ROTARY ENGINES WITH MOVABLE PARTITION.

ROTARY engines of this character are very numerous, and seem, at first sight, to offer the solution of the problem of producing a direct turning movement of a shaft by the action of steam or other pressed fluid. An engine of this character was devised by Watt, a contrivance which consisted of a radial piston attached to the revolving shaft, and which was made to extend the whole length of a cylinder and revolve within it, its outer edge touching against the barrel of the cylinder. To obtain a steady piece against which the steam might react in its effort against the piston, a partition piece was introduced of such a character as to revolve about a longitudinal axis in the cylinder barrel, so as to allow the piston to pass freely when coming up to it, but so arranged as to drop down with its edge against the revolving shaft after the piston had passed.

An engine on similar principles has been invented by Mr. John Pinchbeck. The broad character of the Pinchbeck engine is not unfamiliar, but the ingenious combination by which the working pieces mutually support each other in preserving secure joints is one of novelty, and one which greatly adds to its efficiency. The main mechanism is an excentric cylinder revolving with a shaft whose axis coincides with that of a larger and fixed cylinder in such a manner that the outer edge of the revolving cylinder is always in contact with the interior surface of the fixed cylinder. The excentric piece A is always pressed against by a sliding piece, B, a piece extending the whole length of the cylinder, and constrained by appropriate guides to move radially to the fixed cylinder. The excentric itself causes this piece to rise, the downward movement being produced by an external force. Effectually to complete the combination, an intermediate piece C is introduced, and paired as shown by fair cylindrical surfaces to the steadied pieces A and B.

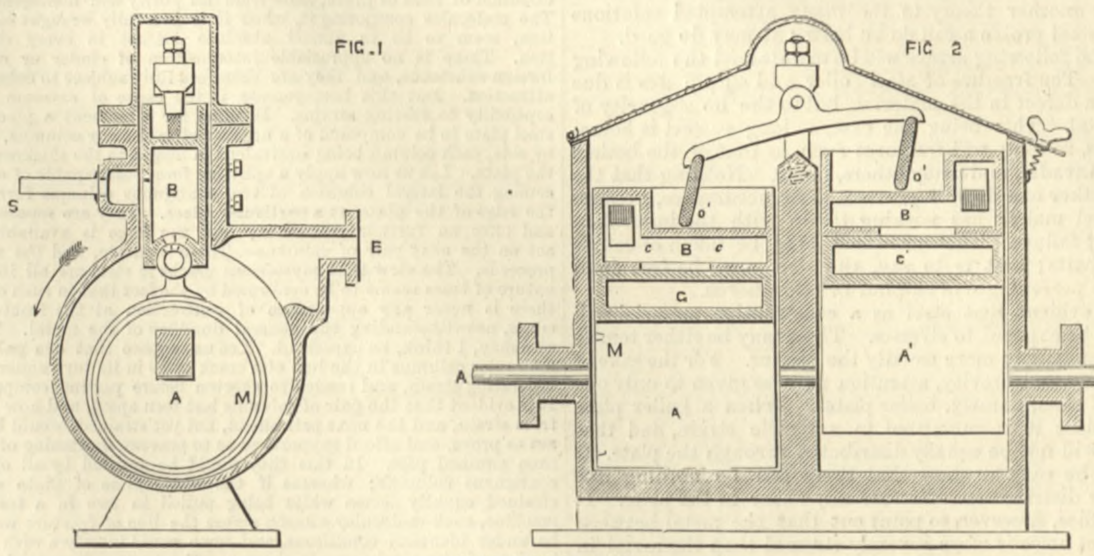
If this mechanism be set in motion by turning the shaft A connected to the excentric cylinder A, the two chambers, into which the partition B divides the space between the excentric piece and the cylinder in which it works, become alternately expanded and contracted. Steam being admitted to the expanding chamber and allowed to exhaust from the contracting one, the contrivance is set in motion.

This distribution of steam is carried out in a novel manner. In many of these engines this is obtained by channels cut in one of the steadied pieces working against a surface in the fixed frame provided with suitable steam and exhaust ports. In this case the ports are constructed in the intermediate piece and in the moving piece with which it is jointed. The cylindrical part of C is hollow, and is perforated as shown by the black spaces, these perforations extending from *c* to *c* as indicated in Fig. 2, a longitudinal section. Similar spaces are provided in the lower part of B, which is also hollow to allow of the steam passing through to them. Steam enters by the pipe S into the casing enclosing B; the orifices cut in the side of B facing this pipe must evidently be of such a depth as never to obstruct the flow of steam in its reciprocation. The exhaust channel E is situated on the other side of the partition. To complete the steam entry arrangements, a perforation is made from the hollow of C, leading into the left-hand chamber. When the block B is at its highest point, the excentric arm of A being vertically upwards, the steam is on the point of entering, as at this time the blanks between the channels of C are about to cease blocking the channels in B. A slight movement and the steam enters, filling the chamber to the left, and forcing round the excentric cylinder and the shaft to which it is secured, in the direction of the arrow. The steam on the other side exhausts freely through E. As the revolution continues, the ports open wider and wider, until the shaft has turned through 45 deg., after which it begins to close, contracting gradually until the angle has become 90 deg., when they close entirely and are situated as shown in Fig. 1. The remaining half of the revolution is obtained by the expansive action of the steam, the ports during this period remaining closed.

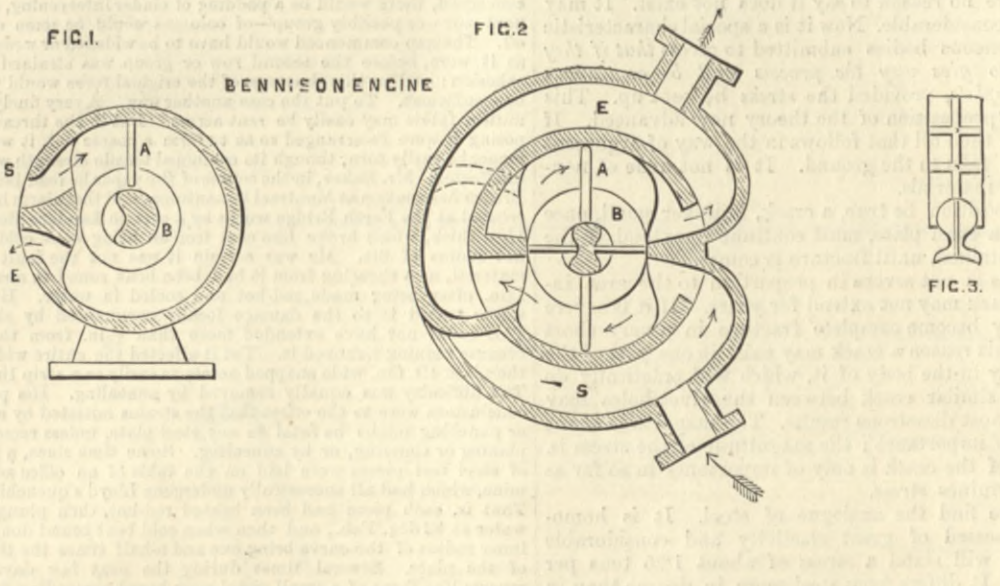
If a single engine were employed the momentum of the machinery would have to carry the revolving cylinder past its upper vertical position, as in this position the chamber is not divided by the partition. The peculiarity of this engine lies, however, in the use of two cylinders, not so much to avoid dead points as to obtain a mutual action between the reciprocating blocks. The second cylinder and its mechanism are so disposed that the upward movement of the block in the one engine carries out the downward movement of the block in the other, a suitable lever connection being employed. This second engine and the arrangement of its parts can be seen from the longitudinal section, Fig. 2; the fittings are the same as in the other, but so placed that when one reciprocating block is up the other is down. The connecting mechanism alluded to consists of a lever rocking about an adjustable fulcrum O, the ends of the lever being paired to intermediate pieces O', which are in their turn paired to the sliding blocks. It can easily be seen how this arrangement carries out the idea of causing the reciprocating block to follow the excentric cylinder in its downward movement. And it will also be observed that the jointing is such that when wear has taken place all the parts are adjusted up to their work again by screwing down the fulcrum O. It is true that in this case four distinct groups of mechanism are employed; the two excentric cylinders with their sliding blocks and intermediate connecting pieces; the two arms of the lever with their intermediate links paired up with the reciprocating blocks. This does not, however, apparently much complicate the construction, and certainly does a great deal towards keeping down wear and keeping up steam tightness in this particular class of engine.

A good many joints require attention in this engine. There are the fronts and sides of the reciprocating block; the connections of the intermediate piece C with the reciprocating block, with the surface of the excentric cylinder, and with the sides of the fixed main cylinder; also the jointing of A with the inner surface of the fixed cylinder and with its flat ends. The large faces of the sliding blocks work against a flat plate, shown on its right in Fig. 1, which can be adjusted by set screws; the ends have cross strips of metal fitting in corresponding recesses, and kept up against its surface by springs behind, shown in Fig. 3. The port faces or connection between the pieces C and B are accurately fitted, the ends of C having strips kept against the rubbing surface by springs, as indicated in Fig. 3. The face of this piece towards the turning cylinder is well fitted, this, as well as the port face, being kept up to its work by the external force acting on the reciprocating piece above, derived from the action of the neighbouring engine. The touching surface between the excentric cylinder and the fair cylinder is rendered effectual by making the connection between this cylinder and the revolving shaft square, the shaft being forged square and passed into a square hole in the cylinder. A little play being purposely allowed, set screws are so placed as to set the revolving cylinder outwards against the fixed. A fair surface contact is obtained here because of the similar curvature. For the sides of this piece metallic rings *m* are fitted in annular grooves running around the ends as near to the outer edge as possible, and kept against the sides of the fixed cylinder as with the packing of an ordinary piston. To prevent dirt obtaining access to the working parts, the upper part of the machine is closed by a light cover. An engine of this description with 8in. cylinders will develope a brake horse-power of about five, running at 450 revolutions, with a steam pressure of 45 lb. on the square inch. With duplicate valve gearing and duplicate steam and exhaust channels, this engine can be made reversible.

The Bennison engine, which is manufactured by the same firm as the previous engine, Messrs. R. Waygood and Co., may be said to be in some respects the converse of the Pinchbeck engine. In the Pinchbeck engine, the sliding partition is moved in a fixed frame by the revolution of an excentric cylinder; in the Bennison, the sliding partition is moved in a revolving frame by the action of a fixed excentric piece. The simple movements of this engine can be seen from Fig. 1. A fixed cylinder is so shaped that a radial partition A, while revolving about its axis, is compelled to take an excentric course. To accomplish this completely, an inner fixed cylinder is shaped so as to have a similiar excentricity with the outer, there being a constant radial distance between them. Turning on this central cylinder is a cylindrical piece B, whose outer surface touches that part of the outer cylinder which penetrates farthest into the interior. The piece A is paired with the piece B by means of a longitudinal slot in B, to allow of A sliding in and out as it is acted upon by the fixed excentric surfaces. This formation extends the whole length of the cylinder. Upon turning the shaft B, the chamber between one side of the partition A and the fixed excentric abutment from the large cylinder increases, that on the other decreasing. Suitable steam and exhaust channels being provided at S and E, one chamber is expanded by the action of the steam, the other being opened out to exhaust, the consequence being that the piece A is forced round, carrying with it the shaft piece B. As A comes up on the other side of the excentric abutments it sinks back into B, reappearing as it comes out on the other side; the above action is then repeated and continuous rotation kept up. The actual Bennison engine differs from this in having four rotating sliding blocks, two opposite excentric abutments on the same cylinder, and in having the steam and exhaust passages so disposed as to well balance the machine when at work. If used as in Fig. 1, there would always be a considerable axial pressure—a pressure caused by the unbalanced steam force on A pushing the drum B hard against the axle passing through it. This force causes a considerable amount of wear in the axles or bearings of many engines, an action which might be termed a rimering out of the bearings. By placing four sliding pieces A equidistant around the revolving piece B, the ports being arranged as shown, so as to admit steam on opposite blades and exhaust from opposite blades, it is clear that the axle having equal opposite forces on either side is relieved from any pressure. No separate valve gear is employed; the revolving blades or pistons passing the ports cause the steam to act upon them at the proper time. The several joints are not generally fitted with special packing arrangements for preserving tightness. The ends of the blades, where pairing with the fixed cylinder, are rounded and touch home as they revolve, an extra security resulting from the centrifugal action set up forcing them out against their working surface. Where the blades pass into the drum the surfaces are flat and accurately-fitted, a treatment which appears to secure proper tightness. This joint is aided greatly by the peculiar action of the engine, which is such that when the steam is exerting a force on one side a blade, this being the case when it is moving through the upper and lower quarters between the excentric abutments, the blade is stationary towards the turning drum, and is held against the side of the slot by the force of steam, thus assisting to keep it tight. As the blade passes the abutments there is an equal pressure on both its sides, as at this time it is passing a port; it is therefore free to pass into the slot by the action of the abutments, and no leakage can occur, as the pressure on each side is the same. Similar remarks apply as it passes outwards, after turning past the extreme position. The power exerted by this engine is fairly large for its size, a result due to the fact



PINCHBECK'S ENGINE.



BENNISON'S ENGINE.

that one revolution of the shaft gives opportunity for two cylinder volumes of steam to do work. There being four blades, each of which is acted upon through two quarters of the cylinder in a revolution, the aggregate volume swept through is evidently twice that of the cylinder. This engine is as much used as a pump as a motor; a 14in. pump delivering over 1000 gallons of water, while running at 200 revolutions per minute; and this water delivered, as might be deduced from the examination of its construction, in a steady stream.

THE STEEL PROBLEM.

THE history of steel supplies numerous examples of failure. Mr. Maginnis' experience only differs in magnitude from that of several other engineers. English and Scotch steel are not specially liable to failure. The same peculiarities manifest themselves in American, German, and French steel. Steel makers in a body, and the majority of steel users, state, and with reason, that as a constructive material it is unrivalled for strength and ductility. No one now disputes the accuracy of this proposition. It leaves the solution of the steel problem quite unaffected. That problem is—Why does a material so ductile and so strong split and break? Cracking is the last thing to be expected of it. Toughness is the great speciality of steel. Why should a tough strong metal crack? This is the question. It does not appear that any answer has ever been given which is accepted as conclusive. To add another theory to the many attempted solutions of the steel problem can do no harm; it may do good.

In the following article will be maintained the following thesis. The fracture of steel boiler and ship plates is due not to a defect in the material, but to the homogeneity of the metal. This being the case, so long as steel is homogeneous, so long will fractures such as that of the boilers of the Livadia, and many others, occur. Nothing that the steel maker can do will prevent their occurrence, because the steel maker has nothing to do with the immediate cause of failure. This statement is to be taken of course with limits; that is to say, the steel must be free from notable percentages of sulphur or phosphorus.

It is evident that steel as a constructive material will always be exposed to stresses. These may be either tensile or compressive; more usually the former. For the sake of simplicity and brevity, attention may be given to only one form of steel, namely, boiler plates. When a boiler plate is in place it is submitted to a tensile strain, and that strain will not be equally distributed through the plate. It would be easy to show that there can be nothing like equable distribution of stress anywhere in the plate. It will suffice, however, to point out that the metal between the rivet holes is more severely stressed than the metal in the body of the plate. If this is conceded it follows that some portions of the plate are more liable to fracture than others, in so far as they are more severely stressed.

It is a peculiarity of all materials of whatever kind, that under anything like a constant stress they give way by degrees. That is to say, one portion parts company with its fellow a little before another portion. The interval of time marking precedence of rupture may be extremely minute—but we have no reason to say it does not exist. It may also be very considerable. Now it is a special characteristic of all homogeneous bodies submitted to stress *that if they once begin to give way the process will be continuous until it is complete*, provided the stress be kept up. This is the crucial proposition of the theory now advanced. If it is not true, then all that follows in the way of argument or deduction falls to the ground. It is not true of non-homogeneous materials.

If the proposition be true, a crack, however small, once developed in a steel plate, must continue to extend, if the stress is maintained, until fracture is complete.

If the stress is not severe in proportion to the area involved the crack may not extend for years. If it is severe the crack may become complete fracture in a very short time. For this reason a crack may exist in one part of the steel plate, say in the body of it, which will practically do no harm. A similar crack between the rivet holes may produce the most disastrous results. The magnitude of the crack is of no importance; the magnitude of the stress is. The locality of the crack is only of importance in so far as location determines stress.

In glass we find the analogue of steel. It is homogeneous, possessed of great elasticity and considerable strength. It will stand a stress of about 1·25 tons per square inch. It differs from steel more in degree than in anything else. From this cause all the bad qualities of steel are magnified and intensified in glass. It supplies, therefore, ready to our hands an admirable means of illustrating the truth of the propositions set forth above. We have only to start a minute crack in glass to cause its complete rupture, provided the material is stressed. It may be said here that the force required to fracture glass in which a crack has been started by a diamond is out of all proportion small compared to that which steel will sustain. The answer is that the strain will depend on the cohesive strength of the material. Steel is about thirty times as strong as glass; hence at least thirty times as much force will be required to develope a minute crack into a fracture. It may be conceded, however, that much more will be needed in the case of steel, and yet the main argument will not be affected. It is necessary here to point out that the magnitude of the initial crack is of no consequence in the case of glass. The crack made by a glazier's diamond is so shallow that its depth can only be expressed in thousandths of an inch.

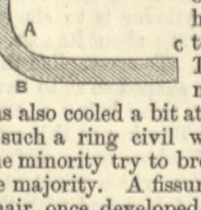
It must be clearly understood that everything and anything that is called a crack in a steel plate is not necessarily mischievous. There are cracks and cracks. Thus the crack produced by a glazier's diamond is very peculiar. It is in no sense a scratch. A diamond cannot be cut by a lapidary to produce a crack. A diamond ring will not and cannot "cut" glass; it will only scratch it. The cutting diamond is really a chip or flake of diamond—a natural crystal, in fact—and has not a ground-up but a natural cutting edge, and it requires some knack in applying it to the glass even then to use it successfully.

What may be termed a fatal crack in a steel boiler plate must be strictly analogous to a crack made by a diamond in glass.

That cracks once started will extend in steel has been demonstrated over and over again. Armour-plates afford a good illustration. After one has been struck by a heavy shot, the cracks started by the impact of the projectile will continue to extend; the plate making a peculiar singing noise the while. The special developing powers of cracks in homogeneous mixtures are well known, and provided for in daily practice. Thus, a small hole is punched by the corner of a shutter in a plate glass window; there are minute radiating cracks visible. Leave the pane to itself, and the crack will extend under the influence of the vibration due to street traffic. The prudent owner sends for the glazier, who passes a diamond in a circle round the hole outside the longest of the radiating cracks. The damage will not extend beyond this circle, and the worst that can happen is that the circumscribed piece will drop out, when the hole can be stopped by a new piece cemented in. When a crack starts in a fire-box a hole is drilled at each end and a rivet put in. The crack will stop at the holes. It ought to be quite unnecessary to extend illustrations of what must be well known and admitted by all engineers. Mr. J. Head, in his address as president of the Institution of Mechanical Engineers, said:—

The superior tensile strength and ductility of steel as compared with wrought iron, and its independence in these respects of the direction of fibre or grain, arise from its purity and homogeneity. The molecules composing it, when it is in a fully wrought condition, seem to be in almost absolute contact in every direction. There is no appreciable interposition of cinder or other foreign substance, and they are therefore fully subject to cohesive attraction. But this homogeneity is the cause of extreme susceptibility to tearing strains. Imagine for a moment a piece of steel plate to be composed of a number of molecular columns, side by side, each column being equivalent in height to the thickness of the plate. Let us now apply a splitting force just capable of overcoming the lateral cohesion of two contiguous columns forming the edge of the plate at a particular place. They are separated, and offer no further resistance; and the force is available to act on the next pair of columns. These separate, and the split proceeds. The view that mysterious cracks in steel are all in the nature of tears seems to be confirmed by the fact that in such cases there is never any appearance of contraction at the fractured edges, notwithstanding the general ductility of the metal. This also may, I think, be explained. Let us suppose that one pair of molecular columns in the line of a crack came in its turn under the separating strain, and tended to shorten before parting company. It is evident that the pair of columns last torn apart, and now free from strain, and the next pair ahead, not yet strained, would both act as props, and afford support, so as to prevent shortening of the then strained pair. In this they would be assisted by all other contiguous columns; whereas if the whole piece of plate were strained equally across while being pulled in two in a testing machine, each molecular column across the line of fracture would be under identical conditions, and none would interfere with the tendency in its neighbours to shorten. Cracks in soft steel plates, unaccompanied by contraction at the fractured edges, must then of necessity be tears; and tears cannot show evidence of contraction. A wrought iron plate is not liable to tears of this kind, because possibly the cinder which permeates it acts as a sort of padding between the molecular columns. Suppose a similar strain to be applied to the edge of an iron plate, and to leave the first pair of columns separated and just beyond the range of cohesion. If we were dealing with steel, the next pair of columns would now be sustaining the full brunt of the force. But iron being the material concerned, there would be a padding of cinder intervening, and the next pair—or possibly group—of columns would be some distance off. The gap commenced would have to be widened or wedged out, as it were, before the second row or group was strained beyond cohesion; and for this the range of the original force would perhaps be insufficient. To put the case another way. A very finely woven muslin fabric may easily be rent across. But if the threads composing it were re-arranged so as to form a coarse net, it would no longer be easily torn, though its combined tensile strength would be unaffected. Mr. Baker, in the course of the paper he read before the British Association at Montreal last autumn, said that alarm had been created at the Forth Bridge works by a certain Landore steel plate $1\frac{1}{8}$in. thick, which broke like cast iron on being bent cold to the flat radius of 6ft. He was certain it was not the fault of the material, as a shearing from it had been bent round to a radius of $1\frac{1}{2}$in. after being made red-hot and cooled in water. He afterwards traced it to the damage locally commenced by shearing. This could not have extended more than $\frac{1}{16}$in. from the edge, because planing removed it. Yet it affected the entire width; for the plate 4ft. 6in. wide snapped across as easily as a strip 1in. wide. The difficulty was equally removed by annealing. His practical conclusions were to the effect that the strains initiated by shearing or punching might be fatal to any steel plate, unless removed by planing or rimering, or by annealing. Some time since, a number of steel test pieces were laid on the table of an office adjoining mine, which had all successfully undergone Lloyd's quenching test. That is, each piece had been heated red-hot, then plunged into water at 82 deg. Fah., and then when cold bent round double, the inner radius of the curve being one and a-half times the thickness of the plate. Several times during the next few days sharp reports like those of a small pistol were heard proceeding from the office. The cause was not immediately detected; but it was afterwards accidentally discovered that some of the test pieces had developed fine cracks across the outer surface of the bend. Although quite sound at first, they had evidently been under severe strain, and their tuning-fork form had caused the sharp report when they gave way. There was no sign whatever of contraction along the fractured edges.

To recapitulate. The failure of steel plates is caused by the formation in them of very minute fissures or cracks of the specific kind needed, and the application of sufficient stress. Thus, for example, a boiler plate is flanged in a ring to take a furnace tube. It is left all night. In the morning the ring is found to have detached itself from the boiler. A little consideration will show that however kindly the metal lent itself to the work of flanging, stresses have been set up in it. At the point A a compression stress has been set up; at the point B a tensile stress. From A to C circumferential stresses run round the ring. The diameter of the ring at C is now 3ft. The hole in the plate was, before flanging took place, 2ft. 2in. in diameter. The flanging was done while the metal was heated a bit at a time; it was also cooled a bit at a time. We may rest assured that in such a ring civil war is raging among the molecules. The minority try to break loose; they are constrained by the majority. A fissure of the proper kind no bigger than a hair once developed somewhere about A or B, and off comes the ring. It will be argued that if this were true annealing would be of no use. This is not so. Annealing is of use, not because it prevents the formation of incipient cracks, but because it demolishes the internal stresses which render the cracks operative for mischief. The stress alone, or the crack alone, will do no mischief. Combine them and an extended fracture is certain to ensue.



Incipient cracks of the right sort occur in iron just as they do in steel; but they have no power of extension. The want of homogeneity in the material is fatal to their progress.

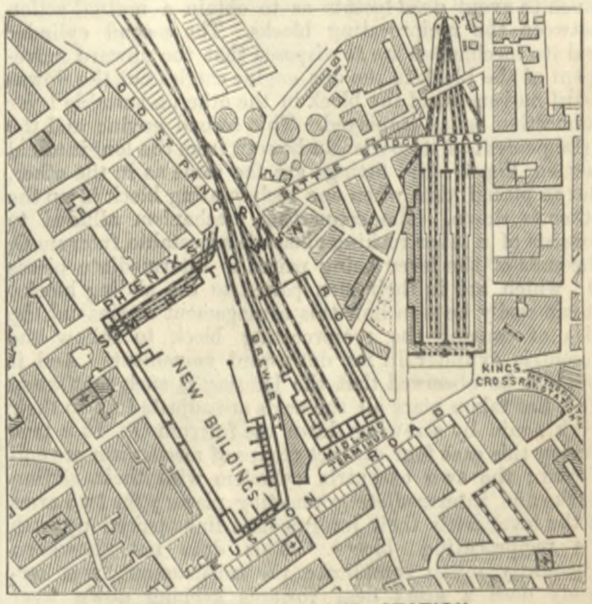
It is very doubtful if any advance has been made towards eliminating the uncertain character of steel. For more than twenty years it has been before the world as a material used for shipbuilding and boiler plates, and twenty years ago it manifested the same admirable qualities it does to-day. It also manifested qualities not admirable; Messrs. Harland and Woolf's experience with the Istria, for example. There is, therefore, no reason whatever to imagine that any progress can be made in the means of its production which will render it quite exempt from such failures as those recorded by Mr. Maginnis and "Snap." Neither is it very easy to see how the boilermakers or the shipbuilders can do much more than they do now. Every precaution should be taken to prevent the formation of incipient cracks—which will be quite invisible in most cases—and to get rid of them if formed. Thus the edges of boiler plates should always be planed and *smoothed*. To merely run over them once and tear off a coarse shaving may do as much harm as good. All rivet holes should be drilled, or at least rimered out to a *smooth* surface. The boring out of flanged rings would probably be productive of great good. The utmost caution should be used in caulking to use tools in such a condition that they cannot start cracks.

Nothing new is suggested here. The fact that such precautions have long been used is the best possible evidence of the truth of the proposition put forward at the beginning of this article, and repeated here, namely, that the formation of extremely minute cracks in a homogeneous material like steel is certain to cause ultimate fracture, provided stress is put on the plate. The apparently treacherous nature of steel is due wholly to its homogeneous texture, and until for that has been substituted a non-homogeneous or fibrous texture, steel will remain untrustworthy. L.

THE MIDLAND RAILWAY, ST. PANCRAS EXTENSION.

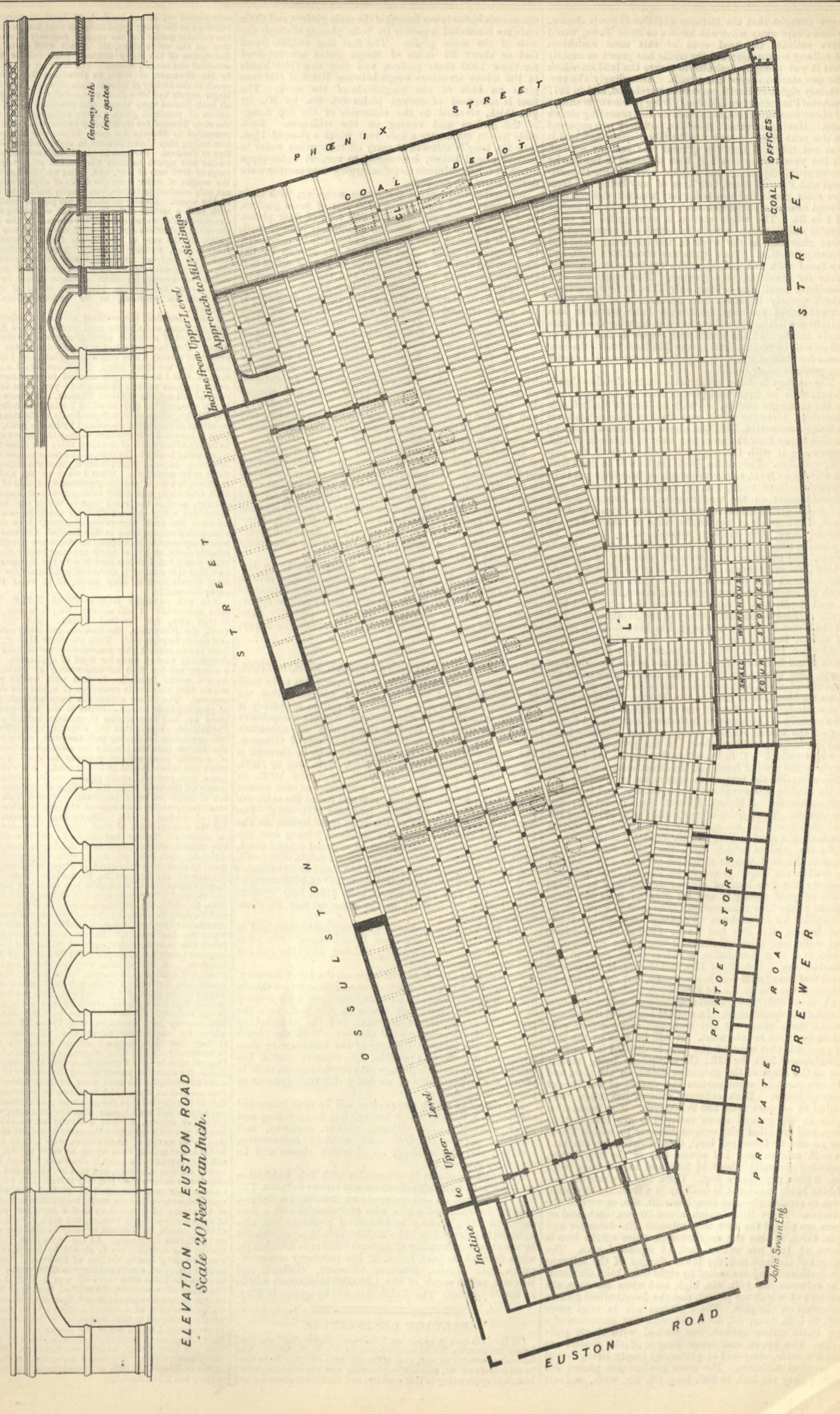
PROBABLY few people are aware that the largest railway goods station building in the world is now being constructed at the London terminus of the Midland Company in the Euston-road, and that the works are already far advanced. This part of the metropolis has seen great changes during the last few years. At the end of the last century it seems to have been a suburban pleasure resort, the Old Brill Tavern, with its surrounding garden, being shown on the maps of that period, and a public-house of the same name, and a Brill-street, having been cleared away for the present works. Legend gives us much earlier information, and if a certain antiquarian, called Dr. Stukeley, is to be believed—who published his "Itinerarium Curiosum" in 1758—the station now being built covers the site of what is designated in his book as "Cæsar's camp, called the Brill, at Pancras." Few relics of a past age have, however, been found in the excavations, one bronze celt, or spear-head, and some silver coins of various reigns back to Edward II., being all that can be identified. Probably more were dug up when the fields and gardens were replaced by streets and houses a hundred years ago. Middle-aged men may remember the neighbourhood of Battle Bridge some thirty-six years ago, when the Great Northern Railway was commenced, and when the Small-pox Hospital occupied the site now covered by the present terminus at King's Cross. At that time Somers Town—as the district in the angle between the New-road and Old St. Pancras-road was called—had become a crowded and somewhat unsavoury congerie of narrow streets and shabby houses. The valley of the Fleet seems to have had an unenviable notoriety, although this part of it never attained quite so evil a fame as did the neighbourhood of Field-lane, which, with its surroundings, was cleared away about the same time, and the site of which, though partly occupied by the Farringdon-street Station and the recently erected Fish Market, is not yet fully built upon.

In the years 1867-70, when the Midland Company, with the bold, forward policy which has always characterised it,



SKETCH MAP, MIDLAND STATION.

made the Bedford and London extension, a considerable portion of Somers Town was cleared away to make room for the St. Pancras terminus, the skill of Sir George Gilbert Scott and Mr. W. H. Barlow being displayed in the design of the present hotel and passenger station. One would



THE MIDLAND RAILWAY, ST. PANCRAS EXTENSION.

(For description see page 488.)

have thought that the Camden (Midland) goods station, which swept away what was known as Agar Town, would have satisfied the need even of this most ambitious of railway companies; but the traffic has grown so rapidly that it was thought desirable to secure the land on which the new station is now being built. Accordingly the proprietary rights of Earl Somers were purchased, and in 1877 an Act of Parliament was obtained giving powers over an area of about fourteen acres, as marked on the preceding sketch map. Having advanced thus far, no hurry was apparent in the next step; no one was hastily dispossessed, and it was not till 1883 that the ground was entirely cleared. In the year 1879, access had been obtained to the site by constructing the bridge and viaduct over Old St. Pancras-road and Phœnix-street, two lines of way being laid from the main goods line to a temporary wooden viaduct continued nearly to the Euston-road, with a downward incline of 1 in 35. The whole station is surrounded by ornamental walls—nearly a mile in length—of somewhat the same character as the work in the adjoining hotel and passenger station. These walls are about 30ft. high, and are faced with red Leicestershire bricks, with Mansfield stone for mouldings and parapet. The bricks are of a peculiarly small size—rising only 11in. to four courses—which greatly improves the appearance of the work. Large arched openings filled with light wrought iron screens are left in the walls to assist in lighting the private roads inside. At the south-west corner a fine block of offices will be erected, and in the Midland-road—the new name for Brewer-street—a large four-storey warehouse for dry goods is being built.

The station is being constructed on two levels—that is to say, with an upper and ground floor, as has been done in the passenger station, but with a different kind of construction. Over the whole area an iron floor or platform is being constructed, 18ft. 6in. above the ground level, and on this upper floor the numerous lines of rails will be laid, connecting it with the approach roads north of the passenger station. Part of the goods traffic will be dealt with on this upper level, in covered sheds or buildings yet to be erected, inclined roads, 1 in 30, from Ossulton-street and Phœnix-street on the western side, and Euston-road on the south, giving access for vans and carts from the street level. But much of the traffic is to be managed on the ground floor, the railway wagons being lowered by hydraulic lifts, as is already done at Broad-street, Blackfriars, and other of the terminal stations in London. These lifts are marked L on the plan on page 489. At the northern end of the station, a space 437ft. by 83ft., with its longer side fronting Phœnix-street, is set apart for a coal depôt, and is separated from the other part by a wall. Hitherto the coal delivery of the Midland, like that of the Great Northern Company, has been done by means of shoots, the railway wagons on the uppel level being discharged into the street vans below. But just as it has been found in South Wales, Hull, and other coal-shipping ports, that such a method breaks the coal, increases the amount of slack, and renders it more liable to gas explosions on board, so in London also, the merchants find that the waste by dust and small coal is increased by the shoots. The remedy is the same in both cases, namely, the lowering of the loaded wagons bodily, without breaking bulk, and discharging quietly below. In the present case there is a hydraulic lift, C L, by which the wagons are lowered down to the ground level, and the street vans are brought close alongside the wagons to receive the coal. This part of the station was completed in August last, and is now in the occupation of Messrs. Rickett, Smith, and Co., coal merchants. The portion of the station next adjoining the coal depôt will be set apart for milk traffic, and will be reached by a road incline, 1 in 15, from Phœnix-street.

As the girders which carry the upper floor have to support the dead weight of ballast over its entire surface as well as the buildings yet to be erected, and have also to carry the live load of railway trains, they have been made of great strength, and we give on page 498 some details of the floor construction. The ground varied in its suitability for foundations. Formerly occupied by streets and houses, the site had to be cleared of the cellars and walls, and then excavated at the places of support, down to a firm foundation, which is in all cases in the London clay. A depth of 12ft. to 15ft. below the ground level was found sufficient in most cases, but on the eastern side near the line of the old Fleet-ditch, cylinders had to be sunk about 40ft. through soft mud before a sufficiently firm foundation was reached. In another portion of the ground an old burial-place was met with, and many coffins were taken away for re-interment. It will be seen by the plan on page 489 that most of the area is divided into rectangular spaces 35ft. by 33ft., the exceptions being mainly due to the shape of the ground as shown on the plan, and in some cases to accommodate the curves of the lines of railway below. Each ordinary column has when fully loaded to support from 250 to 300 tons. The foundation holes in the ground above referred to are 12ft. to 15ft. deep, and are filled with cement concrete to within 7ft. of the ground or lower rail level, thus distributing the load on each column over 144 square feet of the clay below, imposing generally about $1\frac{1}{2}$ tons, and in no cases more than 2 tons per square foot. Upon the concrete 3ft. 6in. of blue brick in cement is built up in a truncated pyramid form to receive the cast iron bases 4ft. 6in. square of the columns. These bases weigh about 30 cwt. each, and on them are placed the cast iron columns 2ft. diameter and $1\frac{1}{2}$in. thick, so that the maximum pressure on the iron is about $2\frac{1}{2}$ tons per square inch of sectional area. The flanges of the base and the lower flanges of the columns are machined, and are united by eight bolts $1\frac{1}{2}$in. diameter. The columns are 14ft. 6in. high, and upon the caps, the surfaces of which are planed, rest the longitudinal girders indicated on the plan. These girders are in most cases 35ft. to 50ft. long, 4ft. deep, and with the exception of a few extra strong girders, are formed with single plate webs. The upper and lower flanges of the girders are 2ft. 4in. wide, composed of plates and amply strengthened by vertical stiffeners. The cross girders are placed 7ft. apart; they are 30ft. to 33ft. long, 1ft. 4in. wide, and rest upon stools on the lower flanges of the main girders, and their ends are connected together by bolts passing through the web of the main girder. The fact that 187,000 lineal feet or about 35 miles of flange plates are required for these 1900 cross girders, and that the rivet heads in the whole structure weigh between 700 and 800 tons gives an idea of the magnitude of the work. The floor is composed of curved plates 6ft. 2in. by 3ft. by $\frac{3}{8}$in. thick, rivetted to the underside of the top flange of the girders and resting on the stiffeners. Each plate has in its centre a hole into which a piece of $1\frac{1}{2}$in. tube 2in. long is screwed to carry off the surface water to gutters placed below, converging to vertical water-pipes attached to the columns and discharging into earthenware drains below the ground.

Altogether there are 400 columns, weighing, with their bases, about 2000 tons, about 4750 tons of main girders, 8300 tons of cross girders, and 950 tons of floor plates. About two-fifths of this quantity has already been erected, and it is expected that the remainder will be completed by December, 1886. The front of the station in the Euston-road and the side buildings in Brewer-street and Ossulton-street are well advanced, and the warehouses on the upper floor will be commenced during 1886.

Mr. John Underwood, C.E., of the Midland Railway, is the engineer, and the whole of the works have been designed and carried out under the supervision of Mr. J. A. McDonald, M. Inst. C.E., who has previously carried out important works of the Midland Railway. Mr. Joseph Firbank, of Newport, Mon., is the contractor for all except the ironwork, which is let separately. The whole of the ironwork, amounting as detailed above to about 16,000 tons, is being made and erected by Messrs. Andrew Handyside and Co., of Derby, and London; Eastwood, Swingler and Co., Derby; and John Butler, of Stanningley, near Leeds; these three firms having each about an equal quantity.

In looking at this—one of the largest of iron structures—the question arises whether steel could not have been used with advantage. The transition period between iron and steel is rapidly passing away, and although at the present time small spans could not be made quite so cheaply of steel as of iron, and it would be inexpedient, in view of future wasting by rust, to reduce the thickness of the floor-plates, it is probable that in a very short time railway engineers will prefer steel, the extra cost being so trifling and the superiority in strength so great.

