mr. Fletcher and Mr. Longridge, and to associations like their own, for the influence they had exerted in bringing about a better construction and working of steam boilers.

Mr. Boswell, in the course of his paper, which was illustrated by numerous diagrams, said boiler furnaces were divided into two distinct classes, "external," or those which were separated from the boiler and "internal," or those which were contained within the boiler itself. The boilers which had external furnaces were no doubt right from a theoretical point of view, the fire lying at the lowest part of the vessel tending to give a perfect circulation; but they were practically a failure except under special conditions, such as clean water, easy firing, or where waste gases were used in lieu of raw fuel, of which they were very wasteful, owing to the great loss by radiation from the furnaces, sides, &c. Consequently the internal flue, from which there was very little loss by radiation, was the most suitable for general work. The internal flue was almost invariably made circular, of such a diameter as to be sufficiently strong to resist the collapsing pressure, and large enough to enable an easy handling of the fire, so as to work economically and consume the smoke; its position had also to be convenient for attention to the fire-bars, ashes, &c., and to allow a ready adjustment of the fire grate and bridge to suit the requirements of the flue. Bridge walls should never be too high, as the gases being drawn through a contracted opening, were liable to pass away only partly consumed, and the flame was somewhat prematurely cooled, whilst some of the plates were liable to become overheated by flame impinging upon them too severely. Efficiency, economy, and immunity from the smoke nuisance were best achieved when there was plenty of boiler power at hand. Although cast iron and copper possessed numerous advantages over other metals, they also had their disadvantages, and as they were now seldom used, except for special purposes, he would pass on to deal with wrought iron, which had perhaps been used to a greater extent than any other material for boiler furnaces, but he did not think it would long remain in general use, as it was fast being superseded by mild steel manufactured specially for boiler furnaces. In the selection of iron for boiler construction he should recommend that only the brands of the well-established houses should be used, and he might add that it did not necessarily follow that iron which would carry the required load in tension was the best for furnace construction, as ductibility and tenacity were of great importance, and any material that showed the slightest trace of failure owing to workshop manipulation should at once be cast aside as unfit for boiler purposes. It had been erroneously supposed that seeing the material is under a compression, almost any brand would do; but this was a fallacy, as a boiler furnace was never put to the test until such a case as shortness of water occurred, when with any margin of safety, however great, it was certain to lose its strong circular form, and become subject to a tensile bending and overheating strain, and unless the material was very tenacious and ductile it would rupture, as was often the case, with fatal results. Seeing that the improvements in the manufacture of iron could scarcely be said to have kept pace with the increase of pressure used, they would have to turn their attention to the more suitable material which was provided in mild steel. A few of the advantages of steel, in addition to its tenacity and ductility, were its freedom from blisters or laminations, which were seldom seen, or when they did occur were generally found to be very slight and unimportant. It was now made so homogeneous, and if it might be said to have any fibre, this ran equally in all directions; the percentage of carbon was also so low and so well controlled that it was now easily welded and worked by men, when once they became accustomed to handling it, whilst it might be purchased at half the cost of such brands as "Lowmoor." But all its advantages were entirely lost when it was badly handled, and it became less reliable than common iron; first-class boiler-makers, however, seldom used any other material for furnaces. Perhaps the strongest form of boiler furnace was the circular form, as well as the most convenient for making and working, as any portion could at any time be easily gauged for distortion; but when a flue was immersed in water, as in a boiler, there was a tendency, from its buoyancy, to rise at mid length and so lose its circular form, becoming oval, major axis horizontal. This might account for weak flues collapsing top and bottom, as was often seen; but as few furnaces were now made without some kind of expansion or anti-collapsing seams which would take up this movement, and so strengthen the flue, the duty of calculating the strength was now dispensed with. In construction, the best seam for the longitudinal direction was the welded seam, but as the circular seams had to take up and give out expansion and contraction in different directions, as well as to be of such a form as to strengthen the flue against collapse, they must consider which was the best seam out of a number now available. The lap joints would allow a circumferential expansion and contraction, but not a longitudinal one, and it was very seldom used; the T was very rigid, and of no use except to strengthen against collapse, as it restricted freedom in all directions; the flanged seam would take up and give out expansion and contraction in a longitudinal direction, only restricting the circumferential expansion in the same degree as it resisted the collapsing pressure; the Bowling hoop, and also the Hawksley Wilde flange, would yield to expansion and contraction in any direction, but, like all the before-mentioned seams, possessed one inherent defect, which was that when repairs were required the front end plate had to be cut away to withdraw the furnaces. To overcome this difficulty he—Mr. Boswell—had designed and patented a furnace and seams which would resist collapse, yield to expansion and contraction, and could be readily withdrawn from the boiler without the removal of the front end plate or fittings, whilst at the same time an effective heating surface was secured, and no costly construction was involved. The chief feature of this design, which was exhibited in diagram, was that a conical form was given to each section of the flue. Mr. Boswell then stated, that in working, care should be taken not to try to get a greater amount of work out of a boiler than it was capable of giving with efficiency, for although as much as 30 lb. of coal per square foot of grate could be consumed, it was more economical to work at about 20 lb. per square foot when it could be properly and fully consumed. Care should be taken to adopt means to prevent loss of heat by radiation, especially from the front end plate, for front plates, exposed to a piercing atmosphere, with furnaces heavily fired, had been known to give trouble and require repairs after a very short career, owing to the extreme limits of expansion and contraction; and as the furnace was liable to suffer from the failure of some minor detail or fitting, a good reliable fusible plug or low-water valve should be applied. The amount of deposit was not always a guide as to the suitability or otherwise of the feed-water; peculiar character was of more importance than quantity, as $\frac{1}{32}$in. thickness of some kinds of deposit would cause more trouble than $\frac{1}{2}$in. of others, those containing lime in carbonates generally being the worst, particularly when grease was present in the feed-water. Steam users were occasionally unduly alarmed at the appearance of some slight blister, fracture, or other defect, and at once sent for some local boiler-maker; this, however, was often a mistake, and boiler-makers had been known to renew a plate when perhaps one hour's caulking or dressing might have served to leave the boiler in a safer and better condition than after the application of a new plate. Although the working boiler-maker might be qualified to do a good repair, he was not always qualified to advise, and the best and cheapest course for a steam user was to call in the insurance company's inspector or a firm of boiler-makers who kept a qualified inspector, so that the repairs might be done efficiently and cheaply. Inspectors were often called in to test boilers after repairs, which were found to be quite unsuitable to their requirements, whereas if an inspector had been called in at first the repairs might have been more satisfactory at a much less cost, whilst the workmanship could not be doubted. In conclusion, Mr. Boswell said the object of his paper had not been to give a theological exposition, but to lay before the members a few facts and practical suggestions which had occurred to him during his avocation as boiler-maker and inspector.

The President said they had never had a more practical paper before the Society. The scientific treatment of boilers had not been much thought of until a comparatively recent period. Until a few years back, almost any one could be a boiler-maker, but now, in that district at least, boiler-makers carried on their business on thoroughly scientific principles.

Mr. Thos. Ashbury, C.E., in proposing a vote of thanks to the reader of the paper, said that district was pre-eminently a boiler-making district, and they could not anywhere in the world, within a radius of twenty miles, find so many practical and first-class boiler-makers.

Mr. Councillor Asquith, in seconding the motion, remarked that there need be very little trouble with the smoke nuisance if they had plenty of boiler room, but scarcity of boiler room was one of the defects in the warehouses of Manchester.

The vote of thanks was unanimously passed, and the proccedings closed.

## AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, February 27th.

DURING the past few days several important railway enterprises have been developed. New roads are to be constructed as soon as capital can be borrowed. Several branch lines will be constructed. Numerous feeders are projected. A large amount of bridge building work is talked of, and within six days orders for at least 6000 tons of bridge iron have been placed, to be delivered during the summer. A number of new roads are projected, to develope valuable mineral and agricultural territory. Railway builders are anxiously awaiting the improvement in the general trade, in order that idle capital may be invested in railway properties, and manufacturers are preparing to meet these new requirements upon very reasonable terms; in fact, the productive capacity is so great that profits are merely nominal. Two thousand five hundred miles of new railway have been recently projected. One line is 230 miles long, extending from Parkersburg, on the Ohio, eastward, through West Virginia, developing one of the richest mineral fields in America. A great deal of capital is being invested in mineral, timber, and agricultural lands, which are being purchased at from 2 dols. to 5 dols. per acre, in view of the prospective railway building, which will develope the new territory. Rail makers have inquiries for large quantities of rails for these new enterprises, and the probabilities of business are certainly more encouraging this week than they have been for months. Large blocks will be placed at 26 dols. at mill; small logs are selling at 27 dols. and 27·50 dols. One unfavourable feature at present is that the earnings and traffic of railways is still below the average, but the conditions are favourable to an improvement, and railway managers have confidence that an improvement will develope itself within thirty days. The extremely cold weather of the past thirty days has retarded traffic and depressed earnings, but there is every reason to believe that a reviving demand is on its way, and that the iron trade of the State will be considerably in excess of the volume of last year's business.

The lumber interests of the country are taking advantage of the favourable logging weather, and are making immense cuts in all lumber districts. Architects and surveyors, both here and at other Altantic coast cities, report a season of building activity as near at hand. Capital will doubtless take advantage of the extremely low prices, and therefore a season of comparative activity may be safely looked for. The textile manufacturing interests are still afflicted with very active competition. Production is in excess of demand, stocks are large, wages are being reduced, and serious strikes are in progress. The manufacturers of machinery and motive power of all kinds have, within the past two weeks, received a good many orders for the making of machinery for municipal requirements and railroad purposes and manufacturing demand. The manufacturing interests of the country generally are prepared for an improving business, but few specific evidences of activity can be furnished; but there are numerous inquiries for material covering all kinds of iron and steel, which will develope into business during March. The labour question is giving but very little trouble.

Our highest commercial authority here will shortly publish tables of labour and wages, showing that, as compared to one and two years ago, the condition of American labour is better, because of the decline in breadstuffs and wearing apparel.

To-day's quotations on the Metal Exchange are 16 dols. 50c. to 17 dols. 25c. for iron. Tin is unsettled at 17 dols. 80c. for spot and 17 dols. 40c. for futures; tin-plate, 4 dols. 35c.; copper, 11 dols. to 11 dols. 35c.; lead, quiet; foreign, 4 dols. 30c.; spelter, dull, 4 dols. 75c.; merchant iron, 1 dol. 75c. to 2 dols.; nails, 2 dols. 20c. to 2 dols. 30c.; plate iron, 2c.; shell, 2 dols. 50c.; flange, 3 dols. 50c.; angles, 2 dols.; tees, 2 dols 50c.; beams and channels, 3 c.; steel plate, 30 dols. at mill. The prospects for an increase of productive capacity are better to-day than for some weeks, by reason of a greater number of inquiries in brokers' and manufacturers' hands. At the same time the iron trade is surrounded with many uncertainties. Should the railroad companies be heavy buyers, demand will improve. The impending change of administration will probably be productive of good results. Congress has refused to order the suspension of silver coinage, and has left a good deal of unfinished work for future consideration. Political matters have much to do with business, and when the new President announces his policy and his cabinet, it will go far to strengthen or weaken confidence in the new incumbent.

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

(*From our own Correspondent.*)

THE market is this week again exercised by the increasingly critical condition of Russian negotiations. In some directions the effect of the war feeling upon traders here is to infuse a spirit of more earnestness into transactions, and to make them firmer in price. Should hostilities occur, the demands upon this district would be considerable. A more legitimate cause of strength is the revival in the American iron and steel industries, accompanied by an average advance of quite 5 per cent. in prices.

Orders do not yet show much improvement, though colonial and Government requirements are affording a considerable amount of employment. Many ironworks, however, continue in only partial operation. Messrs. Noah Hingley and Sons are a prominent exception, since they are busy, largely on Australian orders for bars and other merchant sections. From the Round Oak Works of the Earl of Dudley, horseshoe bars are going away somewhat freely to Australia. Marked bars remain at £7 10s. to £8 2s. 6d.; medium bars are £6 10s.; ordinary, £6; and common, £5 12s. 6d. down, occasionally, to £5 5s.

The output of sheets will be increased next week by the partial re-start of the Capponfield Works, formerly belonging to the Chillington Iron Company, under new proprietary of Messrs. William Molineux and Co. Best thin sheet makers reported this —Thursday—afternoon in Birmingham large inquiries from the colonies and North America, and certain of the firms are very busy. Others, however, are laying off some of their mills. Common merchant singles are £6 10s., and galvanising singles, £6 12s. 6d. upwards. Shropshire sheet makers demanded better prices, and quoted singles £7 10s., Liverpool; doubles, £8 2s. 6d.; and lattens, £9 2s. 6d. Ordinary rolled wire rods for fencing were priced by the same people £6 5s., Liverpool.

Messrs. John Lysaght and Sons, galvanisers, whose sheet iron-works are at Wolverhampton, are contemplating increasing their production of black sheets, and they are at present turning out some 500 tons of galvanised sheets a week, chiefly on account of Australia, South America, and the Cape. A proportion of this output is being made up into roofing and constructive work. Although the large Wolverhampton works are kept going as fully as possible, the firm are yet unable to make all the black iron which they consume, and they contemplate taking an additional works.

Heavy tube strip is decidedly firmer in price. The makers who have been successful in getting the orders for the strip mostly needed in the making of the pipes to be laid in the Soudan are hard at work getting off lots of from 800 to 1000 tons in a line.

Pig iron is going off in limited parcels, and prices do not improve. An evidence of the dissatisfaction of the Midland makers with current rates is the circumstance that several furnaces are just now being blown out in Derbyshire and Northampton. Best Derbyshire pigs are 42s. delivered, and common 40s. 6d., native all mine pigs are 57s. 6d. to 60s.. part mines 42s., and cinder sorts 36s. 3d. to 37s. 6d.

The machine and tool firms of Birmingham and the district are doing a little more. In some cases the average complement of hands is employed, and where men have lately been discharged a few are being taken on. The orders are both for home and for export, for Government and for private use. Among the orders received on Wednesday were some from the Chinese Government, who require half-a-dozen lathes, and some bullet making machinery. The work will be executed by Messrs. James Archdale and Co., of the Manchester Works, Birmingham. And an order from the Mint has likewise just come to hand at these works.

A shaping machine for planing armour plates has been finished by Messrs. Archdale, and at the close of the week it will be despatched to the Chatham Dockyard. This firm are considerable producers of shaping machinery, but this is, perhaps, the largest tool of the class which they have yet turned out. Its weight is 24 tons. The total length of the bed is 18ft.; the length of the stroke of the ram is 3ft., and the longitudinal traverse of the saddle 9ft. The power of the gear can be made 20 to 1, but when it is required to run the machine faster it can be reduced to 12 to 1. Alike in circular, horizontal, and vertical cutting, the tool is self-acting. It is driven with a link motion, which gives a quick return stroke to the ram. The links and the connecting-rod are of cast steel. Small and large work can be operated by the circular motion. The ram being adjustable, rack and pinion can be used if it be desired. The link motion is the style adopted by this firm in all their planing machines. Messrs. Archdale tell me that they obtained this order in full competition, their design being considered by the dockyard authorities as the most suitable for the purpose in view. A small-sized shaping machine the firm some time ago sent to Woolwich Arsenal. The Roumanian and Danish Governments have each also obtained tools from this firm.

Constructive engineers and machinists in this part of the kingdom are looking to secure some of the work which is just now needed for the Indian State Railways and for the Oude and Rohilkund Railway. The former are requiring plate and triangulated girders, steel transverse sleepers, steel fish-plates and fish-bolts and spikes. For the Oude Railway fifty underframes for covered goods wagons, pumping machinery, and pipes and hydrants are desired.

Among Birmingham and Wolverhampton engineers considerable interest is still excited upon the action of the War Department in permitting the purchase of American pumps. Mr. Richard Tangye, the chairman of Tangye's Limited, defends the Government. He states that his inquiries have satisfied him that "the duty required of the pumps was so great that there was not the slightest chance of any suitable for the work required being in stock in England, and many months would be needed to make them." Mr. Tangye congratulates the department upon having found the pumps ready to their hand.

Mr. Tangye's view is not that, however, of by any means all the heavy pump makers here. Messrs. Joseph Evans and Sons, of Wolverhampton, hold that Mr. Tangye is incorrect in his supposition that no manufacturer could have supplied the pumps in a reasonable time. They do not hesitate to assert that they should have been very pleased to have guaranteed the delivery of the six "Duplex" pumps, equal in capacity to those from America, within thirty days, and that at a cost of about £2000, instead of nearly £4000.

The Council of the Wolverhampton Chamber of Commerce, in their annual report, remark that great disappointment was felt at the announcement that certain engines and pumps had been ordered in New York, "which it is stated could have been supplied from this town at least as good in quality, quicker in point of time, and at 20 per cent. less cost."

The assurance of Mr. Brand that it is the intention of the War-office, having got a pattern, to employ English manufacturers, and a statement by the Under Secretary of State for the Home Department that he is informed that tenders will be issued with the least possible delay, are assisting to lessen the dissatisfaction which was at first caused. The pumps are of 18in. steam area, 5in. water area, and 18in. stroke.

The reply of Mr. Brand concerning the contract for portable railway plant and five 18in. gauge locomotives, placed with Mr. W. G. Bagnall, of the Castle Engine Works, Stafford, is regarded here as wholly satisfactory. It is beyond question that small locomotives of the class which have just been ordered are a speciality of the firm.

As to the pipes, there is now no room for doubt that they will all be manufactured in this country, and possibly in this district. Dr. Tweddle, of America, was associated with Messrs. John Russell and Co., of Walsall, in the laying of the experimental line of three miles at Aldershot a year ago, and Messrs. Russell could have secured the whole of the contract for the first fifty miles if they had been able to supply the pipes within the stipulated time. Mr. W. B. Harrison, the chairman of the company, states that there can be no reason, in case of future requirements, why everything in connection with the line should not be manufactured in this country, provided time is given.

The pipes for the oil line which Dr. Tweddle is laying in the Caucasus have been mostly made in this district.

The railway wagon and carriage builders keep busy, although no additional work has been placed for the Suakim Railway. I may, however, remark that some months ago, when first the expedition to Khartoum was contemplated, 400 wagons of Messrs. Brown, Marshall, and Co.'s build were supplied to the Government and were shipped to Egypt. The same firm are now supplying 174 wagons and brake vans for the new Hull, Barnsley, and West Riding Junction Railway, and it is understood that some 250 wagons for the same line have been ordered elsewhere. The coaches have gone to Manchester. The Birmingham Railway Carriage and Wagon Company are active in much part on export account. Amongst the orders that they have recently accepted are handsome saloon carriages of unusual size for South America.

The wages movement in the nut and bolt trade has proceeded so far satisfactorily, yet, unless one employer at Darlaston consents before the 19th instant to join the Masters' Association, there appears some probability that the agitation may have proved fruitless. This firm only employs twenty-five men, but it is in a position to dictate its own terms. Much sympathy is expressed in the movement, and resolutions in its favour have been passed by several bodies.

The opinion of the Council of the Wolverhampton Chamber of Commerce upon the present state of trade is, that if the suggestion is correct, that it is due to the enhanced value of gold, there is no prospect of better prices either in South Staffordshire or elsewhere. The most hopeful outlook is that the development of railways in India will facilitate an interchange between the empire and this country, of corn on the one hand, and manufactured goods on the other; but, in the opinion of these traders, that development is not going on at a rate likely to produce any marked change.

Mr. R. Smith-Casson, the general manager of the Round Oak Ironworks of the Earl of Dudley, last week read a paper on "Gaseous Fuel" before the Birmingham section of the Society of Chemical Industry. Mr. Casson remarked that the most perfect process ever used for producing heat by combustion was the oxy-hydrogen blow-pipe. The principles deduced from these considerations had been embodied in the construction of furnaces which had been in use for seven years at the Round Oak Works.

Prospects in the North Staffordshire iron trade are better. Specifications are coming in rather more freely, and the mills are running about four turns per week. Bars are selling fairly, especially for the Australian and South American markets. Prices are a shade firmer. Common crown bars are £5 10s. to £6, and inferior qualities £6 10s. to £7 10s. Puddled bars are £3 to £4. The plate trade continues unsatisfactory. Ordinary sorts delivered Liverpool, or equal, are £7 to £7 5s. Heavy sorts are £7 10s. to £8. Hoops average about £6. Steel is coming into the district in increasing quantities.

## NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

*Manchester.*—There is very little change to report from week to week in the condition of the iron trade of this district. Business in all branches both of the production and the manufacture of iron continues dead, and buyers are still held back by a want of confidence in the future. No one will buy for stock, and where occasional orders of a speculative character are given out, it is only where long forward deliveries can be obtained at excessively low prices. Generally, however, there is a continued indisposition to go beyond actual known requirements, and these are only small.

The Manchester iron market on Tuesday was moderately well attended, but transactions were again only on the limited scale that has obtained of late. Nominally quoted prices were unaltered, but there is a continued under current of weakness in the market, which leads to very low prices being taken to secure orders. For Lancashire brands of pig iron the quoted list rates remain at 41s. to 41s. 6d., less 2½, for forge and foundry qualities delivered equal to Manchester. For some weeks past, however, as I have previously reported, local makers have been prepared to give way 6d. per ton on these figures to secure orders, but they find they are still considerably undersold by district brands, and the necessity of some further concession if they are to secure orders is now being pressed upon them. The leading makers of Lincolnshire iron quote about 40s. 6d. to 41s. 6d, less 2½, as the basis of their minimum prices for delivery equal to Manchester, but there are sellers of some of the district brands open to take 39s. 6d. to 40s., less 2½, and there are very few orders being got at much above the last-named figures, whilst in one or two exceptional cases even less has been taken. There is comparatively very little doing in North-country iron, but where transactions are reported the basis of prices is about 43s. 10d., net cash, for good foundry Middlesbrough delivered equal to Manchester, and this figure has been taken for deliveries over the whole of the year.