The lighting of the basement station will be an important work. It is probably an unprecedented task to light by day as well as by night one chamber ten acres in extent and only 14ft. high, and it seems a manifest opportunity for electric lighting. We shall probably have occasion to refer to this work again when the superstructure is built.

THE SCOTTISH INTERNATIONAL EXHIBITION.

The Exhibition of Industry, Science, and Art to be held in Edinburgh next year has so far advanced that we think some details and general information regarding it may be interesting to our readers. Twenty competitive plans were sent in, from among which the executive selected one by Messrs. Burnet and Lindsay, of Glasgow. The main entrance to the Exhibition will be through a permanent building of steel and glass, 320ft. long by 120ft. wide, with a central dome 120ft. high and 100ft. in diameter. Four smaller domes will stand at each corner of this building, while under these and round the sides are picture-galleries, in all 600ft. long and 30ft. wide. The temporary buildings are of the same cross section as the well-known South Kensington building, joining into the permanent building, and consist of a grand central court, 750ft. long by 50ft. wide, with twenty-six courts, each 135ft. long by 50ft. wide, placed on both sides and at right angles to it. At the end of this central court the "Old Edinburgh" is introduced, and eight courts, each 120ft. long by 50ft. wide, branch off from it in the same manner as those mentioned above.

The site has been granted by the city authorities and is only a few minutes' drive from Princes-street. Six acres of the buildings are now nearly finished, while the rest are in a forward condition.

The allotment of space will begin on the 1st of January, and space for a large number of most interesting exhibits has been applied for. Sub-committees have been formed in all the most important towns in Scotland, with the provost in every case as chairman, and the undertaking has met with the most cordial support. With the object of making the internal lighting of the buildings by electricity as interesting as possible, the executive council has decided to divide the buildings into seven sections, so as to afford the opportunity of as many different systems as possible being shown.

The classes in which our readers will be most interested are Nos. 1, 5, 6, 8, 9, which are mining, &c., printing and paper making, prime movers, railway, tramway, and vehicular appliances, civil and military engineering, building, and shipbuilding, all of which classes will be very fully represented.

The special sections in connection with this Exhibition are—fine arts, women's industries, and artisan sections. The first will include oil and water-colour drawings, sculpture, drawing in black and white, also photographs and a loan collection of pictures; architectural drawings are also included in this section. The Exhibition will greatly benefit by the enormous number of summer visitors to Edinburgh, while through its port, Leith, it has passenger communication with Russia, Sweden, Germany, Holland, and Belgium, not to speak of the 1,500,000 inhabitants within an hour's journey. The Exhibition will be opened in May.

SALVAGE ENGINEERING.

On the 17th inst. a paper on "Salvage Engineering" was read before the Dundee Mechanical Society by Mr. T. N. Armit. The lecturer proceeded to say, that although good men had from time to time cropped up, salvage engineering was the most neglected branch of engineering in this country, and that other countries had outstripped us, if not in skill, at least in organisation. After referring to the many bogus schemes that had been launched upon the gullable public for the certain recovery of almost every lost ship on the wreck chart, Mr. Armit went on to give a graphic description of the many methods practised for the recovery of stranded and sunken vessels. The floating of the Great Britain by Mr. Bremner, of Wick, in Dundrum Bay, was a pronounced epoch in the history of salvage engineering. Although many much larger vessels had been since successfully floated, they had nearly all been floated upon known and practised plans, or by a combination of practised plans. After eulogising the Conservancy of the river Thames for their ability in removing wrecks, the lecturer proceeded to describe his most interesting connection with the iron sailing ship Columbo sunk in eight fathoms of water in the Bay of Panama. Previous to Mr. Armit's arrival, contractors from Callao had agreed to raise the sunken ship, together with her cargo of 1800 tons of coal, and, being unskilled as to the effects of the weight of water upon the decks of sunken ships, their efforts not only resulted in failure, but greatly tended to the destruction of the vessel. He also mentioned his plan of dealing successfully with such a serious difficulty as that of raising a wooden superstructure under water, covered by canvas, to the height of 16ft. above the Columbo's deck all round the vessel, was adopted on his advice in the case of the sunken Orient steamship Austral in Neutral Bay, Sydney Harbour. After describing the various modes of applying compressed air in the raising of sunken ships, Mr. Armit said:—I have told you about floating stranded vessels, of overcoming their damages either by steam pumps and divers, by building platforms inside of them, by floating them on pontoons, or by assisting them with external buildings.

I have described the ordinary method of raising sunken ships with pontoons, and also the most skilful plan of floating them by the erection of a wooden superstructure up to the surface of the water. You have also had a description of the compressed air process of turning a ship into a diving-bell, and I have warned you against the use of air bags. But there is still a most important method that I have not yet alluded to in connection with deep-water pontoon raising. I have told you about Mr. Wood's tidal rise and fall work in the river Thames, and I have no doubt many of you observed the plan on which I raised the fallen girders of the Tay Bridge, which acted independently of the rise and fall of tide, by means of horizontal screws and hydraulic jacks, making one lift from the ground to the surface, so that the girders could be beached to be dry at low water of the same tide; but these methods of pontoon raising belong to the past, or at least, confined to weights under 1000 tons—no mean weight either if you saw it suspended, or begin to think of its magnitude. What I want to see, and what I hope I shall see, is a set of sea-going pontoons, capable of raising at least 2000 tons each, and fitted with permanent steam winding machinery, so that the many vessels which sink to depths where divers can safely descend shall no longer lie as a reproach to the talent of this great engineering country. I do not say that the recoverable wrecks lying in the English Channel and elsewhere would remunerate a company to construct the plant I speak of, because most, or all, of them are now barely worth the price of scrap iron; but I do say that it is in the highest degree discreditable that this country is devoid of appliances for the recovery of large vessels sunk in deep water, or in water that divers can easily descend to.

You will naturally inquire—Could H.M.S. Vanguard have been recovered? I will answer, No; she was too deep then, if not now, for practical diving. But the Grosser Kurfurst, the Pomerania, the Electric, and many other ships should, and could, be recovered. Take the river Mersey, for instance. I have known many highly recoverable vessels sunk in these waters completely thrown away for want of appliances. Indeed, I have a strong opinion that no conservancy or harbour board should receive special legislation to deal with wrecks until they have shown that they are in possession of appliances suitable for their removal. The Mersey authorities have acquired the heroic habit of planting their wrecks. Theirs is the Irish method—they blow them up, and then shelter themselves behind a special Act of Parliament. I said that the difficulty in deciding what was the best appliances for dealing with the great variety of wrecks around the British Isles was possibly the strongest reason for the absence of a really great salvage company in the United Kingdom. I think this reason should no longer exist. A few good-going salvage boats, with powerful steam pumps, would, I think, overtake all or nearly all the cases under the heading of stranded vessels; while a set of large sea-going pontoons, equipped with steam winding machinery, would meet most of the requirements under the heading of sunken vessels. There are, however, other reasons for the non-existence of such salvage companies in this country as those of Svitzer and Neptune in the Baltic. Around the British shores there is a tidal rise and fall varying in different parts from 4ft. up to 60ft. No wonder, then, at the great number of simple cases of stranding that present pretexts for almost any one styling themselves "salvors." Scarcely a Lloyd's agent around the coasts but considers himself a more or less talented salvage engineer, and although these gentlemen may often be superior in skill and assiduity to the special agents sent by underwriters to represent them, they have always the gratifying consolation that, whether successful or not, underwriters have to "pay for the whistle." But as underwriters have not always found this to be agreeable, some of them have banded themselves together into "Associations for the Protection of Marine Insurance Interests." A few of these societies have acquired a sufficient amount of appliances to warrant them calling themselves salvage companies; but when I inform you that these companies are conducted on the basis of "heads I win, tails you lose," you will not wonder that salvage companies have not made very rapid strides in this country. Far be it from me to infer that there are not in this country men second to none either in the Baltic or elsewhere for engineering talent and ship-raising skill; but is it fair that these talented salvage surveyors should continue to personally conduct their dangerous operations for a fixed salary? Depend upon it—and I speak from wide experience—that most of them—the charm of travelling and the novelty of the work having worn off—relegate the hard work to their subordinates, and seek that comfort on shore which is seldom to be found upon a wreck. Is it to be expected that the man who participates in the profit will not scheme and work harder than the man who, whether through failure or success, receives a certain remuneration? I will not trouble you with describing the many unskilled and inexperienced men in the service of underwriters, who for the most part would be far better making than trying to raise wrecks, but will briefly call your attention to another drawback against the success of a purely salvage company, and that is the general disinclination of shipowners to have their property salved. I do not believe that Mr. Chamberlain was warranted in making the wholesale attacks upon shipowners that he made both inside and outside the House of Commons. I do not deny that I have had painful experience of shipowners not only wishing, but trying, to thwart the salvage of their vessels, but I should be sorry to hold this up as a reflection on the British shipowner. At the same time, I do not think that the day has arrived when it should be compulsory for the shipowner to suffer loss in the loss of his vessel. Underwriters were, in their inception, a mere auxiliary to shipowners. They undertook to share the losses with them—it was a mutual adventure; but, like many other customs, the mutual bearing of loss has grown to be "more honoured in the breach than in the observance." Consequently the offer of a salvage company to an owner now-a-days is usually consigned to that limbo over which the charwoman reigns. In conclusion I would say to the young men before me who may have intentions of turning ship raisers, don't try it unless you feel that you have strong, healthy constitutions. It is a calling with many fascinations. It presents opportunities for the shrewdness of the merchant, the skill of the engineer, and the heroism of the sailor; but it is a hard life.

MILLS' INSTANTANEOUS BOAT ENGAGING AND DISENGAGING GEAR.

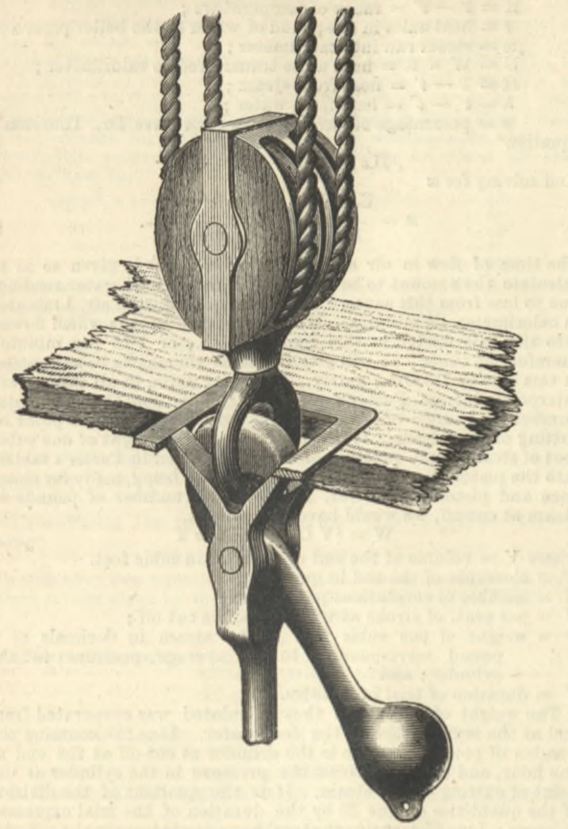


Fig. 3.—Block Engaged

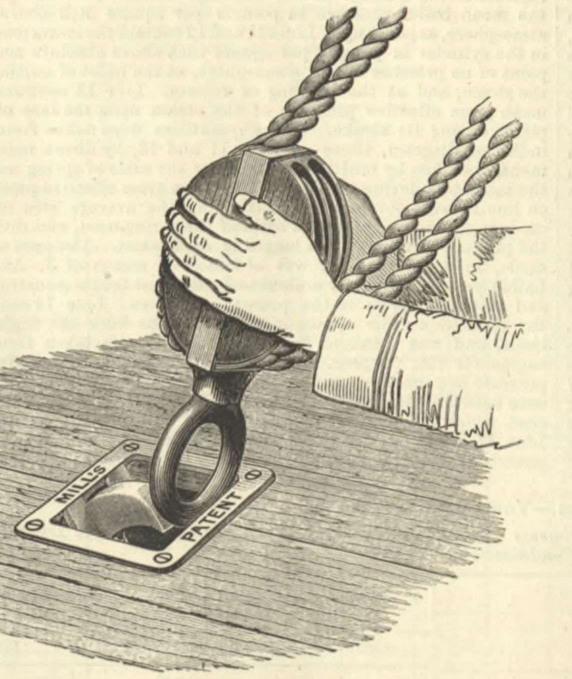


Fig. 2.—Act of Engaging

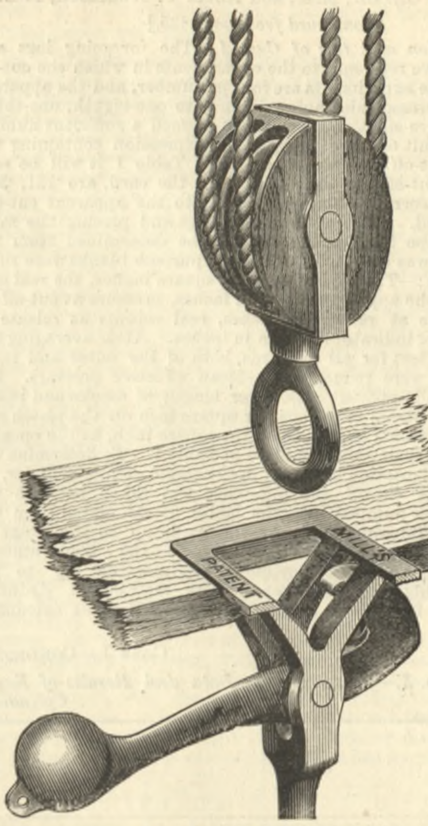


Fig. 4.—Block Disengaged

MILLS' INSTANTANEOUS BOAT ENGAGING AND DISENGAGING GEAR.

THE boat engaging and disengaging gear illustrated by the accompanying engravings has been made with a view to removing the defects of many of those yet proposed, and to comply with the Board of Trade requirements for passenger and emigrant vessels. It combines automatic and the non-automatic at will, with great simplicity, and it seems to be perfectly trustworthy. Fig. 1 shows the general arrangement, but it may also

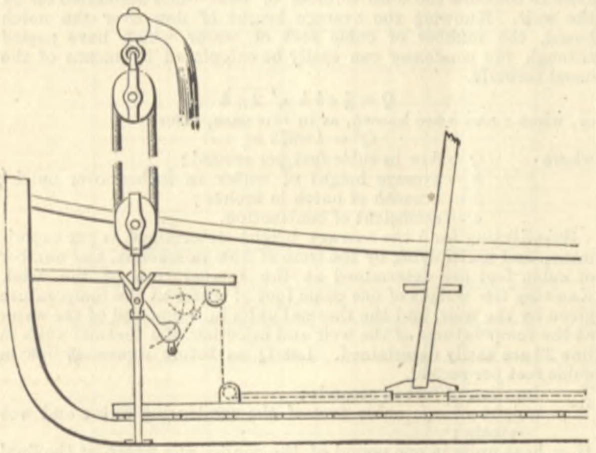
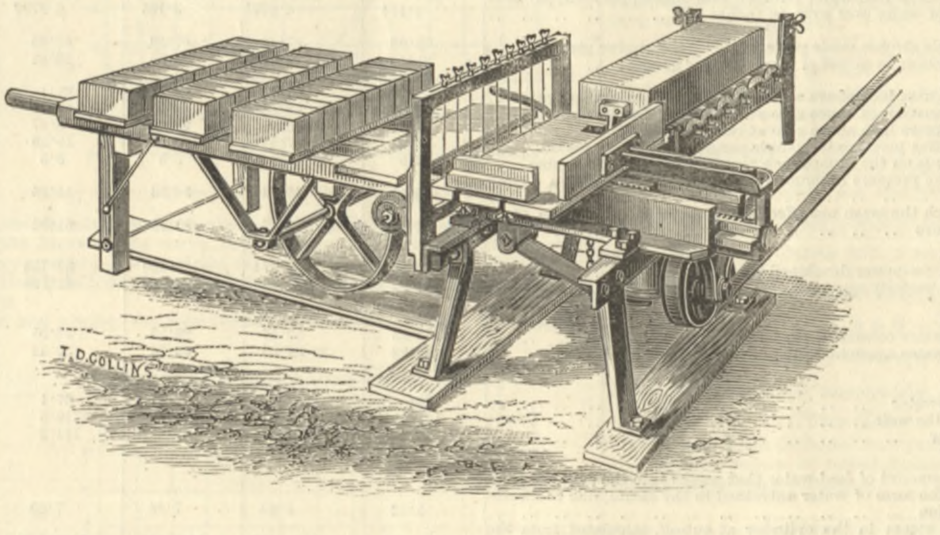


Fig 1

be fitted to stem and stern post, in slings, or any other convenient position, causing no obstruction in any part of the boat. The lanyard for simultaneous disengagement of the two hooks may, when used, be carried along the side of the boat. Fig. 2 shows the eye of the block being forced into the wedge-shaped opening in which the hook is hinged, the hook being forced aside against the resistance due to the weight attached. Fig. 3 is a section of the wedge-shaped casting containing the hook, and shows the block eye as caught and the weight down; and Fig. 4 shows the position to which the hook must be raised to release the block. The act of engaging is so simply effected that if the eye comes anywhere within the boundaries of the hole above the hook, a push engages it. The hook is below the level of the woodwork, and cannot be fouled by anything. The inventor, Mr. W. Mills, of High Southwick, Sunderland, has had much sea experience, and knows the requirements, and has apparently thoroughly fulfilled them. It will be noticed that no room is taken up by the gear, and the boat can be hoisted to the davit head. Mr. W. A. Tindall, commander of the telegraph steamship International, speaks in the highest terms of it.

OTWAY'S BARROW-LOADING BRICK CUTTING TABLE.

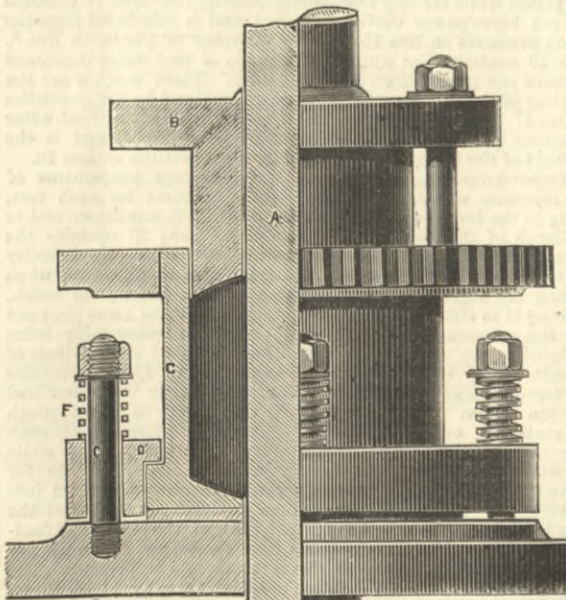
THE accompanying engraving illustrates a very useful machine invented by Mr. G. Otway, of 22, Bengeworth-road, Brixton. A barrow with four empty boards is placed in position in front of the table; the buffer in front of the rollers is in an upright position, in front of the clay, and the single wire at the other end has been adjusted to cut a piece of clay the exact length to make ten bricks, the lad standing in the same position as when working one of Murray's tables. The clay now issuing from the die of the pug mill, its end will strike against the buffer, causing it to go down below the surface of the table, at the same time the single wire will descend and make a rapid cut. The lad will now pass the severed clay along the rollers on to the table, in front of the strained wires, and by moving the lever on his right will put the machine in operation and cut and push the bricks on to the board on the barrow. Before the bricks are finished cutting he will leave go the lever, and by the machine's own action will reverse its movement, then in its backward movement it will advance the board pusher—underneath the surface of the table—against the board and push it sufficiently on the barrow to make room for another board being placed ready for the next row of bricks, at the same time its backward movement will bring up the buffer ready to meet the clay issuing from the die. The lad repeats this operation of placing the empty board in front of the wires, and the machinery pushes first one row of bricks and then two rows, then three, but the last row is not pushed, as it is already in the right position on the barrow. The barrow is then wheeled away and another empty one placed in position. Several of the machines are at work, and will push from forty to sixty on a barrow, and



a barrow to take the usual load of forty is 2ft. shorter, and therefore easier to use than the ordinary barrow.

SPARKES' REVOLVING STUFFING-BOX.

THE accompanying drawing represents an entirely new arrangement of stuffing-box for piston-rods or pump rods. Its objects are to prevent the possibility of the rod becoming scored, or wearing oval, or in any other way "out of truth." It also reduces the friction between the rod and packing to very much less than where the ordinary fixed stuffing-box is used. This is accounted for by the fact that the box is so constructed and



attached to the cylinder cover as to allow a certain amount of lateral movement, so that instead of, as usual, the packing being nipped sufficiently tight to spring after any sideway movement of the rod, the whole stuffing-box with gland and packing is free to slide to and fro on the ground face at its base. The only misgiving felt in making the first was that there might be some difficulty in keeping the joint between the bottom of the stuffing-box and the cylinder cover steam and water-tight, or that to do so it would have to be pressed on to the seat s heavily as to make it difficult to rotate. In actual practice neither of these difficulties have occurred, the joint is perfectly tight, and the stuffing-box can be very easily turned. Two of these stuffing-boxes, one on a vertical and one on a horizontal cylinder, have been working for seven months, and neither has caused a minute's trouble or had any special attention since put on, the rod in both cases is in better condition, and the packing used has not been half as much as usual. Of course the means of turning the stuffing-box will vary considerably according to circumstances.

In both cases referred to above it has been found most convenient to use a worm and worm wheel. The wheel is keyed into the outside of stuffing box, and the worm engaging with it is carried on a light shaft mounted on two small pillars screwed into the cylinder cover; on one end of this shaft is a small ratchet wheel, and a lever with a pawl attached to it. The lever is moved by the valve spindle, and turns the ratchet wheel one tooth for every revolution of the engine, so that the motion given to the stuffing-box is very slow, and the power absorbed practically none. Where this arrangement is carried out in constructing new engines the additional cost would be slight, and more than compensated for by the advantages gained. It is quite applicable to existing engines, and in many cases without disturbing or altering the cylinder cover, the only essential condition for this being sufficient room between the existing stuffing-box and the crosshead when the piston is at the back of the cylinder.

CRITICAL TEMPERATURES AND PRESSURES OF SOME VAPOURS.

By C. VINCENT and J. CHAPPUIS.

THE following abstract of this paper is published in the *Journa of the Chemical Society*:—

	Critical temperature T°.	Boiling point t°.	T − t.	Critical pressure P.	$\frac{273+T}{P}$
Hydrogen chloride.	51·5°	−35·0°	86·5°	96 atmos.	3·4
Methyl ,,	141·5	−23·7	165·2	73 ,,	5·7
Ethyl ,,	182·5	−12·5	195·0	54 ,,	8·4
Ammonia	131·0	−38·5	169·5	113 ,,	3·6
Methylamine.. ..	155·0	−2	157·0	72 ,,	5·9
Dimethylamine ..	163·0	+8	155·0	56 ,,	7·9
Trimethylamine ..	160·5	+9·3	151·2	41 ,,	10·5

In both series the critical temperature rises progressively, but the difference between the critical temperatures of two successive members of the series diminishes rapidly with the introduction of CH_2 into the molecule. The differences between the critical temperatures and the boiling points gradually increase in the first series, but diminish in the second; the difference is not constant, as Nadejdine and Pawlewski have stated. The ratio of the absolute critical temperature to the pressure $\frac{273+T}{P}$ increases gradually with the complexity of the molecule, whilst the critical pressure decreases, or, in other words, for members of the same series, derivatives of the same type, the highest critical temperatures correspond with the lowest critical pressures.

Dewar has already remarked that in simple gases and typical gases under the same molecular volume, the higher critical temperatures correspond with the higher critical pressures, and the two quantities are sensibly proportional, the ratio $\frac{273+T}{P}$ having a constant value of about 3·5—*Phil. Mag.* (5), 18, 210. The authors' results confirm this conclusion so far as concerns hydrogen chloride and ammonia.

CYLINDER CONDENSATION IN STEAM ENGINES. AN EXPERIMENTAL INVESTIGATION.*

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

[*Continued from page* 425.]

19. *Calculation and law of Case I.*—The foregoing logs and Table No. 1 have reference to the experiments in which the cut-off was varied. The experiments are four in number, and the apparent cut-off taken corresponded approximately to one-eighth, one-third, one-half, and five-eighths, these being deemed a sufficient number in order to permit of the forming of an expression containing the per cent. of cut-off as a variable. From Table 1 it will be seen that the true cut-offs, as calculated from the card, are ·131, ·330, ·443, and ·589, corresponding respectively to the apparent cut-offs above-mentioned. After averaging the logs and placing the same in suitable shape for use, the data to be determined from the indicator cards was calculated. For this purpose blanks were ruled so as to contain:—The area of cards in square inches, the real cut-off in inches, the apparent cut-off in inches, pressure at cut-off in inches, pressure at release in inches, real volume at release in inches, length of indicator diagram in inches. After averaging the results of each test for all the cards, both of the outer and inner cylinder, they were reduced to:—Mean effective pressure. Per cent. of real and apparent cut-off per length of stroke and initial pressure of the steam in pounds per square inch on the piston and pressure of the steam in pounds on the square inch, at the opening of exhaust and their values entered in Table 1. To determine the amount of condensation of steam in the steam engine cylinder, up to the point of cut-off, the difference was taken between the amount of water pumped into the boiler as calculated from the weir and the amount shown by the cards up to the point of cut-off. The ratio of this quantity to the true amount will be the per cent. of cylinder condensation up to the point of cutting off the steam. The method of deducing the amount of feed-water pumped into the boilers as calculated from the thermal units of the weir will be described below. The meter readings in this case were of no account, for the reason already mentioned, namely, that three boilers were used while the meter indicated the amount for two of them. The per cent. of condensation, as determined, increases as the ratio of expansion increases. Fig. 1 will serve to show the final results more clearly. The ordinates representing per cent. of cut-off in length of stroke and the abscisses the amount of condensation expressed in per cent. of the total amount of steam furnished to the engine.

20. *General method of calculation and of deduction of law of condensation, with varying ratios of expansion—use of graphical method.*—In the annexed table will be found the observed data and the calculated results of the experiments made with the engine, and in the manner precedingly described for variable cut-off—see Table No. 1. The experiments were four in number, and the results are arranged in parallel columns under their respective cut-offs, namely, ·589, ·443, ·330, and ·131 of the length of the piston stroke. A smaller ratio of expansion could not well be obtained on account of the size of the boilers, these not being able to supply the demand for steam made upon them by the engine when subjected to a greater load. For facility of reference, the quantities as far as practicable are arranged in groups, and the lines composing them numbered.

Case I.—Condensing.—Variable Cut-off.

Table No. I.—*Containing the Data and Results of Experiments made at Sandy Hook, Conn., to determine the Laws of Cylinder Condensation.*

Number of line.			Fraction of the stroke of piston completed when steam was cut off.			
			·589	·443	·330	·131
1	Time.	Date of commencing experiment	a.m. 11.32, May 25.	p.m. 2.04, May 25.	p.m. 2.36, May 24.	a.m. 10.16, May 24.
2		Date of ending experiment	p.m. 1.02, May 25.	p.m. 4.04, May 25.	p.m. 4.31, May 24.	p.m. 12.16, May 24.
3		Duration of experiment in consecutive minutes	90	120	115	120
4	Total quantities.	Number of double strokes made by the engine piston, per counter.. ..	6144	8095	7741	8274
5		Number of pounds of feed-water pumped into boilers, per weir	8788·5	10222·4	7331·5	3375·5
6		Number of pounds of feed-water pumped into boilers, per weir, per hour	5859·	5111·2	3895·1	1687·75
7		Average height of water over weir, in inches	4·474	4·0161	3·195	2·2782
8	Engine.	Number of double strokes made per minute by the engine piston	68·26	67·45	67·32	68·95
9		Vacuum in condenser in inches of mercury, per gauge.. ..	21·43	22·06	20·95	22·61
10	Steam pressures in cylinder per indicator.	In pounds per square inch above atmosphere in boilers, per gauge.. ..	56·83	61·28	60·1	61·1
11		In pounds per square inch above zero at cutting off the steam.. ..	61·54	68·34	62·10	49·11
12		In pounds per square inch above zero at release	38·28	32·03	21·05	8·47
13		Mean gross effective pressure in pounds per square inch on piston	47·94	47·11	36·03	19·36
14		Pressure in pounds on the square inch required to work the engine ..	3·5	3·5	3·5	3·5
15		Mean net effective pressure in pounds per square inch on piston during its stroke	44·44	43·61	32·53	15·86
16		Per cent. of which the mean net effective pressure is of the mean gross effective pressure	92·69	92·57	90·16	81·92
17	Power. Absolute.	Gross effective horse-power developed by the engine	174·589	169·474	129·420	52·158
18		Net horse-power usefully applied	162·82	156·88	116·685	42·728
19	Power. Economic.	Pounds of feed-water consumed per hour, per gross effective P. ..	33·35	30·16	29·55	32·35
20		Pounds of feed-water consumed per hour, per net effective P. ..	35·98	32·58	32·78	39·49
21	Temperature in deg. Fah.	Of the injection-water	69·	67·7	71·6	67·1
22		Of the water in the weir	131·9	131·44	135·7	116·3
23		Of the feed-water	—	1·4·	140·	114·3
24		Per cent. of the amount of feed-water that passes into the cylinder from the boilers in the form of water entrained in the steam, due to incomplete evaporation	5·22	5·68	7·86	7·69
25		Total pounds of steam in the cylinder at cut-off, calculated from the pressure of the steam in the cylinder at the point of cut-off.. ..	6790·251	7454·477	4847·418	1685·159
26		Pounds of steam in the cylinder at cut-off, calculated from the pressure of the steam in the cylinder at the point of cut-off at the end of one hour	4526·834	3727·24	2529·24	842·579
27		Total pounds of steam in the cylinder at release, calculated from the pressure of the steam in the cylinder at release, immediately before the opening of exhaust.. ..	6902·309	7805·352	5049·612	2288·183
28		Total number of thermal units in the steam expended by the engine, as calculated from the feed-water consumed	9031477·5	10481821·8	7340169·	3451899·8
29		Total number of thermal units, as per weir	7929754·6	9113387·6	6354643·1	3014080·5
30		Total number of thermal units, as per weir, per hour	5286503·	4556694·	3631225·	1509040·
31		Per cent. of the steam evaporated in the boilers, not accounted for by the indicator at cut-off	22·73	27·08	33·87	50·07

Time.—Lines 1 and 2 contain the date and time of beginning and concluding of each of the tests, and line 3 the duration in consecutive minutes.

Total quantities.—Line 4 contains the number of double strokes made by the piston, obtained by subtracting the indications of the counter at the beginning from the reading at the completion of the test. Line 5 contains the total quantity of feed-water pumped into the boilers, as calculated from the rise in temperature of the condensing water which flowed over the weir. It is obtained by dividing the total number of heat units as calculated from the weir, together with the heat units due to radiation, and those converted into work by the heat units in one pound of the steam at the pressure of the boiler, corrected for the heat units due to the water of priming, minus the heat in one pound of the water of condensation. It will be seen thus that the weir, at least in this case, came in to good advantage, as without it and with insufficient meter readings the tests in this case could certainly not have been used. Line 6 contains the number of pounds of feed-water pumped into the boilers per hour, and is found by dividing the total pounds of feed-water on line 5 by the duration of the test in hours. Line 7 gives the average height of the water flowing over the notch. By means of the partitions placed in the tumbling bay and the perforations in the last one, the water passed in a steady flow under the pointer attached to the micrometer screw, so that nothing interfered to ascertain the correct reading of the micrometer scale. Line 8 are the number of double strokes made by the engine piston per minute, and are the quotients of the division of the quantities on line 4 by the quantities on line 3. Line 9 is the observed vacuum in inches of mercury per gauge, and each test represents the average of the readings taken. Line 10 contains the mean boiler pressure in pounds per square inch above the atmosphere, as per gauge. Lines 11 and 12 contain the steam pressure in the cylinder in pounds per square inch above absolute zero, or point of no pressure of the atmosphere, at the point of cutting off the steam, and at the opening of release. Line 13 contains the mean gross effective pressure of the steam upon the face of the piston during its stroke. These quantities were taken from the indicator diagram, those on lines 11 and 12, by direct measurement, and then by multiplying them by the scale of spring used in the indicators during the test. The mean gross effective pressures on line 13 were obtained by multiplying the average area of the cards in square inches by the scale of the spring used, and dividing the product by the average length of card taken. The area of the cards, in square inches, was obtained by means of J. Amsler-Laffon polar-planimeter, undoubtedly the best for its construction and accuracy known to the present engineers. Line 14 contains the pressure on the square inch required to work the engine by itself, and was obtained from the friction cards taken from the engine for this purpose. Line 15 contains the mean net effective pressure in pounds per square inch on the piston, and is the difference between the quantities on lines 13 and 14. Line 16 is the per cent. which the quantity on line 15 is of the quantity on line 13. Line 17 contains the gross effective horse-power of 33,000 foot pounds raised 1ft. high, developed by the engine and calculated for the mean gross effective pressure on line 13, the number of double strokes on line 7 of each test and the distance travelled by the piston while making one stroke, namely, 7ft. Line 18 contains the net horse-power usefully applied, and is calculated from the piston pressures on line 15, and for the speed of piston on line 8. Line 19 contains the number of pounds of feed-water consumed per hour per gross effective horse-power. These weights are the quotient of the division of the quantities on line 6 by the quantities on line 17. Line 20 contains the number of pounds of feed-water consumed per hour per net effective horse-power, and is the quotient of the quantities on line 6 by the quantities on line 18.

Temperatures.—Line 21 contains the average temperature of the injection water. This was nearly constant for each test, owing to the large body of water from which it was drawn and to the depth of the pipe below the ground. Line 22 contains the average temperature of the weir during each trial. No difficulty whatever was experienced in obtaining this temperature, when holding the thermometer in the water where leaving the notch, allowing it to strike the bulb. Thus, giving at the same time not only the true reading, but also preventing an undue eddy being produced in the weir, which would have affected the readings of the micrometer scale taken at the same time. Line 23 contains the temperatures of the feed-water, taken after the water had left the meter. Sufficient water was allowed to pass through the meter in order not to be affected by direct connection with the pipe, &c. This temperature was usually taken while the water was fed to the boilers used in the trials. As far as the third boiler would permit a continual stream was fed into the boilers in order to keep the boilers as much as possible at the same level. Line 24 contains the per cent. of the amount of feed-water that passed into the cylinder from the boilers, in the form of water, entrained in the steam, due to incomplete evaporation. The following is the method in detail in which these tests were made, and the manner of arriving at the result:—The weight of the calorimeter empty was first taken. Seventy pounds of water of known temperature t'' was then introduced, this being a convenient figure to handle, and about the capacity of the tank. The three-way cock connecting the worm of the calorimeter with the pipe leading to the boiler was then opened, and steam allowed to flow into the air until the connections were of the same temperature as the steam, and the time of flow noted. The cock was then turned, and the steam flowed into the calorimeter, heating the 70 lb. of condensing water = W up to any observed temperature t', the whole volume of water being well agitated, so as to equalise the temperature. The time of the latter flow was noted, and the boiler pressure recorded.

Let W = the weight of condensing water;
w = the weight of wet steam;
t'' = initial temperature;
t' = final temperature;
R = $t' - t''$ = range of temperature;
t = heat units in one pound of water at the boiler pressure;
x = steam run into calorimeter;
U = W × R = heat units transferred to calorimeter;
H = T − t' = heat from steam;
$h = t' - t''$ = heat from water;
y = percentage of priming; we then have Dr. Thurston's equation*

$$Hx + h(w - x) = U.$$

And solving for x

$$x = \frac{U - hw}{H - h}; \quad y = \frac{w - x}{w}.$$

The time of flow in air and in the calorimeter is given so as to calculate the amount to be deducted from the feed-water reading, due to loss from this cause. Thus, in test 1, flow in air, 1 minute; in calorimeter, $2\frac{1}{2}$ minutes. We see that the weight which flowed into the calorimeter in this time is $5\frac{3}{8}$ lb., or 2·15 per minute; therefore $3\frac{1}{2}$ times 2·15 will give the total amount to be subtracted in this case = 7·525 lb., nearly. The heat units, in all cases, were interpolated from Porter's tables. Line 25 contains the total number of pounds of steam in the cylinder up to the point of cutting off the steam. It is calculated for the weight of one cubic foot of steam at the pressure of cut-off, as given in Porter's tables, into the piston displacement, due allowance being made for clearance and piston-rod. Thus, if W = total number of pounds of steam at cut-off, we would have for one end,

$$W = (V\,C + V')\,N\,w\,T$$

where V = volume of the end of cylinder in cubic feet.
V′ = clearance of the end in question;
N = number of revolutions per minute;
C = per cent. of stroke at which steam is cut off;
w = weight of one cubic foot of the steam in decimals of a pound corresponding to the average pressure in the cylinder; and
T = duration of trial in minutes.

The weight of the steam thus calculated was evaporated from and at the temperature of the feed-water. Line 26 contains the number of pounds of steam in the cylinder at cut-off at the end of one hour, and calculated from the pressure in the cylinder at the point of cutting off the steam. It is the quotient of the division of the quantities on line 25 by the duration of the trial expressed in hours. Line 27 contains the total pounds of steam in the cylinder at release, calculated from the pressure of the steam in the cylinder, immediately before the opening of the exhaust. The calculation is in all respects similar to the calculations of line 25, substituting for c the length of stroke completed up to the opening of the exhaust. Line 28 contains the total number of thermal units in the steam as calculated from the feed-water consumed. As the total number of thermal units passed into the engine is the sum of the quantities of the heat expended, we have for the whole number of thermal units: the thermal units shown at exhaust plus the number due, the energy expended in driving the engine, and its controlling apparatus plus that due to radiation and conduction. The quantities in line 28 are the sum of these three forms of expended heat. Line 29 contains the total number of heat units accounted for by the weir. Knowing the average height of flow over the notch board, the number of cubic feet of water which have passed through the condenser can easily be calculated by means of the usual formula.

$$Q = \tfrac{2}{3}\,c\,b\,h\,\sqrt{2\,g\,h}$$

or, when c and b are known, as in this case, then

$$Q'' = 1{\cdot}6673\,h^{\frac{3}{2}}$$

where Q = flow in cubic feet per second;
h = average height of water in inches over notch;
b = breadth of notch in inches;
c = coefficient of contraction.

Substituting for h the average height determined as per experiment, and multiplying by the time of flow in seconds, the number of cubic feet are determined at the temperature of the trial. Knowing the weight of one cubic foot of water at the temperature given by the weir, and the thermal units in one pound of the water at the temperatures of the weir and injection, the thermal units in line 29 are easily determined. Let Q as before represent flow in cubic feet per second.

T = duration of test in seconds;
W = weight of one cubic foot of the condensing water and wet steam;
H = heat units in one pound of the condensing water at the final temperature, and
h = heat units in one pound of the injection water, then
B T U the total units of heat contained on line 29 becomes

$$B\,T\,U = Q\,T\,W\,(H - h).$$

Line 30 contains the total number of thermal units as per weir per hour. It is the quotient obtained by the division of the quantities on line 29 by the duration of the trials in hours. Line 31 contains the per cent. of the steam evaporated in the boilers, not accounted for by the indicator at cut-off. Line 6 giving the water actually consumed per hour by the engine, and line 26 being the amount indicated by the diagrams, the difference is the amount not accounted for by the indicator, existing in the form of water in the cylinder. The per cent. which the quantity is of line 6, is the amount of condensation in the steam engine cylinder, to the point of cutting off the steam. Knowing the percentage of condensation for the various ratios of expansion as determined in these trials, and in order to readily determine the amount of condensation for other points of cut-off, the results have been plotted, the locus of the curve showing the per cent of cylinder condensation for the ratios of expansion under which the engine may be run—Fig. 1.