In manufactured iron business continues very slow, and works are only being kept going about four days a week with orders coming in from hand-to-mouth. Some of the makers still hold to £5 10s. for good qualities of bars delivered into the Manchester district; but for prompt specifications £5 7s. 6d. is in most cases being taken for both Lancashire and North Staffordshire makers, with hoops to be got at £5 17s. 6d., and local-made sheets at £6 17s. 6d. to £7 per ton. Makers, however, show a disinclination to take these low figures for long forward delivery, and merchants who have been "bearing" at all heavily, are finding it difficult to cover their sales.

A general tendency to quiet down is reported in the engineering trades, and, to keep works going, any new orders giving out are competed for at extremely low prices.

The giving out abroad of Government contracts for engineering work is again causing some commotion in the trade, and the pump makers in this district are anything but satisfied with explanations given in the House of Commons with reference to the orders placed in America for pumps for the Soudan. Whether the pessimist view taken by Messrs. Tangye as to the abilities of makers of this class of machinery to meet the requirements of the Government applies simply to Birmingham or not, it has given considerable offence, and so far as Lancashire is concerned, I know of at least one firm in the Manchester district who would gladly have accepted the contract for the Suakim-Berber pumps, and have given the delivery of the first in from fourteen to twenty-one days of confirmation of the order. Not only so, but the firm would have brought actual past experience to bear upon the work, as they have already made precisely the same class of pumps for identical work abroad.

Messrs. J. Spencer and Co., of Hollinwood, near Manchester, have just completed a specially designed lathe for studs and crank pins, with the object of dispensing with all forge or smith work in the operation. This tool, which has been made for the works of Messrs. Buckley and Taylor, of Oldham, may be described as a 12in. centre hollow spindle capstan rest lathe, and it is probably as large a size in this class of tool as has been made. It is adapted for turning all kinds of studs, small crank or any description of pins, out of the solid bar up to 4in. diameter. The fast headstock of the lathe is double-geared, with a 4⅛in. hole right through the spindle, and a cone chuck at each end to secure the bar which is passed through the spindle. The bar can be operated upon by five separate tools of various forms for different kinds of work, such as roughing out, finishing, squaring, cornering, pointing or ending, without any forging or smith work on the bar being required, and the studs are finished at one setting without loss of time for changing or resetting tools. A screwing apparatus is also attached which will screw up to 2½in. Whitworth threads, and this can be run along the slide so as to be out of the way of the capstan rest when turning. The lathe is also fitted with a loose headstock, so that it can be used as a general tool for doing work between centres when required. The bed of the tool is cast in the form of a trough, so arranged as to collect the soap and water used when the lathe is in operation; and the slides are protected from any injury which might arise from the cuttings and water. In the screwing head a special feature is introduced that the dies do not require any machinery or fitting into the holders, the die being simply fixed into a sliding holder that can take any diameter which is required, and the dies are made adjustable to meet wear and tear. In their patent self-feeding hand drilling machines, which are pretty well known, Messrs. Spencer are bringing out some improved designs, and they have introduced a new swivel bracket to enable the tool to drill at any angle. In a large planing machine for taking in work 12ft. long, 4ft. 6in. wide, and 4ft. high, which the firm had also in hand, I noticed one or two improvements. The table is driven by a large spur wheel, in place of the small rack pinion usually employed, and this has been introduced to give a smoother motion when cutting; the table has also slides of flat surfaces, instead of the usual V slides, and the gearing is placed behind the upright, so that the cross slide does not interfere with the working of the strap in any position. For the lubrication of the table slide rollers revolving in oil are fitted into recesses in the bed, with a spring that keeps them up to the table, so that they touch it every time it runs across.

An improved fire-escape, which is a combination of the advantages of the fly ladder and telescopic systems, and in which the difficulty of carrying a wire shoot as well as box on the one escape has been very successfully overcome, has been built by Messrs. W. Rose and Co., of Manchester. The escape is constructed of two ladders, one sliding over the other, and the rising ladder is wound up and down by a powerful windlass, so arranged that the spokes of the two ladders, in whatever position, are always kept directly opposite to each other. The box is ingeniously arranged to allow the copper wire shoot to pass through the centre, and by the combination of the box and shoot a fire-escape and a standing fire station are obtained in the one apparatus.

With the exception that the cold weather of the past week has helped to give a little more activity to the demand for house fire classes of fuel, the condition of the coal trade remains without material change. Common round coals, for iron-making and steam purposes, continue bad to sell, and can be got at very low prices. Engine fuel, so far as the better sorts of slack are concerned, is perhaps not quite so plentiful; but the demand is still only moderate. Although there is no quotable alteration in prices, the tendency continues in the favour of buyers, and when contracts have to be renewed generally some concession on old rates is obtainable. At the pit mouth best coal averages 8s. 6d. to 9s.; seconds, 7s. to 7s. 6d.; common, 5s. 3d. to 5s. 9d.; burgy, 4s. 6d. to 5s.; and slack from 2s. 6d. and 3s. for common up to 4s. for the best sorts.

Shipping has again been quiet, with steam coal delivered at the high level, Liverpool, or the Garston Docks ranging from 6s. 9d. for common, to 7s. and 7s. 3d. for the better qualities.

*Barrow.*—There is no improvement in the demand for pig iron, although the outlook is more cheerful. Enquiries are made with more spirit both by home and continental consumers, and it is expected this will lead to new business during the ensuing few months. Makers have already entered into fairly large delivery engagements, but they are not of a pressing character. Prices are firm, but are not quotably altered. No. 1 Bessemer is quoted at 44s. 6d. net, immediate delivery, and 45s. 6d. forward delivery; while mixed parcels are quoted at 44s. per ton net at makers' works. Stocks remain heavy, but are not increasing. In the steel trade there is nothing new to report, except the acceptance of some fair orders for railway material. Some Government contracts are expected in this line. It is reported that orders have been freely given for general steel goods, such as bands, wire, billets, bars, &c., and that there is a fair trade doing in mild and hard steel for cutlery and general purposes. Shipowners have booked new orders this week, including two large 6000-ton steamers placed with the Barrow Shipbuilding Company. The graving dock shipyard at Barrow, which has been closed for a few months, is about to be re-opened. Iron ore finds a poor market at from 8s. 6d. per ton net at works. Coal and coke dull, and in limited request. The work of strengthening the viaduct on the Furness Railway over the rivers Severn and Trent has been commenced. It is intended to make it sufficiently strong to enable the heaviest engines to pass over it at ordinary speed. Some difficulties are pending in this district relative to the increase of royalty charges on iron ore, and in one or two cases the closing of important mines, such as those of Hodbarrow and Lindal Moor, are threatened.

## THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

I OBSERVE it was stated at the Miners' Conference at Rotherham on Monday that there has been during the last two months a largely increased quantity of coal sent to London. As 1884 showed a very heavy drop on the tonnage of 1883, it is only fair to all parties to note that in January and February of 1884 the quantities sent to the metropolis were unusually low, owing to London merchants and consumers laying in heavy supplies in the latter part of 1883 in anticipation of a strike. This accounts for the tonnage in the early months of 1884 being abnormally limited. The quantity of coal carried to London last month by rail was 578,186 tons, as compared with 547,035 tons in February, 1884; and for the two months to February 28th, 1885, 1,216,432, as compared with 1,116,710 for the two months to 29th, 1884. The increase in February last was 31,151, and the increase on the two months, 99,721. Messrs. Newton, Chambers, and Co., of Thorncliffe, again head the list, their tonnage for February being 27,018.

I have just been examining the official return of the Hull Chamber of Commerce and Shipping, showing the quantity of coals brought to Hull from each colliery in Yorkshire and other districts. The total quantity sent was 84,416 tons, as compared with 90,536 tons for February of 1884. The exports from Hull to foreign countries have increased from 26,435 tons in February, 1884, to 32,540 tons last month. Germany, with 5747 tons, heads the list, Belgium, with 4121 tons, coming second, and Malta third, with 3754 tons.

The Board of Trade returns for the month of February continue to show a serious decrease in our exports in iron and steel. The value sent last month was £1,480,087, as compared with £1,892,565 and £2,023,825 for the corresponding months of 1883 and 1884. In coal, coke, &c., the respective values in these three periods have been £676,427, £739,696, and £691,557. Pig iron for the same months shows values of £224,382, £164,361, and £144,601. In hardware and cutlery the value exported last month was £216,626, as compared with £294,633 and £231,090 for the corresponding months of 1883 and 1884. The increasing markets are Russia, Germany, Argentine Republic, and Australasia. The markets which show a decrease are Holland, France, Spain and the Canaries, United States, Foreign West Indies, Brazil, British North America, British Possessions in South Africa, and British East Indies. In steel rails the value exported last February was only £170,382, as compared with £301,670 and £230,886 for February of 1883 and 1884. To Russia, Sweden and Norway, Germany, Egypt, and British Possessions in South Africa, no rails were sent last month. To Holland there was only sent the value of £32; to Spain and Canaries £28, against £12,498 for the previous February; to Italy £7, against £6119 for February, 1884, and £32,295 for February, 1883. The United States shows a tremendous falling off—£19,371 for February, 1883, £18,833 for February, 1884, and only £130 for the last month. Heavy drops are also shown by Mexico, Brazil, Argentine Republic, Chili, Peru, and Australasia, the latter market having decreased from £80,513 to £39,638. British North America, on the other hand, has increased from £685 to £11,478, and British East Indies from £26,531 to £75,231. The exports of unwrought steel have fallen from £79,672 to £61,243; and of manufactures of steel and iron combined from £29,432 to £22,932. Bilbao River and Cantabrian Railway Company is the title under which the old Bilbao Iron Ore Company is known. The company was originally formed to supply the steel manufacturers in England and elsewhere with high-class hematite iron ore, for which the Spanish mountains of Bilbao are famous. Of late years they have found their business becoming very much that of a carrying company—hence the change of title. In their annual report for 1884 the directors state that the gross receipts of the railway for the past year have amounted to £74,362 18s. 5d., and the working expenses—inclusive of royalties—to £39,181 1s. 9d., or 52·68 per cent. The total shipments of ore from the Bilbao River were in 1884, 3,196,548—metrical—tons, against 3,428,187 tons in 1883, showing a decrease of 231,639 tons. The falling off in the trade of the river was due to the quarantine restrictions in force during nearly four months of the year, and to the very severe depression experienced in all branches of the iron and steel trade. The directors add that, in face of these adverse conditions, it is all the more satisfactory that the company carried and shipped in 1884, 603,571—English—tons, against 602,352 tons in 1883, and that the net revenue of 1883 has also been maintained, although there was necessarily an increased proportionate cost of working the largely reduced traffic carried during the existence of quarantine, which caused a general disturbance of the company's operations. On January 1st there was an estimated stock of a quarter of a million tons of ore in the various deposits alongside the company's line, and the shipments for the first two months have been 114,336 tons, against 105,220 tons in the corresponding period of 1884.