21. *Calculations in detail—results discussed and classified—final expressions and curves representing them.*—On examining Table 1, it will be found that the conditions intended to have been kept constant during the trials vary somewhat. The distance travelled by the engine piston in the tests of Case I. does not vary more than 7ft. per minute from the average, and the difference between the greatest and lowest speed during the trials amounts to but 13ft. per minute. When taking into account the controlling power of the engine, the degree with which the pulley heated, and consequent expansion of its rim, a fluctuation of from 1 to $2\frac{1}{2}$ per cent. at the greatest could, with the limited amount of time and assistance, hardly be avoided. The steam pressures as recorded per boiler gauge also show some fluctuation. This, however, was not due to any inexperience in firing, but to the greater demand made by the engine upon the boilers than these were originally intended for. As the work of the engine came down to its ordinary conditions—that is, to the capacity of the boilers—a more uniform boiler pressure was obtained, varying not more than $1\frac{1}{2}$ per cent. between the highest and lowest pressures, while the difference in the whole range amounts to but 5 per cent. of the highest boiler pressure recorded. As shown in our later tests, condensation changing slowly with the initial pressures, the difference due to a slight variation of the boiler pressure would not appreciably affect the law of condensation at the varying cut-offs of ·589 and ·443 respectively. Having discussed the two constant factors and their slight variation during the tests of Case I., the per cent. of cut-off per length of stroke and the amount of condensation can now be taken into consideration. From Table No. 1, we have for a

Cut-off of ·589; cylinder condensation = 22·73 per cent.
·443; = 27·08
·330; = 33·87
·131; = 50·07

From which we see that the condensation increases rapidly with expansion of steam; or, in other words, with longer exposure of

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

* American Institute "Report on Steam Boilers, 1871," p. 17.

the sides of the cylinder, cylinder head, and piston to the decreasing temperatures of the expanding steam. Plotting these results upon paper, and making the abscisses represent the amount of condensation, or the per cent. of the total steam condensed in the steam engine cylinder, excepting that due to the priming, and letting the ordinates represent the fraction of the stroke completed when the steam was cut off, and tracing the curve through the points of intersection, we obtain the curve as represented in Fig. 1.

22. *Method of deducing algebraic expressions for variation of condensation in Case I., and functions of size of engine and area of surface exposed.*—Taking the actual figures in Table 1, as found by experiment for cut-off and cylinder condensation, and an intermediate point from the curve between the cut offs of ·131 and ·330, we have for

Cut-off = y = ·131	condensation = x = 50·
·225	= 41·
·33	= 34·
·45	= 27·
·59	= 22·5

The locus of these points appearing to follow an hyperbolic expression, we applied the general equation of an hyperbola.

$$(x + a)(y + b) = c, \text{ or}$$
$$xy + bx + ab = c.$$

Transposing, we have—

$$bx + ay - c = - xy,$$

and substituting the above values for x and y, we have—

$$50\,b + {\cdot}13\,a - c = - {\cdot}0650 \quad . \quad . \quad . \quad (1)$$
$$34\,b + {\cdot}33\,a - c = - {\cdot}11225 \quad . \quad . \quad . \quad (2)$$
$$22{\cdot}5\,b + {\cdot}59\,a - c = - {\cdot}13275 \quad . \quad . \quad . \quad (3)$$

Equating (1) and (2) and eliminating c, we have—

$${\cdot}16\,b - {\cdot}20\,a = {\cdot}04725 \quad . \quad . \quad . \quad (4)$$

and performing the same operation with equation (1) and (3) we have—

$${\cdot}275\,b - 46\,a = {\cdot}06775 \quad . \quad . \quad . \quad . \quad (5)$$

We now have two equations with two unknown quantities; eliminating a from these by the ordinary rules of algebra, we have—

$${\cdot}0186\,b = {\cdot}008185$$
$$b = 44005$$

Substituting the value of b in (4), we have—

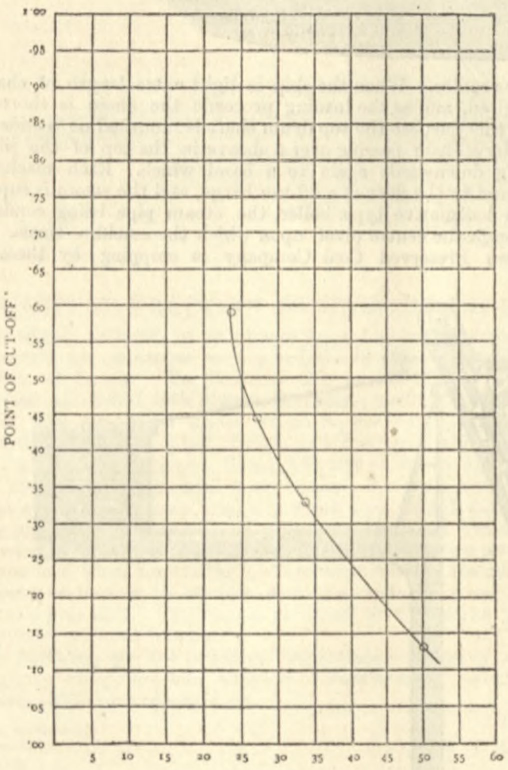
$${\cdot}0704 - {\cdot}20\,a = {\cdot}04725$$
$${\cdot}20\,a = {\cdot}02315$$
$$a = {\cdot}11575$$

and by substituting the values for a and b in (1), we have

$${\cdot}22 + 0150475 - c = - {\cdot}0650$$
$$\text{and } c = {\cdot}3000475.$$

As the values of a, b, and c, when calculated by the other of the

Fig. 1



Per cent. condensed.—Condensation with Boiler Pressure Variable.

original equations, differ only in the fifth and sixth decimal places from the results obtained above, these values for the coefficients of x and y in the hyperbolic equation, and of the constant may be taken as their true values, thus determining experimentally the law of cylinder condensation as a function of the ratio of expansion. We thus have the following values for $a = 0{\cdot}11575$, $b = 0{\cdot}44005$, and $c = 0{\cdot}3000475$, in accordance with which we will take

$$a = 0{\cdot}12;\ b = 0{\cdot}44;\ c = 0{\cdot}3,$$

and substituting these values in the general case, we have

$$x\,y + 0{\cdot}44\,x + 0{\cdot}12\,y = 0{\cdot}3 \quad . \quad . \quad . \quad . \quad . \quad \text{A.}$$

We now test equation A by substituting y = ·13, 0·225, 0·33, &c., and computing the values for x, we thus find—

y = cut-off = 0·13;	x = cylinder condensation = 0·499;	error of − 0·001
= ·225;	= 0·410;	0·000
= ·33;	= 0·338;	− 0·002
= ·45;	= 0·274;	+ 0·004
= ·59;	= 0·222;	+ 0·002

This equation then satisfies so closely the results obtained by direct observation, that it may be taken to represent the law of condensation, as a function of the cut-off for this engine under the conditions used. It is the equation of an hyperbola, and may be put under the form

$$(x + 0{\cdot}12)(y + 0{\cdot}44) = {\cdot}2472 \quad . \quad . \quad . \quad . \quad . \quad \text{B}$$
$$\text{or if } x' = x + 0{\cdot}12 \text{ and } y' = y + {\cdot}44$$

we have
$$x'\,y' = 0{\cdot}2472,$$

which is the equation of an hyperbola referred to its asymptotes. Discussion of the equation. In the equation A, if the cut-off be zero, then $y = 0$, and $x = {\cdot}3 \pm {\cdot}44 = {\cdot}68$, or nearly 70 per cent. of the steam will be condensed in the cylinder when the cut-off is the least possible. If we allow steam to follow full stroke, $y = 1{\cdot}0$, and we find $x = {\cdot}12$, or at full stroke 12 per cent. of the steam will be condensed in this engine. The latter conclusions are, however, of less value, because they result from extending an empirical formula too far beyond the limits of the experiments, on which it is founded in both directions. As a matter of curiosity, we notice that equation B shows that when the cut-off is − 0·44, the condensation will be infinite. Cylinder condensation as function of area exposed. The area of cylinder surface exposed to the action of the initial steam varying directly as the cut-off, we obtain from the curve of Fig. 1, when allowing z to represent the area in square feet of the cylinder, and its piston exposed to the steam for a

Cut-off of ·6;	square feet of area exposed = z = 13·86
·5;	= z = 12·21
·4;	= z = 10·56
·3;	= z = 8·91
·2;	= z = 7·26
1;	= z = 5·61
·0	= z = 3·96

Plotting these, as in Fig. 2, making the ordinates the fraction of stroke completed when steam is cut off; and the abscisses the area in square feet exposed to the initial steam, corresponding to these cut-offs, we find the locus of the points to be a straight line, whose equation is

$$x = 3{\cdot}96 + 16{\cdot}5\,z;$$

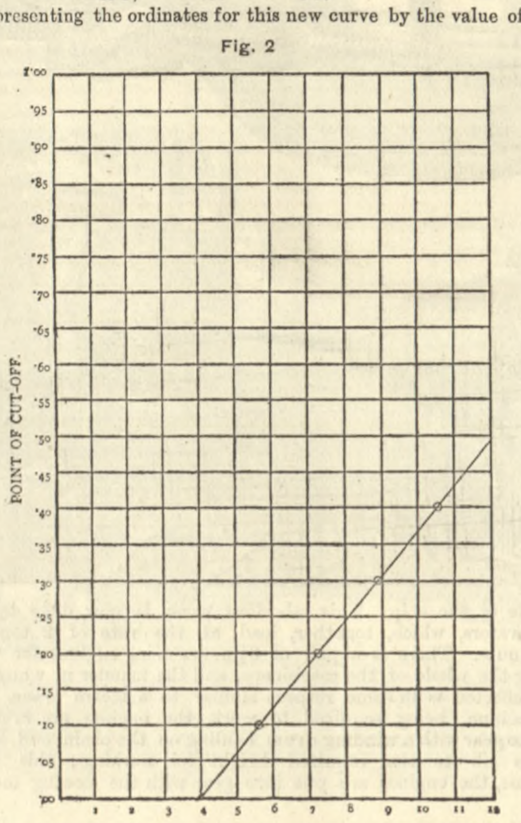
that is, the area exposed to the action of the steam varies directly as the cut-off, as it should, as increase of admission increases the surface exposed. From the above conclusion, we consequently infer that the amount of condensation expressed as some function of the area of surface exposed must follow the same general law. The constants of the equation representing this law are determined in precisely the same manner as were the constants in the equation representing the law of cylinder condensation, in which the cut-off per length of stroke is the variable function. From Figs. 1 and 2 we have

letting x = per cent. of condensation, as before,
y = cut-off per length of stroke,
and z = area of surface exposed:

x = 22·4;	y = ·6;	z = 13·86 square feet.
25·;	·5;	12·21
28·5;	·4;	10 56
36·;	·3;	8·91
44·;	·2;	7·26
53·5;	·1;	5·61
68 1;	·0:	3·96

as representing the ordinates for this new curve by the value of z,

Fig. 2



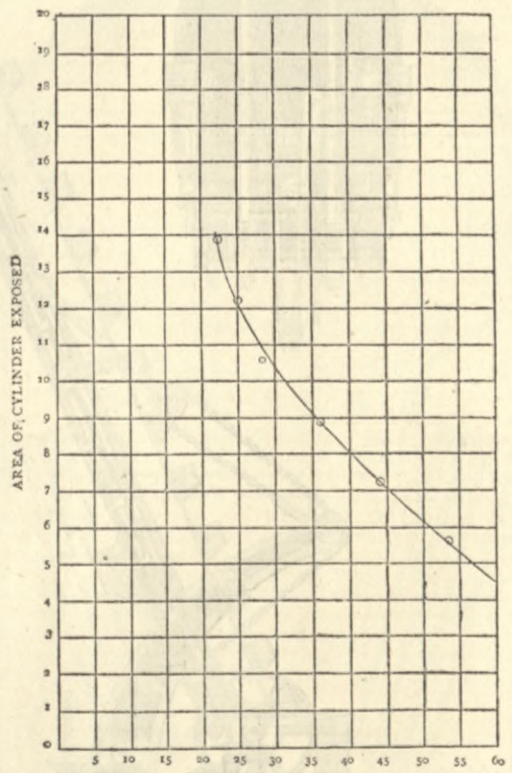
Areas of Surface Exposed.—Condensation with Variable Areas Exposed.

and the abscisses the corresponding cylinder condensation, we find the locus of the curve, represented on Fig. 3, to have the same general appearance of the curve of Fig. 1. We infer consequently that it follows the general law, the equation of which for this case is

$$x\,z + b\,x + a\,z = c \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{C}$$

x and z being the two variables mentioned above. Transposing,

Fig. 3



Per cent. of Condensation.—Condensation with Variable Areas Exposed.

eliminating and substituting, as in the first application of the general formula, we find for the values of the constants

$$a = - 4{\cdot}77;\ b = - 1{\cdot}026;\ c = 221{\cdot}36,$$

and these values substituted in equation C, gives

$$x\,z - 1{\cdot}026 \times - 4{\cdot}77\,z = 221{\cdot}36 \quad . \quad . \quad . \quad . \quad \text{D}$$

By substituting the values of z, and calculating for x, we find when

z = 13·86;	z = cylinder condensation = 22·01;	error of − 0·39
12·21;	25·00;	± 0·000
10·56;	28·50;	± 0·000
8·91;	33·50;	− 2·50
7·26;	41·06;	− 2·94

This equation then satisfies the results obtained by experiment so closely, that it may be taken to represent this law of condensation as a function of the area exposed in square feet in this engine, to the action of the steam during the set of trials made for Case I. The equation is that of an hyperbola and may be written,

$$(x - 4{\cdot}77)(z - 1{\cdot}0266) = 216{\cdot}47 \quad . \quad . \quad . \quad \text{D}$$
$$\text{or if } x' = x - 4{\cdot}77, \text{ and } z' = z - 1{\cdot}026$$

we have
$$x'\,z' = 216{\cdot}47,$$

which is the equation of an hyperbola referred to its asymptotes.

(*To be continued.*)

(*To be continued.*)

NAVAL ENGINEER APPOINTMENTS.—Frederick G. Jacobs, assistant engineer, to the Excellent, additional, for the Glatton.

THE PHYSICAL SOCIETY.

AT the meeting of this Society held on December 12th, 1885, Professor F. Guthrie, president, in the chair, Mr. C. F. Casella and Professor T. E. Thorpe were elected members of the Society. The following papers were read:—

"On a Magneto-electro Phenomenon," by Mr. G. H. Wyatt. The author had conducted a series of experiments with a view of testing experimentally an expression obtained by Mr. Boys for the throw of a copper disc, suspended by a torsion fibre between the poles of an electro-magnet, when the current was made or broken, and communicated by him to the Society on June 28th, 1884. Discs of various metals and of various dimensions were used, the results being such as to agree with the theory within narrow limits. It was, however, found that when the throw of the disc was used to measure the magnetic field, the value obtained from the throw at break was uniformly greater than that obtained on making the current. Professor S. P. Thompson observed that the case presented was analogous to that of the ballistic galvanometer, and that for the theory it was necessary that the magnetic field should be made and destroyed before the disc had moved sensibly. Mr. Boys believed that the results of the experiments showed this to be the case, since the result of such a movement would be to increase the throw on breaking the current when the disc made an angle of less than 45 deg. with the lines of force, and to decrease it when the angle was between 45 deg. and 90 deg., whereas no such variation from the theoretical result was observed.

"On Some Thermo-dynamical Relations," by Professor William Ramsay and Dr. Sydney Young. In this paper experimental proof is given of the following relations:—(1) The amount of heat required to produce unit increase of volume in the passage from the liquid to the gaseous state, at the boiling point under normal presssure, is approximately constant for all bodies. (2) If these amounts of heat be compared at different pressures for any two bodies, then the ratio of the amount at the boiling point under a pressure p_1 to the amount at another pressure p_2 is approximately constant. (3) The products of the absolute temperature into the rate of increase of pressure, with rise of temperature, are approximately the same for all stable substances. (4) The rate of increase of this product, with rise of pressure, is nearly the same for all stable substances. (5) A relation exists between the absolute temperatures of all bodies, solid or liquid, stable or dissociable, which may be expressed in the case of any two bodies by the equation—

$$\frac{T_A}{T_B} = \frac{T_{A'}}{T_{B'}} + c\,(T_{A'} - T_A)$$

T_A and T_B being the absolute temperatures of the two bodies corresponding to any vapour pressure, $T_{A'}$ and $T_{B'}$ absolute temperatures at any other pressure, and c a constant which may be zero or a small positive or negative quantity. (6) The variations from constancy of the expression $t\,\frac{dp}{dt}$, though small, may be expressed by a similar equation. (7) If L_A, $L_{A'}$, L_B, and $L_{B'}$ represent similar relations of latent heat at different pressures the same for A and B, it seems probable that

$$\frac{L_A}{L_{A'}} = \frac{L_B}{L_{B'}} + c\,(T_{A'} - T_A)$$

(8) The ratio of the heats of vaporisation of any two bodies at the same pressure is approximately the same as that of their absolute temperatures at that pressure. Finally, the author's conjecture that this statement is also true of dissociating bodies. A large part of the experimental work consisted in obtaining the relation between vapour pressure and temperature of different substances, values of $\frac{dp}{dt}$ had been obtained from these observations in two ways—by plotting curves with t and p as co-ordinates and drawing tangents, and by the method of differences. Professor Perry suggested that the curve should be expressed in such a form as

$$\log.\, p = d - \frac{\beta}{t} - \frac{\gamma}{t^2}$$

which Rankine has shown to be a very true expression for the relation between pressure and temperature, and that $\frac{dp}{dt}$ should be obtained from this by differentiation.

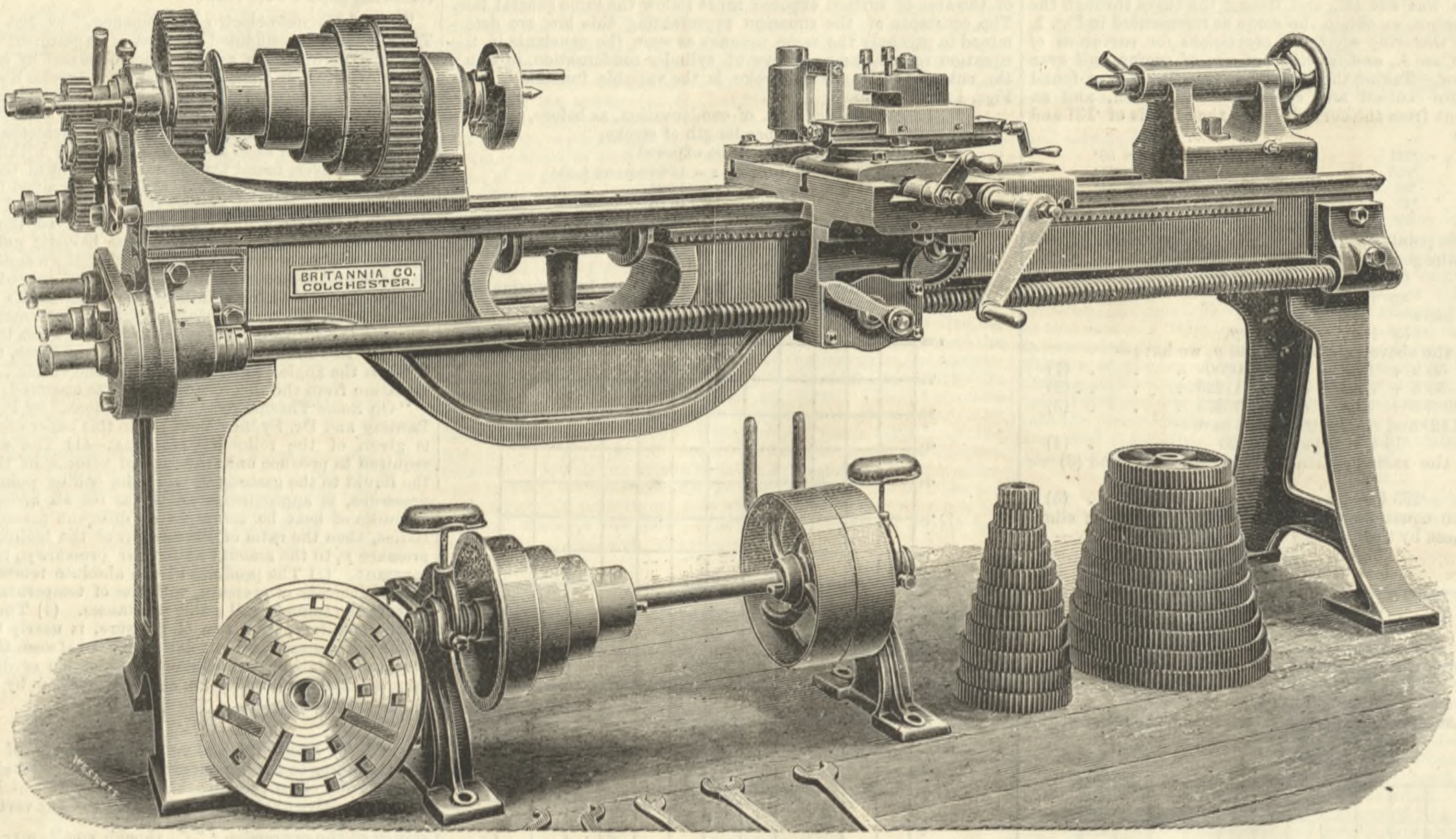
Professor Guthrie hoped the authors would experiment upon the vapour-tensions of mixed liquids—a subject to which he had himself given some attention.

PUMPING ENGINES AT HANNIBAL, MO.—The contract trial of the new pumping engine at this place recently put in by the water company was made November 5th, with results which are highly satisfactory to both the company and the builders of the machinery. The engine is rated at a capacity of two and a-half million gallons of water in twenty-four hours, at a plunger speed of 150ft. per minute. It is of the compound condensing type, known as the Reynolds-Corliss, with one high-pressure cylinder 23in. diameter; one low-pressure cylinder 45in. diameter; and two plunger pumps 17in. diameter, all of 30in. stroke. The engine weighs complete about 100 tons. The record of the test gave—water pumped per hour, 117,794 gallons; coal burned per hour upon a basis of 10 lb. evaporation (*sic*), 207 lb.; head pumped against, including friction, 248ft.; revolutions of engine per minute, 33; steam pressure, 79 lb.; receiver pressure, 7 lb.; vacuum, 26in. Pounds of water raised 1ft. high with the consumption of each hundred pounds of coal, 118,327,035. The *Hannibal Journal* adds, with the extreme refinements usually practised in expert trials, the duty would be increased to over 125,000,000.

ENGINEERING SOCIETY, KING'S COLLEGE, LONDON.—At a general meeting of the above Society held on Tuesday December 8th, the President in the chair, Mr. F. C. Fairholme opened a discussion on "Railway Brakes." He observed that it might even now be safely said without fear of contradiction, that the question as to which is absolutely the best brake remained still undecided, and that in all probability each of the more important systems would continue to retain a certain number of adherents, according to climatic differences, and to the peculiar circumstances of various railways. Amongst the general requirements of railway traffic at the present day, however, that of automatic action in case of accident was now very generally recognised, even by most of its former opponents, to be one of the most important, and Mr. Fairholme therefore restricted his remarks to those brake systems which fulfilled this condition. He dealt mainly with the Westinghouse automatic compressed air, Smith's automatic vacuum, and the Heberlein automatic friction brakes, as being now the chief representatives of the three most important groups respectively, and as having been awarded gold medals at the Inventions Exhibition. He also mentioned the Carpenter, and the Wenger compressed air, the Saunders vacuum, and other brakes of the respective groups, and laid stress upon the differences which now exist between the Heberlein automatic friction brake and the Clark-Webb chain brake. Mr. Fairholme also mentioned that among the qualities that a good brake should possess was the power of automatically adapting itself, in the case of each vehicle, to variations in the load, and this has been arrived at in an invention brought out by Messrs. Sloan and Hawks, a model of which was afterwards shown and explained to the meeting by the inventor. Mr. Fairholme then pointed out at some length the relative advantages and disadvantages of the several brake systems, remarking on the tendency of the railway companies of this country seeming rather in favour of vacuum brakes, while on the Continent, partly owing to the extent of through traffic, the various forms of compressed air brakes appeared to be extending their adoption for the fast trains, and the Herbelein automatic friction brake was adopted for the local lines on the Prussian State Railways, besides making much progress in other countries both for fast and local traffic.

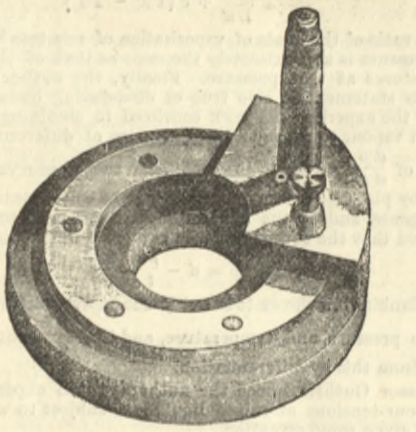
GENERAL PURPOSE LATHE.

THE BRITANNIA COMPANY, COLCHESTER, ENGINEERS.



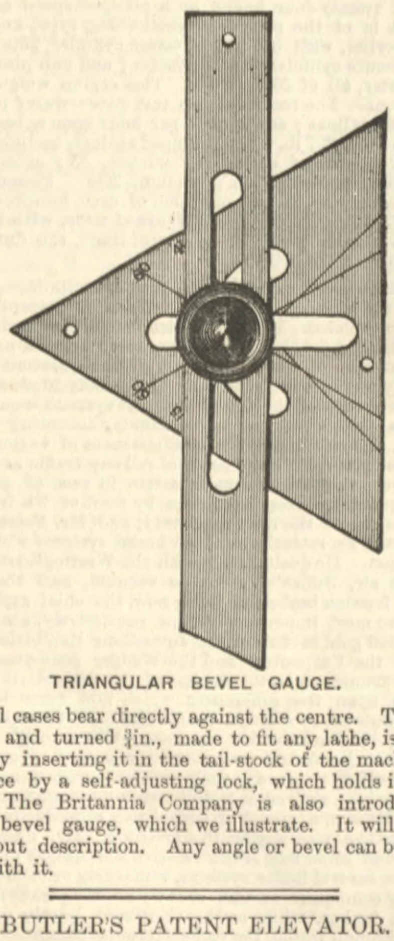
GENERAL PURPOSE LATHE.

THE engraving above illustrates a neat and serviceable lathe, made by the Britannia Company, Colchester. In connection with this lathe, and others, may be used Kelly's patent revolving



KELLY'S REVOLVING HEAD.

head, as illustrated by the accompanying engraving, which shows the back. This tool has all the value of a turret head at one-quarter the cost, the expense being no more than an ordinary drill chuck; it holds six tools, thereby avoiding loss of time in changing, and giving more accurate work. The spindle revolves upon a disc, in which are the holes or sockets for tools,

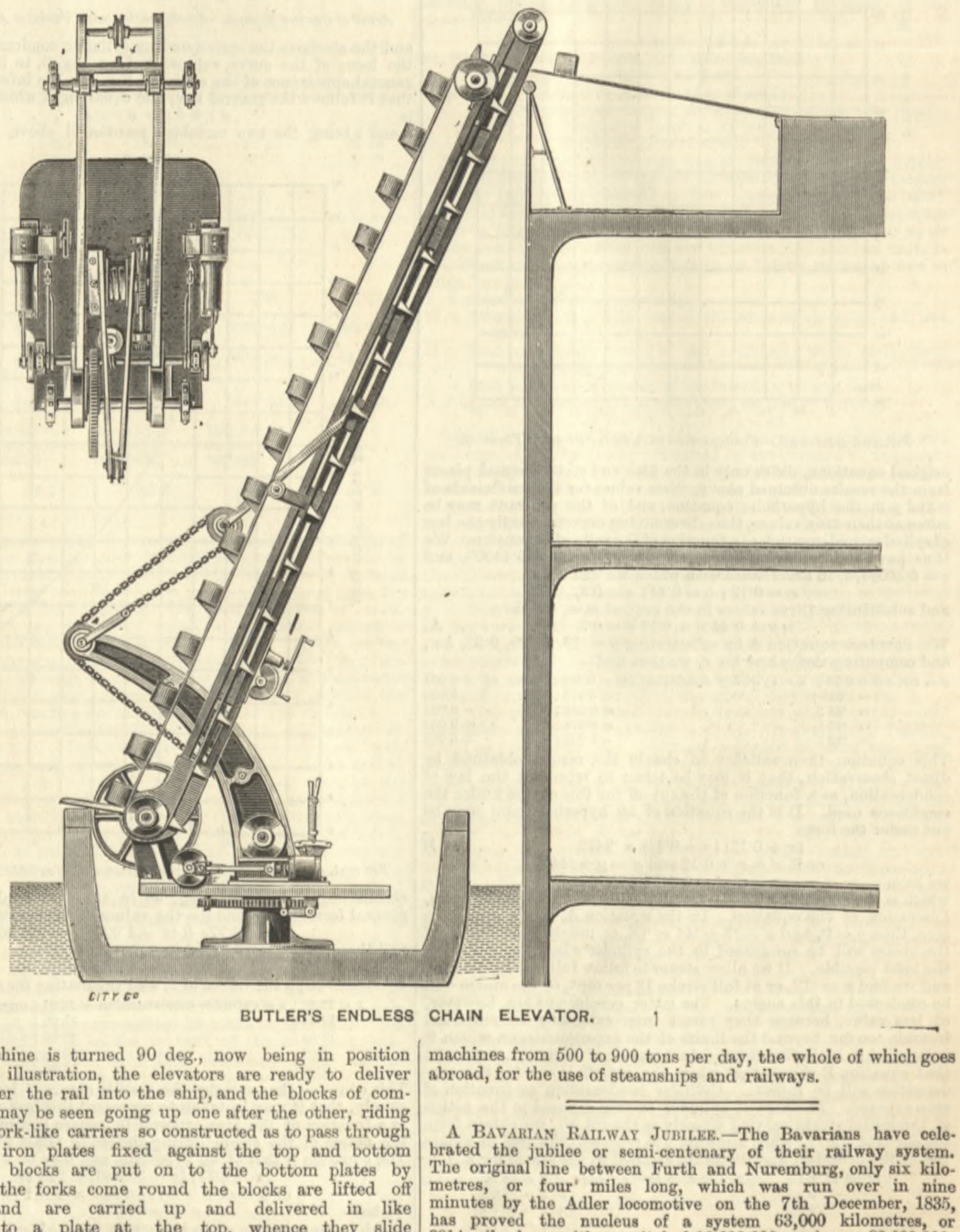


TRIANGULAR BEVEL GAUGE.

which in all cases bear directly against the centre. This spindle is of steel and turned ¾in., made to fit any lathe, is instantly adjusted by inserting it in the tail-stock of the machine; it is held in place by a self-adjusting lock, which holds it firmly in position. The Britannia Company is also introducing the triangular bevel gauge, which we illustrate. It will be understood without description. Any angle or bevel can be instantly obtained with it.

BUTLER'S PATENT ELEVATOR.

WE illustrate an elevator, designed by Mr. Samuel Butler, of Cardiff, for loading ships with crown patent fuel Until these machines were constructed the blocks were handed up from man to man, standing on stages suspended against the side of the ship. This laborious work is now done by the elevators, which, together, load at the rate of 2 tons per minute. There is a pair of 6½in. reversing engines for working the whole of the machinery, and the manner in which this is effected is in some respect similar to a steam crane. The machine being required to work, the engines are first put into gear with a winding drum hauling on the chain and lifting the jib to the required height for working; this being done, the engines are put into gear with the slewing motion,



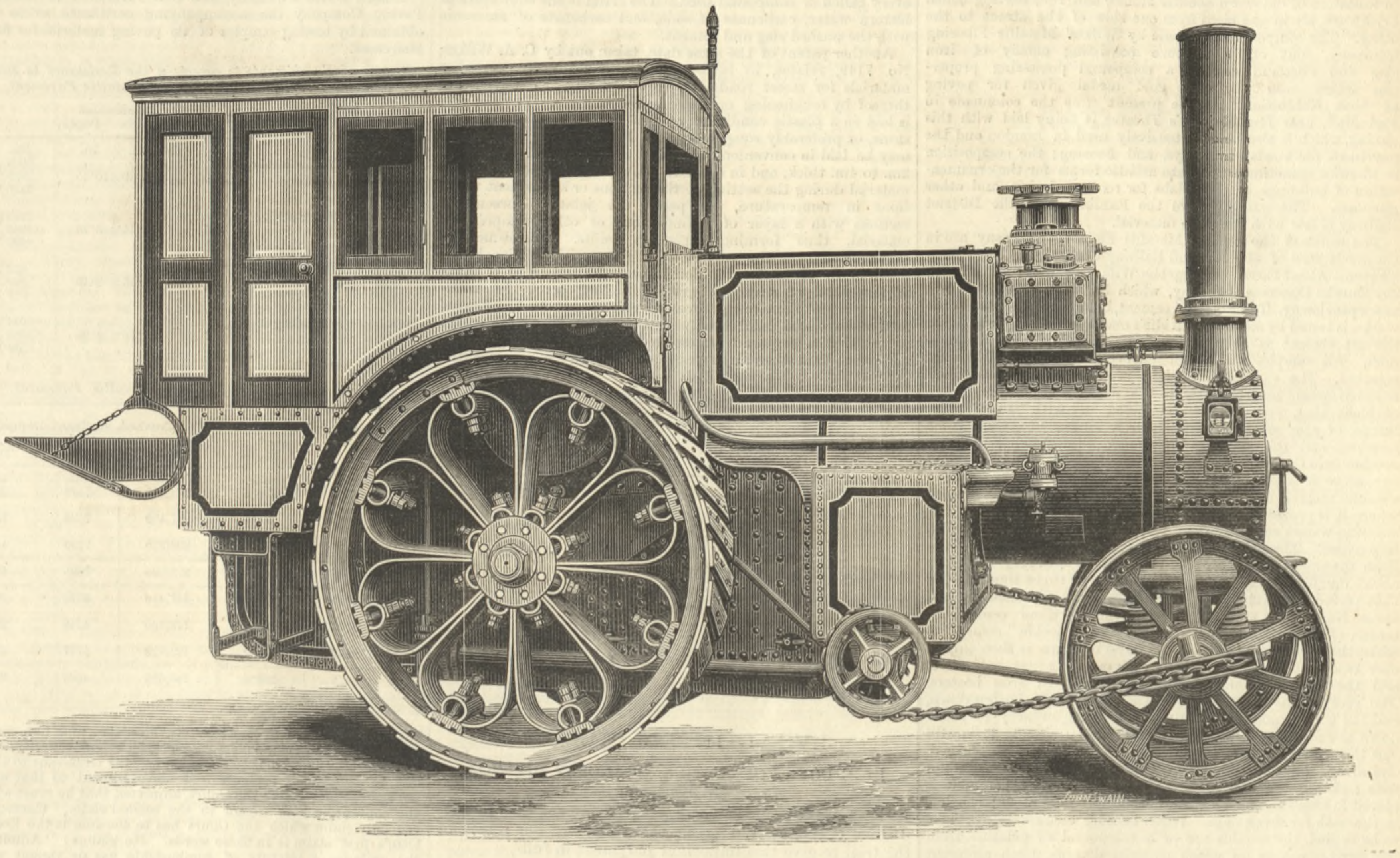
BUTLER'S ENDLESS CHAIN ELEVATOR.

and the machine is turned 90 deg., now being in position shown in the illustration, the elevators are ready to deliver the blocks over the rail into the ship, and the blocks of compressed coal may be seen going up one after the other, riding on prongs or fork-like carriers so constructed as to pass through slots in the iron plates fixed against the top and bottom drums. The blocks are put on to the bottom plates by hand, and as the forks come round the blocks are lifted off the plate, and are carried up and delivered in like manner on to a plate at the top, whence they slide down wooden shooters into the ship, the stowing men being then ready to place them carefully side by side in the hold. The endless chains forming the elevators are made up of Ewart's patent links, which facilitate the lengthening and shortening of the elevator in a few minutes, as the height of the ship may require. When the ship is light extra length of chain is required, and as the loading proceeds the chain is shortened. For this purpose the top drum shaft is mounted on a slide kept up by a chain passing over a sheave in the top of the jib and going downwards again to a hand winch. Each machine is secured to the floor of a 60-ton barge, and the steam is supplied by a locomotive type boiler, the steam pipe being conducted through the centre pivot, upon which the machine turns. The Crown Preserved Coal Company is shipping by these two machines from 500 to 900 tons per day, the whole of which goes abroad, for the use of steamships and railways.

A BAVARIAN RAILWAY JUBILEE.—The Bavarians have celebrated the jubilee or semi-centenary of their railway system. The original line between Furth and Nuremburg, only six kilometres, or four' miles long, which was run over in nine minutes by the Adler locomotive on the 7th December, 1835, has proved the nucleus of a system 63,000 kilometres, or 3914 miles long, with a capital of 16,000,000 marks, or £8,000,000. The capital for the original line was only 132,000 florins, or £13,200, while the gross receipts for the first three months of working were 6091 florins, and the first year's dividend was 13½ per cent. The number of passengers carried has increased from 475,219 during the first year to 1,357,864 in 1884.

HIGH-SPEED TRACTION ENGINE FOR INDIA.

MESSRS. J. AND H. McLAREN, HUNSLET, LEEDS, ENGINEERS.



HIGH-SPEED TRACTION ENGINE FOR INDIA.

WE recently referred in our pages to a high-speed traction engine built for passenger service in India by Messrs. J. and H. McLaren, of Leeds. We illustrate this engine above. It is compound, and fitted with Messrs. McLaren's well-known spring wheels. The conditions under which it was built stipulated that it should attain a speed of eight miles an hour while hauling a load of about 2½ tons. Some difficulty exists in finding a bit of road suitable for trial near Leeds. We were ourselves present at the preliminary trial trip which took place before the engine was quite completed. It was brought to an untimely conclusion by the cottar coming out of the low-pressure piston-rod crosshead when descending a hill without steam. The nut on the piston-rod came in contact with the cylinder cover and knocked a hole in it. The engine returned to the works with one cylinder without trouble.

The following are the principal particulars:—Boiler of steel throughout, except fire-box, which is of Farnley iron. Working pressure, 150 lb. per square inch.

Heating surface—

Fire-box	35·5 sq. ft.
Tubes	104·8 „
Total	140·3 „
Grate area	6·6 „
Forty-two 2in. tubes	5 ft. long.

Cylinders—

High-pressure, 6½in. diameter } 12in. stroke, steam jacketted.
Low-pressure, 10 „ }

Shafts—

Crank shaft, 3½in. diameter, 3¾in. crank pinks }
Intermediate shafts, 3¾in. diameter } all forged steel.
Main axle, 5in. diameter }

Wheels—

Driving wheels, 5ft. 9in. diameter by 1ft. 4in. wide, fitted with patent springs: front wheels, 3ft. 9in. diameter by 10in. wide.

Gearing—

All of crucible cast steel, arranged in three speeds.

Ratio of speeds, fast gear—

Six turns of crank to one of driving shaft; intermediate speed, twelve to one of driving shaft; slow speed, twenty-two to one of driving shaft.

Tanks under boiler and foot-plate of ample capacity for twenty miles run. Weight of engine, 9 tons 15 cwt. empty.

The crank shaft is all inside the cab, and is directly under the driver's eye; the fly-wheel is also inside the cab.