A serious accident took place at the Holbrook Colliery, Eckington, belonging to Messrs. J. and G. Wells, on Saturday morning. The workmen were being let down the shaft to commence a day shift. The cage had descended fifteen times, and while making the sixteenth descent eight men were in the cage, which was run into the shaft bottom with great violence. It appears that the rope was torn away from the drum in the engine-house, and the capple attached to the drum was broken, the bolts being thus forced off. The cage went down with such force that it was completely smashed, and the eight men were pitched out and seriously injured. The ascending chair was dashed into the headgear, but the Ormroyd safety hook did its duty and suspended the chair. The engine driver, named John Wilson, was seriously injured, the woodwork case round the drum was burst away, and the roof of the engine-house broken in and greatly damaged. The whole of the men in the cage were hurt, several of them seriously. The rope, which was of the usual wire construction, had been in use about six weeks, and had previously given no indication of its being weak.

Mr. John Lewis, proprietor of a small mine called the Crossing Main at Hungoland, near Sheffield, which he worked with a miner and a boy—three hands altogether—was caught in a fall of roof last Thursday and buried alive. Labourers from Hungoland village worked in relief parties to rescue him, but it was thirty-six hours before he was reached, and life was then extinct.

## THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

DURING the past week a fair amount of business has been done in Cleveland pig iron at slightly improved prices. The tone of the market held at Middlesbrough on Tuesday last was, however, somewhat quieter, neither buyers nor sellers being anxious to transact business. In one or two cases No. 3 g.m.b. was sold by merchants at 34s. per ton, but their usual quotation was 34s. 3d. Some merchants are ready to offer No. 3 at 34s. 3d. for delivery to the end of June. Makers are well supplied with orders for the present, and are not prepared to commit themselves far ahead, as they consider probabilities to be in favour of a rise. The lowest price currently accepted by makers is 34s. 6d. per ton, and some of them go so far as to ask 6d. more. Forge iron is firm at 33s. 3d. per ton. Merchants have apparently no power to alter it, as the makers hold the existing stocks in their own hands.

Warrants are nominally 34s. per ton.

Messrs. Connal and Co.'s stock of pig iron at Middlesbrough decreased 30 tons during the week ending Monday last.

Exports of pig iron from the Tees are equal to the average this month, 17,790 tons having been sent away to Monday last. More than half of this went to Scotland.

The demand for manufactured iron has not improved much, and the prices now ruling scarcely cover the cost of production. Ship plates are £4 15s. to £4 17s. 6d. per ton; angles £4 10s. to £4 12s. 6d.; and common bars £4 17s. 6d. to £5, all free on trucks at makers' works, cash 10th, less 2½ per cent. discount. Steel plate and angle makers are busy, and have raised their prices somewhat. Steel plates command about £7 per ton at works, and angles £6 10.

The value of goods exported from Middlesbrough during February, exclusive of coal and coke, was £107,579, being a decrease of £38,875 when compared with February, 1884. The value of exports from the Tyne last month was £145,052, being a decrease of £14,615.

Messrs. Allhusen and Co., of Newcastle, have commenced to make railways and to put down other plant at Haverton Hill for working the salt they have there discovered. It is said they intend to proceed with three bore holes in addition to the one already made.

The smiths, joiners, and shipwrights connected with the Wear shipyards are still out on strike against the reduction of wages and alteration of working hours sought to be enforced against them. At present there is little prospect of a settlement.

According to the Cleveland ironmasters' statistics issued last week, there are ninety-five blast furnaces in operation, of which seventy-one are producing Cleveland iron, and the remainder hematite, spiegel, and basic pig iron. The make of iron of all kinds during the month amounted to 180,323 tons. The stock of pig iron in the whole district on February 28th was 377,737 tons, being an increase of 6320 tons since January 31st.

A meeting of the Cleveland Institution of Engineers was held at Middlesbrough on Monday, the 9th inst., the president, Mr. Alfred Hill, occupying the chair. Mr. Macdonell, of Stockton, read a most interesting paper on the gradual reduction of wheat into flour by means of grooved chilled rollers with differential velocities. The paper was well illustrated by diagrams, models, and specimens of grain, meal, flour, and impurities, as found at various stages of the process. One of the chilled rollers usually employed was exhibited, its surface having been grooved specially with teeth of various pitches from fine to coarse. Mr. R. H. Appleton, who has at Stockton one of the largest and most modern milling plants in the whole country, was present, and invited the members to inspect it. With this object in view, the discussion was adjourned, after passing a hearty vote of thanks to Mr. Macdonell for his paper.

In the decease of Mr. John Dunning, of the firm of Jones, Dunning, and Co., Middlesbrough has lost one of its oldest and most remarkable citizens. Mr. Dunning commenced his professional career as a clerk about forty years since. His industry and force of character soon made him conspicuous in the then small but rapidly increasing town. He was soon made the chief local agent of the owners of the Middlesbrough estate, who were then, and still are, the Pease family. He assisted materially in building up the colossal fortune which they have long possessed. When the town was incorporated Mr. Dunning became also borough surveyor, and held the two scarcely compatible positions for several years. He became partner in the iron smelting firm already mentioned, though he took no part in the management. He was managing director, and finally sole proprietor of the unfortunate wrought nail company established to work the patents of F. F. Jones. He was also owner of the gas works at Sidmouth, Devon. Though not brought up an engineer, he nevertheless undertook operations of considerable magnitude in civil engineering, gas engineering, and architecture. Though his course was not unattended with failures, still he attained on the whole a fair number of successes. He occupied the civic chair one year, and was an alderman of the borough when he died, at the early age of fifty-eight.

## NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE iron market has again settled into a condition of quietness, not to say comparative inactivity. The animation of the previous week was due to a reported improvement in the Scotch steel trade and the placing of Admiralty contracts in the Clyde. Some extra speculative buying resulted, but the market is again as dull as possible. The shipments of pig iron in the past week amounted to 8135 tons, against 8575 in the preceding week, and 10,636 in the corresponding week of last year. The exports to Germany are considerably larger than of late, but the requirements of other continental countries are small. The demand for the cheaper qualities of pigs is on the increase at the moment, and smaller additions are therefore being made to the stock in the warrant stores. There is no change in the amount of the production, the furnaces in blast numbering ninety-three, compared with ninety-seven at the same date last year.

Business was done in the warrant market on Friday down to 41s. 5d. cash. On Monday transactions occurred at 41s. 3½d. to 41s. 3d., and on Tuesday business took place at 41s. 3½d. cash. Business was done on Wednesday at 41s. 3½d. cash to 41s. 1½d. To-day—Thursday—the market was somewhat firmer, and closed with buyers at 41s. 4d. cash.

The market values of makers' iron are a shadow lower, as follows:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 51s. 6d.; No. 3, 46s. 9d.; Coltness, 54s. 6d. and 50s. 6d.; Langloan, ditto; Summerlee, 51s. and 46s.; Calder, 52s. and 46s. 6d.; Carnbroe, 48s. 6d. and 46s.; Clyde, 46s. 9d. and 42s. 9d.; Monkland, 42s. 3d. and 40s.; Quarter, 42s. and 39s. 9d.; Govan, at Broomielaw, 42s. 6d. and 40s.; Shotts, at Leith, 51s. 6d. and 51s.; Carron, at Grangemouth (specially selected, 52s. 6d.), No. 3, 47s.; Kinneil, at Bo'ness, 44s. and 43s.; Glengarnock, at Ardrossan, 48s. 6d. and 43s.; Eglinton, 43s. and 39s. 6d.; Dalmellington, 47s. and 43s. The total shipments to date are 77,813 tons, against 93,497 twelve months ago.

The steel trade is in a favourable condition. One or two additional shipbuilding contracts are in the market, but a further material increase of prices is not expected in the meantime, and makers will be quite able to cope with the orders now in hand without making extra arrangements for production.

Makers of sugar crushing machinery, who were exceedingly busy last year, are in some cases now becoming very slack, and have been obliged to discharge a large number of their workmen.

During the past week three locomotives, valued at £4998, were dispatched from the Clyde for Calcutta, a small dredger worth £650, to the same place, there being also among the week's shipments £10,500 worth of machinery, £3560 sewing machines, £2500 steel goods, and £16,700 general iron manufactures.

There is rather less doing in the shipping department of the coal trade. The week's despatches from Glasgow aggregated 18,885 tons; Greenock, 122; Irvine, 1498; Ayr, 8238; Troon, 3134; and Grangemouth, 4406. In Fifeshire the demand is unsatisfactory. Stocks are accumulating at the pitheads, and it is reported that at a majority of the collieries the men are obtaining only four days' work in the week, while in some instances their employment does not exceed seven days in the fortnight. The foreign shipments of coals at Leith were about 3700 tons. A few days ago the Fife and Clackmannan Coalmasters' Association held a meeting at Burntisland, Mr. Spowart, of Bromhead, in the chair, when the present condition of business was discussed. Several members urged that both prices and wages ought to be discussed, but it was ultimately agreed that no alteration should be made in the meantime.

During the first two months of the year it appears that the general shipping trade of the Clyde has been fairly active. As compared with the same period of last year the arrivals show an increase of 12,277 tons, while there has been a decrease of 3297 tons in the sailings.

A few additional contracts for shipbuilding have been placed on the Clyde. Messrs. R. Duncan and Co., of Port Glasgow, have received an order to build a sailing ship of 1600 tons register for Messrs. Lindsay and Co.; Messrs. Barclay, Carle, and Co., of Glasgow, are to build for Messrs. Letham, Bincle, and Co., an iron sailing ship of 1400 tons; and the London and Glasgow Engineering and Iron Shipbuilding Company are to construct a steel screw steamer of about 1800 gross for the Indo-China Steamship Company.

Despite the backward condition of the shipbuilding trade, the masters at Port Glasgow are having a good deal of trouble with the ironworkers. The rivetters of Messrs. John Reid and Co. have been out on strike since the middle of December, although offered wages which, it is said, would yield them an average of 7s. to 8s. a day. The men lately demanded that the firm should dismiss the foreman rivetter before they would consent to discuss the question of wages. This Messrs. Reid and Co. declined to do, and the other employers, sympathising with this apparent ill usage of the firm, have resolved that until the men withdraw from the position they have taken up, no society men shall be taken on in any of the yards in the district.

## WALES & ADJOINING COUNTIES.

(*From our own Correspondent.*)

PRELIMINARY movements are to be seen around us—an affair of outposts before the great struggle upon the Bute and Taff amalgamation. This promises to be a keen contest, and open and concealed strategy must be noted. Last week, for instance, there was a rumour circulated in Cardiff to the effect that the Taff Vale were afraid that they had the worst of the bargain, but on inquiry I found that this was a fiction; "they were very well satisfied." One good step in the way of tranquilisation has been proposed, and that is to unite the Rhymney and Taff Vale Railways. The Rhymney only paid 5 per cent. last year, and this principally owing, I am told, to some large outstanding payments having been made. If the shareholders are wise they will induce their directors to call a meeting and get their fortunes linked with the Taff. The advantages would be considerable—a uniform rate, equal benefit to small and large freighters, use of both lines, and entire freedom from congestion, as one line would relieve the other; moreover, a fair dividend would then be certain.

The Taff Vale Company is working the new line to Newport from Pontypridd and the Rhondda vigorously. A good deal of coal, too, from Aberdare has been sent over the line; as many as eight large trains one day last week.

The coal trade remains generally about the same. Exports at Cardiff for foreign destinations showed an increase. For example, 154,000 tons were despatched last week, as compared with 133,000 tons the previous week; but in the district generally there is a certain degree of slackness prevailing, and the business is spasmodic and exceptional. There are one or two favoured collieries, for instance, holding good contracts, and these enjoy the best trade. I must note, in defiance of quiet times, a stiffening of price for best samples, and an objection to deliveries a long way ahead. Our coalowners have a notion that the fleet will be busy in a short time, and I should not be surprised at prices getting up. Ruling prices are for steam, screened, 10s. to 10s. 6d.; small, 4s. 6d. to 5s. House varieties remain unchanged, and there is not much doing with them.

The sale is announced on Monday next of Tyla Coch plant, the property of a limited company who sublet under the Tyla Coch Company. I am sorry to see that they have come to grief, for the prospects were good, and it is hoped that powerful friends may yet pull them through.

The export returns, for the year 1885, of coal to foreign destinations show so far unfavourably. January began with a decline, and February followed. If March show a similar falling the outlook will be less hopeful than is now thought likely.

In January the exports of coal from Cardiff amounted to 569,593 tons; February, 527,000 tons. From Swansea: January, 80,802 tons; February, 65,832 tons. From Newport: January, 131,505 tons; February, 124,197 tons.

Newport has, so far, shown a livelier iron trade. In January 10,931 tons were sent away; in February, 2977 tons. Cardiff in the two months only sent away 6933 tons, and Swansea only 349 tons. It is interesting to note how various industries attach themselves to certain places. Newport has the pre-eminence as an iron port, Cardiff as a coal port, Swansea as a patent fuel port. In the last two months Swansea sent away close upon 50,000 tons of patent fuel.

Little is doing anywhere in iron and steel. Ebbw Vale has been making a few hundred tons of rails for the Suakim-Berber line, and Cyfarthfa is tolerably busy on a new order. Business is, it must be confessed, dull.

In tin-plate there is a good deal more activity shown than in any ironwork. Prices are firm, and orders are being put in at a satisfactory rate. Swansea is showing more solid practical work in this industry than any other place, though the Monmouthshire works have not much to complain about. The advantage derived by Swansea is in connection with its port. Formerly the custom was to send tin-plate consignments by rail to Liverpool, and thence to America. Now there is a good deal of direct shipment, and at present vessels are coming in very satisfactorily, and some substantial cargoes are preparing. A local journal contrasts the shipments of Cardiff and Swansea not by the percentage of increase, which is misleading, but by the actual volume of work done. It shows that in 1883 Cardiff sent away 6,786,524 tons of coal, and Newport 1,585,032. In 1884, Cardiff 7,000,115; Newport, 1,724,960. In 1884. Cardiff exports reached 9,611,847 tons, and her imports 1,278,663, and, compared with the other ports of the Bristol Channel, Cardiff beats them considerably even when added together.

The first sod of the new dry dock for the Slipway Company at Newport was cut this week.

At a meeting of the Monmouthshire and South Wales Coalowners' Association this week Mr. Edward Jones, Varteg, was elected chairman, and Mr. Edward Martin, Dowlais, vice-chairman.

Mr. Nixon's colliers have held a meeting, whereat they complained that the reduction of wages should have been fixed for March 1st. They contend that the reduction should date from May 1st.

The Newport Town Council will oppose the Bute and Taff amalgamation.

Cardiff and Monmouthshire line has passed Standing Orders.

LOCOMOTIVE ENGINES FOR THE SUAKIM-BERBER RAILWAY.—Messrs. Manning and Wardle, of the Boyne Engine Works, Hunslet, Leeds, are building a number of locomotive engines for the Suakim-Berber Railway. Some have already been sent to London for shipment, and others will be sent to Hull at soon as possible. They are of the type generally used by contractors, and are built for a 4ft. 8½in. gauge. There are two sizes, the larger being on six wheels, all coupled; and the smaller on four wheels, all coupled. The larger size have 12in. cylinders, and wheels of 3ft. diameter; and the smaller size have 9in. cylinders and wheels of 2ft. 9in. diameter. The firm are sending out with the engines wrought iron sheathing ⅜in. thick, made in two parts, and so constructed as to cover the entire engine above the foot-plate, on which the edges of the cover rest. The sheathing is painted white. It is provided with suitable doors to give access to the tank, and to other parts of the engine. The driver is completely sheltered. For his convenience there are inserted in the sheathing a number of spectacle glasses, which are protected by doors so constructed that the extent of opening can be regulated to ¼in. The sheathing has been tested with a Snider rifle, and has been found to be bullet-proof at forty yards distance. These covers weigh from 3 to 4 tons in the case of the large engines, and from 2 to 3 tons in the case of the small ones. Extending around each engine from below the foot-plate to within about 3in. of the ground, there will be screens of stout canvas stretched on light iron framework, the object being to keep the sand out of the motion parts.

## THE PATENT JOURNAL.

*Condensed from the Journal of the Commissioners of Patents.*

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

### Applications for Letters Patent.

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

*3rd March*, 1885.

2777. MAKING MOULDS in SAND, E. Buckley, London.
2778. COMMUNICATING BETWEEN PASSENGERS and GUARDS, J. Puntis, Basingstoke.
2779. PERMANENT WAY, &c., of RAILWAYS, R. and W. Welford, Sunderland.
2780. QUICKLY ELEVATING, &c., WATERPROOF and SUN-SHADE COVERINGS, C. C. Hadingham, London.
2781. ADJUSTABLE PROP, &c., for USE in MINES, S. Morgan, Birmingham.
2782. RING ARMATURES for DYNAMO ELECTRIC MACHINES, G. C. Fricker and W. C. Mountain, London.
2783. REGULATING FEED CARBONS in ELECTRIC ARC LAMPS, W. C. Mountain, London.
2784. JERRYS or PERPETUAL CUTTING MACHINES, J. W. and F. W. Taylor, Manchester.
2785. PICKS, HAMMERS, &c., J. Willis, Sheffield.
2786. CARBON CONES and CASES, J. Morris, Basingstoke.
2787. COMBINED ASH-PAN and CINDER-SIFTER, W. A. Turner, Birmingham.
2788. FASTENING WINDOWS without SASH WEIGHTS or CORDS, E. Prince, Walsall.
2789. DRIVING CHAIN, &c., for VELOCIPEDES, W. Morgan, Birmingham.
2790. RINGS for CURTAINS, &c., J. S. Walford, Birmingham.
2791. OPENING, &c., BOTTLES with INTERNAL STOPPERS W. Weston, Liverpool.
2792. SPRING MATTRESS, T. Whitworth, Dewsbury Moor.
2793. CONDUCTION of ARTIFICIAL LIGHT, W. Richards, London.
2794. FLYING TARGETS, N. G. Moore, London.
2795. SECONDARY BATTERIES, H. J. Allison.—(*P. Benjamin, United States.*)
2796. BRUSHES, H. J. Allison.—(*A. Albright, United States.*)
2797. CONDENSING STEAM, G. Best, London.
2798. RECORDING the DURATION of SUNSHINE, W. E. Wilson, London.
2799. SIGNALLING and INDICATING APPARATUS, A. G. Brookes.—(*J. C. Wilson, United States.*)
2800. PREPARING COLOURED or DYED YARNS, A. G. Brookes.—(*H. F. Straw, United States.*)
2801. MACHINERY for WINDING YARN, A. G. Brookes.—(*H. F. Straw, United States.*)
2802. SPRING CLASPS, J. L. Thomson and J. J. Unbehend, London.
2803. APPARATUS for TEACHING ARITHMETIC, H. J. Haddan.—(*C. Pelletier, France.*)
2804. VESSELS or FLOATING RESERVOIRS, W. S. Page, London.
2805. PRINTING MACHINES, J. C. Mewburn.—(*J. Derriey, France.*)
2806. MINERAL AMALGAM or CEMENT, J. Cawley, London.
2807. PERFORATING MACHINES, A. W. L. Reddie.—(*E. B. Stimpson, United States.*)
2808. LAMPS for BURNING MINERAL OIL, T. W. Shaw and T. M. Harvey, London.
2809. BOAT-DETACHING APPARATUS, E. P. Alexander.—(*H. E. Foster, United States.*)
2810. ORNAMENTAL PANEL WORK, J. Watterworth, London.
2811. STEAM BOILERS and FURNACES, C. A. Knight and G. W. Thode, Glasgow.
2812. ELECTRICAL ILLUMINATION of RAILWAY TRAINS, R. H. Woodley, London.
2813. INCREASING, &c., the POWER APPLIED to a CYCLE or CARRIAGE, R. and J. R. Stansell, and F. J. Noble, Timaru, New Zealand.
2814. CUTTING TOOL, J. H. Churchman, Harrow.
2815. TREATING and STORING CIGARS, C. F. Hall, London.
2816. BREAK-DOWN GUNS, F. Beesley, London.
2817. VENTILATING APPARATUS, E. Aldous, London.
2818. ELECTRICAL CONDUCTORS, C. A. Day.—(*H. F. Campbell, United States.*)
2819. LOOM SHUTTLES, C. A. Day.—(*L. Goddu, United States.*)
2820. VALVE for PUMPS, W. Brown and C. N. May, London.
2821. SPIKE or NAIL, W. Stobbs, London.
2822. CHAIRS, A. Harrison and J. Hayes, London.
2823. PRODUCING RELIEF SURFACES for LETTER-PRESS PRINTING, A. J. Boult.—(*O. Mergenthaler, U.S.*)
2824. CASTORS for FURNITURE, &c., S. M. Michelsen and G. Sylvester, London.
2825. SMOKE-CONSUMING FURNACES, F. B. Geisler and A. Logemann, London.
2826. ELECTRICAL SHELL FUSE for PROJECTILES, E. L. Zalinski, London.
2827. TAKING MOULDS in DENTISTRY, A. J. Boult.—(*Dr. F. Mannhardt, Germany.*)
2828. REPRODUCING WRITTEN MATTER, I. Ramsdell, London.
2829. IMPRESSION TRAYS or CUPS, A. J. Boult.—(*Dr. F. Mannhardt, Germany.*)
2830. UTILISATION of BI-SULPHIDE of CARBON VAPOUR as a MOTOR, W. R. Lake.—(*W. S. Colwell and A. J. Davis, United States.*)
2831. BOTTLE STOPPERS, W. R. Lake.—(*F. B. Thatcher, United States.*)
2832. LOCKS and KEYS, W. R. Lake.—(*B. Moser, U.S.*)
2833. APPLICATIONS of ELECTRO-MAGNETISM to AIR CHAIRS, &c., W. L. Wise.—(*G. Edard, France.*)
2834. MAGNETO-ELECTRIC APPLIANCES, W. L. Wise.—(*G. Edard, France.*)
2835. POTS for MELTING LEAD, J. C. Ridley, London.
2836. TIMEKEEPERS, W. L. Wise.—(*W. Osborne, Germany.*)
2837. ADJUSTABLE TOOTH for EXTRACTORS, &c., W. R. Wise.—(*A. Bajac and Messrs. Béjot and Co., France.*)

*4th March*, 1885.