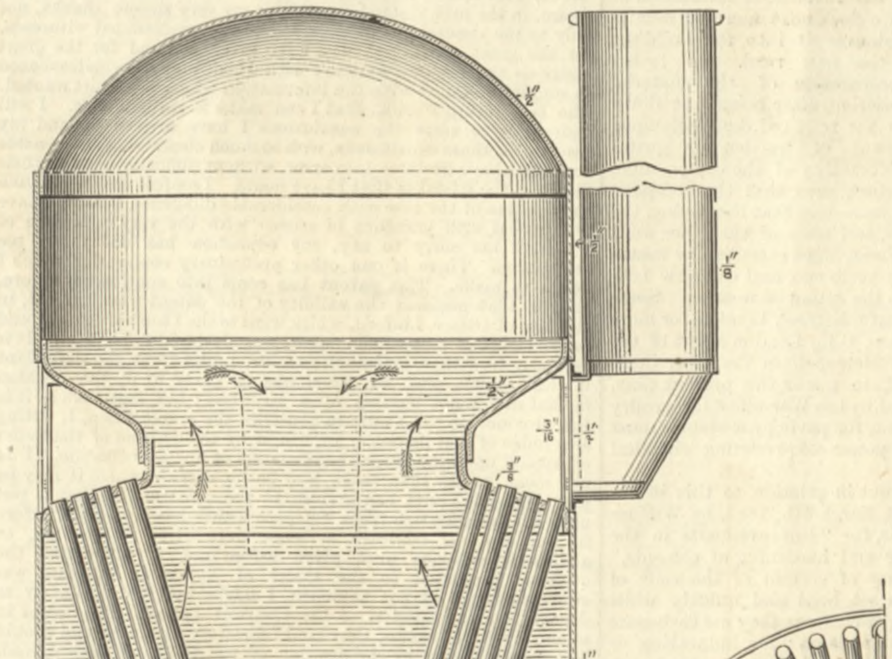
All handles, brake wheel, clutch levers, &c., are arranged within easy reach of the driver. All the clutch gears are interlocking, so that it is impossible for the driver to put in more than one set of gear at one time.

The steerage gear is arranged so that there is no backlash. The chains take hold of sectors outside the leading wheels. These sectors admit of both chains being kept tight, so that the wheels are always ready to answer to the steerage—a matter of great importance at high speeds. A few spring washers are put under the nuts at the end of the chains, which greatly assist the chains to withstand sudden shocks. Large oil boxes are cast on the steerage sectors, from which the front wheel bushes are constantly supplied with oil. The steerage chains are secured at both ends with double nuts and split pins, all of ample dimensions. The front wheels are fitted with chilled bushes running on case-hardened axle ends. The width of the cab inside is 6ft. 6in. A seat is arranged at the back end, on springs, to carry four passengers. There are sliding doors at the back of the cab for taking in fuel, &c.

An eye-witness supplies us with the following somewhat graphic report of the test made by the Government Inspector.

"I wish you had been with us on the Monday when the inspector came. We had a grand run. Started from the opposite end of Leeds—three miles from works—about 3.30 p.m., and ran about eight miles over cross-country roads, where the track was just about the width of the engine, and we had some very steep pinches, plenty of them 1 in 10, both to go up and down, but no long hills; some of them were so steep we had to put the very slowest speed in gear to get up. However, the inspector was well pleased with the way the work was done. Just at the finish of the eight miles stretch we had to go down into the valley of the Wharfe, and it is no exaggeration to say that for a short distance the declivity was 1 in 6 or 7, and though we got down very well, I could not help wondering what the result would have been if the brake strap had broken. We then had a mile or so of splendid road, but could not get along at any pace in consequence of hills and traffic; but after leaving the village of Harewood we had four miles of straight road, wide enough, but with some long rises of about 1 in 20. We passed the first milestone in five minutes, the second one in seven minutes, having had to stop to let a trap pass; passed the third milestone in six minutes, having also eased up to let some carts get out of the road; the fourth mile, in which most of the gradients were in our favour, we ran in barely five minutes, making four miles by the milestones in twenty-three minutes. The inspector was abundantly satisfied.

"I omitted to say we had a 3 tons load behind the compound, and during the whole run of sixteen miles we never took in any water, but had as much left in the tank as would have carried us another four miles, and the one supply of coals in the bunker carried us all the way."



THE GENETIC BOILER.

THE "GENETIC" MULTITUBULAR BOILER.

MESSRS. T. TOWARD AND CO., St. Lawrence Ironworks, Newcastle-on-Tyne, are introducing a new boiler, of which we give sections. It will be seen that this boiler, which is cylindrical, consists vertically of two parts —a lower part containing the fire-box, fire-door, and tubes, and an upper part of the same or different diameter, the two parts being connected by a large central water tube or neck, and also by circulating tubes; the upper part serves as a steam receiver, the water level extending up into it. The fire-box is made as is usual in vertical boilers, but is much shorter, the space between the top of the fire-box and the top of the lower part of the boiler being occupied by fire tubes, which are inclined at an angle to suit the curvature of the tube plates. These tubes run in circles around the central neck, and discharge the hot gases into the space between the lower and upper part of the boiler. This space is enclosed to form a flue by means of a portable casing or smoke-box doors around the circumferences of the two parts; the chimney takes its rise from any suitable part of this casing, according to the situation in which the boiler is fixed. Our engravings are so clear, we think, that no further description is required. It is claimed that the boiler possesses the following advantages: Extraordinary strength, combined with great simplicity in construction, no flat surfaces, no stays, no parts liable to get out of order, economy in space and fuel, perfect accessibility for examination or repairs, highest evaporative efficiency, and considerably lower in price than any other boiler of equal power.

The tubes, it will be understood, are put in from below. There is room enough left to expand them above.

WILKES' METALLIC PAVING.

The streets of "Old London" at the recent Inventions Exhibition at South Kensington were paved with a material, in imitation of old worn boulder stones, and red, herring-boned brickwork, all in one piece from one side of the street to the other. The composition is made by Wilkes' Metallic Flooring Company, out of a mixture consisting chiefly of iron slag and Portland cement, a compound possessing properties which won the only gold medal given for paving at that Exhibition. At the present time the colonnade in Pall Mall, near Her Majesty's Theatre, is being laid with this paving, which is also being extensively used in London and the provinces for roads, tramways, and flooring; the composition is likewise sometimes cast into artistic forms for the ornamentation of buildings, or into slabs for roofing, facing, and other purposes. The subway from the Exhibition to the District Railway is laid with the same material.

The works of the Wilkes' Metallic Flooring Company are in the goods yard of the Midland Railway Company at West Kensington. About three years ago the Wilkes Company united with the Eureka Concrete Company, which had been established five years previously. The Portland cement, before it is accepted at the works, is tested by means of an Aidie's machine. The general strain the set cement is required to bear is 750 lb. to the square inch. All samples which will not bear a strain of 500 lb. are rejected. The various iron slags are carefully selected, and rejected when too soft, and at the works a small percentage of black slag, rich in iron, is mixed in with them. The lumps of slag are first crushed in a Mason and Co.'s stone breaker, and then sifted through ½in., ¼in., and $\frac{1}{16}$in. wire meshes into these three sizes for mixing. Next the granulated substance is thoroughly well washed with water to remove soluble matter and impalpable dust, and afterwards placed where it is protected from the access of dust and dirt. The washing waters carry off some sulphides, as well as mechanical impurities. The Portland cement is not used just as it comes from the works, but is exposed to the air in a drying room for about fourteen days, and turned over two or three times during that period. The slag is also turned over three times dry and three times wet, and mixed with the Portland cement by means of water containing 5 per cent. of "Reekie" cement to make the whole mass set quickly. The mixture is then turned over twice and put into moulds; each mould is first half filled, and the mixture then hammered down with iron beaters. The rest of the composition is then poured in, beaten down, and the whole mould violently jolted by machinery to shake down the mixture and to get rid of air holes. While it is still wet the casting is taken out of the mould, its edges are cleaned, and after the lapse of one day it is placed in a bath of silicate of soda; should the casting be allowed to get dry before it is placed in this bath no good results would be obtained; it is left in the bath for seven days. When delicate stone carvings have to be copied, the moulds are of a compound of gelatine, from the flexible nature of which material designs much undercut can be reproduced. For the foregoing particulars we are indebted to Mr. William Millar, the working manager at West Kensington. Sometimes the composition is cast in large heavy slabs, moulded on the top to resemble the surface of roads of granite blocks. A feature of the invention is the rapidity with which the composition sets. For instance, the manager states that a roadway was finished at the Inventions Exhibition at seven o'clock one night, and at six o'clock next morning four or five tons of paper in vans passed over it into the building, without doing any harm to the new road. In laying down roads, much of the preparation of the material is done on the spot, and the composition, after being put down unsilicated in a large layer, has the required design stamped upon its wet surface by means of wooden or gutta-percha moulds. As regards the durability of the composition, Mr. T. Grover, one of the directors, says that the company guarantees its paving work for ten years, and that the paving, the whole of the ornamental tracings, and some of the other work at Upton Church, Forest Gate, Essex, were executed by means of Wilkes' metallic cement three years ago, and will now bear examination as to its resistance to the action of weather. Some of this paving has been down in Oxford-street, London, for more than six years. Mr. A. R. Robinson, C.E., London agent of the company, states that the North Metropolitan Tramway Company has about 25,000 yards of it in use at the present time, and that the paving is largely used by the War-office for cavalry stables. The latter is a good test, for paving for stables must be non-slippery and have good power of resisting chemical action.

Three patents have been taken out in relation to this invention. The first of them, No. 2886, March 4th, 1885, by William Millar and Christian Fair Nichols, for "Improvements in the means of accelerating the setting and hardening of cements," takes advantage of the hydraulicity of certain of the salts of magnesia, by which the cements set hard and quickly while wet. For accelerating the setting of cements they use carbonate of soda, alum, and carbonate of ammonia; for indurating or increasing the hardening properties of cements they use chloride of calcium, oxide of magnesia, and chloride of magnesia or bittern water; for obtaining an intense hardness they use oxychloride of magnesia. The inventors do not bind themselves to any fixed proportions, but give the following as the best within their knowledge. For coloured concretes for casts or other purposes they use:—Carbonate of soda, 8·41; carbonate of ammonia, 1·12; chloride of magnesia, ·28; borax, ·56; water, 89·63; total, 100·00. For gray concrete for any purpose they use:—Alum, 8·46; caustic soda, ·28; whitening or chalk, ·56; borax, ·56; water, 90·14; total, 100·00. For floors or slabs *in situ* they add to cement, well mixed and incorporated with any required proportion of agglomerate for a base, liquid composition of the following proportions:—Oxide of magnesia, ·29; chloride of magnesia, ·29; carbonate of soda or alum, 4·74; water, 94·68; total, 100·00. Articles manufactured by the invention are afterwards wetted with chloride of calcium and placed in a bath containing a solution of silicate of soda or chloride of calcium. The strength of the chloride of calcium is equal to about 20 deg. specific gravity.

The second patent is dated June 11th, 1885, No. 7148, taken out by C. A. Wilkes and William Millar, for "an improved metallic compound for flooring, paving, and other purposes," and has for its object to provide a paving compound which is not slippery or liable to soften in hot weather, which sets rapidly, and is durable. According to the patent three parts of blast furnace slag are added, one part of hydraulic cement, and enough water to give the proper consistency. To each gallon of water used is added one part of bittern water, the dregs from the manufacture of sea salt, or one part of brine, or about 5 per cent. of carbonate of soda, and 2½ per cent. of carbonate of ammonia. In the compound they sometimes use potash in the proportion of about 5 per cent. of the carbonate of ammonia and carbonate of soda, and when potash is used with bittern water or brine, the proportion of the latter is correspondingly reduced. The compound is of a blue-gray colour; but when a more striking colour is desired, red or yellow oxide of iron may be added. When more speedy induration is necessary they add about 1 oz. of copperas to every gallon of compound used. The claim is the admixture of bittern water, carbonate of soda, and carbonate of ammonia with the washed slag and cement.

Another patent of the same date, taken out by C. A. Wilkes, No. 7149, relates, in laying *in situ* any metallic or other materials for street roadways, to completing the convenience thereof by roughening or grooving the surfaces. The concrete is laid in a plastic condition upon a bed of hard core, broken stone, or preferably rough concrete. For footpaths the material may be laid in convenient sections, say 4ft. to 8ft. square and 2in. to 4in. thick, and in order to allow for the expansion of the material during the setting of the sections or subsequent variations in temperature, he packs the joints between the sections with a layer of felting cloth or other compressible material, thus forming expansion joints. Sometimes he slightly roughens the surface of the material, to give better foothold to pedestrians. Sometimes the grooving is made in imitation of ordinary granite paving setts. In tramway pavement there are grooves to give a grip to the horses' feet, and a slight camber between the rails. He states in the patent that a great advantage in laying a pavement by the method is, that when any repairs are necessary a piece of the exact size can be manufactured at the works, and stamped to the same pattern as the adjoining pavement, then placed at once in position on the removal of the worn portion, thus saving the time necessary for the setting of the concrete on the spot.

Messrs. David Kirkcaldy and Son furnished to the Wilkes' Paving Company the accompanying certificate as to results obtained by testing samples of its paving material for fireproof staircases.

Results of Experiments to ascertain the Resistance to Bending Stress of twelve Slabs of Wilkes' Metallic Pavement.

Test No.	Description.	Span.	Dimensions. Breadth. Depth.		
R.			in. in.	lbs.	lbs.
5501	Window heads			3026	
5500		3·6	4·80×10·15	2889	2801
5499				2486	
5504	Thick steps			5373	
5502		3 0	12·15× 6·10	4943	5081
5503				4927	
5505	Thin steps			822	
5506		3·0	12·15× 2·10	819	823
5507				527	
5510	Landing			5044	
5508		2·6	11·70× 4·95	3963	4179
5509				3531	

Results of Experiments to ascertain the Resistance to Thrusting Stress of six Slabs of Wilkes' Metallic Pavement.

Test No.	Description.	Dimensions.		Base area.	Crooked slightly. Stress.	Sq. in.	Sq. ft.	Crushed, steelyard dropped. Stress.	Sq. in.	Sq. ft.
		inches.		sq. in.	lbs.	lbs.	tons.	lbs.	lbs.	tons.
1854	—	2·00	6·00 × 6·00	36·00	177,650	4934	317·2	283,620	7878	506·6
1856	(12 × 12 × 2 reduced to 6 × 6 paving slab ..)	2·00	6·00 × 6·00	36·00	164,820	4578	294·4	271,430	7539	484·8
1855	—	2·00	6·00 × 6·00	36·00	156,300	4313	277·3	266,370	7399	475·8
				Mean	166,256	4608	296·3	273,806	7605	489·0
1857	—	5·00	6·00 × 6·00	36·00	98,200	2727	175·3	157,440	4373	281·2
1858	(12 × 12 × 5 reduced to 6 × 6 fireproof floor.)	5·00	6·00 × 6·00	36·00	91,530	2542	163·4	148,260	4118	264·8
1859	—	5·00	6·90 × 6·00	36·00	88,470	2457	158·0	133,820	3717	239·0
				Mean	92,773	2575	165·6	146,536	4069	261·6

LEGAL INTELLIGENCE.

HIGH COURT OF JUSTICE, CHANCERY DIVISION.

Before Mr. Justice Pearson.

On Saturday judgment was given in the case by Mr. Justice Pearson. We break the thread of our report of the trial to give this important judgment in full.

Judgment.

Mr. Justice Pearson: In this case Dr. Otto, the inventor of the silent gas engine, has brought an action against Mr. Robert Steel, and complains that Mr. Steel has infringed his patent. The infringement is not denied. The only defence to the action is that the patent is invalid. The case has been argued before me for four weeks, with some intervals, altogether for sixteen days, and I desire, in the first instance, to tender my very sincere thanks, not only to the counsel in the case, but to the professional witnesses, for the great assistance they have given me, and for the great clearness and extreme patience with which they have endeavoured to supply the Court with the information which the Court wanted. The best return I think that I can make to them is this. I will endeavour to state the conclusions I have arrived at, and my reasons for those conclusions, with so much clearness as shall enable them, if I have deviated into error, without difficulty to place their finger on the mistakes that I have made. I confess that I approach the decision of the case with considerable diffidence, because I have had to deal with branches of science with the very rudiments of which, I am sorry to say, my education has not made me acquainted. There is one other preliminary observation which I desire to make. This patent has come into controversy before, and on that occasion the validity of the patent was disputed, in the case of Otto *v.* Linford, which went to the Court of Appeal, and in the Court of Appeal the patent was declared to be valid. It is perfectly true that, inasmuch as a Mr. Linford was the defendant in that action, and Mr. Steel was no party to it, the decision in that case is not binding upon Mr. Steel; but inasmuch as it is the province of the Court to construe the specification, I, sitting as a judge of first instance, am bound by the decision of the Court of Appeal upon the proper construction of the specification. I do not mean to say that there may be no cases in which it may be plain that the Court has arrived at the construction that is put upon the specification from evidence which has been given before it, and that if contrary evidence were given before me, or additional evidence were given before me, to show that the evidence presented to the Court of Appeal in the case was either incorrect or not sufficient, I might not feel at liberty to depart from the decision of the Court of Appeal. But except in some very strong case of that kind I certainly should be, and should feel myself bound by the decision of the Court of Appeal, and, accordingly, in this case I intimated to the counsel that with regard to one of the objections taken in the course of that action, an objection to the specification on the ground that Dr. Otto had not, as it was alleged, stated any proportions of the mixture with reference to the residuum that he intended to use, the Court had decided that that was no objection to the patent, and I feel myself bound by that decision. With regard to the question as to whether or not the patents then produced to the Court were anticipations, or whether I could look into the question as to whether they were anticipations or not, I will offer one or two observations, when I come to that part of my judgment. For the first part of it, I consider myself unfettered entirely by anything that took place in Otto *v.* Linford, considering as I do that the points that have been argued before, were not argued before the Court of Appeal in that case.

The earliest patent for a gas engine that has been introduced at the trial of this action is a patent by Mr. Wright in the year 1833. Whether there were earlier patents or not I do not know, but certainly from the date of that patent down to the present time the way in which motive power has been obtained has been this. In a cylinder in which a piston moves a charge of combustible gas and air is fired at one end. The expansion of the gases produces at once pressure, the piston is moved to the other end, and it is then either brought back by another charge fired at the other end, or it is brought back by the momentum of the fly-wheel to which the piston is attached. The charge fired at either end is identical in composition, and inasmuch as in Dr. Otto's engine he uses only a charge at one end, I may dismiss altogether any considerations of engines that act with double charges. I think that is all that it is necessary for me to state, in order that what I am now going to say with regard to this present patent may be intelligible.

Dr. Otto, in 1876, took out this patent, through Mr. Abel, for improvements in gas motor engines. And his first claim, which is the claim that has been impeached in this action, I will read in a minute. I say that is the claim which has been impeached in this action, because although there was an attempt made to impeach the second claim also, when I rejected the admission of the publication of M. Beau de Rochas, Mr. Moulton, who has conducted this case for the defendant not only with singular ability, but with an admirable endeavour to avoid everything irrelevant to the case, and to confine his evidence and his argument to that which he desired to prove before the Court, admitted that he must withdraw the contention with regard to the second claim. Consequently, the only claim which the Court has to consider is the first. Dr. Otto's first claim is in these words. He claims: "Admitting to the cylinder a mixture of combustible gas or vapour with air separate from a charge of air or incombustible gas, so that the development of heat and the expansion or increase of pressure produced by the combustion are rendered gradual, substantially as and for the purposes herein set forth."

The first objection, as I understand it, taken to this claim was this, that reading that claim, Dr. Otto alleges that he has described how to place an incombustible, and, if I may so say, pure mixture—an incombustible fluid or air—next to the piston, and between the piston and the charge, so as to alleviate the pressure and shock which would be produced if it were not there. And the first objection to this claim is this, that there is not in fact in Dr. Otto's engine anything like a pure incombustible fluid or air there. The next objection taken was this: That if, as was alleged, the mixture, when the whole charge and the residuum are taken together in Dr. Otto's cylinder, be heterogeneous, then the description contained in this claim is quite wrong; because it says that the development of heat and the expansion or increase of pressure produced by the combustion are rendered gradual. It was said by Mr. Moulton with considerable force, if you allow the mixture to be homogeneous, then I admit that there is a slowness or a gradualness of combustion; but the moment you allege that the mixture is not homogeneous, then there is no gradual development of heat; there is no gradual expansion of pressure; no gradual increase of pressure; and if you say the effect is to support the pressure after the maximum pressure, and to make the descending line in the diagram shown by the indicator to be more gradual than it would be if that which you call increase of pressure were not there, you ought to substitute the word "decrease" for "increase," and to say that there is a gradual decrease of pressure. I hope I have stated Mr. Moulton's objections fairly. I certainly have endeavoured to do so.

Now, in order that I may consider their validity, I must look myself at the specification. It was read through at considerable length by the Attorney-General, and I do not mean, therefore, to go through the whole of it, but to point out one or two passages which I think are sufficient to show the reasons for the conclusion at which I have arrived. On page 3 Dr. Otto says this:—"According to the present invention, a combustible mixture of gas or vapour and air is introduced into the cylinder, together with air or other gas that may or may not support combustion in such a manner that the particles of the combustible mixture are more or less dispersed in an isolated condition in the air or other gas, so that on ignition, instead of an explosion ensuing, the flame will be communicated gradually from one combustible particle to another, thereby effecting a gradual development of heat and a corresponding gradual expansion of the gases, which will enable the motive power so produced to be utilised in the most effective manner." To my mind nothing can be more opposed to the idea of a pure incombustible layer of air or pure air than that statement of Dr. Otto, in which, so far from saying that there will be no combustible matter near the piston, he says most distinctly that when the charge enters, the combustible particles of that charge will be dispersed through the cylinder. But there is another word there to which I desire to call attention, because I think it meets Mr. Moulton's second point. He says this:—"Instead of an explosion ensuing, the flame would be communicated gradually from one combustible particle to another." What is the meaning of the word "explosion" there? I had a great deal of evidence before me as to the proper meaning of the word "explosion." I do not think it necessary to refer to that. I am looking simply at what the specification means, and I think in so doing the specification ought to construe itself. Now when he says: "Instead of an explosion ensuing, the flame will be communicated gradually from one combustible particle to another," does he not plainly mean that—instead of there being a perfect and active combustion at first—not that there will be no explosion; because if there were no explosion there would be no power or very slight power generated; but that after the first ignition—it may be, if you please, in popular language, to a certain extent an explosion—there would be a subsequent combustion spreading from one particle to another through the whole of the charge up to the piston. And that, to my mind, is supported by other parts of the specification. I turn to page 4: "On the ignition of the charge the combustion at and near the port C is comparatively rapid." That seems to me, therefore, to point to a certain amount of explosion, in popular language; "but as the ignition extends towards the front of the charge it proceeds more and more slowly, owing to the greater dispersion of the combustible particles. The gradually increasing pressure thus produced by the gradual expansion of the products of combustion, and also of the surrounding fluid due to the heat evolved, causes the piston to complete its outstroke." Then, omitting some part, it goes on in this way: "By this mode of operating shock resulting from sudden explosion is avoided, partly through the dispersion of the combustible charge as described, and partly because the first admitted charge of air which does not become completely mixed with the combustible charge acts as a cushion between this and the piston"—I look at these words—"the shock resulting from sudden explosion is avoided." What is the meaning of that? To my mind it is plain that what he intends to say is this:—Whereas if you fire off the whole of a very explosive charge at one moment in the cylinder you would have a shock, if you fire off that charge in such a way that although there is an explosion at the commencement you do not explode the whole matter, but burning part of the matter at first, you burn the residue of it at a later period, you avoid shock, and you get an increase of pressure towards the end which supports, therefore, the motive power. To my mind the whole theory of Mr. Moulton's on which that part of the defendant's case was launched—and as I shall show on which it proceeded apparently in the minds even of his witnesses in preparing to give their evidence in this case—was based on an entire misapprehension of the specification and of what Dr. Otto claimed. I think, therefore, the first charge against this claim, namely, that it describes that which does not and could not exist, is not well founded. Dr. Otto does not claim putting between his charge and the piston and keeping up to the moment of ignition a pure incombustible layer of air. I think also the second objection is wrong subject to the remark that I am about to make. I think that if Dr. Otto's theory is right, his use of the word "increase" of pressure is not to be found fault with; but, of course, that may depend to a certain extent upon whether Dr. Otto is right that his mixture becomes eventually heterogeneous, and not homogeneous. The Atterney-General claims for him that his mixture is heterogeneous. Mr. Moulton says that if it be anything it is homogeneous, and I think, therefore, that the next step that I must take is to consider whether, when the charge is fired in Dr. Otto's engine, the whole charge inside the engine—by which I include the residuum with the charge—is homogeneous or heterogeneous. Before I do that, I should say one word upon the question of air or residuum. The Attorney-General suggested that I ought not to take residuum as applying to the first figure of the patent. He said, and said accurately, that in the third figure there was provision made by the conical shape, and prolonged shape of the cylinder for keeping the residuum in, but that, inasmuch as in the first figure the piston went down to the end of the cylinder, there was no provision there for keeping in what was called in Otto v. Linford a notable quantity of residuum, and that I ought, therefore, to apply this first claim to the drawing in of air only, and not to the admission of residuum. I intimated to him that I thought I could not do so, and I remain of that opinion. It seems to me that whether you draw in air, or whether you leave in residuum, you produce exactly the same effect, and, looking to the whole of the patent, I think that every word of it is satisfied just as much by leaving in residuum as by drawing in air; and it seems to me that, in order to obtain that residuum, you fire off a charge first in order to get that residuum, and then leave it in in front of the charge you are going to admit, you have, in fact, admitted a charge of residuum in front of your charge which is to explode.

The next question, and a question which was fought, not with more ardour than was necessary, but certainly with very prolonged energy, was the question as to what this mixture is just at the moment of ignition. Has it become homogeneous, or does it remain heterogeneous? That it is neither one nor the other, I think everybody will admit, and that it is absolutely impossible to produce in the Otto engine a charge of gas and air, which I was told came in at the rate of between 60 and 110 miles an hour, and yet that that charge so coming in shall remain absolutely distinct from the charge of residuum that it finds in the cylinder. The defendant's case was this. He said that coming in at that rate it would naturally go in a direct line up to the piston. It would then impinge upon that piston, turn round in curls, if I may say so, and mix completely with the residuum, so that the whole charge in the cylinder would become one perfectly united mass of air and combustible gas. On the other hand, Dr. Otto says that is not so; no doubt a certain portion of the gas from the charge penetrates the residuum, and if it did not do so my claim would be useless, and my patent an absurdity, and it is simply because some of the gas does penetrate the residuum, and that I am able, therefore, to burn it at a later period, that my patent is a useful patent, and that my claim altogether is feasible. It is very difficult to look inside the cylinder and to see what takes place there. I can only judge of it by such facts as have been proved by the evidence, and on those facts I must endeavour to form the best conclusion I can. There were three experiments that were tried in order to ascertain what the mixture was immediately before ignition; the one was the analysis performed by Professor Dewar, and, as far as I can judge, that is the most satisfactory, to my mind, of all the experiments. He did this: he took samples of the gas from three different points in the cylinder, one close to the charge, one a little way removed from the charge, and the other close up to the piston. I need deal with one of those only, because one will show, to my mind, the reasons why I have come to the conclusion which I shall state. At the port he found 10 per cent. of combustible gas; in an intermediate point—I leave out decimals—he found 7 per cent. of combustible gas, and close up to the piston he found 5 per cent. of combustible gas. That is exactly what you ought to find, if Dr. Otto's theory is right. The second experiment was the experiment of the eudiometer, which was tried, I think, by Sir Frederiok Bramwell and Mr. Imray. That consisted in taking gas from the cylinder, practically at the same points from which Professor Dewar took it; but instead of analysing the gas when so taken, it was put into an instrument, which was not described to me and which I know not, and tried to show its capacity for ignition, and the result was this, that the gas taken close to the port ignited at once; the gas taken at the intermediate point ignited slowly and with difficulty, and that the gas taken close to the piston would not ignite at all. These two experiments, therefore, confirmed each other.

The third experiment was tried by the defendant, and that was what has been called very conveniently the platinum experiment. The platinum experiment is, to my mind, an exceedingly ingenious experiment, but it started, to begin with, on the supposition that the layer of air next to the piston was incombustible; and the object of the platinum experiment was to show that it was not incombustible. The experiment was this. Mr. Clerk attached to the end of the piston a small piece of coiled platinum wire, extending from the piston not more than ¼in. The size of the wire—not the exact wire—was shown to the Court. It was very thin indeed, exceedingly small, and it would occupy a very little space. That was connected with an electric battery, and in four several experiments it was heated to different heats. It was heated first by one cell; it was heated a second time by something above one cell and less than two cells; it was heated to two cells; and it was heated to three cells. The lower heat was what was called a red heat; the higher heat was a white heat. The first heat, I think, was 1100 deg. Fah. The higher heat which was got, I think, was as high as 1800 deg. Fah. Attaching that to the end of the piston, it was said—If now the theory which the defendant believed was Dr. Otto's theory be true, there cannot, by any possibility, be any combustion close to the piston, because according to Dr. Otto's theory, what he has there is an incombustible layer absolutely unaffected by the charge which he puts in. They accordingly tried it in that way, and they then moved the piston lower down, and at last got it down to the place where it would compress the charge. I had produced to me several diagrams of the working of the engine in that way, and it was stated to me that you could so moderate the heat of the platinum wire that you could get it to work in such a way that no firing should take place until you got the piston down exactly to where the piston would go, ordinarily compressing the charge in an Otto engine; and that then it would work the instrument in the normal way in which it is worked under the ordinary system described in Dr. Otto's patent. In order to prove this different diagrams were produced to show the working of it. When you look at those diagrams, they are so absolutely abnormal that the merest tyro who had once seen Otto diagrams could not for one moment mistake them for Otto diagrams. I do not myself possess the knowledge which would enable me to account for the diagrams which were produced to me, or to say to what cause I ought to attribute their variety. I can only say that the diagrams, so far from being Otto diagrams, are as various in their different forms as the moods of the most capricious fairy. I do not pretend to account for them. I should have thought that if the mixture were homogeneous, as Mr. Moulton laboured to show that it was, you then might have had—I do not say the Otto diagrams, but I say diagrams as regular, comparatively, as the Otto diagrams, because, working with the same heat of the platinum from time to time, and with the same homogeneous mixture, you ought, to my mind, as far as I can understand this matter, to have had the ignition in the same place, wherever that took place in the cylinder. You ought to have had the diagrams showing that, and you ought to have had uniformity between them. I put, therefore, this platinum experiment aside, except so far as to say that if it shows me anything it seems to me to show that the mixture is not homogeneous but must be heterogeneous. Judging as fairly as I am able to do from those experiments, I come to the conclusion that the mixture is heterogeneous and not homogeneous. But the moment I said to Mr. Moulton that it seemed to me that the mixture was rather homogeneous than pure, Mr. Moulton immediately said, if that be so the case is mine; and he then turned to another part of his subject, which he argued with very great ability, and he said, now let me look then at what your theory is. If you have not a layer of pure air between the charge and the piston you must have one that is either homogeneous or heterogeneous, and what have you got? You put in your combustible charge, and in front of it you have the residuum. You are doing exactly the same thing which Lenoir did. Lenoir put in his charge and left what residuum he could not drive out in front of it. You say that you put in a stronger charge and that you put in residuum in front of it. Be it so. You use the residuum therefore merely as a diluent. How does that distinguish your engine from the Lenoir engine? Taking the average strength of the mixtures that work in the Lenoir and the Otto, the Lenoir works with 1 to 12; you work with 1 to 8, but in addition to 1 to 8 you have so much residuum as brings it up to the 1 to 12 in the Lenoir engine, and you have, therefore, practically in your engine exactly that which you have in a Lenoir engine, because the additional inert matter that is to be found in the Lenoir engine is made up in your engine by the residuum which you put in or leave in. Where is the difference? *Paullum sepultæ distat inertiæ celata virtus.* The difference seems to me to be this, and it is a very great one—the difference in the arrangement. In the one case in the Lenoir engine you have a homogeneous charge of 1 to 12 all mixed together; in the other you have a mixture of 1 to 8 for the combustible charge, and I take it sufficient residuum to make it equal to 1 to 12 in the Lenoir engine. But the arrangement is so different that the effects must necessarily, to my mind, now that I have heard all the evidence, be very different. The 1 to 12 explosion in the Lenoir produces, admittedly, but very small power; the 1 to 8 produces so much power that if you had not the residuum in front of it, you would have the most violent shock; and I suppose I may say, before very long, you would knock your engine to pieces; but having the residuum in front, which operates as Dr. Otto says in his patent, it takes off the shock, keeps the combustion alive, and sustains the pressure. You get a far greater power than you get in the Lenoir engine, which is shown by the more gradually descending line of diagram, as opposed to the quickly descending lines in the Lenoir engine. The differences in the effect of what I may call the arrangement of the charges are these: that in the Lenoir engine you would get uncertain firing, slow firing, late firing, extra consumption of gas, and moderate power; whereas in the Otto engine you get certainty of firing, rapid firing, early firing, great diminution of the consumption of gas, and an extraordinary increase of power. It seems to me to be impossible to say that the two things can be the same, when the results of them are so exceedingly different. I come, therefore, to the conclusion, on this part of the case, that the mixture is heterogeneous and not homogeneous; and that, even if Mr. Moulton be accurate in saying that the residuum is used as a diluent, it is used under such very different circumstances that you cannot say that one is comparable to the other.

The last part of the case, which gave me, towards the end of it, greater difficulty, was the question of anticipation. When the case was before the Court of Appeal in Otto *v.* Linford, the previous patents that were produced were the Lenoir patent and Barnett's patent, and, I suppose, Hugon's patent as well. I may at once correct an omission in what I have said by saying that, although I have left out Hugon's name, I have done so because Lenoir's name has been used throughout the argument before me, there being, as I understand it, no real difference between the Lenoir engine and the Hugon engine, except that the Hugon engine has a better apparatus for lighting, and is lighted by flame instead of being lighted by electricity. Now, with regard to the Lenoir patent, on the question of anticipation, I do not need to inquire whether I am bound by the decision of the Court of Appeal, when it found that Lenoir's was not an anticipation of Dr. Otto's patent; because I have already come to the cenclusion, for the reasons I have already stated, that Lenoir's patent is not the same as, or anything like, Dr. Otto's patent. With respect to Barnett's patent that was before the Court of Appeal also, and it may be that I am, properly speaking, precluded from looking at Barnett's patent, in order to consider whether Barnett's patent is an anticipation of Dr. Otto's or not, but, even if I had to consider that matter, in spite of the respect that I feel for Barnett as an inventor, notwithstanding all that the Attorney-General has said with regard to the obscurity in which his patent had rested for fifty years nearly, I should come to the same conclusion as the Court of Appeal did, namely, that if Barnett does anything by his patent, it is to tell you to get rid of the residuum instead of retaining it.

The patent which struck me as seeming more like Dr. Otto's patent than any other, was Million's patent, which was not before the Court of Appeal; but, having considered the matter, I think the Attorney-General's account of the meaning of that patent is the right one, and that M. Million did not intend to use the residuum. The whole of the specification which it is important to read is to be found on page 10, and is the "Third means of employing gases as motive agents." He says this: "Instead of introducing cold gases into the cylinders during a certain portion of the stroke and igniting them afterwards when the induction ceases which takes place according to the firstly described method, another arrangement might be adopted. The motive cylinder might be made longer than necessary, in order that the piston shall always leave between it and the end of the cylinder a greater or less space according to the pleasure of the constructor, such as one-fourth or one-third more or less of the volume generated by the motive piston. This space is called by the inventor a cartridge. On opening the slide valve the gases would be allowed to enter suddenly from the pressure reservoir into this cartridge towards the dead point, and this induction having ceased an electric spark would ignite the gases in the cartridge by which the driving piston would be set in motion." It seems to me that he contemplates nothing but gases entering the cartridge: he contemplates as soon as the gases have filled the volume left by the piston, those gases being ignited by the electric spark. I can find nothing in that, therefore, at all comparable to Dr. Otto's plan for drawing in first either incombustible fluid such as residuum or air, and packing that in front of his charge in order to get the benefit when the charge is fired. There was no other anticipation suggested. I think I have dealt as far as my powers enable me with the whole of the case. I come to the conclusion that the first claim is strictly accurate, according to Dr. Otto's specification. I come to the conclusion that the mixture when fired in Dr. Otto's engine is heterogeneous in its composition and not homogeneous. I come to the conclusion that the firing of that charge in Dr. Otto's engine with the residuum in front of it—the whole composition being made heterogeneous—has exactly the effect which Dr. Otto describes in his first claim. I also come to the further conclusion that Dr. Otto's invention has not been anticipated by any of the specifications which have been put in before me, and I therefore decide that Dr. Otto's patent is a valid and good patent. That being so, and the infringement being admitted, there must be the usual decree for an injunction, with the usual consequences, according to the ordinary frame of the orders of this Court, and of course I must make the decree with costs, which must be allowed on the higher scale.

I presume, Mr. Attorney-General, you will probably ask me to certify that the validity of the patent came into question in the course of this action?

The ATTORNEY-GENERAL: If your lordship pleases.

Mr. JUSTICE PEARSON: I wish to suggest to you what has occurred to me on that point. Especially having regard, not to the little difficulty I had, but to the greater difficulty I might have had with regard to the decision of Otto *v.* Linford, I think I ought to certify that the validity of the patent came into controversy here so far as regards the first claim, so that in any future trial nobody may be fettered by supposing that something came into controversy before me which did not.

The ATTORNEY-GENERAL: I am much obliged to your lordship. I have also to ask your lordship for a certificate, which is only a formal one.

Mr. JUSTICE PEARSON: The Registrar suggests that inasmuch as you have got one certificate you are not entitled to another.

The ATTORNEY-GENERAL: I venture to think it is not necessary because it was given in Vice-Chancellor Bacon's action; but, my lord, it might be said afterwards that different parts of the patent had been attacked, and, I venture to think it is of importance to have a certificate in each action in which the validity is tried.

Mr. JUSTICE PEARSON: I agree with you, and if you ask me for it I shall give it to the extent to which I have said.

The ATTORNEY-GENERAL: I quite understand that the validity of the patent, so far as the first claim is concerned, came in question. Now, I have to ask your lordship for a formal certificate under Section 27 that the plaintiff has proved his breaches. That merely means that he has proved the infringement.

Mr. JUSTICE PEARSON: They have admitted that.

The ATTORNEY-GENERAL: If your lordship pleases, I ask for that. Then I have to ask your lordship for an order under Section 31 of the Patent Act. I will tell your lordship at once that if your lordship came to read the section, I do not think it is necessary, but it is this:—"In an action for infringement of a patent, the Court or a Judge may certify that the validity of the patent came in question, and if the Court or a Judge so certifies, then in any subsequent action for infringement the plaintiff in that action, on obtaining a final order or judgment in his favour, shall have his full costs, charges, and expenses as between solicitor and client, unless the Court or Judge trying the action certifies that he ought not to have the same." Now, my lord, I have here, as your lordship knows, the order of Vice-Chancellor Bacon, which I, of course, will put in.

Mr. JUSTICE PEARSON: What strikes me is this. I have decided this case on evidence that was not before the Court on the former occasion.

The ATTORNEY-GENERAL: But I want respectfully to point this out. The statute gives us the right.

Mr. JUSTICE PEARSON: Then it assumes, I think I must take it, that the validity of the patent is impeached on the same grounds on which it was impeached before, and nothing would be more just than that the costs as between solicitor and client should be given them. I give you costs on the higher scale.

The ATTORNEY-GENERAL: Your lordship does that?

Mr. JUSTICE PEARSON: Yes, costs on the higher scale, certainly.

The ATTORNEY-GENERAL: Then I have to ask your lordship for an order for the repayment of the money which was paid into Court by the plaintiff as a foreigner.