2838. CIGAR CUTTERS and HOLDERS, T. Osborn and A. Osborn, Birmingham.
2839. LAYING of PIPES and MAINS, J. Sturgeon, Westminster.
2840. SUPPLYING FURNACES with FUEL, J. Proctor, Manchester.
2841. TAKING-UP MOTION, W. Gibson and J. Harling, Halifax.
2842. GUMMING and PASTING PAPER, J. J. Allen, Halifax.
2843. METALLIC PROTECTIVE SLIDE BACK SIGHT COVER, W. Lightwood, Birmingham.
2844. SHAVING, &c., BOXES, A. Hepburn, Newcastle-on-Tyne.
2845. YARN CLEARERS, T. Bowla's and J. Barratt, Manchester.
2846. REGISTERING the FLOW of WINE, F. M. King and J. M. Porter, Leeds.
2847. BAR HANDLES for VELOCIPEDES, S. Martin, Birmingham.
2848. FASTENING on HANDLES, T. Birbeck, Bishop-wearmouth.
2849. MARKING OUT LAWN TENNIS COURTS, A. A. T. Attree, Worthing.

2850. IMPROVING ILL-DEFORMED INSTEP of the HUMAN FOOT, T. Holland, jun., London.
2851. CHAIRS, J. Bell, Frome.
2852. FUSE PIECE, J. L. Fuller, Charlton.
2853. WRENCHES, E. Marshall and G. Phillips, Lozells.
2854. AUTOMATICALLY TURNING-ON STEAM, &c., H. Holden and R. G. Brooke, Salford.
2855. DRESSING FLOUR, W. P. Thompson.—(*J. Fiechter and Sons, France.*)
2856. GAS, E. Davies, Liverpool.
2857. PINIONS, H. W. Ley, London.
2858. GUMMING PAPERS, &c., TOGETHER, J. J. Royle, London.
2859. PAINT BRUSH, L. S. Bickley and J. R. Winn, Cardiff.
2860. FURNACES and HEARTHS, D. and L. Roberts, Stockton-on-Tees.
2861. DETERMINING PRESSURES and WORK DONE by the THERMO-ELECTRIC PROPERTIES of METALS, A. W. Anstruther, Woolwich.
2862. CENTRIFUGAL MACHINES, J. Laidlaw, Glasgow.
2863. COOLING WINES, &c., T. Fishburn and E. T. Stead, Scarborough.
2864. KEEPING MEAT, &c., COOL, T. Fishburn and E. T. Stead, Scarborough.
2865. PRODUCING TRANSPARENT ICE, G. H. Lloyd, London.
2866. SECURING MILK CANS against ROBBERY, H. Wise, London.
2867. RAILWAY CARRIAGE ROOF LAMP, W. P., G. E., and C. E. Cherry, Hull.
2868. HYDRAULIC RAMS and RAM PUMPS, J. Keith, Glasgow.
2869. PREVENTING WASTE of WATER in WATER-CLOSETS, C. Campion, London.
2870. WATER WASTE PREVENTERS, D. James and J. Harsant, London.
2871. SCHOOL TABLETS and BLACKBOARDS, G. M. and E. G. Hammer, London.
2872. APPARATUS for OPENING OYSTERS, A. F. Link.—(*A. Halewyck-Royon, Belgium.*)
2873. GULLY TRAPS, S. Kirby, London.
2874. INCANDESCENT ELECTRICAL LIGHT, F. Spurny and J. Wejtruba, London.
2875. FUEL ECONOMISERS, A. Lowcock and T. Sykes, Manchester.
2876. FLUID METERS, P. M. Justice.—(*J. Thomson, U.S.*)
2877. EXTRACTING METALLIC LEAD from SULPHUROUS LEAD ORES, F. Ellershausen, London.
2878. ELECTRIC ROTARY BRUSHES, W. S. Frost, J. L. Mérigot, and G. C. C. Fein, London.
2879. FOLDING CHAIRS, M. O. Hund.—(*L. K. Smedes, United States.*)
2880. TRANSMITTING ROTARY MOTION, E. Bray and J. Heald, Leeds.
2881. HEATING APPARATUS, E. P. Alexander.—(*H. Cuau, sen., and H. P. Cuau, jun., France.*)
2882. PORTABLE PRESSES for HAY, &c., T. Knight, London.
2883. GLASS CASES for FERNS, FLOWERS, &c., W. Cutler, London.
2884. TREATING LIQUIDS with ATMOSPHERIC AIR, &c., W. F. B. M. Mainwaring and J. Edmunds, London.
2885. PURIFYING SEWAGE and WATER, W. F. B. M. Mainwaring and J. Edmunds, London.
2886. ACCELERATING the SETTING of CEMENTS, W. Millar and C. F. Nichols, London.
2887. COMBINED GAS LAMP with HYDROCARBON CONTAINER, W. Potter, London.
2888. MUSIC STOOLS, &c., A. J. Boult.—(*W. A. C. Matthie, Canada.*)
2889. APPARATUS for BURNING SOLID HYDROCARBONS, J. Roots, London.
2890. PARALLEL RULES, G. Shaw, London.
2891. RAILWAY and TRAMWAY LOCOMOTIVES, D. McI. Reid, London.
2892. EMBOSSING LEATHER, A. Croft, London.
2893. TELEPHONIC TRANSMITTERS, C. D. Abel.—(*La Société Générale de Téléphones, France.*)
2894. HEATING, ENRICHING, and CONSUMING COAL GAS, W. Potter, London.
2895. SADDLES for VELOCIPEDES, C. Leni and H. J. Brookes, London.

*5th March, 1885.*

2896. DYNAMO-ELECTRIC HORSE CLIPPER, C. de Salazar, London.
2897. SELF-ACTING REVOLVING MAGNETIC ELECTRIC BRUSH, C. de Salazar, London.
2898. EMBROIDERING MACHINERY, T. Wright, Glasgow.
2899. ENGRAVING COPPER, STEEL, WOOD, &c., C. I. and F. Edmondson, Manchester.
2900. PENCIL CLASPS, R. P. Scott, London.
2901. SHAVING, C. Davies, Birkenhead.
2902. PUMP LUBRICATOR, R. Young, Leith.
2903. LOOM CRANK STRAPS, J. Gullery, Belfast.
2904. SAFETY APPARATUS for HOISTS, W. Netherwood, Halifax.
2905. VENTILATORS, P. M. Walker, Halifax.
2906. FASTENING GLOVES, BOOTS, and SCARVES, G. R. Stokes, Hanley.
2907. MAKING CLAY BATS, H. S. Till Stoke-on-Trent.
2908. COMBING and CLIPPING the FRINGES of TOWELS, &c., J. Brown, near Belfast
2909. SMOKING PIPES, W. H. M. Neave, Sheffield.
2910. METALLIC BOXES, W. P. Thompson.—(*E. Picard, Belgium.*)
2911. COMPASSES for SHIPS, &c., H. C. Williams, Liverpool.
2912. EXTRACTING the BLACK from BLACK OSTRICH FEATHERS, M. Myers, London.
2913. STIRRING FISH WHILST DRYING, R. A. Girling, Saxmundham.
2914. AUTOMATIC APPARATUS for the MANUFACTURE of POTTERY, T. Willett, London.
2915. THREE-CYLINDER ENGINE, F. Adams, London.
2916. DIVIDING DOUGH into LOAVES, W. Hamilton, Glasgow.
2917. HEATING and DISINFECTING APPARATUS, for URINALS, &c., L. A. Groth.—(*L. Gühring and W. Kohrer, Germany.*)
2918. PRODUCTION of GAS for USE with LIQUID FIRE-EXTINGUISHING CHEMICALS, J. O. Spong, London.
2919. CHIMNEY TOP, W. Tebboth, London.
2920. PIANOFORTES, G. P. Venables, London.
2921. INCREASING the HEATING EFFECT of STEAM, H. J. Haddan.—(*P. Porte and C. Dubroca, France.*)
2922. FABRICS for OVERCOATINGS, &c., J. Broadhead, London.
2923. RAILWAY ROLLING STOCK, J. Lutley, London.
2924. AUTOMATIC ELECTRIC COUPLER, J. S. Raworth, London.
2925. UTILISING the CASES of SPENT CARTRIDGES, R. Morris, London.
2926. DRAUGHT and DUST EXCLUDER for DOORS, J. Gagon, London.
2927. FIBROUS, FIREPROOF, and WATERPROOF COMPOSITION, W. Millar and C. F. Nichols, London.
2928. LUBRICATORS, H. Roberts, London.
2929. THROWING the CYLINDER of a PRINTING MACHINE OUT OF GEAR, G. Newsum, London.
2930. BEATER BARS, &c., J. M. Casswell, London.
2931. CHUCKS for LATHES, J. Delger, London.
2932. SHELLS for ORDNANCE of LARGE or SMALL CALIBRE, J. Baldie, Plumstead.
2933. CELLAR COVERS and COAL PLATES, W. Hayward and W. Eckstein, London.
2934. WOOD PLANING and MOULDING MACHINES, A. Ransome and T. J. Wilkie, London.
2935. CASK-MAKING MACHINES, A. Ransome and T. J. Wilkie, London.
2936. HOLDERS for ELECTRIC INCANDESCENT LAMPS, S. Z. de Ferranti, London.
2937. BREECH-LOADING FIRE-ARMS, H. A. Schlund, London.
2938. LAMPS BURNING MINERAL OILS, E Edwards.—(*A. Hanniet, Belgium.*)

*6th March, 1885.*

2939. BOOTS, &c., S. Hall, Leeds.
2940. WINDOW FASTENER, N. Bonnett, Brighton.
2941. ACCUMULATORS, W. Chattaway, Birmingham.
2942. LAMP BURNERS, W. H. Bulpitt, Birmingham.
2943. VALVE COCKS, T. Dipple, Birmingham.
2944. DECK MOUNTS for GUNS, A. C. Koerner, Paris.
2945. SHOVELS, &c., W. Bell, Sheffield.
2946. MOTIONS of LOOMS, T. H. Blamires, Halifax.
2947. DOOR FASTENER, J. H. Plant, Liverpool.
2948. CURLING PIN, W. Fearnley, Manchester.
2949. WHISTLE LOCK, T. A. Vaughton, Birmingham.
2250. AUTOMATON CANOIST, W. Brierley.—(*J. Schoenner, Germany.*)
2951. FOLDING, &c., MACHINE, J. Horner, Leeds.
2952. BOTTLES, D. B. Morison, Hartlepool.
2953. SPRING MATTRESSES, J. Westgarth, Warrington.
2954. MOTIONS of LOOMS, R. L. Hattersley and J. Hill, Keighley.
2955. WINE CARRIER, R. B. Beard, Birmingham.
2956. ATTACHING KNOBS to their SPINDLES, E. Collier, Birmingham.
2957. TREBLE-SPRINGED SHUTTLE TONGUE, &c., J. Cross, Oldham.
2958. ADVERTISING, G. French, London.
2959. TURNING LATHES, J. Barrow, Glasgow.
2960. ELECTRICALLY CONTROLLING SPEED of MOTORS, C. J. Bosanquet and W. A. Tomlinson, London.
2961. NOZZLES for HOSE, W. Cullen, London.
2962. CLOCKS, &c., W. A. Lait, London.
2963. METALLIC FENCES, B. G. Devoe and L. T. Brookhart, Springfield, U.S.—*5th March*, 1885.
2964. KILNS, J. Price, London.
2965. ADMISSION VALVE and GEAR, P. Brotherhood, London.
2966. FOOTSTEP for POSTS, A. E. Gilbert, Glasgow.
2967. PENS, A. N. J. Contarini and G. M. Braggiotti, London.
2968. DISCHARGING CONTENTS of BOTTLES, W. C. Cartmel, London.
2969. VEHICLES, J. Jackson, London.
2970. INSULATED ELECTRIC CONDUCTOR, E. W. Lancaster, London.
2971. VELOCIPEDES, W. Smith and G. Hicking, London.
2972. VELOCIPEDES, P. Adie, London.
2973. PRECIPITATING LEAD from ORES, W. E. Gedge.—(*F. Ellershausen, Spain.*)
2974. FURNACES, D. Purves, London.
2975. SPRING BUTTON FASTENERS, H. J. Haddan.—(*H. Bauer, Germany.*)
2976. PRINTING, &c., MACHINE, T. A. Richardson.—(*E. W. Blackhall, Canada, and J. H. Smith, U.S.*)
2977. DOMESTIC STOVES, A. Kohlhofer and J. G. Haller, London.
2978. CLEANING TRAM-RAILS, E. Edwards.—(*J. B. Chaudron and L. V. Manourg, France.*)
2979. TREATING DRY ABSORBENT BODIES, E. P. Louvot, London.
2980. TURNING of MALT, R. C. Sinclair, London.
2981. COMPRESSING TRUSSES of HAY, &c., H. Harris, London.
2982. REVERSIBLE NAVAL or other CAP, M. Gottheimer, London.
2983. OIL and GAS BURNING STOVES, C. Toope, London.
2984. WATCHES, H. Wagner and M. Gerstley.—(*L. Brandt et Fils, Switzerland.*)
2985. ELECTRIC ARC REGULATORS, J. G. Statter, London.
2986. LIGHTING, J. G. Lorrain, London.
2987. FIBROUS MATERIAL, H. H. Lake.—(*J. Odelga, Austria.*)
2988. WATER-CLOSETS, H. C. Kürten, London.

*7th March, 1885.*

2989. BRUSH, &c., W. Giffard and W. E. Clarmont, Manchester.
2990. WASHING and CLEANSING FLUID, E. Green and E. Needham, Halifax.
2991. CHARGES and CARTRIDGES for SMALL ARMS, C. Dixon, Birmingham.
2992. BRICKS, &c., for SMOKE FLUES, J. E. Beanland, Halifax.
2993. PUMPS for MARINE, &c., PURPOSES, E. L. Lange, Manchester.
2994. FRICTION CLUTCHES, W. Pepper, Stockton-on-Tees.
2995. STUDS or SLEEVE-LINKS, F. McIlvenna and W. Thompson, Liverpool.
2996. MANGLING, T. Bradley, Liverpool.
2997. BRACES or TROUSERS' SUSPENDERS, E. Farrow, London.
2998. RAILWAY SIGNAL INDICATORS, G. Jefferies, Essex.
2999. FRAME SAWS, E. Newton, Clapton.
3000. COMPOSITE MOULDS, S. B. Furnival, Birmingham.
3001. SOLITAIRES, W. Neale, Birmingham.
3002. INDICATING WATER LEVEL in STEAM BOILERS, J. J. Royle and M. Mitchell, London.
3003. NECK-TIE and COLLAR COMBINED, H. G. B. Thompson and J. Sternberg, London.
3004. CABLES for ELECTRIC TELEGRAPH, &c., MESSAGES, J. C. Sellers, London.
3005. LAYING, &c., ELECTRIC TELEGRAPH, &c., WIRES, J. C. Sellars, London.
3006. STEERING of VELOCIPEDES, C. Leni, London.
3007. TYPE WRITERS, A. A. Common, London.
3008. STEAM BOILER FURNACES, H. Callas, London.
3009. PAPER PULP, W. H. Richardson and W. Bertram, Glasgow.
3010. GALVANIC BATTERIES, H. J. Allison.—(*S. Norris, United States.*)
3011. OILCLOTH, &c., J. C. Mewburn.—(*C. A. Bilard, France.*)
3012. JOINT CONNECTIONS for SANITARY DRAIN, &c., PIPES, W. R. Hale, London.
3013. PANTS, H. Cooper and R. Steele, London.
3014. TREATING the LIMBS of HORSES, &c., with WATER, E. Heath and A. A. King, London.
3015. METALLIC PISTON, &c., PACKINGS, G. Murdoch, Belfast.
3016. BREECH-LOADING MAGAZINE RIFLES, F. A. Wendt, London.
3017. PROPULSION of SHIPS, W. and J. Beesley, London.
3018. TABLE, &c., WEIGHING MACHINES, W. B. Avery, London.
3019. WORKING ORDNANCE, H. S. Maxim, London.
3020. WEIGHING SCALES, H. J. Haddan.—(*R. Watson, United States.*)
3021. PARALLEL VICES, I. Qurin, London.
3022. CUTTING, &c., STONE, H. J. Haddan.—(*Francois Maurice Royrant, France.*)
3023. ALCOHOLOMETER, A. S. Aldy, London.
3024. CANDLE-HOLDERS, C. D. Abel.—(*P. Lehmann, Germany.*)
3025. PRESS for PRINTING, EMBOSSING, &c., A. S. Coghill, London.
3026. STEAM TRAMWAY, &c., ENGINES, T. Hunt, London.
3027. LIFT PUMPS, A. J. Boult.—(*A. Ferrero, Italy.*)
3028. BREAD BAKING PAN and COVER, T. Mayes, New York.
3029. INSTANTANEOUSLY HEATING WATER, J. Winterflood, London.
3030. TAPS or COCKS, G. H. Hughes, London.
3031. FASTENING TIES, &c., to COLLARS, F. A. Jack, London.
3032. VENTILATING SEWERS, J. G. Gibbons, London.
3033. THREE-SPEED GEAR for VELOCIPEDES, B. Carr, London.
3034. EQUATORIAL TELESCOPES, G. F. Redfern.—(*L. A. Blain and G. Lussault, France.*)
3035. MOTOR without BOILER, F. Roland, London.
3036. TEACHING of ARITHMETIC, S. Legg, London.
3037. TELEPHONIC TRANSMITTING INSTRUMENTS, S. P. Thompson and P. Jolin, London.
3038. COVERING WALLS and CEILINGS, H. H. Lake.—(*J. M. Baker, United States.*)
3039. WORKING GUNS, W. Anderson, London.
3040. STEAM and other ENGINES, W. Lowrie, London.

*9th March, 1885.*

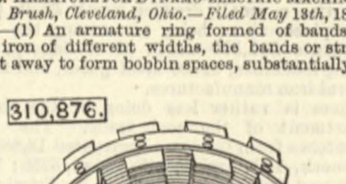
3041. WARP LETTING-OFF MOTION for LOOMS, D. Greenhalgh, Halifax.
3042. SPINDLE STUD, J. Yates, Burnley.
3043. SAFETY KNOBS, B. Poole, Birmingham.
3044. BULKHEAD DOORS WATER-TIGHT LIFTING, W. Madge and J. T. Ford, Southsea.
3045. WIRE NET or TRELLIS WORK, W. T. Smith, Birmingham.
3046. BILLIARD BALLS, W. H. Blackwell and J. Ridyard, Ashton-under-Lyne.
3047. PREVENTING BURSTING of CISTERNS, T. G. Normanton, Barrow-in-Furness.
3048. HOLDING LEATHER BUTTS, J. Cooper, Wollaston.
3049. GALVANIC BATTERIES, J. J. Coleman, Glasgow.
3050. STARCH, W. P. Kelly, Graique.
3051. CONNECTING the ENDS of DRIVING BELTS, G. Williamson and I. Jackson, Manchester.
3052. BEARINGS for BICYCLES, &c., W. Andrews, Birmingham.
3053. LEATHER DRESSING MACHINES, A. Anderson, Paris.
3054. MEASURING, &c., MACHINES, T., F., and L. Lydon, Galway.
3055. FILTER PRESSES, R. J. Friswell and A. Myall, London.
3056. PNEUMATIC ORGAN SOUNDBOARD, F. A. Slater, London.
3057. ROASTING JACK MEAT HOOKS, J. Weekes, London.
3058. PERAMBULATORS, H. A. Reinhold, London.
3059. COMBINED HAT BRUSH, HAT REVIVER, &c., W. A. Gladen, London.
3060. SIGNALLING APPARATUS, W. S. Frost, London.
3061. VENEER, A. de B. d'Este and C. de B. d'Este, London.
3062. VENTILATORS, W. P. Buchan, Glasgow.
3063. LUBRICATORS, J. Günther, Nakel.
3064. NAVIGATING the AIR, J. C. Mewburn.—(*P. A. C. de Sparre, France.*)
3065. TILE, P. Simons, London.
3066. RECTIFYING COLUMNS, J. H. Johnson.—(*C. Heckmann, Prussia.*)
3067. WHEELS, R. H. Lea, London.
3068. RAILWAY CHAIRS, J. E. B. Armytage, London.
3069. BATHS, E. M. G. Gee, London.
3070. HEATING and VENTILATING FLUES, J. D. Garrett, London.
3071. COMBINED CLOCK-CASE and CABINET, J. Harrington, London.
3072. SOWING GRAIN or SEED, W. R. Lake.—(*G. Woolnough and F. Dehne, Germany.*)
3073. COUPLING BUFFERS, G. Turton and F. J. Talbot, London.
3074. TRIPOD STAND, J. L. Watkins, London.
3075. DE-SILVERING LEAD, &c., H. A. Nye and J. Whalley, London.
3076. HOLDING and GIVING MOTION to TWIST DRILLS, E. D. Barker, London.
3077. COPYING LETTERS, &c., W. R. Lake.—(*C. A. Thompson, United States.*)
3078. TRICYCLES, &c., R. Varty, London.
3079. MATERIALS for LINING FURNACES, &c., H. E. Newton.—(*J. E. Verdié, France.*)