Mr. JUSTICE PEARSON: Yes.

The ATTORNEY-GENERAL: Then I ask your lordship for the costs of the shorthand writers' notes, which, I think your lordship will agree, have been of great use.

Mr. JUSTICE PEARSON: Certainly.

The ATTORNEY-GENERAL: Then I ask your lordship to direct an account of profits—we elect to have that—and also to fix a time within which the gas engines in the possession of the defendants shall be given up or rendered unfit for use, according to the invention.

Mr. JUSTICE PEARSON: What time do you want?

Mr. GRAHAM: My friend, Mr. Moulton, has been obliged to go away, on account of his health.

Mr. JUSTICE PEARSON: I am very sorry to hear that.

Mr. GRAHAM: He has been, practically, overworking himself in this case, and I have been taken by surprise. I did not know I should be left to mention this on the last day. What I am now instructed to ask your lordship is that the injunction should be suspended until we have had time to carefully consider with Mr. Moulton the judgment your lordship has given this morning?

The ATTORNEY-GENERAL: There is no question of suspending the injunction. My learned friend may have a month to consider whether he will appeal before we enforce the order as to costs.

Mr. GRAHAM: That is all I want.

Mr. JUSTICE PEARSON: Of course, you have a right to go on.

The ATTORNEY-GENERAL: He can scarcely ask for suspension.

Mr. JUSTICE PEARSON: I cannot suspend the injunction.

Mr. GRAHAM: It has been done in previous cases.

Mr. JUSTICE PEARSON: This is the second action in which the Court has declared in favour of the patent.

The ATTORNEY-GENERAL: The third.

Mr. GRAHAM: With great deference I submit this is not the second nor the third, but it is practically a new action, because the thing has been fought on different particulars of objections, and at all events whether it is the third or the first, it is an action of extreme difficulty, and in the absence of my friend, Mr. Moulton, I think your lordship might suspend the injunction until we have had the opportunity of carefully considering your lordship's judgment with Mr. Moulton—say for three months.

The ATTORNEY-GENERAL: That could not be done. My friend, Mr. Graham, says he is taken by surprise by my friend Mr. Moulton's absence. He well deserved and wanted a holiday, but his intention to go away had been fixed long before, and I knew the day he was going.

Mr. GRAHAM: Not to my knowledge.

Mr. JUSTICE PEARSON: The only thing I can do for you is this. At the present moment I must make the order as I have stated it. If you wish to suspend the injunction you must make a positive motion for that. That will enable you to do so, when Mr. Moulton is, as I hope he may be, happily restored to us.

Mr. GRAHAM: If I may venture to say so the motion shall be made as soon as possible after Mr. Moulton returns.

Mr. ASTON: Meanwhile the injunction goes.

Mr. GRAHAM: I beg your lordship's pardon. My friend, Mr. Aston, suggests that in the meantime the injunction goes. I understood your lordship to suspend the injunction until Mr. Moulton has come back.

Mr. JUSTICE PEARSON: No.

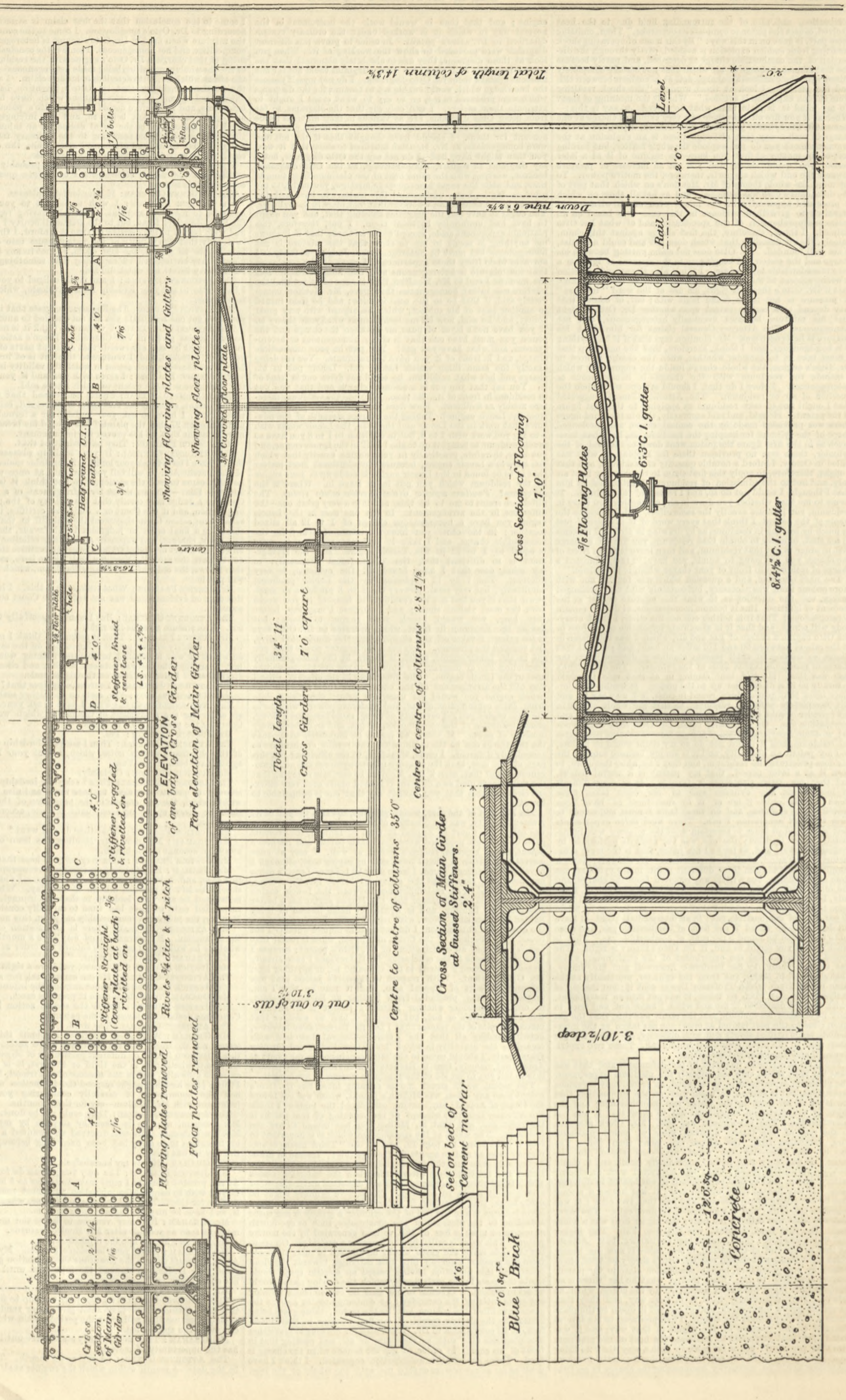
The ATTORNEY-GENERAL: I ask your worship to fix a month as the time within which they shall give up or render useless the engines, because that will cover the period within which my friend can make the application.

Mr. GRAHAM: That might fairly stand over until Mr. Moulton has the opportunity of moving.

The ATTORNEY-GENERAL: I say so—a month. Then that will be the date—a month within which the engines shall be given up,

MIDLAND RAILWAY EXTENSION—DETAILS OF IRONWORK.

(For description see page 488.)



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CAOUTCHOUC.—*You will find articles on india-rubber in the Encyclopædias. There is no treatise on packing.*

W. L.—*All the surfaces are not calculated—that is to say, all surfaces under the fire are omitted, such as the bottoms of the furnace tubes. One-third is usually deducted for flues, and about one-fourth for water surface.*

THE SAGGING OF WIRE ROPES.

(*To the Editor of The Engineer.*)

SIR,—Can any of your readers tell me how much a steel wire rope, 1⅞in. diameter, would sag in the middle when placed in a horizontal position with a load of 3 cwt. passing over it; the rope to be fixed at one end and the other having a concrete block suspended to it passing over a pulley; the block to weigh 20 tons? The length of rope from pulley to other end is 230 yards. ROPER.

Cornwall, December 21st.

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THE ENGINEER.

DECEMBER 25, 1885.

THE ROYAL AGRICULTURAL SOCIETY.

MR. JENKINS, the secretary to the Royal Agricultural Society, has been compelled to call attention to the growing dissatisfaction manifested by the members of the Royal Agricultural Society concerning the method in which prizes are awarded. At the last meeting of the Farmers' Club, when the question was discussed at considerable length, Mr. Jenkins pointed out that there are 9300 members; of these, a little over 300 compete for the very large sums awarded for cattle, horses, pigs, and sheep. We shall not be far wrong if we say that among these competitors over £5000 are distributed every year. The agricultural engineers and implement makers do not get so many hundreds. Probably £100 would cover the cost of all the prizes awarded for machinery or implements last year. A very considerable proportion of the funds of the Society is drawn from exhibitors who pay high prices for their stands; and these gentlemen now begin to assert, and that pretty plainly, that they are being dealt with unfairly, and that a proper proportion of the funds of the Society should be given to those who have rendered agriculture possible in this country. We have over and over again urged the same thing; in other words, we have maintained, and we do maintain, not only that it was bad policy to give up engine and implement trials, as regarded the best interests of the Society, but that it is bad policy as regards the interests of the whole community. It is stated, and we know with a certain amount of truth, that some of the leading agricultural engineers are entirely opposed to the competition for prizes system. They make no secret, to do them justice, of the reason why. They hold that in the case of portable engines, for example, finality was reached long since. Finality, that is to say, in the sense that the portable engine is now as good as it ought to be for the price. That the world-wide reputations which they enjoy have been won by hard fighting years ago. That the effect of the prize system would be to bring numerous new competitors into the arena who could easily beat the past record of the best engines. These new men would take prizes and go far to cut out the older firms, who, to avoid such a contingency, would have once more to gird on their armour, and go and do battle for their reputations. Such a feeling is perfectly natural, and we are not at all surprised that it makes its influence felt. On the other hand, however, the junior firms see the matter from an entirely different point of view. They say, "Let the best man win. It is quite unfair to us that you should be suffered to enjoy a monopoly on the strength of a past reputation." This feeling is also perfectly natural.

Now, the Royal Agricultural Society should be strictly impartial, and therefore quite uninfluenced by the desire of one set of men to get a market, and another set to keep it. The business of the Society is to administer the funds at its disposal for the good of the community, and the Council ought to see that this cannot be done by giving all the prizes to beef and mutton growers. If we examine the present state of the engineering and implement trade it will, we think, be found that neither the agriculturist nor the engineer has much to plume himself upon. For years back there has been no decided advance made in any implement save the self-binding reaping machine, and the idea of that did not originate in this country; it was imported from America. It is but justice to the Royal Agricultural Society to say that it has of late years given more prizes for reaping machinery than for anything else, and the reaping machine has undergone more improvement than any other implement. It is a legitimate deduction that the action of the Royal Agricultural Society has had a great deal to do with placing a most valuable machine in the hands of the farmer. In what other direction can improvement be found? In the thrashing machine we find certain modifications made from time to time, principally in straw shakers. It is much to be doubted, however, if any real advance has been made since the Cardiff Show in 1872. Practically no attempt has been made to reduce the power required, or to diminish first cost. We say this with our eyes open to the circumstance that little improvements in detail and arrangement are being made every now and then. But we still hold, nevertheless, that the thrashing machine of 1885 is not really better than the thrashing machine of 1875. If we turn to steam ploughing we find that finality was apparently reached long ago. So far as the Royal Agricultural Society's influence is concerned, the British agriculturist is left in the hands of a couple of firms. No one can be more sensible than we are of the important work accomplished by these firms. It may be right, but it does not seem right, that the agriculturists of Great Britain must take what they make, or nothing. In portable engines no attempt has been made, save by a couple of firms, to produce engines better and more economical than those shown at Cardiff. The best known firms in this trade have made identically the same engines for years and years; and this while it is well understood that far better and more economical engines can be made. It is possible that no exception need be taken to all this if England's farmers and England's engineers had no competition to fear. Ask any maker of engines and implements about the foreign market, and if he speaks truthfully he will admit that his prizes have been of the greatest value to him in pushing his trade. Such an *imprimatur* will be more necessary than ever ere long. The implement trade with Europe is fast departing from our shores. The makers of corn drills, for example, tell us that Germans and Frenchmen can supply their own wants. Nothing but superlative excellence and a moderate price can enable us to retain our markets. We may rest content to remain quiet in Sleepy Hollow, but there can be only one end to our repose—a rude awakening.

It is quite likely that what we say will be distasteful to many of our readers. It is none the less our duty to say it. In the Arctic regions men benumbed with severe cold sleep, and if they sleep they die. Our position is strictly analogous to that of the traveller. If we sleep, we die. There is but too much tendency among wealthy firms of great reputation to believe that the world will always go on as it has done, and that improvement in engines and implements is not needed. It is the business of a body possessing national importance, such as is the Royal Agricultural Society, to correct this impression. It should do what is right without fear or favour. If the compound portable engine is better than the simple engine, let it make the fact known authoritatively. If a better steam plough can be found than the farmer now uses, let it be sought for. To assert that the Society does its whole duty by the agricultural community when it awards prizes for fat beasts of all kinds is absurd. It has far wider and more important duties to fulfil. Nor is it for one moment to be assumed that existing firms of great reputation need fear the result of a contest with younger men. They ought to be as well able now to win in such a race as they ever were; and who will dispute that fresh medals and prizes would not prove of service to them in foreign markets? Concerning the inner life of the Royal Agricultural Society very little is known. It is easy to see, however, that such a body may be easily dominated by a few leading spirits. An energetic minority can do just what it pleases. It is said that many agricultural engineers of weight and influence have advocated a return to the implement and engine trials on a large scale; but that they have been overruled by others who assert that the lion's share of the prize money must go for cattle, and horses, and sheep. There ought, we imagine, to be some means by which those who hold different views, while contributing to the funds of the Society, could make themselves heard to some purpose; perhaps they will. Mr. Jenkins' action in the matter is at least encouraging, and we venture to hope that the day is not distant when the agricultural engineer and the implement maker will have a chance of getting some of the good things distributed at the annual shows of the Royal Agricultural Society.

THE MANAGEMENT OF MEN.

THE sources of success and the causes of failure in business have formed subjects of consideration by tongue and pen on more than a few occasions; and their consideration must and will, while a business world endures, enlist attention and excite interest. Men past middle life, whose efforts have been successful, and who have sons growing up, watch those sons, study their characters, and observe their school or other educational progress, and speculate how they will fare in life's battle. The qualities of character that go to make a man succeed in business are not very numerous, but they lie deep, and must be born with their possessor. Like the infant, they will be feeble and inactive at first, and their process of development will be less rapid than the child's physical development. Training and education will do much to increase their efficiency.

Probably no quality is so valuable—certainly none is more so to its possessor—than a knowledge of men; and a clear perception of how to turn that gift to account. It is neither our province nor our intention to consider this subject, save as it applies to engineering; and to do even this as thoroughly as it deserves is beyond the limits of space at our disposal. It is very usual to see in advertisement columns: "Wanted, a works manager; one who understands the management of men." This is a prudent stipulation. The whole success of a works depends, among other things, upon the respect and influence the executive head can command. That invaluable quality called tact is the chief, if not the only, method of gaining it. It is of course necessary that a manager should be thoroughly well informed in his business; but he must also know how to teach clearly his subordinates how to do what he wants done; and he should not only be able to make his instructions quite understood, but also do so without exciting any irritation in the breasts of his men. The best work, all else being equal, is usually done "in good temper." An old adage says: "Work done in a hurry," &c. A paraphrase of that might substitute the words "bad temper" for "hurry," and leave its truth unimpaired. It is not so much even in the words used to the workman as in the manner of speaking them that tact is shown. The artisan of the present day is different from his prototype of, shall we say, forty years ago. The latter had less education; he was less independent than his class now are. He was therefore more easily managed; he was more pliable and docile. The workman of the present day is of another stamp, and, let some persons say what they please, a really first-class workman is as good as any man of his trade ever has been—and he knows it. Such men, however, need able and judicious management. Nothing irritates a man who really knows his business so much as for manager or foreman to come constantly to him in a patronising way, and, with considerable assumption of superior knowledge, "show him how to do it.' Another unwise thing is for a manager to shift men working time-work from one job to another before the first is complete, without any particular reason for so doing. It is also very injurious to the working of a shop for a manager to give way either to favouritism or special grudges. Both lead to injustice, jealousies, and all that is bad. The most successful manager or head of a large establishment is he who can get his work done by men in a good temper, and who are inspired with an interest in their work. No man ever does his best unless he has a real, personal interest in his job; and a good workman who likes his manager or his foreman will almost always have an interest in his work. Where a manager, from one cause or another, sees cause to make a change of any magnitude in the customary practice of the shop, or routine of the work, he ought as far as possible to do it by degrees, so as to avoid exciting irritation. It may be perfectly lawful, perfectly within his own or his employer's right, to make this or that change; but it may not be wise or prudent to do so abruptly. Strikes have on more than one occasion been provoked by this sort of thing; and strikes are unpleasant for all concerned. A system, we believe, prevails in some shops and yards of fines for petty breaches of discipline. Such a system may very easily be allowed to drift into a form of petty tyranny, greatly injurious to the interests of proprietors. Some employers of large numbers of men get along very amicably with them, chiefly, we fancy, because they employ only good hands, and try to keep their men together by making it worth their while to stay. They have built schools and reading-rooms, provide medical attendance at a low rate, and do all that they can to make them comfortable; by this means demonstrating to their employés that they have an interest in their well being—thus they gain the respect of most, if not all, their men, and make them less inclined to lend an ear to the agitator. Action of this sort, too, keeps their men out of public-houses and beer shops, and those who have so low an opinion of working men as to think it a waste of time and money to try to keep them away from such resorts by giving them reading-rooms or free libraries might change their view if they knew that in at least one important English town efforts made to get a free library were twice defeated by the publicans. In other than purely manufacturing branches of engineering, a thorough knowledge of men is essential to the efficient conduct of work. For example, in the dealings of an engineer and his assistants with contractors, one engineer will let his contracts more readily and at a lower figure, and to usually better firms than will another, simply because of his mode of dealing. His specifications are reasonable, concise, and practical; he does not refuse moderate concessions where a good cause can be shown; and he discourages reports about the nature or progress of the works from any but his own inspector or representatives. Another engineer may be equally well informed, equally able; but he is a harasser, and creates friction and irritation. Contractors are shy of his work, knowing that do what they will, they cannot give satisfaction, and may lose money. The difference between these two examples is that one understands human nature, he knows and understands how to manage men, and the other does not.

In connection with this subject, it is matter for regret that apparently no better method of payment than that of piecework can be devised in this country. It is true that payment by results prevails in other things as well as in this; but that is beside the present issue. It is matter of complaint, often well founded, that workmen now take no special interest in any shop or any master—"Here to-day, there probably to-morrow," is their motto. But have not employers or their system something to do with this? As we have pointed out above, the heads of some big firms do certain things for their men which make them prefer to stay, such at least as are not born nomads. Just firms flourish and prosper when others around them drift hopelessly to the Bankruptcy Court. They cannot keep their men together; men come, work a while, and just as they are getting "into the work" have so little interest in the place that they leave. Such firms cannot turn out first-class work—it is impossible. There is no point about piecework payments calculated to make an identity of feeling or interests between the master and the men in it. If a man makes a very good draw on pay-day he thanks himself for it; no thanks, at all events in his opinion, to his master. The work has been done, is paid for, and there is an end of it. In timework the matter is rather different; about it are certain channels through which a master can show that he appreciates a good and willing workman. He can increase his pay to better purpose, and if he be wise he will too, to a really deserving man. In piecework, purely and absolutely unmixed selfishness is the spring of action, and though selfishness is a natural and very universal feeling, especially in these days of fierce competition, it is not usually considered one that is a great promoter of self-respect, or of harmony—both very desirable things to attain.

In America a sort of co-operative system prevails in some places. In this way, if a workman saves some money, be it ever so little, he can purchase a share in the business of his employer; and if he be in other ways eligible, and that the opportunity arrives, he can by degrees purchase his way up by taking more shares. Of course, this system gives him and all his fellow shareholders a direct and personal interest in the prosperity of the concern. He certainly works for himself, but in a more manly and dignified manner than as a pieceworker; although piecework is in extensive operation in the States as well as with us, but the share system operates to elevate it. The pieceworker there knows that by exerting himself he can have more capital to invest in the business; such additional capital strengthens the firm or company, and renders more secure the ties of interest which hold the men together. It is possible that some form of this system would prove beneficial to masters and men alike in this country if it got a fair trial.

SALT IN SOUTH DURHAM.

IT is some time since we referred in THE ENGINEER to the progress of the salt industry in South Durham, but during that period there has been steady progress in the development of the trade, though there have been some of the difficulties which seem almost inseparable from its prosecution. Last year, at the termination, the official statistics show that there were thirteen salt pans at work in South Durham at the Port Clarence works of Bell Brothers, and that the produce for that year was 22,775 tons. This year at least two additional works have begun production. The largest of these is that carried out at the Cowpen Marsh works of the Newcastle Chemical Works Company, where there are at the time of writing six salt pans in operation, and others are in course of erection. It is expected that other schemes will be carried out for the development of the salt resources of South Durham, and it is believed that there will, in the course of a year or eighteen months, be a production that will be equivalent to the supply of the whole of the needs of the chemical trade on the banks of the neighbouring river Tyne. Whether this will be the case remains to be seen, but it is at least certain that the production is increasing and that there must be a very material diminution in the consumption of Cheshire salt by the Tyne chemical works. It is probable that the saving to the latter, where they have to buy the salt, will be less than had been anticipated, because there is an ample demand for the salt made in South Durham, and for some time to come there will be a manufacturing consumption more than equal to the enlarged output. But the tendency will be to increased competition in the North-eastern salt trade, because not only will there be a larger production in South Durham, but Cleveland will also come into the market as a producer; and thus, subject to the fluctuations of the market, we must anticipate that there will be cheaper salt for the chemical trade of the North because of the enlarged yield at a point so much nearer than that from which the supply has been exclusively drawn, down to a very recent period, and from which much is still drawn.

VACANT SPACES IN LONDON.

THE angular course taken by the new street through Soho from Oxford-street has, we observe, caused to be left several small triangular spaces which cannot be availed of for the erection of buildings likely to bring to the Metropolitan Board of Works any return worthy of consideration. We shall be anxious to learn the use to which they are to be put. As we have said, we cannot think that they can be disposed of to any pecuniary advantage, and we should hope that they may be utilised in such a manner as to somewhat relieve the great monotony that exists in most of our London thoroughfares. On a small scale, we should think that the course contemplated with regard to similar spaces opposite St. George's Hospital might, to a certain extent, be followed with those of the Soho street. Every tree or shrub that can be planted in such a locality will be a distinct gain to the public; nor can the influence of such planting on the health of the metropolis be wholly disregarded. An opportunity is therefore now afforded to the Board of gratifying both æsthetic taste and sanitary views. Properly planted and maintained, these spaces would add greatly to the effect of the new street, and would so directly contribute to the recoupment of the Board by increasing the value of the sites that will be available to it for sale or letting. We trust the opportunity pointed out will not be neglected. Every few feet of space that can be preserved open in a city like London is of value to its inhabitants, and we hope such a consideration will prevail over any desire to get the uttermost farthing. At the best, these spaces could only be utilised for the most insignificant erections, and if these be permitted they must greatly detract from the appearance of the new street when completed.

GERMAN COMPETITION.

COMPLAINTS of the intensity of German competition in the English markets, particularly in the cheaper classes of goods, are increasing on every side. In handy knick-knacks of cutlery and hardware requisites, as well as in certain grades of plated goods, the German manufacturer seems to be outstripping the American. Sheffield feels this rivalry more keenly than any other of the large towns. Over 100 German travellers now regularly visit Sheffield. A large manufacturer, repeatedly pressed of late to make concessions on edge tools and similar goods, which he was in the habit of sending to the Continent in great quantities, made inquiries, the result of which somewhat startled him. He found that it would pay him to abandon production in Sheffield altogether, and transfer his works to Germany. There he would be free from vexatious tariffs which handicap his goods, and would have the run of the English markets all the same; while he would enjoy the advantages of long hours and low wages. The result of his investigations will be a demand that his men concede 15 per cent. in wages, which will probably lead to a strike. German-made scissors are freely bought in Sheffield and sold again, being offered at rates with which local firms cannot compete; and the Sheffield windows display German-made goods at one-third less than Sheffield prices.

LITERATURE.

England's Supremacy. By J. S. JEANS. London: Longmans, Green, and Co. 1885.

To write the history of England's supremacy would appear to imply that that supremacy had long departed. But this is a postulate which Mr. Jeans—the secretary of the Iron and Steel Institute—will not admit for a moment; And yet, reading the pages of his interesting work, we must confess that our feeling of trust and faith in the immortality of English commerce and industry might well be shaken. From his official position of course Mr. Jeans has many opportunities of judging of the state of English trade, without awaiting the results of the Royal Commission, and it would, perhaps, have been more desirable if he had given us a little of his own private experience, and some of the opinions of the members of the Institute with which he is connected, instead of piling together and digesting the official and unofficial statistics of Europe and America. Statistics in themselves are at best bald and sketchy. It is impossible to arrive at any satisfactory conclusion on any given subject from a perusal of tables and statistics, however intelligently arranged, however methodically read; and this for the simple reason that statistics are never absolute, but only give approximations. It is difficult to find a common denominator for anything. For instance: suppose it is desired to make a correct estimate of the value of labour at the present day, and to compare the result with the remuneration labour received, say, a generation or half a century ago. Anybody at all accustomed to statistics will know that even an approximately correct estimate of these two cannot be arrived at. In the first place, it is practically impossible to find the proper average of wages paid in any given trade at the present day in England alone. But let us suppose that such an average, sufficiently near to form a working basis, had been found. It would become quite impossible to correctly compare the value of that wage to the contemporary working man with the value of the wages of the artisan of fifty years ago. The purchasing power of money has in some directions increased in the interval; in others it has diminished. The wants of the working man have also increased in some matters, whereas in others they have, it is to be hoped, very much diminished. It would, therefore, be impossible to compare the condition of the working man of to-day with that of fifty years ago, and to arrive at a correct and scientific answer solely by statistics. This is very vividly illustrated whenever it becomes desirable, for political or other purposes, to compare the condition of the American artisan with that of his English prototype. No satisfactory results are attainable, because a common denominator cannot be found; the circumstances and conditions are so totally different that statistics alone will not guide us. It is only when we get the personal experiences of such men as Mr. Pidgeon, and study the labour statistics at our command by the light and colour of statements by practical men, that anything like an idea of the relative position of the labouring classes in the two countries can be obtained. The same argument holds good in estimating other factors. For this reason we regret that Mr. Jeans should have confined himself so exclusively to statistics, and we fear this considerably detracts from the usefulness of his otherwise invaluable work. It is, for instance, Mr. Jeans' aim—and of course he is correct in his premises—to show that England has progressed wonderfully socially and industrially since the middle ages, and from this he draws the conclusion that England must continue to progress in the same ratio, or perhaps even in a greater. He is able to prove by statistics that no other country in the world approaches us in the progress that we have made, and that America herself, with all her enormous wealth, is still far behind the mother-country. But, though she is not ahead of us, she has prospered at so enormous a rate during the last few years, that if this rate of progress be continued for any length of time, and our rate is not increased to an unprecedented extent, we shall be left far behind in the race for supremacy. What influence the conquest of Burmah, the opening of trade routes between China and India, and the development of the Congo may have on British commerce, it is, of course, practically impossible to foresee. These will prove great and mighty factors in the commercial history of the end of this century; but the probable political events of the future cannot form legitimate subjects for calculation in a work of this kind, and are consequently not taken into consideration. The conditions of production, on the other hand, under which the rival nations labour are of a very different character, and offer food for deep reflection, not altogether of an optimistic nature we fear. Mr. Jeans is forced to admit that in regard to labour conditions we are at a disadvantage. At no very distant period of the world's history we were virtually the only nation possessed of skilled artisan labour, but since then matters have changed. Foreign countries have not been slow to train and organise their cheaper and more docile labouring population in the ways of technical work and co-operative or factory production. On the Continent hours of work are longer, the wages are lower, life is cheaper, and the wants of the working-classes are much fewer. Competition is therefore by no means easy. Notwithstanding Mr. Jeans' optimism, it is difficult to see one's way to a rose-coloured forecast of the outlook of the British workman. Labour is one of the conditions of production. Natural resources are another. Mr. Jeans is perfectly correct in saying that success is due more to character than to opportunities, and that England was a great nation before her natural wealth had been discovered and scientifically developed; but we cannot see our way to follow him when he goes further and maintains that England will continue to assert her supremacy even after these resources have been exhausted. The natural wealth of England was discovered and developed at a very opportune period, when the industrial arts were in their cradle. Its exhaustion, however, in the face of foreign competition, would probably be little short of disastrous. It is quite possible, and we must all hope it certain, that those great qualities of character to which England owed her success will not desert her at so critical a time, and that she will still come triumphant out of the ordeal; but we must remember that we have as rivals in the field our own offspring, whose life has only just commenced, who possess in an eminent degree our national qualities, and who are settled in a country the natural resources and wealth of which are simply fabulous.

Notwithstanding its professed optimism, there is, indeed, a strong undercurrent of pessimism in the book; and when speaking of Belgium, or the mechanical appliances and technical education of the Continent, the author's belief in English supremacy seems to waver considerably. This is still more markedly observable when he touches on America, and the condition of production there. Indeed, it would appear as though he attributed the fact of our still being in the van as much to the protective tariffs of foreign countries, if not more so, than to the superior excellence of English manufactures. He does not conceal from himself that foreign manufactures have improved marvellously, but he does not apparently admit that England has remained practically stationary, or has even retrograded, as some seem to think. Yet it cannot be denied that there is a strong feeling on the Continent and the colonies that English work is no longer so trustworthy as it used to be. Even that wonderful product of the nineteenth century, the British workman, whom it was once the fashion to extol to the skies, has become a byeword even among his own countrymen. Whether this is to be regarded as the result of trades unionism, or as the consequence of deficient education, we are not informed. It is, however, noteworthy that in America and Belgium, where protection is rampant, the reputation of the artisan is much higher. In America, of course, we know that the social status of the artisan is very much better than in England, but in Belgium this is not the case. How, then, comes it that Belgian manufacturers are able to produce better and more cheaply than we can? This no doubt is one of the puzzling questions which English economists cannot or dare not answer, and which have led in no small measure to the Fair-Trade agitation of late years. It is a question which Mr. Jeans flits over as quietly and litheły as he can. He feels himself on slippery ground, and probably is glad to leave it lest the ice should break under his feet. But it is a question that cannot and will not be shelved. That cheaper labour, which, however, is able to produce equal results, should compete with our own, and not only oust us out of neutral markets, but even come to our very doors, and undersell us in our own country, seems an incredible state of things, and how to remedy it must puzzle all orthodox political economists who would scorn the very suggestion of retaliatory duties, and to whom the very phrase "Fair-Trade" is highly objectionable. We have refrained from giving extracts, and we fear this notice will convey but a very faint idea of the labour, patience, and diligence of which Mr. Jeans' work is a monument. He certainly manifests wonderful perseverance and energy in worming out figures even in apparently the most hopeless cases. His statistics of Russian labour conditions are an instance of this. Nor can we help admiring his courage in tackling a subject so vast and difficult of condensation. To say that his book is an invaluable statistical compilation would be but a very inadequate definition. Much of the work he has done has never been attempted on such a scale before—to witness, statistics of labour and of the cost of living throughout the world. A more interesting, more engrossing work it would be difficult to find.

SHIPBUILDING ON THE CLYDE.—The annual statistics of the Clyde shipbuilding trade have now been made up, and it appears that 241 vessels have been launched, with an average tonnage of 193,458 as compared with 296,854 in the preceding year. The following table gives the tonnage put into the water in the last twenty-four years:—

Year.	Tons.	Year.	Tons.	Year.	Tons.
1885	193,458	1877	169,710	1869	192,310
1884	296,854	1876	174,824	1868	169,571
1883	419,664	1875	211,824	1867	108,024
1882	391,934	1874	262,430	1866	124,513
1881	341,002	1873	232,926	1865	153,932
1880	241,114	1872	230,347	1864	178,505
1879	174,750	1871	196,229	1863	123,262
1878	222,353	1870	180,401	1862	69,967

The highest tonnage launched by one firm this year has been 40,866 tons, by Messrs. Russell and Co., of Greenock and Port-Glasgow; Messrs. William Denny and Brothers, of Dumbarton, coming next, with 16,423 tons; Messrs. A. M'Millan and Son, Dumbarton, 13,228 tons; Messrs. Alexander Stephen and Sons, Glasgow, 11,549 tons; and Messrs. Robert Duncan and Co., Port-Glasgow, 10,626 tons. Messrs. John Elder and Co.—now the Fairfield Company—who for a series of years were about the top of the list, stand eighth this year, with a total tonnage of 9026. The proportion of sailing vessels to steamers built this year has been unusually great, in consequence of the shipping trade being overstocked with steam vessels. The whole of the vessels put into the water by Messrs. Russell and Co., twenty-eight in number, were sailing ships. The work on hand is much larger than it was at the end of last year; but several builders have still little or nothing in their yards. The steel tonnage built on the Clyde, which rose gradually from 18,000 tons in 1879 to 133,670 in 1884, has this year been 92,677 tons.

RAILWAY MATTERS.

THE October traffic receipts of the Hull and Barnsley Railway and Dock amount to £11,726.

THE Kimberley Railway Extension was declared open on the 28th ult. by the High Commissioner in presence of 10,000 spectators. The festivities in connection with the opening continue for a week on a great scale.

THE Hull and Barnsley Railway, which has now been in operation for about four months, was finally inspected by General Hutchinson, Board of Trade Inspector, last week. The General made a journey over the railway, in company with Mr. Shelford, C.E., who represented the company, and we understand the inspector expressed himself highly satisfied.

IN a little Ohio village where there was an obnoxious liquor saloon, the people hit upon an excellent means of getting rid of it. One night when it was full of people, the *Globe* says, they passed a cable round it, and attached the cable to the rear van of a goods train. Happily, the inmates got out before the train moved off; but the saloon at any rate, does not stand where it did.

THE Trans-Siberian Railway Co. has already finished its first section of 135 kilos. between Ekaterinburg and Kamishoff, and its early completion to Tiumen is confidently expected. The canal between the Obi and the Yenisei is already so advanced that navigation will probably be inaugurated on it by the spring of 1887, if not even earlier. Sibiriakoff has established a line of steamers on the Angara, which unites Lake Baïkal to the Yenisei, and which has been thought too turbulent for navigation.

ON the 15th inst. a new branch line of railway connecting Earle's shipyard with the Hull and Barnsley Railway at the Alexandra Dock was opened without any ceremony, and the first consignment of steel armour-plates intended for H.M.S. Narcissus, the belted cruiser now in course of construction by Earle's Company, was received from Sir John Brown's works at Sheffield, *viâ* the Hull and Barnsley Railway, and were deposited alongside the vessel. The completion of this line will materially assist Earle's Company in carrying out its contracts, the Hull and Barnsley Railway rates being considerably lower than the North-Eastern Railway Company's.

IN reporting upon an accident which occurred on the 18th instant near Garrison-lane Junction, Birmingham, on the Midland Railway, Major Marindin says :—"The evidence in this case, and the marks which were apparent upon the permanent way when I examined the line, showing that one wheel, after dropping off inside the left or low rail of the curve, had been running over the chair tops inside this rail for a distance of 97 yards, while the corresponding wheel was still running upon the outer rail of the curve, prove conclusively that the fracture of the leading engine axle, which was found to be freshly broken, was the cause and not the effect of the accident." The total weight on the leading wheels was 11 tons 12 cwt. 3 qrs.; on driving wheels, 12 tons 17 cwt. 1 qr.; and on trailing wheels, 10 tons 10 cwt. 3 qrs.

ON the 17th inst. a remarkable escape occurred to a lady travelling by the Cornish down mail train, who had not been aware that it did not stop at Hayle. She unfastened the door and jumped from the train just after it had passed that station. She alighted within about 3ft. of the viaduct, which is 30ft. high. She was found to have received some bruises and cuts, but that was all. On the same day a supposed lunatic leapt from a Midland express while travelling between Loughborough and Trent Junction. The man had booked to Nottingham, and when the train was running at a high speed he suddenly jumped from the carriage. Some platelayers ran towards him, when to their great surprise he got up and ran away. If this had been from the States it would have been said, "Ah, that's from America."

THE Chicago, Burlington, and Quincy Railway Company has what is called "an air-brake car" in operation, and all train men are required to take lessons in the practical workings of the automatic brake. The car is fitted up with all the appliances for the thorough exposition of the principles on which the brake works. Three sets of brakes are arranged so that they can be coupled together after the manner in which they appear on the train. In the few hours devoted to study and instruction in the car, they learn more than they would in years of experience on the road. The *Chicago Inter-Ocean* says the car will remain in each city along the line about two weeks. All trainmen are required to take a course of instruction, and must have a certificate of their competency before before allowed to go out on their run. The *Railroad Gazette* says similar school cars have been and are still in use on other lines.

THE accidents on American railways in October are classed as to their nature and causes as follows, by the *Railroad Gazette* :—Collisions—rear, 46; butting, 13; crossing, 3; total, 62. Derailments—broken rail, 9; broken frog, 1; broken bridge, 1; spreading of rails, 8; broken wheel, 5; broken axle, 5; broken truck, 1; broken brake-beam, 2; broken tram or coupling, 1; accidental obstruction, 1; cattle on track, 3; wash-out, 1; misplaced switch, 6; rail removed for repairs, 2; malicious obstruction, 1; purposely misplaced switch, 1; unexplained, 7; total, 55. Other accidents—boiler explosion, 1; broken parallel-rod, 2; broken wheel not causing derailment, 1; cars burned while running, 2; total, 6. Total number of accidents, 123. No less than ten accidents were caused by trains breaking in two; six are attributed to fog; four to the failure to use signals promptly; three to misplaced switches; two to cars blown or run out of siding upon the main track; two to the wreck of a preceding train; and one to mistake or misunderstanding of orders. The enormous proportion of derailment continues, but the unexplained derailment has decreased.

A REPORT on Victorian railways, embracing a period of eighteen months ending June 30th last, has been issued. At the end of 1884-5, 1676 miles were constructed, as compared with 313 miles in 1871-2. Capital cost amounts to £22,914,449, equal to £13,672 per mile. In 1871-2 the cost per mile stood at £32,060, showing the effect of cheaper rails and improved machinery in lessening cost of construction. There were carried during the year over 34 million passengers, as compared with a million and a-half fourteen years ago. The receipts per mile amounted to £1318, against £2388 in 1871-2. The receipts per train mile equalled 6s. 4d., against 10s. 10d. The profit earnings vary from 3·12 per cent. on the North-Western system, to 6·43 on the Hobson's Bay lines. The average may be put at 3·95. The ratio of working expenses to capital equals 58·54 per cent. In providing railways for the several districts, considerations other than profit are looked to. The principle adopted is to give each portion of territory a fair share of railway accommodation. All new servants are obliged to insure their lives. This, however, only makes provision in case of death or upon the attainment of the age of 60.

LOCOMOTIVE No. 137, on the Boston and Albany Railroad, used in the passenger service, has a very remarkable record. The *Boston Traveller* says it came out of the shop new April 23rd, 1883, and on October 30th, 1885, was sent in for general repairs, having in the meantime—for thirty months and seven days—made daily trips. The average run for the 921 days was 203 miles, or an aggregate of 184,726 miles. During this time only twelve days were lost for repairs, and no repairs were made until April 27th, 1884, when the engine had run 78,812 miles. During portions of the months of April and June, and the whole of the month of May, the engine ran 400 miles every day, making—with extra trips Sundays—10,910 miles in May, and a total of 26,740 miles in the three months named, or an average of 8913 miles per month. The twelve days lost for repairs were distributed over the period from April 27th, 1884, to October 30th, 1885, and, in almost every instance, the repairs were of an unimportant character, and in the shape of renewals. The driving boxes of the engine were of cast iron, but have lately been replaced with steel. The weight of the engine is 42 tons, its cylinders are 18in. by 22in., its driving wheels 68in. in diameter, and the boiler 52in. in diameter. There are 231 2in. tubes, and the steam pressure is 160 lb.

NOTES AND MEMORANDA.

IN London, last week, 2671 births and 1725 deaths—about 10 per hour—were registered.

IN Greater London, last week, 3437 births—20·4 per hour—and 2163 deaths—12·8 per hour—were registered, corresponding to annual rates of 34·5 and 21·7 per 1000 of the population.

A CHIMNEY 18 metres—or nearly 60ft.—high, for a factory at Breslau, has been made of compressed paper blocks stuck together by silicious cement. It cost less than if built of brick, is incombustible, and is sufficiently elastic.

THE deaths registered during the week ending December 19th shows that in twenty-eight great towns of England and Wales corresponded to an annual rate of 23·0 per 1000 of their aggregate population, which is estimated at 8,906,446 persons in the middle of this year. The six healthiest places were Brighton, Blackburn, Birkenhead, Huddersfield, Sunderland, and Norwich.

AN experiment of cleaning main water pipes of incrustations by means of chemicals was successfully accomplished last year in Leipzig. The main pipe between reservoir and the pump, 2·8 miles long, and 15½in. in diameter, was covered with incrustations about 1in. thick. The cleaning lasted two months, and during this period the main pipe was filled eight times with solution of hydrochloric acid, three times with solution of soda, and once with solution of chloride of lime. By this means the incrustations were entirely removed, and the gauges at the pumps showed pressure 30 lb. less than before.

CONSUMPTION seems to be much more prevalent still in some parts of the United States than in England. The comparative mortality by absolute number of deaths from fifteen most important causes of death in Rhode Island, which includes New York City, during twenty-five years, from 1860 to 1884 inclusive, is given as follows:—Consumption, 12,500; pneumonia, 5500; old age, 4500; diseases of the heart, 3600; apoplexy and paralysis, 3500; scarlatina, 3200; fevers, typhoid, &c., 3100; diarrhœa and dysentery, 2600; diphtheria, 2500; cholera infantum, 2500; diseases of the brain, 2400; cancers, 2000; croup, 1500; diseases of the kidneys, 1200; bronchitis, 1000.

ACCORDING to the *Journal des Fabricants de Papier*, a material called asphalted jute is being largely employed in Germany for covering roofs, for isolating damp walls and floors, and for preventing bad odours from reaching apartments situated over stables, &c. It consists of strong jute cloth coated with specially prepared asphaltum, and covered on each side with strong asphaltum-coated paper. In order to obtain a very compact product, the whole is submitted to very strong pressure. The material can be used on farms for making tight reservoirs, in the construction of bridges, and in many other cases where there is need of a material that is at once strong, impermeable, and cheap.

SOUTH of the island Suderoe, one of the Faroe group, a mighty cliff rose sheer out of the sea to a height of from 80ft. to 100ft. Looked at sidewise from a distance at sea, it resembled a great ship in full sail; but seen from Suderoe, it presented the appearance of a monk, whence it received from the Faroese the name of Munken. The Monk was also a valuable landmark for sailors, warning them against a dangerous whirlpool which swept around its base. But it is now only a thing of the past. The occurrence is supposed noteworthy as proving that the continuous wash of the sea, aided in the winter by the action of driving ice blocks, is able to saw through immense masses of rock consisting of hard basalt, cutting them clean across at the water's edge. The exfoliation of basalt is, however, so rapid, under such exposure, that very little sawing or abrasion by ice is necessary.

A PATENT has been recently taken out in Germany for preparing liquid carbonic acid. Sodium bisulphate in solution in a leaden jar receives an equivalent part of some carbonate suspended in water. The mixture is stirred, and carbonic acid is given off, and led over a drying mixture into a gasometer, where it is condensed into a liquid. The liquid carbonic acid can thus, it is said, be very cheaply produced, and is applicable to a variety of purposes. About 500 litres of the gas, at ordinary pressure, can be supplied for one mark. At this price it will pay mineral water manufacturers to buy gas ready made. By evaporation of the liquid acid so much heat is absorbed that it can be used for the manufacture of ice. The patentee proposes to pass the carbonic acid thus utilised over moist sodium carbonate, which is thus converted into bicarbonate, from which liquid carbonic acid is again prepared.

IN their report on the water supplied to London last month, Messrs. Crookes, Odling, and Meymott Tidy say that "throughout the month of November the river was in a state of high flood, and with this condition there was an appreciable proportionate increase in the amount of organic matter present in the water supply. The absolute increase was, however, very small; the mean amount of organic matter in the Thames-derived supply for November being in excess of the exceptionally small amount present in the supply for October by about the one-sixteenth part of a grain per gallon." Referring to the alarmist views published by misinformed readers of the results of Dr. Koch's gelatine method, they refer to the necessity for disowning the indications, and to the remarks of Sir Francis Bolton and Dr. P. Frankland, who observed: "Any public alarm which the misapprehension of our reports may have caused will doubtless be allayed by a consideration of the fact that micro-organisms are not only present in nearly all natural waters, but that they are inhaled by every inspiration from the air."

AN ordinary adult man expires ·7 cubic foot of carbonic acid in one hour when at rest, so that if such an individual were enclosed in an airtight chamber, 10ft. high, 10ft. wide, and 10ft. long containing 1000 cubic feet space, in one hour the carbonic acid in this chamber would have had added to it ·7 cubic foot of carbonic acid; the air originally contained ·4 parts of carbonic acid in 1000 parts, so that after one hour it would contain ·4 + ·7 = 1·1 parts of carbonic acid per 1000, or 1·1 – ·6 = ·5 parts per 1000 above the permissible limit for health. But if the subject of our experiment were enclosed in a room containing 3500 cubic feet of space, in one hour the amount of carbonic acid would be only $\frac{3·5 \times ·4 + ·7}{3·5} = ·6$ per 1000, *i.e.*, the limit would have just been reached, and at the end of a second hour, to keep the carbonic acid to this limit, another 3500 cubic feet of fresh air must have been allowed to enter the room. That is to say, an adult man requires when at rest 3500 cubic feet of fresh air per hour; a woman or child requires proportionally less. For any individual above twelve years of age, we may take as an average the amount of carbonic acid expired per hour as ·6 cubic foot, and for such an average individual 3000 cubic feet of fresh air per hour is necessary.

A DISASTROUS earthquake which does not seem to have attracted much attention, occurred in Algeria on the night of December 3-4. The area of greatest destruction seems to have been located near M'sila, a small town in the interior. The place was disturbed a second time on the following morning. The last shock was more destructive than the first. The number of victims is estimated at one hundred. The commotion was felt at Setif and at Moscara, whose distance is about 400 kilos. Their direction was east to west. The difference was 7 seconds at Setif, and 8½ at Moscara, where three different shocks were felt. The commotion was noted also in Algiers without any accident being recorded. According to latest news, the series of earthquakes continued some time with unabated energy. *Nature* says, that on the night of the 4th to the 5th inst. a part of Bousaada, a town of 6000 inhabitants, almost exclusively Arabs, was partially destroyed. The church and seventy-one houses were demolished; the victims were not numerous, all the population having encamped in the fields. This town is the centre of a large market, celebrated in all the south of the province of Algiers, 254 kilos. south of the city. Another telegram stated that other commotions were felt on the 6th at M'sila for the second time. These last shocks were reported very heavy; time, 2 and 4 p.m. The time appears to have been the same at M'sila.

MISCELLANEA.

WITH the beginning of 1886 parcels not exceeding 7 lb. in weight will be received at any post-office in the United Kingdom for transmission to Belgium and Germany.

THE vitality of the steam engine is still so far unaffected that it is an important machine even in the field of its modern rivals. It appears that the new balloon constructed by the Meudon aëronauts will be directed by a steam engine, as advocated by M. Henry Giffard. Electricity lacks the power of continuous action.

THIS week several of the steam tramway engines of Messrs. Kitson and Sons, of Leeds, have been started at Wolverhampton on a line some five miles in length, which connects that town with Dudley. The engines worked well. The accompanying new cars are commodious, and will carry 54 passengers, 26 inside and 28 outside, and all under cover.

THE Birmingham Chamber of Commerce have determined to appeal to the traders of the town asking for contributions towards defraying the expenses that would be incurred in making a survey of the Grand Junction and Birmingham and Warwick Canals from Birmingham to London, and preparing a report upon the cost of widening and deepening the canal to allow of the passage of 80-ton to 100-ton barges propelled or towed by steam.

THE American *Engineering and Mining Journal* says "some one is proposing to liquefy natural gas and transport it as a liquid or solid. As natural gas is composed chiefly—95 per cent.—of marsh gas, which can be liquefied only at a very heavy pressure, the probability of explosions would make its carriage and storage in this form rather undesirable. The transportation of natural gas or of water gas through large mains can be economically effected for any desirable distance without having recourse to so expensive and dangerous a plan as that referred to."

A SOMEWHAT serious obstacle threatens in connection with the steam tramway traffic in Birmingham. For some time past the provisions of the Public Health Act have been strictly enforced, and a great number of steam car drivers have been fined for permitting smoke or steam to be emitted from the engines. The drivers are often summoned more than once a week, and their grievances justify their present complaint. They contend that the smoke nuisance is regulated by the state of the atmosphere; that the smoke will persistently hang about the engine at one time, while at another, though a similar amount of smoke is emitted, it is hardly perceptible. Already rumours are afloat from one quarter that certain tramway routes are to be closed, and from another that the drivers have suspended work.

ON the 17th inst., about six o'clock, a serious accident was found to have occurred to the celebrated Pont Neuf, the oldest and best known of the Paris bridges. On that part of the structure crossing the narrower of the streams into which the Seine is divided by the island of the Cité, the third pier had sunk, and the pressure of the arches towards the subsidence had torn up the pavement of the footpaths and the causeway. An alarm was given by persons who were crossing the bridge, and the traffic was at once stopped by the police. A large crowd soon collected, and could see the outer stones of the bridge break off in large masses and fall into the river. Barriers were erected at both ends of the bridge, and the gas pipes crossing it were cut off and rendered secure. It was found that the part of the bridge which had been injured had subsided 65 centimetres. That part of the bridge which crossed the wide stream is secure, but the other part will have to be entirely rebuilt. The city engineers state that the work will be long and tedious, and that while it is going on it will be necessary to erect a temporary bridge connecting the Quai des Orfèvres and the Quai des Grands Augustins. The common proverb, "Solide comme le Pont Neuf," has thus been falsified.

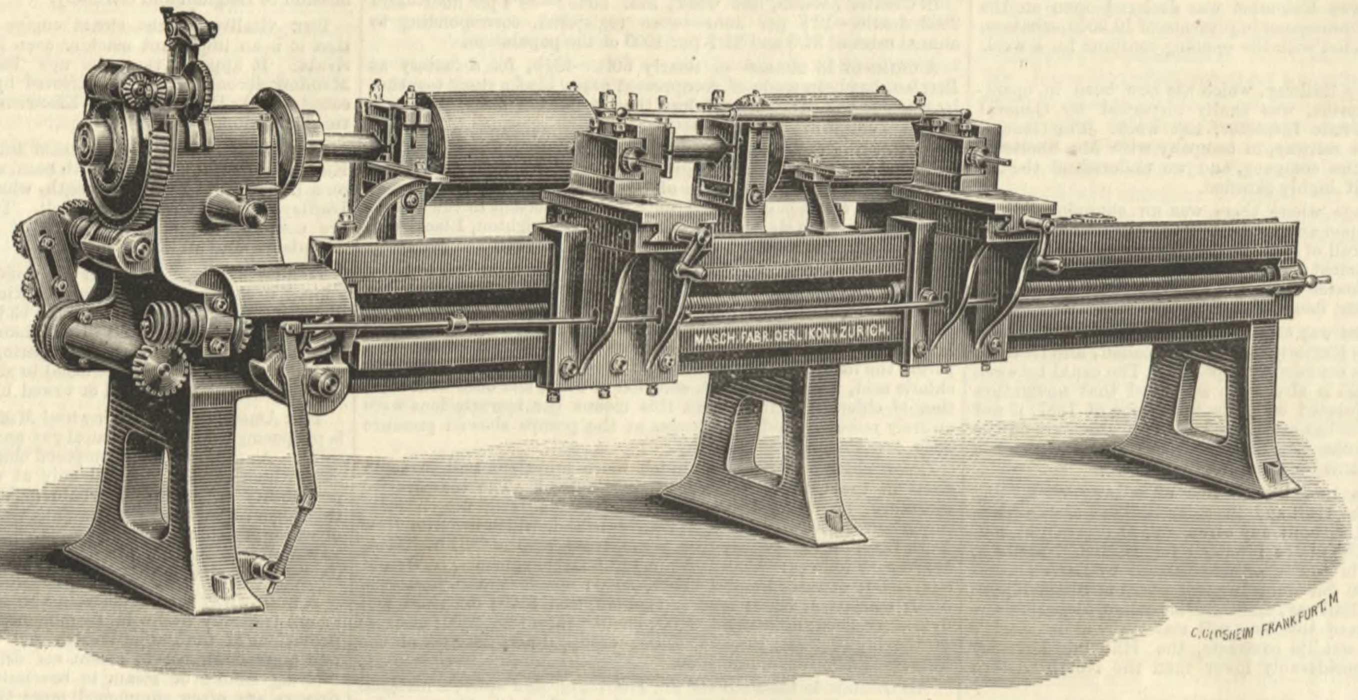
AN interesting paper on "Fire," with special reference to the best materials for fire resisting construction, was read before the members of the Manchester Joule Club at their ordinary meeting on Friday last, by Mr. J. L. Savage, the deputy superintendent of the Manchester Fire Brigade. Mr. Savage very emphatically condemned the large introduction of stone and ironwork construction into the modern buildings as very treacherous materials in the case of a fire, the liability of stone to sudden fracture, and the expanding and contracting properties of iron under varying temperature, introducing elements of very considerable danger under the trying conditions of a fire. Mr. Savage believed in reverting very largely to the old wooden beams, and where iron supports were introduced he strongly recommended that they should be cased over with plaster or cement to preserve them as much as possible from the full effects of the heat in case of fire. Amongst the most recent introductions of fire-resisting materials for building construction, Mr. Savage referred to the successful tests which the Johnson wire lathing had gone through under very severe conditions, particulars of which, with a description of this lathing, have already been given in THE ENGINEER, and with regard to which we may mention that the Manchester Corporation are arranging for further trials being made at an early date.

THE Russian Government has been and is showing very high appreciation of engineering works for Asia. According to the *Journal des Debats* they have decided to create a port at Mikhailoffsky, upon the Caspian, and, by means of a railway which will connect this port with Krasnovodsk, to open up direct communication between the Caucasian ports on the Caspian and Astrachan. Owing to the shallowness of the water the Gulf of Mikhailoffsky was not accessible to vessels of heavy tonnage, the consequence being that goods to be carried by the Transcaspian Railway had to be reshipped on to flat-bottomed punts, thus increasing the carriage to a very considerable extent. These drawbacks were brought into special prominence at the opening of the works upon the Transcaspian Railway, as the workmen as well as the materials had all to be sent round by way of Baku and Astrachan. The enterprise has been facilitated by the discovery in the northern part of the gulf of a new bed, which can easily be made 14ft. deep, and this will suffice to admit the largest vessels navigating in the Caspian Sea. All the work required to be done will be the extracting of 14,000 cubic feet of sand, the cost of which will not exceed 50,000 roubles. The total expense of constructing the port is estimated at 120,000 roubles, and this sum is included in the estimate of the Central Asian Railway, the construction of which will be much simplified by the connection of the Gulf of Mikhailoffsky with Astrachan and Baku.

AT a meeting of the Court of Common Council on the 17th inst., an agreement was sealed in triplicate between the Corporation of London, Mr. Horace Jones, city architect, and Mr. J. Wolfe Barry, C.E., for the superintendence and erection of the new Tower Bridge. The Council considered the Tower Bridge did not fairly come within Mr. Horace Jones's duties according to the terms of his appointment, but they thought that Mr. Jones should be appointed the architect for the erection and construction of the bridge, and that Mr. J. Wolfe Barry, the eminent engineer, should be associated with him in carrying out the work. The original parliamentary estimate for the construction of the bridge, exclusive of the approaches, was £585,000, but in consequence of the Committee of the House of Lords having required certain additional works to be executed, the cost had been increased to £610,000. Mr. J. Wolfe Barry, M.I.C.E., had been requested to state the amount of his remuneration, and had stated that he should expect the usual commission of 5 per cent. on the parliamentary estimate, which would amount to £30,500. After careful consideration, the committee agreed that the sum of £30,000 should be paid to the city architect and Mr. Barry, in such proportion as they might mutually agree upon, for superintending the erection and construction of the bridge, such sum to include the salaries and expenses of all superintendents and clerks of the works, to which terms Mr. Barry had assented.

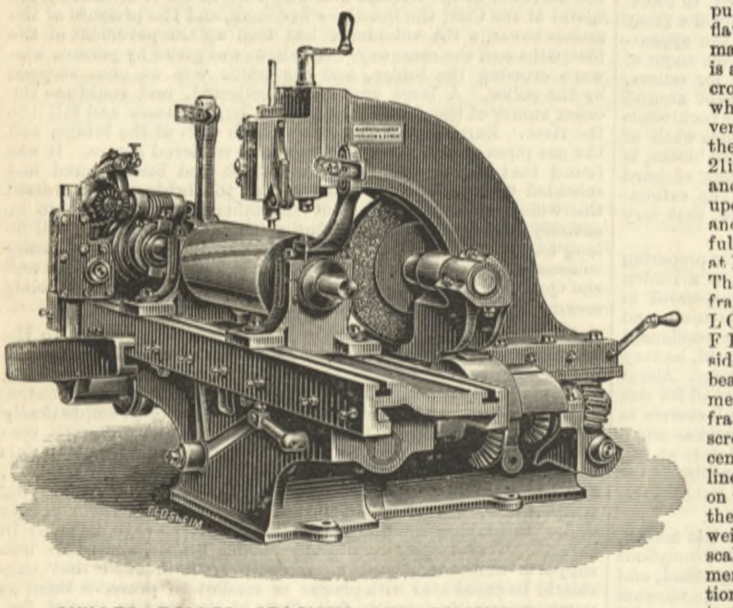
MACHINES FOR GROOVING AND POLISHING CHILLED ROLLERS.

THE OERLIKON MACHINE COMPANY, ZURICH, MANUFACTURERS,



MACHINES FOR GROOVING CHILLED FLOUR MILL ROLLS.

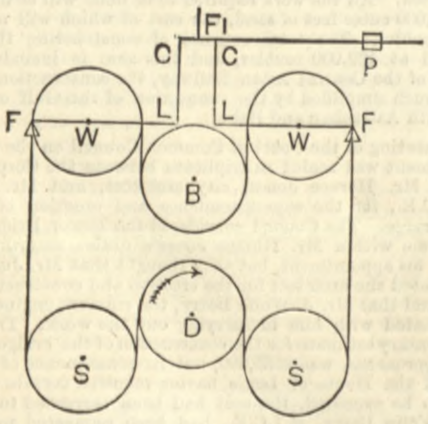
The machines for grooving and polishing the rolls of roller flour mills illustrated by the accompanying engravings are made by the Ateliers de Construction Oerlikon, Zurich. The machines are automatic, and are made for one or two rollers, as shown, and for from 250 to 2000 grooves. The engravings make the construction of both machines perfectly clear. The makers observe that although on a machine with long bed three rolls might be worked at the same time, it could not be so accurately done, as one tends to upset the other to a minute extent when working over so long a length of bed and spindle connection. Fig. 1 is intended for large rollers; a smaller machine for one roller at a time is made. The machine shown at Fig. 2 is made for works where the number of rollers to groove is never great, as, for instance, in the establishment of a milling engineer not a large maker of plant, and in large mills where fitters and turners are kept for the maintenance of the machinery.



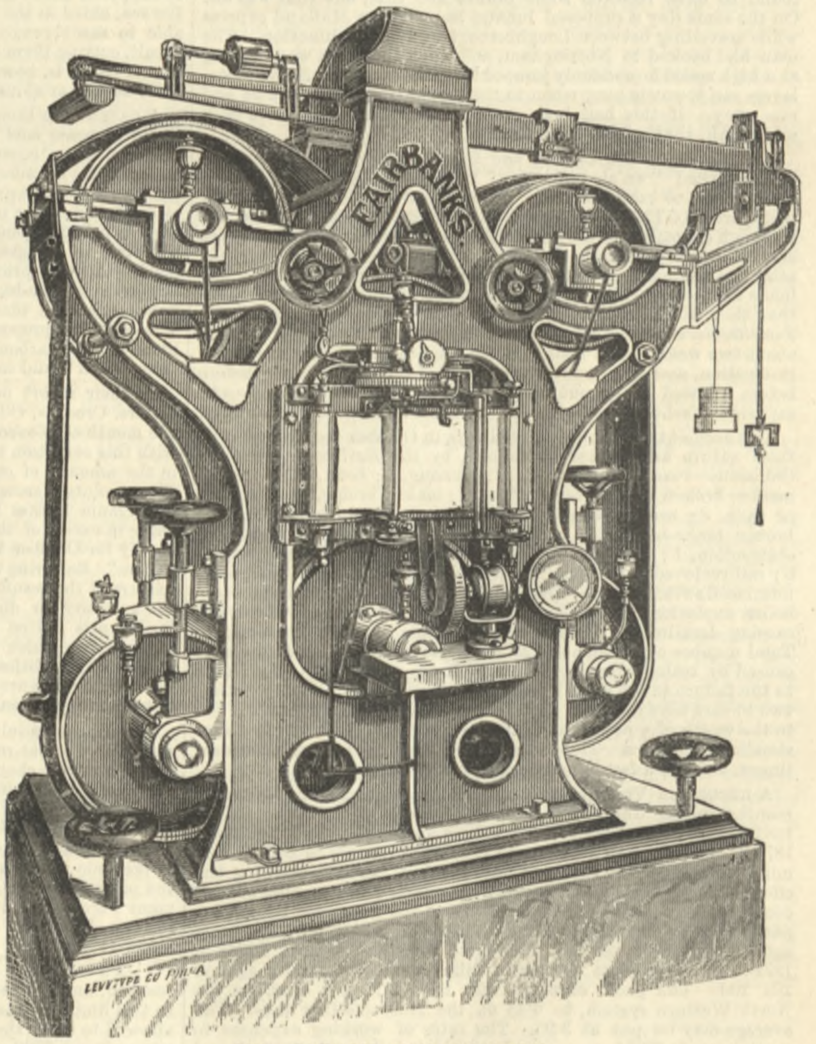
CHILLED ROLLER GROOVING AND POLISHING MACHINE.

THE TATHAM DYNAMOMETER.

The Tatham dynamometer, constructed for the Franklin Institute last year, which measured the power consumed by the dynamo-electrical machines tested by a committee of judges in June last—see report in supplement to the *Journal of the Franklin Institute* for November, 1885—is capable of measuring 100-horse power. The largest machine then measured required 70-horse power; the smallest ·23-horse power. It occupies a floor space of about 6ft. by 4ft., and is about 7½ft. high. The cast iron bed-plate rests upon heavy castors and is provided with levelling screws. Upon this bed-plate are erected the two main frames, bolted together at convenient places and united at the top by a cast iron arch, from which the scale beam is suspended. A movable A frame in two parts is hinged to the bed-plate, and when in position holds firmly the journal boxes of the outside bearings of the two middle shafts. When opened, it gives liberty to change the outside pulleys, or the belts which run upon them. This dynamometer is upon the same principle as the small machine described in the *Journal of the Franklin Institute* for December, 1882, but differs from it, in that the single pulley upon the first motion shaft of the small machine is replaced by three pulleys in the large one.



(Reference being had to the skeleton sketch herewith) the reasons for this change were:—(1) To reduce the height of the machine. (2) To give the journals of the pulley shaft D a fixed position, while the two outside lower pulleys are used to tighten the belt. (3) To make the two pulleys B and D run in the same direction and with the same speed. All of the pulleys are cast iron plate pulleys, turned all over inside and out and accurately balanced. They are 12½in. face and are upon cast steel shafts, 2in. diameter, running in brass boxes, which are from 6in. to 8in. in length. The pulley D is 25in. diameter, crowned and placed upon the first motion shaft, which receives power from an outside belt. The pulley B, 25in. in diameter, ground perfectly true and flat, is upon a shaft which conveys the power to the machine to be tested. In measuring a motor, its power is applied to the pulley B. The two pulleys S and S are crowned, 21in. diameter, and their shafts run in bearings which are upon vertical slides regulated by screws. The vertical movement of these pulleys regulates the tension of the belt. The pulleys W and W are 21in. diameter, slightly crowned, and their shafts run in bearings upon the two lever frames L F and L F, each of which has its fulcrum in a pair of knife edges at F, resting upon the main frame. The inside ends of the lever frames are suspended by links L C and L C to the scale beam F P at equal distances on either side of the principal centre of the beam. There are two adjustments to each of these lever frames. (1) Two micrometer screws adjust the position of the centre of the pulley, so that the line of effect of a belt hung on it on the outside will pass through the fulcrum, and no addition of weight to the belt will affect the scale beam; which is experimentally proved. (2) The position of the knife-edge suspended to the link is adjusted, so that the scale beam weighs accurately any weight suspended by a piece of belt hung over the inside of the pulley. The endless belt used was a four-ply gum belt, 12in. wide and ·26in. thick. The breaking strain was 12,000 lb. It was originally intended to use a three-ply belt, ·21in. thick, and the pulley B was constructed so that the effective diameter would be 25·21in., giving a delivery of belt of 6·6ft. per revolution. The arrows indicate the movement of the belt. It will be seen by the construction that the pulley B is actuated by the difference of the tensions of the two parts of the belt tangent to it, and that the scale beam weighs the same difference of tensions of the same parts tangent to the pulleys W and W. As the accuracy of weighing was the vital requisite, the construction of the dynamometer was entrusted to the celebrated scale-makers, Messrs. Fairbanks and Co. The scale beam was graduated by Messrs. Brown and Sharpe in 600 divisions of $\frac{1}{15}$in., each representing a half-pound with the travelling poise used. On this poise is a small beam graduated in hundredths, so that the small poise upon the small beam is capable of weighing $\frac{1}{500}$ of a pound when the machine is in motion. The more rapid the motion the more delicately can the weighing be accomplished. In testing dynamo-electrical machines, the resistance measured being very uniform, it was only necessary that the belts used should be of even thickness and free from lumpy splicings, to get rid altogether of the tendency to dance, which otherwise afflicts the beams of belt dynamometers. The fastest speed made by the dynamometer in June last was 1700 revolutions per minute, which gave the belt a speed of two and one-eighth miles per minute, or about one-eighth the velocity of a rifle ball. The fastest speed of any test was about 1400 revolutions—9240ft. of belt—per minute, continued for ten consecutive hours, during which the belt ran over 1000 miles. The centrifugal force tending to break the belt at this speed is about 1350 lb. on each part, but this force does not come on the journals or pulleys; it is confined to the belt itself, and stretches it until it becomes slack. The slack is taken up by screwing down the pulley S or S, and when the machine slows or stops the belt is tight. In getting the "friction" of the pulley B after a test, the machine was run light at the same speed that it had run loaded during the test, thus comprehending in similar measure all sources of resistance, whether from friction proper, bending and straightening the belt, or air currents. The force required to bend and straighten the belt was sensibly affected by the temperature of the air. Before the dynamo test began it was observed that the air currents, caused by the rapid movement of the belt, interfered with the functions of the scale beam, and it was found necessary to place sheet iron roofs over the upper pulleys. The lubrication is accomplished by an automatic feed under control. The machine is provided with a counter, which registers the number of revolutions up to 1,000,000. The number of revolutions per minute can be observed to within a fraction of one revolution. It is also provided with apparatus to record the power measured. This, however, was not used during the tests, as direct weighing was found so convenient, and the results could be so quickly calculated. At the end of the scale beam is a vertical rod attached below to an iron cylinder, which floats in mercury in an iron cylindrical pipe. The beam being balanced, any force tending to raise it lifts the cylinder out of the mercury proportionally. This motion, multiplied by levers, is communicated to a pencil point, which moves vertically one-eighth of an inch to the pound, and records the weight upon a paper band moving horizontally 1in. for every 100 revolutions, and recording them. This automatic registration of weight is applied only to the fractions of weight between the even 50 lb., the principal part of the weight being hung at the end of the scale beam in the usual way. By confining the registration to this small excess, it is registered on the large scale above mentioned. The calculation of horse-power measured is very simple. Multiply the number of revolutions by the weight—in one-half pounds—on the scale and divide by 10,000. The result is horse-power and decimals. This, however, supposes a belt twenty-one hundredths of an inch thick. A thicker belt requires a correction in accurate work.



THE TATHAM DYNAMOMETER.

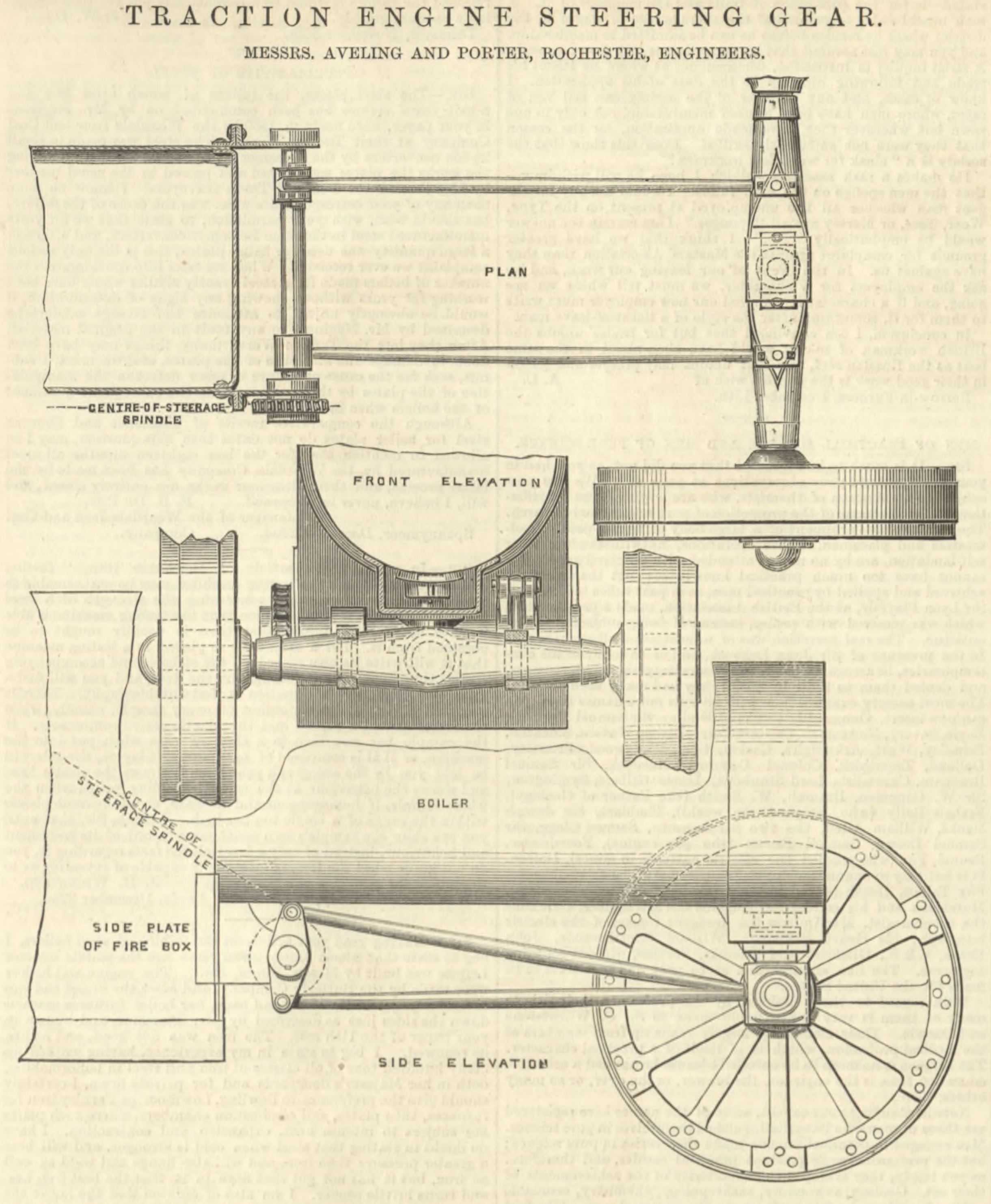
Not the least interesting portion of the report of the committee referred to, is that relating to the "Calibration of the Dynamometer." In order to prove whether or not the dynamometer measured correctly the power transmitted through it, it was used in the determination of the mechanical equivalent of heat on an enormous scale. The water churn used was a cylinder 3ft. diameter and 3ft. long, holding 1223 lb. of water. In the continuous method, devised by Professor Marks, the water entered the churn at nearly uniform temperature and left it at nearly uniform temperature, about 15·5 deg. Cent. higher than it entered. The operation continued for three hours. The first half-hour was occupied in bringing the exit water to uniform temperature, when the experiment proper began and continued for two hours and a-half, during which over five tons of water passed through the churn and was raised about 15·5 deg. Cent. by the continued exertion of about 46-horse power. The result as calculated was:—

Mechanical equivalent for 1 deg. Cent.	..	1391·05 foot-pounds.
Mechanical equivalent for 1 deg. Fah.	..	772·81 foot-pounds.

Dr. Joule's last determination was 772·55 foot-pounds, and Professor Rowland's is higher.

TRACTION ENGINE STEERING GEAR.

MESSRS. AVELING AND PORTER, ROCHESTER, ENGINEERS.

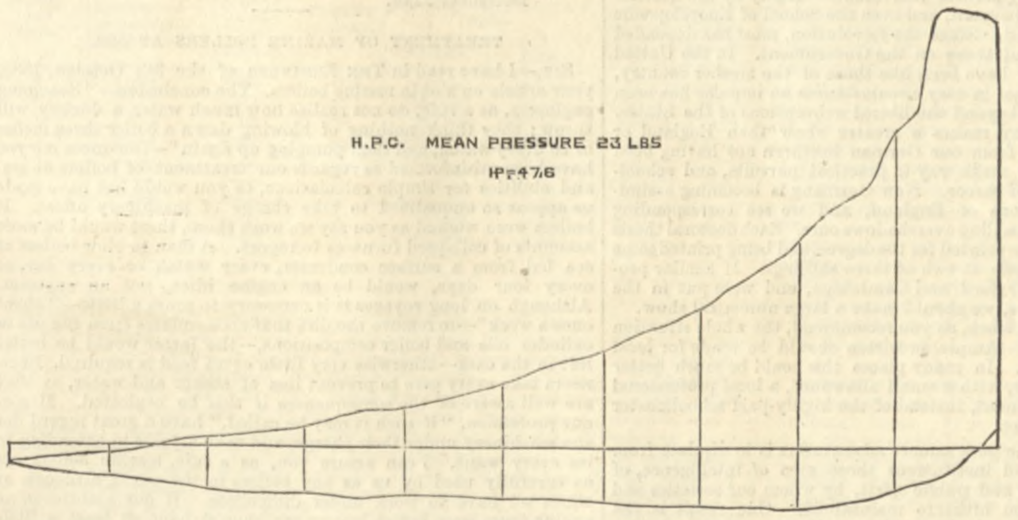


AVELING AND PORTER'S STEERING GEAR.

The accompanying engraving illustrates Messrs. Aveling and Porter's steering gear for traction engines to which reference was made in our account of the Smithfield Club Show. Instead of the ordinary chains which give trouble by stretching, and which are difficult to keep evenly adjusted, Messrs. Aveling and Porter employ two connecting rods; one end of each of these is attached to a lever keyed to the steering shaft, and the other end to the front axle by means of a swivel joint. At all times, when steering, the fore carriage is acted upon on both sides—and not on one only as by the chain system—thus framing the fore carriage to the back steering shaft or axle and avoiding the dragging action of steering by chains. The fore carriage is of wrought iron plates flanged tubular at the ends to cover the axle arms, and left flat in the centre for carrying the thorough pin. In the centre of the carriage is a cast metal block with a slot for the pin, which allows an oscillating motion for adapting the fore carriage to the contour of the road. Between the boiler shell and the top of the thorough pin is a block of india-rubber which acts as a spring. This seems to be a very efficient and satisfactory arrangement.

A PROBLEM IN INDICATOR DIAGRAMS.

WE give here a curious pair of diagrams taken from a compound engine by an eminent maker. To explain what they mean will be a nice problem for our younger readers, and, indeed, for many experienced in taking diagrams. We await solutions; we will give the explanation in a subsequent impression. Meanwhile, we ask such of our readers as feel disposed to attack the problem the following questions:—(1) Are the valves of this engine set wrong? (2) What alterations should be made, if any, to get a different result? (3) Is the engine condensing or not? (4) Are the excentrics or their equivalent wrongly set or not? If so, what alteration should be made? We shall publish the answers we receive, unless the writers express a wish to the contrary. We may add that these are the most remarkable diagrams we have ever seen. They are eminently instructive, and would almost deceive the very elect. We shall answer no questions about them and give no explanations. Our readers must puzzle them out for themselves; at the proper time we shall explain them.



PRACTICAL ENGINEERING.—On Saturday the certificates gained by the students of the Crystal Palace Company's School of Practical Engineering during the winter term were distributed by Sir Frederick Abel, C.B., F.R.S. The report presented by Messrs. S. C. Homersham, M. Inst. C.E., and G. G. André, A.M. Inst. C.E., was highly satisfactory.

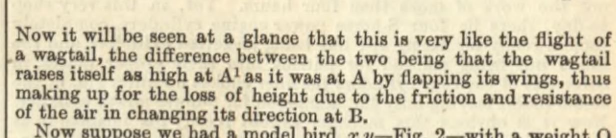
LETTERS TO THE EDITOR.

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

THE PROBLEM OF FLIGHT.

SIR,—It seems to me more probable that soaring is based on the same principles as every other kind of flight, than that Mr. Lancaster's supposition is correct, viz., that the friction of the air can be overcome without any expenditure of work—for this is evidently what his theory amounts to. I therefore venture to suggest the following solution of the problem of soaring flight:—When a model bird is let fall from a height it descends in a wavy line something like Fig. 1, falling from A to B and rising from B to A[1], and so on.

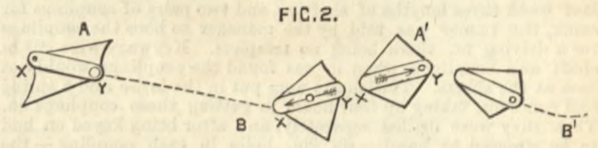
FIG. 1.



Now it will be seen at a glance that this is very like the flight of a wagtail, the difference between the two being that the wagtail raises itself as high at A[1] as it was at A by flapping its wings, thus making up for the loss of height due to the friction and resistance of the air in changing its direction at B.

Now suppose we had a model bird $x\,y$—Fig. 2—with a weight O inside it movable from x to y. Let this fall as before from A, O being at the front end y, it will fall with increasing velocity till it

FIG. 2.



begins to rise at B. Now if while it is rising O be moved back to x, a fresh impetus will be given to the rest of the bird, due to the retarding of O, and the bird $x\,y$ will rise higher at A[1] than it was at A—if $x\,y$ is large compared to the height of the wave—although the centre of gravity of the whole will have fallen. O must now be suddenly raised to y, any backward movement of the bird being prevented by the increased pressure of the air on its wings. The whole will thus be brought to a similar position to what it was at A; work will have been done and flight maintained.