## SELECTED AMERICAN PATENTS.

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

310,876. ARMATURE FOR DYNAMO-ELECTRIC MACHINES, *C. F. Brush, Cleveland, Ohio.—Filed May 13th*, 1884.
*Claim.*—(1) An armature ring formed of bands or strips of iron of different widths, the bands or strips being cut away to form bobbin spaces, substantially as

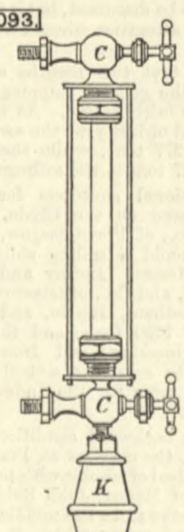
310,876.



set forth. (2) An armature ring formed of alternate layers of wide and narrow band iron, the wide bands being cut away at the bobbin spaces to the width of the narrow bands.

311,093. WATER GAUGE, *Robert L. Willis, Sherman, Tex.—Filed September 5th*, 1884.
*Claim.*—A glass water gauge having attached to the lower valve C thereof a receptacle or chamber K, to

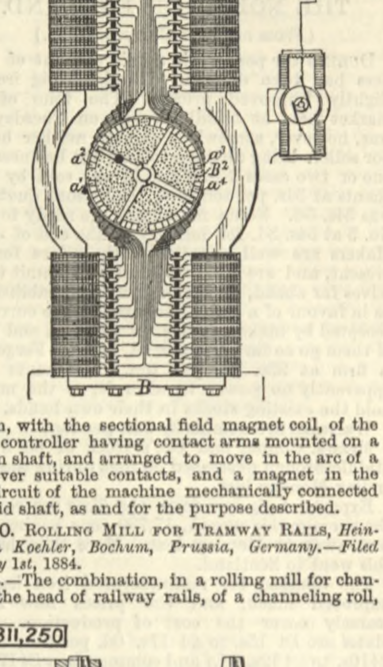
311,093.




receive foreign matter, and provided with a blow-out cock L, at its lower end for relieving said receptacle of said matter, as shown and described.

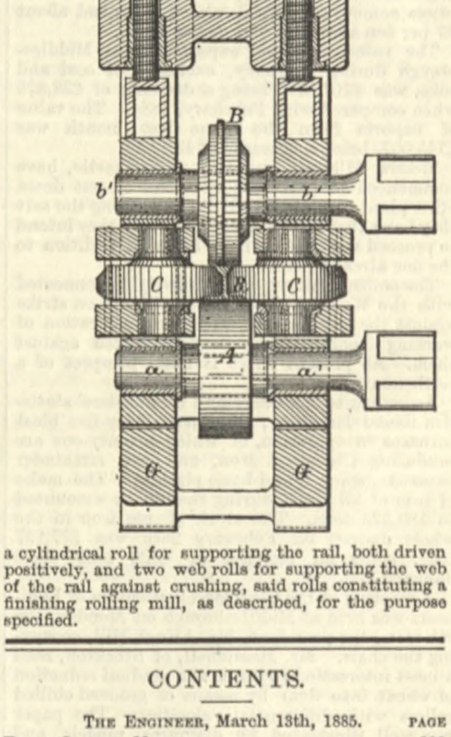
311,141. REGULATOR FOR DYNAMO-ELECTRIC MACHINES, *Benjamin F. Orton, East Saginaw, Mich.—Filed February 7th*, 1884.
*Claim.*—(1) The combination, in a dynamo-electric machine, of two sets of field magnet coils or sections on separate legs or cores of the field magnet for said machine, two contact arms electrically connected and forming the connection between the two sets of coils, two corresponding sets of contacts connected with the coil sections, all arranged as set forth, so that coils will be simultaneously thrown out of circuit on both cores, and a magnet energised by the current of the machine, and having a movable core connected with the shaft supporting the arms, as and for the purpose described. (2) The combination, with base piece or support $B^2$, of the four series of concentric contacts, the four contact arms electrically connected in pairs, and connections from said contacts to coil sections on the field magnet legs, each pair of said contact arms serving as the electrical connection whereby current flowing in the coils on one field magnet leg finds circuit to the coils on another field magnet leg, as and for the purpose described. (3) The combination, in a dynamo machine regulator, of the block $B^2$, contacts $a^1$ $a^2$ $a^3$ $a^4$, arranged concentrically, two double circuit closers each adapted to complete the circuit between two sets of contacts, and the coils connected with said contacts but insulated from one another, and sectional field magnet coils connected with the contacts, as and for the purpose described. (4) The combination, with the sectional field magnet coil and a circuit controller for determining the number of sections that shall be in circuit, of a series of binding posts and a suitable support therefor carried by the cross piece B and ranged parallel with the field magnet. (5) The combination, with the sectional field magnet coil, of the circuit controller having contact arms mounted on a common shaft, and arranged to move in the arc of a circle over suitable contacts, and a magnet in the main circuit of the machine mechanically connected with said shaft, as and for the purpose described.

311,141



311,250. ROLLING MILL FOR TRAMWAY RAILS, *Heinrich Koehler, Bochum, Prussia, Germany.—Filed May 1st*, 1884.
*Claim.*—The combination, in a rolling mill for channeling the head of railway rails, of a channeling roll, a cylindrical roll for supporting the rail, both driven positively, and two web rolls for supporting the web of the rail against crushing, said rolls constituting a finishing rolling mill, as described, for the purpose specified.

311,250

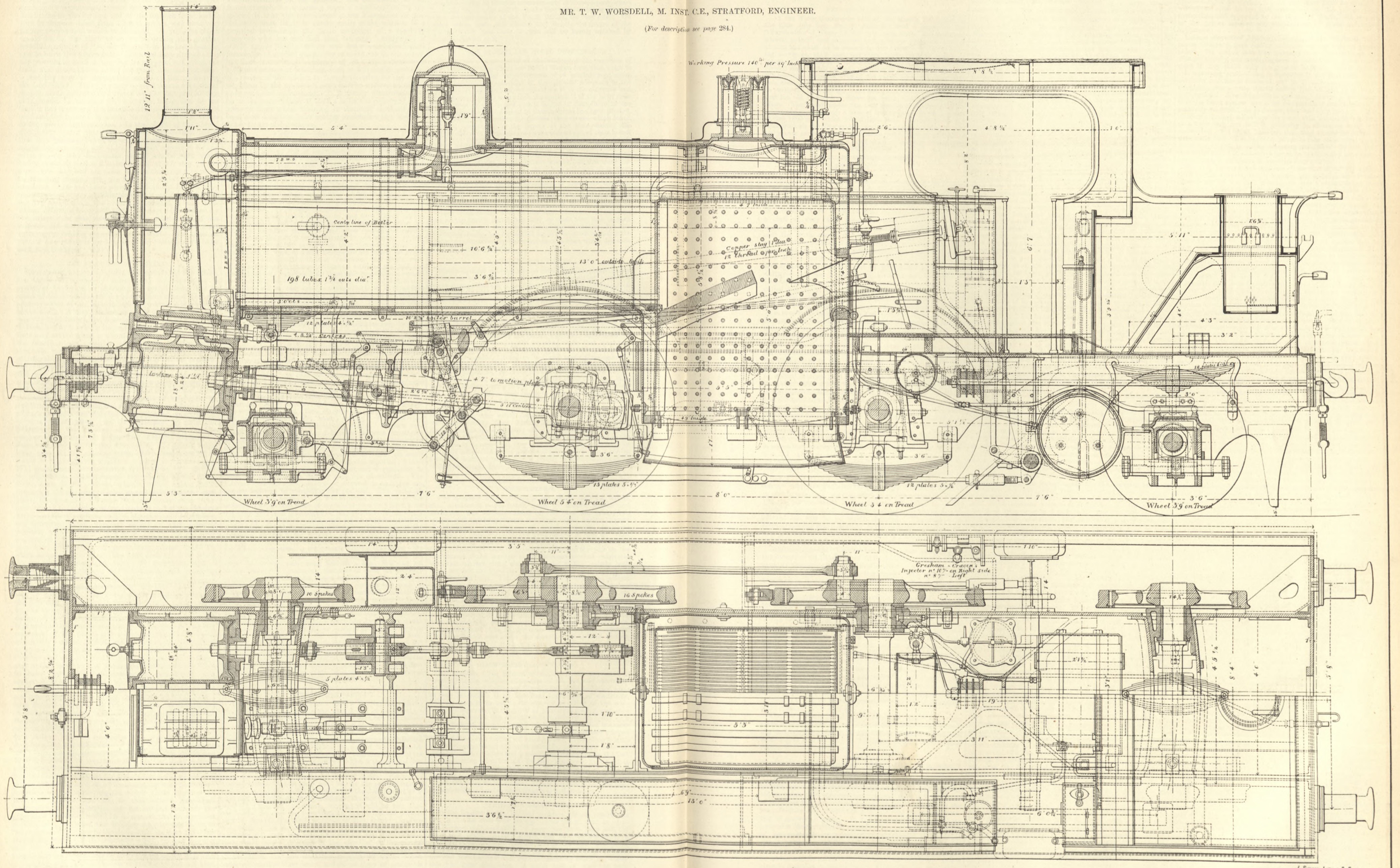



## CONTENTS.

# TANK LOCOMOTIVE FOR METROPOLITAN TRAFFIC, GREAT EASTERN RAILWAY.

MR. T. W. WORSDELL, M. INST. C.E., STRATFORD, ENGINEER.

(For description see page 284.)




J. Swain Litho & Eng