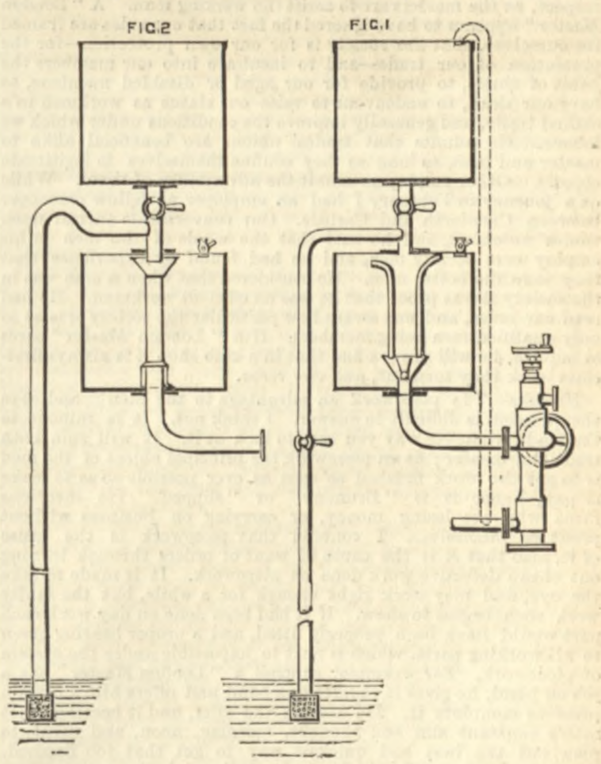
In order that this theory may apply to soaring birds, it is only necessary to make the supposition that they move their centre of gravity without altering the shape of their feathers, perhaps in the act of breathing. In their case the movement would be very rapidly performed, and would only appear as an oscillating or vibratory motion; and I think Mr. Lancaster said that he observed this. It may also be seen when a swift sails straight away from the eye. I have taken soaring flight to be only a steady flight against the wind.

H. C. WYNNE EDWARDS.

Chiswick-street, Carlisle, November 21st.

LIFTING INJECTORS.

SIR,—Enclosed is a copy of the patent specification of my injector auxiliary, for the purpose of increasing the efficiency of boiler injectors, which will doubtless prove interesting to the readers of THE ENGINEER, it being, I believe, the first of the kind introduced. I have had one of my auxiliaries at work for about eleven months, attached to a Gresham's small size injector—No. 3 mm—which had proved inadequate for the lift, viz., about 10ft., but working with the auxiliary applied, has given every satisfaction. I have also one at work at Falmouth, at Messrs. Cox and Co., engineers, it having been fixed there attached to a Bailey's injector, for inspection by the judges of the Royal Cornwall Polytechnic Exhibition held in that town in September last, and was awarded second silver medal. The auxiliary enables an ordinary low-lift injector—small size included—to lift water from a depth of 25ft.; it also renders the injector certain in its action, from the fact that the water in chamber B is above the injector; it also enables the injector to lift water of a temperature of 155 deg. to or about 30 deg. above the usual lifting temperature.



The following is a list of the advantages gained by the use of the auxiliary:—(1) It insures the prompt and easy starting of the injector. (2) The injector is instantly cooled should it happen to blow. (3) It enables the injector to lift from a greatly increased depth of 25ft. (4) It will lift water of a much higher temperature. (5) It imparts a high-lifting power to a small injector, by the use of which slow and continuous feeding is obtained; an advantage when the water is forced through a feed heater. (6) It may also be used as a feeder of anti-incrustation composition. It may be applied to any injector.

S. R. HAWKE.

Ventonleague, Hayle, Cornwall.
November 18th.

TRADES UNIONS AND PIECEWORK.

SIR,—After carefully reading your article of November 27th, on depression in trade, I shall be glad if you will allow me to bear testimony particularly to the latter part. Some eighteen months ago a firm which had been struggling some time in the construction of railway wagons formed itself into an engineering company, limited, with a very able engineer as manager. A fitter was called in to overhaul the shop engines, which had been running some years, and were a pair of 25-horse power fixed, built by an eminent engineering firm in Manchester. Coming to the completion of his job, and about to set the slide valves, he found with a port of 1⅝in. the valve only admitted steam ⅜in. Calling the manager's attention to this, he at once ordered ¼in. to be taken off each end of the valves, and the excentric to be shifted 4⅞in. round the shaft; previous to this alteration, complaints were made that the engines would not do their work with 60 lb. of boiler pressure. Afterwards they did what was required of them at 20 lb. of boiler pressure, and recently one of them, the left-hand engine, has been taken away, and is now being refitted up for sale. Since that time the manager has been replaced by another, who hearing of this improvement having been effected, sent for the fitter to his office, inquiring what alterations he had made to the engines under the late manager's instructions, and when told, expressed great astonishment that an eminent firm should turn out engines in such a manner. But did they? Is it certain and clear that alterations had not previously been made by some mis-manager? Now, Sir, the alteration being found necessary by the manager — who thoroughly understood his business—was quickly done, and was not the work of more than four hours. Yet, in this very shop to-day, there lie four 8-horse power engine cylinders, completely tooled, ready for fitting up; but being jacketted cylinders, and the liners not being marked for putting into their proper places, in three out of the four cylinders the liner chokes up quite ⅜in. of the steam room, leaving only ⅜in. admission for 8-horse power cylinder. Now it is obvious this manager cannot rectify his mistake in as many days as the other was done in hours, being but a small firm. The liners should be drawn out; new ones cast, turned, drilled, slotted, pulled in, and then the cylinder bored and recessed, and liner ends ended off. Some profit going here. Again, having this last week three lengths of shafting and two pairs of couplings for same, the turner was told by the manager to bore the couplings for a driving fit, there being no templets. Keyways were cut in shaft and couplings, when it was found the couplings would not look at the shafts. The shafts were put in the lathe and a spring tool run over, taking up four hours in getting these couplings on. Then they were drilled separately, and after being keyed on had to be rimered by hand — six ⅞in. holes in each coupling — the manager standing by greater part of the time, bullying and making use of obscene language.

Your correspondent, "A London Master," says: "I know scores of cases where mechanics have saved money on piecework." Yes; but has it not in too many instances been at the expense of the purchaser? In this said firm a man is compelled to take piecework. The chipping and filing the throw of a large crank for the Inventories, filing keyways for pump excentric and valve excentric, marking keyways in both excentrics, and fitting two keys in out of the black—the whole for 5s., and out of this he makes a balance of 11d. The manager sees the crank is fair to the eye. But what of the keys—the essential part of the work, but which is not seen?

In this shop, too, the wages are ground down considerably lower than the average of the district, and all overtime paid as bare time, is not this rather the fruits of piecework? Most of your readers know the old argument, What does it matter about your rate of wages or overtime so particularly to you when you are piecework?

I hope some more of your working-class subscribers, now having so little else to do, will take up their pens and ventilate this question. FITTER.

Nottingham, December 7th.

SIR,—I have read the correspondence between a "London Master" and a "Young Fitter," and as a member of the Amalgamated Society of Engineers, I should be glad if you will allow me space in your columns for a few remarks.

"London Master" finds fault with the rules of our society being prepared and revised without having employers of labour upon the committee. Might I ask if the Masters' Association invited any of the different branches of trade to appoint delegates to assist them in the formation of their association, and to help them to frame rules for their guidance? Certainly he will admit that we have working men who are equally able to assist the masters in this respect, as the masters are to assist the working man. A "London Master" appears to have ignored the fact that our rules are framed for ourselves, that the society is for our own protection—for the protection of our trade—and to inculcate into our members the habit of thrift, to provide for our aged or disabled members, to bury our dead, to endeavour to raise our status as workmen in a skilled trade, and generally improve the conditions under which we labour. He admits that trades' unions are beneficial alike to master and man, so long as they confine themselves to legitimate objects. Other employers admit the advisability of them. While on a journey in February I had an employer as fellow passenger between Carnforth and Carlisle. Our conversation turned upon trades' unionism, and he said that the whole of the men in his employ were society men, and he had found by experience that they were the better men. He considered that when a man was in the society it was proof that he was an efficient workman. He had read our rules, and was aware how particular the society was as to only qualified men being members. If a "London Master" cares to inquire, he will always find that in a club shop it is always first-class work they turn out, and *vice versa*.

He asks—"Is piecework an advantage to the men?" and says the question is difficult to answer. I think not. It is ruinous to the trade whatever way you care to look at it. It will ruin both trade and master; as on piecework the principal object of the men is to get the work finished as soon as ever possible so as to make it pay, hence it is "Brummy" or "slipped." He mentions firms who are losing money, or carrying on business without profit to themselves. I contend that piecework is the cause of it, also that it is the cause of want of orders through turning out cheap defective work done on piecework. It is made to take the eye, and may work right enough for a while, but the faulty work soon begins to show. If it had been done on day work each part would have been properly fitted, and a proper bearing given to all working parts, which is next to impossible under the system of piecework. For example, suppose a "London Master" has a job on hand, he gives it to a leading hand and offers him a certain price to complete it. He accepts the offer, and it becomes that man's constant aim and thought, morning, noon, and night, to plan out the best and quickest way to get the job finished. When he has succeeded in his task another job the same as last has to be gone on with, only that the employer informs him that he cannot afford to pay him the same price, as he finds that the men have made about double time; and so on to the end of the chapter. The men's brains are ever on the stretch endeavouring to find out new dodges so as to still enable them to make something like time and half, and the master employs his time cutting the price down, so that the men cannot afford to take the necessary time to make a good job, and the consequence then is that owing to the inferior quality of the work turned out the master cannot get a good market for his goods and has to sell at a low price. He loses his profit, the men do not get fairly paid for their labour, his goods get a bad name in the market, consumers go elsewhere with their orders, and more than likely, instead of figuring in the "Wills and Bequests" column, you will find his name in the "Bankrupt's" column—and all through piecework. A "London Master" finds that when men are dissatisfied with their balance on settling days it is based on an imperfect knowledge of arithmetic. I think he must be blessed with an exceptional lot of ignorant men in his employ, or he is talking of the "good old times" that our parents speak of, as during my fifteen years' experience in the trade I never came across any squad of men but that some, if not all of them, were equal to the task of reckoning up their pay.

With regard to the society being a cloak for worthless workmen, that on the face of it is absurd, as the society—as I have already stated—is for the protection of trade and the members of it. A man must be able to command the average rate of wages in the district where he resides before he can be admitted to membership, and you may rest assured that his assertion is not proof enough. A strict inquiry is instituted, commencing at where he learnt his trade and following him up to the date of his application. I know of cases, and any member of the society can tell you of cases, where men have been refused membership, not only in one town but wherever they have made application, for the reason that they were not sufficiently skilled. Does this show that the society is a "cloak for worthless workmen?"

He makes a rash assertion—which I hope he will withdraw—that the men sponge on the club funds. I would ask any intelligent man whether all the unemployed at present on the Tyne, Wear, Tees, or Mersey are all "sponges." I am certain the answer would be emphatically "No." I think that we have greater grounds for complaint against the Masters' Association than they have against us. In the event of our leaving our work, and we ask the employers for a character, we must tell where we are going, and if a character is required our new employer must write to them for it, something after the style of a ticket-of-leave man.

In conclusion, I am convinced that but for trades' unions the British workman of to-day would have been about in the same boat as the Russian serf, and that unions may prosper and go on in their good work is the earnest wish of A. C.

Barrow-in-Furness, December 15th.

MEN OF PRACTICAL SCIENCE AND MEN OF PURE SCIENCE.

SIR,—It is much to be regretted that you did not, as you had in your mind, extend your observations at page 439. We are now subject to an invasion of theorists, who are levying large contributions under the name of the promotion of pure science and research. The result is the enrolment of a large body of highly-paid schoolmasters and placemen, whose operations, notwithstanding their self-laudation, are by no means attended with unmixed good. We cannot have too much practical knowledge; but that must be achieved and applied by practical men, as in past times in England. Sir Lyon Playfair, at the British Association, made a proclamation which was received with praise, instead of being subjected to due criticism. The real assertion was of a most astounding character. In the presence of Sir John Lubbock, and of so many of his contemporaries, he arrogated to the professors imaginary achievements, and denied them to those by whom they had really been effected. The most cursory examination will give us more names than you can now insert. One readily thinks of Dudley, Sir Samuel Morland, Boyle, Savery, Newcomen, Captain Perry, Bishop Watson, Smeaton, Brindley, Watt, Arkwright, Caslon, Cort, Wedgwood, Priestley, Dollond, Trevithick, Colonel Beaufoy, Murdock, Sir Samuel Bentham, Cavendish, Lord Stanhope, Davie Gilbert, Symington, Sir W. Congreve, Bramah, W. Smith (the Father of Geology), Francis Baily (who weighed the world), Huddart, Sir Joseph Banks, William Allen, the two Stephensons, Samuel Clegg, Sir Samuel Brown, Samuel Brown (the gas engine), Fourdrinier, Brunel, Fox (who studied the electric currents in mines), Dalton. It is not easy to enumerate our contemporaries: The two Lubbocks, Fox Talbot, Heath (silver steel), Crane and Neilson (hot blast), Murchison and his colleagues, Huggins the astronomer, Cummins the conchologist, MacAndrew the dredger; Cooke, of the electric telegraph; Sir Henry Bessemer, William Spottiswoode, John Evans, F.R.S., Gilchrist and Thomas, Perkins, without counting engineers. The like enumeration as to past and present is to be made for the United States.

With regard to those claimed by the professors, their title to many of them is very questionable—even to Sir C. Wheatstone and Darwin. Their claims are largely made up from members of the medical profession, which is in itself of a practical character. The surgeon is no more to be enrolled because he has had a scientific education than is the engineer, the brewer, or the dyer, or so many others.

Notwithstanding your caveat, some of the names here registered are those of men who have distinguished themselves in pure science. Men engaged in practical science make discoveries in pure science; but the professors rarely produce practical results, and therefore, as you imply, they trumpet the superiority of the achievements of their art. Geology, astronomy, anthropology, chemistry, economic science have been largely built up by the practical men. The fact is this: science pure and practical has for three centuries been cultivated in England by nonprofessorial men, either by those engaged in business, or by those having wealth and leisure. It is on this depends the essential differences between England and the Continent. This private enterprise it is which gives the energy to English exertions. On the Continent all is dependent on the Governments, and when these Governments are poor and embarrassed by war, the cause of science suffers. Before the French Revolution, it was by private individuals—largely by the *noblesse*—that science was cultivated, and even the School of Encyclopædic Philosophy maintained. Since the Revolution, most has depended on the Professors, and these on the Government. In the United States the conditions have been like those of the mother country, and now there is a class in easy circumstances an impulse has been given to progress far beyond the liberal subventions of the States. Undoubtedly Germany makes a greater show than England or France. This arises from our German brethren not having been able, until lately, to make way in practical pursuits, and schoolmastership was a chief career. Now Germany is becoming assimilated to the conditions of England, and we see corresponding effects. German bookselling overshadows ours. Each doctoral thesis or essay is obliged to be printed for the degree, and being printed some copies are put for sale at two or three shillings. If similar productions came from Oxford and Cambridge, and were put in the booksellers' catalogues, we should make a large numerical show.

The time has come when, as you recommend, the whole situation should be examined. Ample provision should be made for local instruction in science. In many places this could be much better effected by employing, with a small allowance, a local professional man, as on the Continent, instead of the highly-paid schoolmaster from South Kensington.

The tendency of the pure science adventurers is to displace from scientific societies and institutions those men of intelligence, of business, of liberality and public spirit, by whom our societies and institutions have been hitherto maintained. One result is the constitution of a body of office-seekers, whose main object is personal emolument and display. H. C.

London, December 15th.

VACUUM BRAKES.

SIR,—I suppose most of your readers are acquainted with the fact that a new brake valve has lately been designed by Gresham and Craven for use with the vacuum brake, as now fitted to the Midland and other companies. The old form, which was very complicated and always in the way, has been replaced by a valve corresponding to the disc regulator, which is used to destroy the vacuum and thus to apply the brakes. Should, however, the driver fail to put the small ejector on or forget to do so, a piston working in a cylinder and communicating with the steam brake applies it should the vacuum fall to a certain degree. There is also a notice on these engines stating that the small ejector is always to be kept on. I have considered that there would be less danger of losing steam if this piston was, by a suitable arrangement, connected to the small ejector, as well as the steam brake. It would then prevent the possibility of the ejector being shut off, while it would not need to be full on if there was a complete vacuum. When the driver applies the brakes—and we will suppose he wishes to create a vacuum as quickly as possible—this arrangement would bring about the desired effect as quickly as would be possible. Of course the small ejector would be self-acting except when the driver required to stop the train, when he would take it off by a suitable handle. The moment that he released the handle it would be automatically put on, thus obtaining a vacuum quickly. J. W. DEAR.

Leicester, November 30th.

PECULIARITIES OF STEEL.

SIR,—The steel plates, the failure of which after two and a-half years' service has been commented on by Mr. Maginnis in your paper, were made in 1880 by the Weardale Iron and Coal Company at their Tudhoe Works. The steel was made in small 2½-ton converters by the Bessemer acid process, and before leaving the works the plates were tested and passed in the usual manner by Lloyd's and the Board of Trade surveyors. I know no more than any of your correspondents what was the cause of the failure, but should wish, with your permission, to state that we for years manufactured steel in the same Bessemer converters, and although a large quantity was used for boiler plates, this is the only serious complaint we ever received. When we take into consideration the number of boilers made from steel exactly similar which have been working for years without showing any signs of deterioration, it would be obviously unjust to attribute the strange misfortune described by Mr. Maginnis to any fault in the original material. After they left the Tudhoe Works many things may have been done to damage the structure of the plates, and we must, I submit, seek for the cause of failure in some defect in the manipulation of the plates by the engineer, or in the subsequent treatment of the boilers when in the vessel.

Although the comparative merits of Bessemer and Siemens steel for boiler plates do not enter into this question, may I be allowed to mention that for the last eighteen months all steel manufactured by the Weardale Company has been made by the latter process, and their Bessemer works are entirely closed, and will, I believe, never be re-opened. F. B. DU PRE, Manager of the Weardale Iron and Coal Company.

Spennymoor, December 22nd.

SIR,—In your leading article of December 18th, "Testing Steel," you say "that the testing machine may be quite unable to give us adequate information concerning the strength of a steel boiler." Now, Sir, it is my opinion that the testing machine is able to give much more information than is usually sought to be obtained from it. Let a sample be so placed in a testing machine that it will write its own record of the stresses and accompanying strains that come upon it throughout the test, and you will find a surprising amount of information in that autobiography. There is a critical period in the extension of every sample, namely, when the elastic period is passed and the plastic period commences. If the sample has not been in a state of ease when put into the machine, or if it is composed of hard and soft layers, the tale will be told you by the autograph pencil as it draws the elastic line, and shows the behaviour at the critical yielding point, when the whole sample, if homogeneous and at ease, should become plastic within the range of a single ton per inch. I think, Sir, that until you can show the sample's own continuous record of its treatment and behaviour, instead of only a few isolated facts regarding it, you do not know what the testing machine is capable of revealing as to the molecular condition of a plate strip. J. H. WICKSTEED.

Well House Foundry, Meadow-lane, Leeds, December 22nd.

SIR,—Having read your article on the failure of steel boilers, I beg to state that about thirty-seven years ago the paddle steamer Leipzic was built by Messrs. Pimm, Hull. The engine and boilers were made by the Butterly Company, and after the vessel had run several voyages to Hamburg and back, her boiler furnaces cracked down the sides just as described by Mr. Maginnis, and shown in your paper of the 11th inst. The iron was not good, and had to be renewed. I beg to state in my experience, having worked up many hundred tons of all classes of iron and steel in boilermaking, both in her Majesty's dockyards and for private firms, I certainly should give the preference to Bowling, Lowmoor, or Farnley iron for furnaces, tube plates, and combustion chambers, where such plates are subject to intense heat, expansion, and contraction. I have no doubt in stating that steel when cold is stronger, and will bear a greater pressure than iron, and will also flange and weld as well as iron, but it has not got that fibre in it that the best iron has, and turns brittle sooner. I am also of opinion that the larger the plates are made the worse they are; they cool quicker at the edges than in the centre, thereby causing great strain on the plate when put into the boiler. I am also of an opinion that if the expansion and contraction ring is made the whole length of the furnace, as my patent shows, it will be easier for the plates to be made in the shape required. They will be stronger than parallel furnaces, and not so liable to crack. My reason for writing this is knowing you are always wishful for opinions on such subjects.

13, Margaret-street, Hull, December 22nd. JOHN HARRISON.

TREATMENT OF MARINE BOILERS AT SEA.

SIR,—I have read in THE ENGINEER of the 9th October, 1885, your article on zinc in marine boilers. The conclusion—"Sea-going engineers, as a rule, do not realise how much water a donkey will throw; they think nothing of blowing down a boiler three inches or so every watch, and then pumping up again"—convinces me you have been misinformed as regards our treatment of boilers at sea, and abilities for simple calculations, or you would not have made us appear so unqualified to take charge of machinery afloat. If boilers were worked as you say we work them, there would be more accounts of collapsed furnaces to report. A man to blow boilers at sea fed from a surface condenser, every watch or every day, or every four days, would be an engine idiot, not an engineer. Although on long voyages it is necessary to scum a little—"about once a week"—to remove the dirt that accumulates from the use of cylinder oils and boiler compositions,—the latter would be better left in the cask—otherwise very little extra feed is required. Engineers take every care to prevent loss of steam and water, as they are well aware of the consequences if this be neglected. Men of our profession, "if such it may be called," have a great regard for the machinery under their charge, and take a pride in attending to its every want. I can assure you, as a rule, marine boilers are as carefully used by us as any boilers in the world, although at times we have to work under difficulties. If our abilities in an engine-room were better known we should have at least a little respect shown us and be credited with common sense.

By allowing this a place in your valuable paper, it may induce other sea-going engineers to speak out in their own defence, and give their experience with boilers, which would be interesting to a number of your readers. I enclose scale taken off our furnaces, after twenty-two days' steam, that will show there is not the amount of blowing at random some one would have you believe.

Hull, December 22nd. ALFRED RUTTER.

THE ROYAL ENGINEERS.

SIR,—A great reason which you do not take into account in writing on this matter is the abolition of purchase in the cavalry and infantry. In former days the only way for young men who were either unable or unwilling to buy their promotion, to enter the army, was to join the Royal Engineers or Royal Artillery, the regiments of the late Honourable East India Company, and the Royal Marines. This last corps is, by the way, suffering from a dearth of candidates for the like reason of purchase abolition. It is true, as your correspondent "A Non-commissioned Officer, R.E." states, that the present quickness of promotion in the line may induce many to enter it, but I do not think that young men take the relative number of admissions into the staff college into consideration when determining which branch of her Majesty's service they will enter. It will be found, I expect, that our would-be soldiers take the least troublesome road to glory, declining to pass difficult examinations when they think they can attain to it by easier paths.

As to Royal Engineers not getting their share of minor staff appointments, it seems to me the country would gain little by giving them a special training, and then setting them other work to perform. Of late the corps has no reason to complain of command in the field not being given to its officers; the nation no reason to deplore the result; and no doubt it will continue to entrust its troops to their command, while considering them too valuable to be employed, nevertheless, on ordinary staff duties.

December 21st. NON-PROFESSIONAL.

SIR,—In view of the probable increase of Royal Engineer officers, would it not be well that in the competitive examination some credit should be given to the theory and practice of engineering? By introducing some technical subjects it would be made worth the while of young civil engineers, who have passed through a course of theoretical training, to compete, and would ensure that the candidates had some taste and interest in the profession, since they had made it their business of life. By attracting civil engineers, a number of men would be got, who with six months' training in fortification, military reconnaissance, &c., law, history, signalling, and exercises, and artillery, &c., would be efficient officers and at the immediate command of the authorities. The present system of giving commissions on a schoolboy's examination, and limit of age twenty-two years, is on the face of it absurd.

December 23rd. AN OLD ENGINEER.

DR. LODGE'S MECHANICS.

SIR,—Dr. Lodge's definition of motion very much resembles answering the question, "Is the man dead?" by simply stating, "He is dead." Would not the following be much better: "Motion is the act of moving or being moved from one place to another?" Can mass be expressed in terms of anything else but the weight? I did not state that inertia varied as the weighing machine.

What am I to substitute for the word *double?* "Φ. Π." ought to state plainly what the context implies. Inertia cannot vary directly as the mass and inversely as the momentum, which it must do if inertia is the reciprocal of momentum.

Westminster, December 21st. WILLIAM DONALDSON.

THE JAPANESE VILLAGE.

SIR,—In your account of the reopening of the Japanese Village, Knightsbridge, you mention that the village has been built under the direction of Mr. Tannaker Buhicroson. I beg to state that the Japanese Village houses, temple, and stage in the theatre were built from my plans, and with the assistance of a foreman carpenter under my own personal supervision, as well as the villages in Berlin and Munich. For the Exhibition lately reopened I certainly had a tracing of the positions of the houses and streets, but nothing else. With your love of fair play, I trust that you will insert this in your next issue, and do justice to GEORGE WELDON.

28, Renfrew-road, Lower Kennington-lane, London, S.E.
December 22nd.

THE INFLUENCE OF SILICON ON THE PROPERTIES OF CAST IRON.

By THOMAS TURNER, Assoc. R.S.M.*

THE paper is a continuation of one recently published—Chem. Soc. "Trans.," 1885, 577.

An account is given of experiments on the relative density, hardness, working qualities, and crushing strength of the metal, and the reason of the variations noticed is discussed. The relative density was determined both in mass and in small fragments. In the first case cylinders 3in. by 1in. were employed, and the turnings from the cylinders were used for a second determination. In iron possessing great tenacity the density was slightly increased, but with less tenacity the density was decreased by the force exerted in turning the metal. The hardness was measured by the weight in grammes necessary to produce a scratch with a cutting diamond. The influence of silicon is shown to be quite regular, the greatest softness being produced by from 2 to 3 per cent. The working qualities are taken from the observation of a skilled workman, and agree very closely with the hardness as before determined. The crushing strength tests were performed by Professor Kennedy on cylinders 3in. by 0·75in., and sketches are given of the fractured specimens. The influence is tolerably regular and of the kind previously observed, the maximum value being reached with 1 per cent. of silicon. In the following table a summary is given of the chief results:—

Silicon per cent.	Relative density* of cylinders, 3in. by 1in.	Relative density* of turnings from cylinders.	Relative hardness.	Crushing strength. Breaking load per square inch.	
				Pounds.	Tons.
0	7·560	7·719	72	168,700	75·30
0·5	7·510	7·670	52	204,800	91·42
1	7·641	7·630	42	207,300	92·54
2	7·518	7·350	22	{ 135,600 139,000	60·53 62·05
2·5	7·422	7·388	22	172,900	77·18
3	7·258	7·279	22	128,700	57·45
4	7·183	7·218	27	106,900	47·74
5	7·167	7·170	32	103,400	46·16
7·5	7·128	7·138	42	111,000	49·55
10	6·978	6·924	57	76,380	34·10

* Water at 20 deg. C. = 1.

The author draws the following conclusions from these results:—(1) That a suitable small addition of silicon to cast iron almost entirely free from silicon is capable of producing a considerable improvement in the mechanical properties of the metal. (2) That in these experiments the maximum values are probably reached with the following amount of silicon:—Crushing strength, about 0·80 per cent.; modulus of elasticity, about 1·00 per cent.; relative density, in mass, about 1·00 per cent.; tensile strength, about 1·80 per cent.; softness and working qualities, about 2·50 per cent. (3) That when general strength is required the amount of silicon should not vary much from about 1·4 per cent.; but that when special softness and fluidity are desirable, about 2·5 per cent. may be added. Even in the latter case, however, any increase upon 3 per cent. must be dangerous. These conclusions are only strictly true under the circumstances of the author's experiments, but he hopes shortly to bring forward evidence from independent investigations to support his results.

The cause of these results is discussed. The author is decidedly of the opinion that the production of graphitic carbon is not the only cause of these differences, but that, in addition to the indirect effect owing to the production of grey iron, the suitable addition of silicon has a direct and beneficial influence upon the mechanical properties of the metal.

ENGLISH MANUFACTURES IN GERMANY.—An interesting report, dealing with the importation of Birmingham manufactures into Germany, has been drawn up by Mr. Strachey, her Majesty's Chargé d'Affaires at Dresden. Mr. Strachey attaches but little importance to the high tariff as having a repelling effect upon the Birmingham trade. The real cause of the decline in our exports is, he says, the great advance which German manufacturers have of late years been making in supplying their own market at prices which defy foreign competition. Many of the German goods are, however, of inferior quality to the English.

* Read before the Chemical Society, November 5th.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, December 12th.

THE latest news from Western iron centres shows that there is a marked improvement in demand for barbed wire, crude iron, merchant steel, and plate iron, as well as old rails. Rails are very scarce, and in Western markets command 21 dols. Old wheels have advanced to 15.50 dols. The scarcity of pig lead is imparting a somewhat speculative movement. There are a good many parties offering lead to take advantage of the present higher price. The Calumet Iron and Steel Company is preparing to put its furnaces into blast. The Ohio Valley iron markets have been quite strong during the past week or two, and hardware is moving freely. Some parties report the iron makers extraordinarily busy, and a general advance in crude and finished products ranging from 50c. to 1.50 dols. per ton. Some of these reports must be taken with a little allowance, although it is correct to say that iron makers throughout the Ohio Valley and Lake markets are better than they have been, because of the movements among consumers of material to increase their orders for winter and spring consumption. The Chicago market has been rather quiet in some respects, although heavy hardware specialities are moving very well. Iron nails are quoted at 3 dols.; steel nails 3.10 dols. Philadelphia and New York quotations are 2.50 dols. to 2.60 dols. Foreign material is rather quiet in tide-water markets. Bessemer sales this week are 20.50 dols. Several thousand tons of German spiegeleisen have been sold at 26.50 dols.; English spiegeleisen is wanted at 27.50 dols. Siemens-Martin blooms are at 40 dols.

The attempt to advance merchant steel will probably succeed, although the card rates will not be changed. A good deal of merchant steel has been selling below the market price. Steel rails are less active, but the combination has reached a point where it may meet with a set back for a while. A number of large buyers have stubbornly refused to admit that the upward tendency is genuine; but they have not been able, nor are they now able, to obtain supplies for spring or summer delivery at anything less than 34 dols. No definite arrangement has been made to increase production, although it is substantially determined.

The manufacturers of machinery, heavy and light, have had a good many orders since December 1st, and at this writing there are large negotiations progressing for saw mill, rolling mill, and textile mill machinery, as well as for wood-working machinery, to be put in place during the winter months.

The railroad situation has assumed quite interesting proportions. Mr. Garrett's new line will be pushed through, regardless of what other people will say. It will effect an entrance to New York of the Bound Brook line, if no other way is practicable. Another receivership for the Reading is probable. The Reading will turn a few more somersaults before it lands where it has been trying to get for years. The death of Vanderbilt has had no perceptible influence on stocks. Railroad earnings are not particularly encouraging; the roads which are not able to make good showings are keeping very quiet.

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

(*From our own Correspondent.*)

THIS week has not seen much fresh business in the iron and steel trades of this part of the kingdom, operators have seemed disposed to rather anticipate the holidays. But ironmasters have desired that when on Thursday the works shut down for the holidays the men should have a good "pay," and they have allowed them to make more time than the specifications in hand have of themselves warranted. Some of the works will restart on Wednesday, but at other concerns, on the other hand, the whole of next week will be an idle time.

In the face of the reduction in wages, the course of prices at the January quarterly meeting is anticipated with unusual interest.

For the present the Earl of Dudley's list stands at:—Flats, rounds, and squares, lowest quality, £8 2s. 6d.; single best, £9 10s.; double best, £11; treble best, £13. His lordship's rivet and tee iron is £10 10s. for single best; £12 for double best; and £14 for treble best. Lowest quality tee iron is £9 2s. 6d. Angles, strips, and hoops from 14 to 19 w.g. are £8 12s. 6d., £10, £11 10s., and £13 10s., according to quality. Strips and hoops ⅜in. of 20 gauge are £9 12s. 6d., £11, £12 10s., and £14 10s.; while for ⅛in. a further 20s. per ton is demanded on each quality.

Quotations for plates and sheets of the New British Iron Company are at date:—Plates, best Corngreaves, £8; Lion, £9; best Lion, £10; double best scrap Lion, £11; treble best Lion, £12; and extra treble best, £13. Best Corngreaves checkered plates for flooring and the like are £9, and Lion £10. Strip and fender plates are £7 10s. to £8 10s., according to the brand. Sheets of 20 gauge are:—Best Corngreaves, £8; Lion, £9; best Lion, £10 10s.; double best scrap Lion, £11 10s.; and best charcoal, £13. Hoops the same firm quote:—Best Corngreaves, £7; Lion, £8; best Lion, £9 10s.; best charcoal, £12; and steel hoops, £8 10s. Slit rods are:—Best Corngreaves, £6 5s.; superior, £7; Lion, £7 10s.; best Lion, £9; best charcoal, £11 10s. Steel hoops are £8. Best Corngreaves slit horseshoe bars are £6 10s.; Lion ditto, £7 10s.; and best Lion, £9.

The award of Alderman Avery upon the wages question will regulate directly or indirectly ironworkers' remuneration in the following districts:—North and South Staffordshire, Shropshire, Derbyshire, South Yorkshire, Cheshire, Lancashire, and several works in South Wales.

Prices at date are named at £6 7s. 6d. upwards for singles, £6 10s. and on for doubles, and £7 12s. 6d. for lattens. Common bars are £5 5s. up to £5 10s., and hoops £5 7s. 6d. to £5 15s. A reduction in finished iron-workers' wages of 5 per cent. means a lessening in the cost of manufacture of 1s. 3d., or rather more, per ton; or a reduction of 10 per cent., a lessening of cost of quite 2s. 6d. per ton.

In bar and angle and plate iron local makers are still suffering severely, owing to the competition of North Staffordshire, Warrington, and Middlesbrough firms. It is indicative of the great value to this district of the wrought iron tube trade as an outlet for the consumption of native iron, that it is estimated that the tube works in this district consume at least 10,000 tons of strips per week. The importance to the district, from the same standpoint, of the galvanising industry, is vastly greater.

Competition in the steel trade continues severe. Steel sheets for shovel-making have just been imported into this district from German steel works at about £7 per ton, notwithstanding that there is a carriage upon the steel of 26s. per ton. German steel plating bars for the edge tool makers can be delivered here at less than £5 7s. 6d. per ton. What do the Welsh steel masters say to this?

The pig iron trade is marked at the moment by an accumulation of stocks at the furnaces, arising out of the curtailment of deliveries. Prices are 55s. to 60s. for all-mines and 33s. to 35s. for cinder pigs. Midland pigs are 38s. to 40s. delivered into this district, and Lincolnshire 41s.

The Patent Shaft and Axletree Company, Wednesbury, has effected an important alteration at its two engineering establishments and its steel works this week. It is understood that it amicably reduced wages all round, from the managers of the different departments and the officials in the offices down to pretty much all the workmen.

Very little has been allowed to transpire as to the nature of the change, but it is said that the company has previously been paying wages 5 per cent. above those of some other similar Staffordshire works. Between two and three thousand workmen are affected.

I shall not be surprised at some other firms following the example of the Patent Shaft Company. I have known for some time past that certain important engineering concerns hereabouts other than the Wednesbury Company were contemplating a reduction, if it could be brought about without strife.

Concerning the past year, I have to report that crucial prices are still nominally without change upon the opening of the year, but in reality all-mine pigs are 2s. 6d. per ton cheaper. Common bars and gas tube strip have dropped 10s. on the year. Sheets—singles—have declined 10s., and doubles 15s., and some other descriptions also show a lower basis. In January the official price for marked bars was the same as now, £7 10s.; but then, even as now, only very few firms were able to obtain the figure. Other list firms were selling for export at £7, and even £6 10s. Unmarked bars were £6 to £6 5s., and common qualities £5 10s. to £5 15s. Common sheets—singles—sold occasionally at between £6 15s. and £7, though best firms asked £7 2s. 6d. Doubles could be bought at £7 10s., and lattens at £8 to £8 10s. Best quality sheets were firm at £11 to £13, and best sheets were nominally £15. An impetus was given to trade in February by the war in the Soudan, but it soon fell away again, and at the Birmingham quarterly meeting in April actual prices were low and disappointing. Common bars were £5 10s. to £5 12s. 6d., and galvanising doubles were reduced 5s. on the January meeting, and lattens about 21s. 6d. Boiler-plates now stood at £8 to £8 10s., and hoops at £6 5s. down to £5 12s. 6d. A little excitement was caused in June by a strike of ironworkers in America, but trade continued without any change for the better until July. Several failures occurred in that month, and as illustrating the declining prices for best galvanised iron, Messrs. Morewood and Co. reduced their prices of close annealed cold rolled galvanised flat sheets 10s. as to some gauges, and 30s. per ton as to others; 18 and 20 gauge now became £14 10s., and 26 gauge £16. At the close of August a rise in the spelter market influenced the Galvanised Iron Trade Association to advance prices 5s. per ton. Block sheet makers instantly became firmer, but the improvement did not extend to other branches, and when the October quarterly meetings arrived, things were as quiet again as ever, and the tameness has continued.

On Tuesday a joint court of Arbitrators and Commissioners, under the South Staffordshire Mines Drainage Acts, was held in Wolverhampton to hear appeals against the Arbitrators' draft award for a new mines drainage rate of 6d. per ton for the Old Hill district. The Commissioners' solicitor, however, reported that there were no appeals, and the draft award was confirmed.

At meetings of gas tube operatives in the South Staffordshire and East Worcestershire districts on Friday and Saturday, it was decided to continue on strike at the exceptional works where employers insist upon a 10 per cent. reduction in wages and an additional hour of working each day. Employers contend that these concessions are absolutely necessary if orders are to be secured.

A conference of employers and workmen in the nut and bolt trade has just been held at Birmingham. The workmen asked that the 5 per cent. which was recently taken off wages might be returned, and that a Board of Conciliation should be established which should deal with the question of wages in the future. The employers expressed regret that the condition of trade did not warrant them in granting the 5 per cent. asked for. The formation of a Board of Conciliation was approved, and the meeting was adjourned for a month, that the matter might be further considered.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—Business is now practically suspended until after the turn of the year, and there is little or nothing doing to really test prices. Nominally, there is a firm tone in the market, and a good deal of hopeful talk as to the future, but in the actual prospects of trade there is nothing to warrant anticipations of any early improvement.

There was only a moderate attendance in the Manchester iron market on Tuesday, and practically little or nothing doing to really test prices, which may be said to be nominally unchanged. For pig iron local and district makers were asking their full list rates, Lancashire brands being quoted at 39s. to 39s. 6d., and the better class Lincolnshire irons 39s. to 40s., less 2½, delivered equal to Manchester, with one or two district brands to be got at about 1s. per ton under these figures. Only one or two odd sales were, however, reported, and these were exceptional transactions to cover pressing special requirements. In outside brands some business has been done for next year on the basis of 41s. 4d. to 41s. 10d., net cash, for good named brands of Middlesbrough foundry delivered equal to Manchester, but the transactions are of no great weight, and generally it may be said that users of iron are very indifferent about buying at all largely forward, even at the present low rates.

In hematite the recent upward movement in prices has caused quite a cessation of further inquiries, and although sellers still hold out for advanced rates, 53s. 6d. to 54s., less 2½ per cent., represent the top market prices for good foundry qualities delivered into the Manchester district.

Manufactured iron makers report trade as extremely dull, and where there is any business offering for next year it is on the basis of the exceptionally low prices which have recently been taken to effect sales just to keep works going. Makers, however, are asking quite 2s. 6d. per ton above these figures for forward contracts, and for Lancashire and North Staffordshire bars delivered into the Manchester district the basis of quoted prices is £5 5s. per ton, although £5 2s. 6d. has of late been taken for prompt specification.

The general slackness of work amongst engineers is resulting in the holidays extending over a longer period than usual. Works generally were closed on Thursday until Monday or Tuesday for the Christmas, and there will be a similar stoppage of work for the New Year holidays.

The condition of the engineering branches of industry, as reflected in the monthly reports of the trades union societies, is very discouraging. The returns sent in by the Amalgamated Society of Engineers show trade to be generally bad, and the number of members in receipt of out-of-work support, which has been steadily on the increase during the whole of the past year, is now exceptionally large, upwards of 8 per cent. of the members in the Manchester and Salford districts—and this may be taken as an average throughout the country generally—being on the books at the present time in receipt of out-of-work donation. In spite, however, of these depressing returns, and the fact that from every district trade continues to be reported as bad, a vague feeling of hopefulness that the new year is going to bring forward some improvement pervades many of the branch reports, but no substantial basis can be assigned upon which these expectations of better trade are founded. This feeling is set forth with some appearance of plausibility in the last report of the Steam Engine Makers' Society, which is in a more favourable position as regards its unemployed members than other trades union organisations connected with the engineering branches of industry. The number of out-of-work members in the Steam Engine Makers' Society who are actually in receipt of donation benefit, does not exceed about 4½ per cent., and the returns show a slight decrease in the numbers on the books as compared with last month. Although this decrease in the number of unemployed is much too small to warrant the conclusion that there is any definite improvement in the state of trade, the report takes up a semi-hopeful tone that there is, however, "some consolation in saying that there seems a slight sign that times are about to improve," and that if these continue there are hopes that before the spring of the coming year is far advanced employment will be more plentiful than it has recently been. These encouraging signs, the report states, come from the iron manufacturing districts, as the market reports of this industry were more encouraging than they had been, whilst orders for shipping were more plentiful, and American trade reports were of a more encouraging nature than they had been at any time since the depression set in. In times past all these signs had led to good trade, and upon this basis the report founds the hope that in the present instance the same results will follow to the mutual benefit of all concerned in the country's prosperity.

A new arrangement for driving dynamo electric machines has recently been introduced by Messrs. Browett and Lindley, of Manchester. The engines, which are of special construction, are perfectly balanced whilst running at a high speed of from 250 to 300 revolutions per minute, but the chief feature is the combination of the engine and dynamo upon the same cast iron base, and the dispensing with all strap gearing, the power from the engine being transmitted by friction direct from the fly-wheel. The pulley of the dynamo, which is in direct contact with the periphery of the fly-wheel, has a compressed paper surface which is found to act very well, and to ensure that the friction surface is constantly in perfect contact the dynamo is erected on a specially arranged rocking bed, which is also adjustible vertically as required, whilst the pressure between the surfaces is regulated by an ingeniously arranged tightening gear, which can also be employed for throwing the engine in or out of gear. At the present time Messrs. Browett and Lindley are fitting this arrangement to several different makes of dynamos, such as the American Brush the Crompton, and other types. One great advantage which is obtained by this method of driving, is that the engine and dynamo being built on the same cast iron base, can be put down readily with very little work in the shape of foundations or erecting being required, whilst there are no crank shafts or belting, and the whole arrangement takes no more ground space than the present type of high speed engines that are put down for electric driving.

There has been a fairly active business stirring in the coal trade during the past week in the better qualities for house fire purposes, owing to the general anxiety to get in supplies before the holidays and the stoppage of the pits, which during the ensuing fortnight will extend over five or six days. Apart, however, from this exceptional demand, trade generally is quiet, and for iron making and other manufacturing purposes the demand continues very limited, with works at present taking lessened quantities than usual, owing to the holiday stoppages. Prices are about steady for good qualities of round coal, but in some of the inferior descriptions of fuel they are barely maintained at late rates.

The shipping trade is only moderate, with low prices still ruling both at Liverpool and Garston.

Barrow.—There is a steady though quiet demand for all classes of hematite pig iron, and consumers are displaying increasing indications that they require larger deliveries of all qualities of pig iron. Forward deliveries are being negotiated for with reference to next year, and it is possible, seeing that makers of steel are better sold forward than they have been, and are likely to be still better sold forward when the New Year commences, that a more active state of things will be observed in the iron trade in the ensuing year. The improved demand is mainly confined to the steel trade, and it is evident that the demand for Bessemer steel is improving, for makers have in hand some very large consignments which are for early delivery, and have also the opportunity of securing other orders which are likely to improve the position of the hematite iron trade in reference to the demand which must necessarily ensue for Bessemer pig iron by the increased activity of the steel trade. Pig iron is quoted to-day at 45s. per ton net at works for No. 1 Bessemer, forward delivery; 44s. 6d. No. 2; 44s. No. 3; 43s. 6d. No. 3 forge and foundry iron. The inferior qualities are in limited demand at low prices. Stocks of iron have been largely reduced, but still they represent a considerable bulk of metal. Steel rails are in improved demand at £4 15s. per ton net at works for heavy ordinary sections. The minor branches of trade are indifferently employed, and sales are extremely low. Iron ore finds a poor market at unchanged values, 8s. 6d. to 10s. 6d. per ton being the quotation for ordinary qualities of metal net at the mines. Coal and coke is in steady request, but the tonnage of consumption is much below the average. Shipping is quiet, and freights are low all round.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

ANOTHER effort is being made to establish a sliding scale for the regulation of wages in the coal trade of South and West Yorkshire. The coalowners have always contended that the standard rate of wages should be the existing rates paid in the district; the colliers —or, rather, their delegates—have contended the existing rate, with 10 per cent. added, should form the basis. It is not likely that after the failure of their attempt to obtain an advance of wages to the extent of 15 per cent., and subsequently to 10 per cent. following on the employers securing the return of 10 per cent., in the spring, that the miners' leaders will be prepared to insist upon their basis. If they abandon the 10 per cent. condition, there seems no reason, giving each side credit for an honest desire to effect an amicable arrangement, why a sliding scale should not be in operation early next year.

Several leading Sheffield manufacturers tell me that they anticipate a greatly increased trade with the United States and Canada at the beginning of next year. The Sheffield business is capable of very great improvement. For the year ending September 30th last, the date on which the United States authorities make up their annual returns from their consulates, the value of Sheffield goods sent to the United States was only £450,000. Steel was about £220,000, and cutlery rather over £140,000; whereas we sent to the States last year a value of £287,569 in steel alone; the total exports for that year being £630,686, which was itself a heavy drop on 1883—£811,212. In 1882 we sent to the States a value of £1,277,663; and in 1881, £1,223,828. Steel rails accounted largely for the great increase in 1882 and 1881, the value of steel rails in 1882 being no less than £413,000. No steel rails were sent to America after January, 1884. Sheffield trade with America reached its highest point in 1872, when the exports from the Sheffield consular district reached £1,734,626; in 1878, the lowest point was touched—£429,016. There came a boom which sent up values in 1881 and 1882, but since then the yearly aggregates have steadily decreased, until 1885 shows £450,000, or within about £21,000 of the smallest value ever exported from Sheffield to the United States.

The coal trade in 1885 has not been very gratifying. In 1884 the output of coal diminished by 3¾ million of tons. This had not happened since 1884, and was then a smaller decrease. It is very probable that the production of coal in 1885 will not much exceed that of 1884, as the same causes operate still, viz., lessened production of pig and manufactured iron, little new shipbuilding relatively, and slackness in many of the staple trades of the country. The export of coal, though it does not diminish in the aggregate, increases very slowly compared to what it did a few years ago. In the eleven months of 1884, the output of coal was 21,685,801 tons—value £10,095,808—and for the eleven months of 1885, 21,994,865 tons—value £9,842,163—showing that for the eleven months of this year we have sold 21,994,865 tons, an increase in quantity of 309,064 tons, but have got £252,646 less for it, and a reduction in price of more than 4d. per ton. In coal shipped for the use of steamers engaged in our foreign trade a good business has been done during the year, the quantity exported for the eleven months to the end of November being 6,138,905, an increase of 54,908 tons on the corresponding period of 1884. Shipowners say there is no lack of cargo to carry, but that the rates of freight are low and unremunerative. Considering the very large increase in the production of coal in other countries, it is not considered surprising that our exports do not show so much elasticity as in former years. The railway companies suffered great diminutions in their traffic returns in 1884, and succeeded in economising in 1885 in their coal supplies to the extent of 6d. per ton. Other consumers of coal obtained supplies at a similar reduction. The house coal trade has shown similar results. During the eleven months of this year coal has been taken into the London district by sea to the weight of 4,079,188 tons and by rail 6,398,321 tons—an increase of 281,386 and 204,846 tons respectively, which is really no more than the natural increase of population would account for. The prices obtained during the year show an average of 3d. per ton less in 1885, and the 1884 prices were lower than those of 1883. For 1886 the symptoms are said to be more encouraging. Hematite pig iron is higher by 2s. 6d. to 3s. Scotch warrants are firm at 1s. 6d. advance, and Middlesbrough iron is dearer for forward contracts. The iron and shipbuilding industries, if only slightly revived, would instantly increase consumption, the railway traffic would increase, and the railway companies would require more for locomotive and other purposes.

The fourth edition of "The Illustrated Sheffield List" has just been published by Messrs. W. C. Leng and Co., Sheffield. It is a carefully-compiled and exhaustive list of every variety of mechanical tools and machines, railway plant, timber, machinery, agricultural implements, ships' anchors and tackling, &c., adapted to the requirements of engineers, iron and wood shipbuilders, railway companies, railway coach and wagon builders, contractors, colliery owners, gas companies, gold, tin, and lead mining concerns, ironworks, tea, coffee, sugar, rice, and cotton plantations, &c. &c. It is a work of a most complete and comprehensive character, and gives a clear idea of the extraordinary variety and multiplicity of industries carried on in the Sheffield district. Here are made the armour-plates which coat our war-ships, and the shot and shell to pierce them; the bayonets to make wounds and the surgical instruments to dress them; the parts of the locomotives and the rails they run on. There is scarcely anything in iron or steel which Sheffield does not make—from the finest needles and steel for steel pens to the huge crank shafts and the most ponderous propellers used on board the Atlantic steamers. A work like this is suggestive of almost every handicraft into which steel or iron, metal, copper, or brass enter. The "Illustrated Sheffield List" now includes the "Multum-in-Parvo List" in one volume, and the whole is excellently indexed.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

BUT little business has been done in Cleveland pig iron during the last few days, and it is scarcely likely that there will be any improvement until the holidays are over. Stocks continue to increase and shipments to decrease. Sellers, however, are not despondent; they do not press their iron upon the market, and therefore prices are maintained at the same level as last week. Odd lots of No. 3 g.m.b. are offered by merchants at 31s. 10½d. per ton for prompt delivery, but the minimum rate accepted by makers is 32s. For delivery over the first quarter of next year, 32s. 6d. to 33s. per ton is asked; but neither merchants nor makers are anxious to sell for deferred delivery at the moment. The market price of forge iron is now 30s. 9d. to 31s. per ton. There are no transactions to report in warrants, all known to exist are firmly held, and are not obtainable under 32s. 6d. per ton.

The stock of pig iron in Messrs. Connal and Co.'s Middlesbrough store increased 4027 tons during the week ending Monday last.

Quotations for finished iron are unchanged, very few orders have been given out of late, and future prospects are no brighter.

Shipments continue poor. Up to Saturday last only 35,973 tons of pig iron and 15,347 tons of manufactured iron and steel had been sent away since December 1st.

The shipbuilders of the Tyne, Wear, and Tees, have given notice for a reduction of the wages of platers, rivetters, &c. The extent of the reduction sought is as follows, viz.: 10 per cent. on time rates, and 12½ per cent. on piecework rates. This will take effect on the Tyne and Wear on January 6th, and on the Tees and at Hartlepool on January 18th. A meeting of delegates from the Boilermakers' and Shipbuilders' Societies of the Tyne and Wear has been held to consider the above notice, and a resolution was unanimously come to to resist any further reduction either in time or piecework rates.

Messrs. William Gray and Co., of West Hartlepool, have this year launched twelve vessels, representing 20,386 tons burden, which is an increase of about 3000 tons over and above the tonnage built by them in 1884. At the yard of Messrs. E. Withy and Co., Middleton, near Hartlepool, six vessels were built, of 12,644 tons total capacity. This represents an increase over 1884 of 2000 tons. At Stockton, Messrs. Richardson, Duck, and Co., have built five sailing vessels, one steamer, and fourteen barges, amounting in all to 12,799 tons. Messrs. R. Dixon and Co., of Middlesbrough, have built and launched three iron steamers, two steel steamers, and twenty-two iron fishing smacks; total, 7850 tons. In 1883, this firm launched sixteen vessels, amounting to 30,271 tons. At the port of Whitby no vessels have been built during the present year, the shipyard of Messrs. Turnbull and Sons being entirely laid off. The returns of ships built on the Tyne and Wear are still incomplete, but sufficient is known to warrant the prediction that the output will be very far below that of last year.

So far, the revival of trade in America has done no good to the finished iron and steel makers in this country. On the contrary, their position has been rendered somewhat less favourable by American competition for certain materials they use. Hematite pig iron is dearer, so is purple ore, and so are old rails. The bank rate of discount, which has risen to 4 per cent., is another disadvantage. Scrap iron and steel of all kinds is dearer. What is wanted is that foreigners or colonists should purchase from us highly manufactured articles, such as ships and machinery, which have afforded a living to large numbers of people during construction. What is not wanted is that they should come and take away our materials to manufacture themselves in competition with us. Yet that is what the Americans are doing now.

The Stockton Forge Company has secured the contract for the superstructure of the Penner Bridge, for the Madras Railway Company. There are thirteen spans, 140ft. each—Messrs. Hawkshaw, Son, and Hayter, engineers. The company is also very fairly off for work in the foundry on special work—bridge foundation cylinders—the principal work being the cylinders for the Nerrunderra Bridge, for the New South Wales Government, and another contract for Spain.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

IN the iron market this week business has been restricted by the near approach of the holidays. The market has been comparatively depressed, and speculative operations have been confined within narrow limits. The past week's shipments of Scotch pigs, although not large, compared favourably with those of the same week last year. There have again been large additions to stocks, makers of g.m.b. finding the store the best market at present available for their production. There are 92 furnaces in blast against 93 at this date last year.

Business was done in the warrant market on Friday at 42s. 4d. to 42s. 2d. cash. On Tuesday forenoon transactions occurred at 42s. 1½d. to 41s. 11½d. cash, the afternoon business being at 41s. 11d., 42s., and 41s. 11½d. cash. Tuesday's market was quiet at 41s. 11d. to 41s. 10d. cash. To-day—Wednesday—the market was very flat, with business from 41s. 9½d. to 41s. 6½d. cash.

The current values of makers' iron are as follow:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 46s. 6d.; No. 3, 43s. 6d.; Coltness, 50s. 6d. and 46s.; Langloan, 47s. and 44s. 6d.; Summerlee, 51s. and 45s.; Calder, 51s. and 43s. 6d.; Carnbroe, 45s. 6d. and 43s.; Clyde, 46s. and 42s.; Monkland, 43s. and 40s. 6d.; Quarter, 42s. 6d. and 40s.; Govan, at Broomielaw, 43s. and 40s. 6d.; Shotts, at Leith, 47s. and 46s. 6d.; Carron, at Grangemouth, 51s. and 47s.; Kinneil, at Bo'ness, 43s. 6d. and 43s.; Glengarnock, at Ardrossan, 46s. 6d. and 42s. 6d.; Eglinton, 43s. and 39s. 6d.; Dalmellington, 44s. 6d. and 40s. 6d.

There was shipped from Glasgow in the past week six locomotive engines, valued at £9000, for Bombay, a small steamer, worth £4576, for Rangoon; machinery, £6000; sewing machines, £5920; steel goods, £7780; general iron manufactures, £29,000.

The volume of business in the crude iron trade has been much smaller this year than it was in 1884. At the time of writing the official statistics of the trade are not fully available; but it is evident that the total shipments of pigs for the year will be about 90,000 tons below those of 1884. There is, at the same time, an increase of fully that amount in the arrivals of Middlesbrough pigs in Scotland, the inference being that the home consumption of Scotch pigs, as well as the shipments, show a marked decline on that of the preceding year. In the course of the year warrants have fluctuated between 44s. and 40s. 9½d. a ton, while the extreme fall in the highest class of special brands was 8s. 3d., and that of g.m.b. about 2s. 3d. These latter qualities have since exhibited some improvement, but the prices are weaker than they were twelve months ago.

So far as can be ascertained, the foreign trade in manufactured iron and steel goods is about equal in value to what it was last year, but considerably greater in amount.

The steel trade has done well, and if it gets satisfactorily over certain troubles now threatening in the matter of wages, it will enter upon the new year with fair prospects.

Although the coal shipments in the Glasgow district have been good in the past week, they are very much reduced at some of the other ports. The quantity despatched from Glasgow, including bunker coals, was 27,361 tons; Greenock, 100; Irvine, 2612; Troon, 7403; Ayr, 6041; Leith, 1686; and Grangemouth, 9123 tons. As the colliers in the Airdrie and Slamannan districts have been on strike for three weeks for higher wages, the steam coal trade, which is largely supplied from that quarter, has been depressed, but the wants of consumers have at the same time been small. In other departments the supplies have been more than equal to current requirements.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

EXCEPTIONS crop up to modify every rule. It was a matter of discussion amongst coalowners and shippers lately that sailing vessels were going into the ranks of the obsolete, and lo! there is now at Penarth one of the biggest sailers on record, as far as Wales is concerned. This is the Three Brothers, now loading with Great Western coal. She is said to be next to the Palgrave, the largest sailer in the world. Her registered tonnage is 2900, or about 4000 tons burden, and she is a picture.

Shippers have been busier in getting off their accumulations, and each of the ports—Newport and Cardiff—show an improvement. In some degree, too, this applies to Swansea, but the returns are not yet to hand.

Cardiff sent off last week 138,345 tons, as compared with 133,113 tons the previous week. Taking the coastwise and foreign of Newport coal shipments they amounted to close upon 60,000 tons in round numbers.

I hear of only one colliery speculation in the market—the Aberbeeg. Due notice of this will appear in our advertising columns. Here, I may say, that the coal is the well-known Cwmtillery seam, that the project is in sound, trustworthy hands, and that 10 per cent. is promised as a certainty.

The colliery—the Llantwit—was brought to the hammer last week, but the amount bid not being up to the reserve it was withdrawn, leaving the matter to be settled by private arrangement.

A most delusive condition of things now prevails in the coal trade of Wales. In one valley you find that at a certain colliery the men are working but one or two turns per week, and at a neighbouring one working at least from Tuesday to Saturday. This is owing to the fact that some coalowners are more successful than others in getting contracts. Powell Duffryn, Dinas, and Ferndale Collieries secured another substantial one last week from the Royal Mail Packet Steam Company. I have heard of another contract so keenly fought that the difference between winner and loser was only 1½d. per ton.

Generally speaking, the Welsh coal trade is not good, and a great degree of anxiety prevails amongst the colliery population. Unquestionably there is more distress than what has been known for a length of time.

In the matter of iron and steel the usual quiet state continues. From Newport 2120 tons went to Kurrachee and a small cargo of 40 tons to Bilboa. From Cardiff the export totalled 3145 tons. The same absence of vitality prevails all over the iron district, and the little that is done in rail, bar, and pig could be done in half the time that is occupied. I fear that a reduction of hands is certain unless more orders are received. A number of labourers were paid off at Cyfarthfa on Monday.

The Ystalyfera Tin-plate Works and Gwmos, about which fears were entertained that a stoppage was probable, are going on all right. Ystalyfera is amongst the leading places in the district.

Trade has been tolerably good during the past week, and large shipments have been made. Coke sheets sell at 14s. 6d. to 15s.; Siemens, 15s. 6d. to 16s.; Bessemers, 15s. to 15s. 6d. Wasters are in fair demand. Prospects are better in this industry than in any other, demand being well maintained, and still larger orders could be placed if makers would accept, but there is some degree of uncertainty as to the cohesion amongst manufacturers, and we must wait a week or two for distinctive expression on that head.

An influential memorial has been signed by shippers, coalowners, &c., to Sir W. T. Lewis, praying for increased bridge accommodation at the docks, Cardiff.

LAUNCHES AND TRIAL TRIPS.

ON Thursday, December 10th, Messrs. Oswald, Mordaunt, and Co. successfully launched at Southampton a handsomely modelled iron sailing ship, of 2150 tons net register, named the Toxteth, and of the following dimensions: "Length, extreme, about 280ft.; breadth, 40ft. 6in.; depth of hold, 24ft. 8in. The vessel is built in excess of Lloyd's highest class. She is full rigged, and fitted with skysail on main mast. Ample accommodation is provided in full poop for captain and officers, whilst petty officers and crew are berthed in large iron deck-house amidships. She is fitted with Harfield's patent combined capstan windlass for working anchors and chains. She has been built under the superintendence of Captain Charles Semple, nautical assessor, of Liverpool.

On Wednesday, the 16th inst., the steam fishing cutter Holland, built and engined by Messrs. Earle's Shipbuilding and Engineering Company, Hull, for the Boston Deep-sea Steam Fishing and Ice Company, was taken on her trial trip. The following are the particulars of the vessel:—Length, pp., 100ft.; breadth, extreme, 20ft.; and depth of hold to top of floors, 10ft. 6in. She has a raised quarter deck aft, bridge amidships, and forecastle. Iron casings over engine and boilers, with galley at fore end, is dandy rigged with two pole masts, and has accommodation for captain, mates, and engineers in cabin aft, and for crew in forecastle. The vessel is fitted with patent windlass worked by messenger chain from a 6in. by 10in. steam winch of Earle's special make and design. She is propelled by a set of compound engines on the triple expansion system, also made and fitted by Messrs. Earles, and having cylinders 11½in. by 17in. by 30in. diameter by 21in. stroke, and supplied with steam from a steel boiler made for a working pressure of 150 lb. to the square inch. During the run the weather was very rough, and we are told that the sea-going capabilities of the vessel were thoroughly tested with very good results, the speed attained being about 10½ knots, and the engines worked most smoothly and satisfactorily.

Messrs. Raylton, Dixon, and Co., Middlesbrough, launched a small iron screw steamer 105ft. long by 19ft. beam by 8ft. 6in. depth of hold. The engines, which are compound surface condensing, will be supplied by Messrs. J. P. Rennoldson and Son, of South Shields, the diameter of cylinders being 14in. and 25in. by 18in. stroke. She has been built for foreign owners, and on leaving the ways she was named Cabo Santa Maria.

NEW COMPANIES.

The following companies have just been registered:—

Accrington Corporation Steam Tramways, Limited.

This company proposes to construct and equip tramways at or near Accrington, Lancashire, and to work the same by means of locomotive or stationary engines, cables, wire rope, electricity, or any mechanical or animal power. It was registered on the 12th inst. with a capital of £25,000, divided into 1000 ordinary shares of £10 each and 1500 preference shares of £10 each. The subscribers are:—

	Shares.
C. Courtney Crump, 1, Boscombe-road, Uxbridge-road	10
W. A. Cubitt, Brooklands, Uxbridge-road	10
K. M'Kenzie Dowie, Bedford Park	10
W. Penrose Green, Smithfield Ironworks, Leeds, engineer	10
A. Love, 174, Goldhawk-road, W.	10
G. Alldred, Chiswick, contractor	15
F. Goulding, 53, Shepherd's-bush-road, artist	10
W. Clayden, 269, Uxbridge-road	10
R. Stevens, 65, Cannon-street, licensed victualler	10
Walter Stevens, 65, Cannon-street, licensed victualler	10

The number of directors is not to exceed five; qualification, £100 on shares; the subscribers are to appoint the first; remuneration, £250 per annum.

African Direct Telegraph Company, Limited.

This company proposes to effect telegraphic communication between the Island of St. Vincent and any other Islands of the Cape de Verde Archipelago, and between any of such Islands and the West Coast of Africa, and along the coast thereof. It was registered on the 11th inst. to a capital of £300,000, in £10 shares. Without the sealed and written consent of the Brazilian Submarine Telegraphic Company, Limited, this company may not lay, acquire, or work any line of telegraph to Brazil. The subscribers are:—

	Shares.
*John Pender, 18, Arlington-street	50
*Sir James Anderson, 62, Queen's-gate	50
*W. H. St. John Fremantle Brodrick, M.P., 29, Lower Seymour-street	50
*Thomas Fuller, 13, Chesterfield-street	50
Lord Monck, 24, Onslow-gardens	50
W. R. Drake, 46, Parliament-street, solicitor	50
*Marquis of Tweedale, Haddington, N.B.	50

The number of directors is not to exceed seven; qualification, 50 shares; the first are the subscribers denoted by an asterisk. Minimum remuneration, £1000 per annum, with an additional £500 in each year in which £5 per cent. is paid.

Brighton Electric Light Company, Limited.

This company proposes to acquire the electric lighting works and plant at Brighton, recently carried on by the Hammond Electric Light Company, Limited. It was registered on the 16th inst. with a capital of £25,000, in £5 shares. An agreement of the 1st inst. (unregistered) between Robert Hammond and Frank Wilden Bentley will be adopted. The subscribers are:—

	Shares.
*Robert Hammond, 117, Bishopsgate-street Within, merchant	1
*W. Smithett, 37, Vernon-terrace, Brighton, colonial broker	1
F. H. Bentley, 117, Bishopsgate-street Within, clerk	1
W. Collins, Oliver-grove, South Norwood, agent	1
J. B. Jordan, 67, Ivanhoe-road, Camberwell, clerk	1
E. Brooman, jun., 10, Rockmead-road, South Hackney, clerk	
H. St. John Winkworth Egham, accountant	1
A. F. Hodgson, 117, Bishopsgate-street Within	1

The number of directors is not to exceed five; qualification, 10 shares. The first two subscribers and Mr. Arthur Wright are the first directors. The company in general meeting will determine remuneration.

Great Southern of Spain Railway Company, Limited.

This company was registered on the 15th inst. with a capital of £1,250,000, in £10 shares, to acquire concessions and other powers for the construction of railways, light railways or tramways, canals, docks, harbours, and other public works, in Spain. The subscribers are:—

David Davies, M.P., Llandinam, Montgomery	100
T. Webb, Cardiff, colliery owner	100
E. K. Hett, Eltham, Kent, colonial broker	100
W. G. Burne, Twickenham, shipowner	100
R. Mercer, C.E., Bromley, Kent	100
P. F. Nursey, 161, Fleet-stret, consulting engineer	100
A. F. Yarrow, Poplar, engineer	100

The number of directors is not to be less than five nor more than seven; the subscribers are to nominate the first; qualification, 100 shares; remuneration, £2000 per annum.

Standard Machine Screw Company, Limited.

Upon terms of an agreement of the 8th inst., this company proposes to purchase from Mr. Owen Jones, of 18, Southampton-street, Bloomsbury, the letters patent, No. 3757, dated the 19th of November, 1873, for an improved machine for making screws; also No. 44, dated the 6th of January, 1880, for an improvements machine in screw-cutting machines; and No. 99, dated the 9th of March, 1881, for an improved turning and screw-cutting lathe. It was registered on the 10th inst. with a capital of £50,000, divided into 250 6 per cent. cumulative preference shares of £100 each (but not to participate further in the profits), and 250 deferred or ordinary shares of £100 each. The purchase consideration is £3000 cash, two acceptances of £1000 each, payable at three or six months after date, 50 preference and 250 ordinary shares. The subscribers are:—

	Shares.
E. H. Fowle, Lapley, Penkridge, Stafford	1
William Harvey, Spring Bank, Leeds	1
E. Blakey, Lightcliffe, York, electrical engineer	1
Theodore Brooke Jones, Harrogate, chartered accountant	1
J. A. Bright, Rochdale, manufacturer	1
J. Trehane, Cornwall-residences, Regent's Park	1
T. Edwards, 23, Harp-lane, solicitor	1

The number of directors is not to be less than three nor more than five; the subscribers are to appoint the first and act *ad interim*. Each director residing within ninety miles of the place of meeting will be entitled to two guineas per meeting, and those residing beyond such distance, to four guineas. An additional sum of £20 will be paid to each director for every £1 per cent. dividend upon the ordinary shares above 10 per cent. per annum, but so that such further sum shall not exceed in the aggregate for each director —£1000 per annum.

Permanent Railway-Chair Key Company, Limited.

This company proposes to acquire and work the letters patent, No. 4536, dated 22nd September, 1883, granted to John Steen and Bernard Peard Walker for improvements in the means of fixing or securing steel rails. It was registered on the 12th inst. with a capital of £20,000, in £5 shares, with the following as first subscribers:—

	Shares.
*John Player, Edgbaston, button manufacturer	1
W. Dredge Player, Edgbaston, button manufacturer	1
T. B. Salter, West Bromwich, spring manufacturer	1
G. Salter, West Bromwich, spring manufacturer	1
*J. Birch, West Bromwich, spring manufacturer	1
A. Fairley, Shadwell-street, Birmingham, steel merchant	1
J. F. Fairley, Shadwell-street, Birmingham, steel merchant	1
*J. Steen, Wolverhampton, leather belting manufacturer	1
B. P. Walker, Moseley, consulting engineer	1

The management will be vested in three directors; qualification, 100 shares. The first are the subscribers denoted by an asterisk. The company in general meeting will determine remuneration.

Mysore Reefs Gold Mining Company of 1885, Limited.

This is a reconstruction of the Mysore Reefs Gold Mining Company, Limited. It was registered on the 10th inst. with a capital of £135,000, in £1 shares. In order to ensure the successful reconstruction and to obtain a sufficient amount of capital for the new company, it has been considered necessary to arrange that a large number of shares in this company should be definitely subscribed for. An agreement of the 11th inst. cites that Mr. Samuel Tufnell Southgate, of Lewisham, offered to the committee of shareholders in the old company to take up 25,000 shares in this company, upon the condition that the said shares should be allotted to him credited with 15s. paid up, and the committee accepted such offer. Mr. Southgate having paid to the bankers the sum of £1250, or 1s. per share, payable in pursuance of the scheme of reconstruction, 25,000 shares credited with 16s. per share, paid up, will be allotted him by the new company. The subscribers are:—

	Shares.
*John Harvey, J.P., 5, De Vere-gardens	1
*J. Cockburn, C.E., 11, Heathcote-street	1
Colonel A. Lindsay, 23, Gilston-road	1
L. A. Evans, 33, Walbrook, chartered accountant	1
*C. J. Harvey, J.P., 5, De Vere-gardens	1
F. A. Snell, 1 and 2, George-street, E.C., solicitor	1
J. B. Snell, The Chesnuts, Chislehurst, solicitor	1

The number of directors is not to be less than three nor more than seven; the first are the subscribers denoted by an asterisk and Lewis Henry Evans and Charles Stuart Blair; qualification, 250 shares. The remuneration of the board will be at the rate of £150 per annum to the chairman, and £100 to each other director, and an additional £100 for each 1 per cent. dividend beyond 10 per cent. per annum. Under an agreement of the 8th ult. each shareholder in the old company will, upon payment of 1s. per share upon application and upon agreeing to pay 4s. per share when called upon, be entitled to receive one share, credited with 15s. paid up, in respect of each fully-paid share held in the old company.

New Clydach Colliery Company, Limited.

This company proposes to carry on business as colliery proprietors, ironmasters, engineers, steel converters, ironfounders, and brickmakers. It was registered on the 11th inst. with a capital of £15,000, in £20 shares. The subscribers are:—

	Shares.
William Perch, Cardiff, colliery owner	74
Thomas Walker, Wolverhampton, solicitor	25
*A. H. Walker, M.E., Cardiff	25
S. Loveridge, Wolverhampton, ironfounder	50
P. S. Dowson, Cardiff, brewer	1
D. Watson, Cardiff, brewer	1
W. M. Lewis, Cardiff, colliery agent	1

The number of directors is not to be less than two nor more than five; qualification, £500 in shares or stock. The first are Messrs. A. H. Walker and T. Morgan. The company in general meeting will determine remuneration.

A Proposed New Canal Maritime.—Advices from Berlin state that a Bill for constructing a canal from the mouth of the Elbe, passing through Rendsburg, to Kiel Bay, has been laid upon the table of the Reichstag. The total estimated cost amounts to £7,800,000, of which Prussia is to contribute £2,500,000. Ships not belonging to the German Imperial Navy using the canal will have to pay canal dues. The bill is accompanied by a statement of reasons in its favour. These are of a strategic and commercial nature; amongst the latter is the facility thereby given to German coal merchants for competing with coal merchants sending coal from North English and Scotch ports. Moreover, besides the saving of time effected by passing through the canal, the danger of doubling the Skaw will be avoided. The canal will be under the immediate jurisdiction of the Empire, and the canal dues will be ninepence per register ton, including pilotage and towing for sailing vessels, electric lighting, &c. The estimated time of construction is seven years. The dimensions of the projected canal are given as follow:—Breadth, 200ft. at the surface, 85ft. at the bottom; depth 27ft. 10in., allowing the largest steamers and the heaviest ironclads of the German navy to pass. Its importance to British commerce is proved by the following estimates of time saved by vessels trading between English ports and the Baltic:—London 22 hours; Hull, 15 hours; Hartlepool, 8 hours; Newcastle, 6 hours; Leith, 4 hours. It is estimated that 18,000 vessels out of 35,000 passing the Sound annually will make use of the canal. It is probable that the Reichstag will pass the Bill unanimously.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

Applications for Letters Patent.

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

15th December, 1885.

15,353. Frictional Driving Discs or Wheels for Toys, G. W. Herbert, Birmingham.
15,354. Paring the Brims of Hats, R. Green and T. M. Penney, Manchester.
15,355. Turning-up the Edges of the Brims of Hats, R. Green, Manchester.
15,356. Ironing the Brims of Hats, R. Green, Manchester.
15,357. Coating Tin-plates, S. Thomas, Newport.
15,358. Break Screw Handles, J. M'Ewen, Tettenhall, and S. Thompson, Dudley.
15,359. Hand Parcel Carrier or Holder, E. Phillips, Stirchley.
15,360. Folding Bonnet or Hat Box, J. Collinge, Halifax.
15,361. Stone-breaking Hammers, J. Maters, Newcastle-on-Tyne.
15,362. Tramway Rolling Stock, J. Sanders, Longton.
15,363. Electric Battery Cell, W. Balch, Greenwich.
15,364. Encaustic Tiles, E. G. Colton.—(*F. Frenzel, United States.*)
15,365. Gap Spinning Frames, J. Leeming, Bradford.
15,366. Firegrate, &c., B. Pitt, Bristol.
15,367. Adjusting the Slope of Pictures, &c., A. Butler, Bradford.
15,368. Equilibrium Slide Starting Valve, R. Bentley and T. Ford, Longton.
15,369. Bicycles, &c., A. Easthope, Wolverhampton.
15,370. Uniting the Soles and Uppers of Turned Boots and Shoes, H. J. Allison.—(*A. and E. B. Seaver, and C. D. Wood, United States.*)
15,371. Fireproof Safes, &c., H. J. Allison.—(*C. C. Gilman, United States.*)
15,372. Protecting the Soles of Boots and Shoes, J. M. Baines and S. Washington, Hulme.
15,373. Fastening, &c., Windows, C. Miller, Plumstead.
15,374. Regulating the Transmission of Motive Power to Machinery, R. H. Ridout, Battersea.
15,375. Shuttle-throwing Mechanism for Looms, W. P. Thompson.—(*J. C. M'Creery, United States.*)
15,376. Photographing Appliance, A. Robinson, Liverpool.
15,377. Lawn Tennis Pole, C. W. Carlton, London.
15,378. Middlings Purifiers, W. Klostermann, London.
15,379. Surface Condensers, F. M. Wheeler, London.
15,380. Attaching Shafts to Vehicles, &c., C. Groombridge and J. P. Rickman, London.
15,381. Azo Dyes, J. Y. Johnson.—(*F. von H. Nachfolger, Germany.*)
15,382. Couplings for Railway Vehicles, J. Crabtree, Lincoln.
15,383. Merry-go-rounds, W. Reynolds and C. T. King, London.
15,384. Coupling Apparatus for Railway, &c., Carriages, T. Woodward, London.
15,385. Winding Thread on Tubes, &c., J. C. and F. A. Spach, London.
15,386. Ointment, M. Rook, London.
15,387. Preserving Milk, J. Hooker, London.
15,388. Counter Cases for Storing Reels of Cotton, &c., A. Gutch and J. H. Pratt.—(*F. Meyer, U.S.*)
15,389. Indicating, Registering, &c., Apparatus, J. Hope, Liverpool.
15,390. Dice Games, G. Budweg, London.
15,391. Treating Vegetable Spinning Fibres, M. E. Cohn, London.
15,392. Petroleum and Gas Lamps, H. J. Haddan.—(*A. Cowet, France.*)
15,393. Inkstands, F. van den Wyngaert, London.
15,394. Steering Gear for Velocipedes, F. Wood, London.
15,395. Steam Pumps, R. S. McLaren, London.
15,396. Fenders, P. Webb, London.
15,397. Butter Churns, W. R. M. Thomson.—(*T. Fuhrmann, Hungary.*)
15,398. Propelling Ships and other Vessels, C. N. Nixon, London.
15,399. Transmitting Power, C. Humblot, London.
15,400. Screw Propellers, A. J. Boult.—(*C. W. Field, jun., U.S.*)
15,401. Husking or Decorticating Grain, &c., V. Till, London.
15,402. Filter Presses, J. A. Drake and R. Muirhead, London.
15,403. Variable Tuning-forks, D. W. Segrove, London.
15,404. Glazing, P. Sorel, London.
15,405. Filling Bottles with Aerated Liquids, H. W. Stevens, Colchester.
15,406. Saw Sets, J. Laybolt, Massachusetts, U.S.
15,407. Weft-threaded Knitting Looms, J. J. Adgate, London.
15,408. Fire-extinguishing, W. R. Lake.—(*T. Appleton, U.S.*)
15,409. Metal Shafts, &c., W. R. Lake.—(*R. H. Libby, U.S.*)
15,410. Propellers, A. F. A. Vogelsang, Philadelphia.
15,411. Weft-thread Needles for Knitting Looms, J. J. Adgate and S. P. Kittle, London.
15,412. Sighting Fire-arms, W. R. Lake.—(*Société Dainesi and Co., Italy.*)
15,413. Boots or Shoes, W. R. Lake.—(*M. Walker, United States.*)
15,414. Automatic Lubricators, E. Edwards.—(*A. Behnisch, Germany.*)
15,415. Nozzles and Stoppers for Bottles, &c., S. B. Opdyke, London.
15,416. Applying Postage Stamps and Labels, P. A. Newton.—(*G. Phillips, United States.*)
15,417. Type-writing Machines, G. F. Redfern.—(*E. Enjalbert, France.*)
15,418. Capstans, W. H. Harfield, London.
15,419. Capsule Stoppers for Bottles, E. P. Alexander.—(*W. R. Clough, United States.*)
15,420. Compressed Air, &c., W. L. Wise.—(*V. Popp, France.*)
15,421. Cloth, G. P. Hartley, London.
15,422. Electric Circuits, O. E. Woodhouse, F. L. Rawson, and W. White, London.
15,423. Portable Gun Battery and Conning Tower, W. J. Brewer, London.
15,424. Measuring Electric Resistances, O. E. Woodhouse, F. L. Rawson, J. H. Davies, and E. J. Moynihan, London.

16th December, 1885.

15,425. Guiders for Cotton, &c., Winding Frames, D. Hall, Glossop.
15,426. Velocipedes, M. Woodhead and P. Angois, Nottingham.
15,427. Tobacco Pipe, G. Hollis, Aston.
15,428. Cement, G. Chapman, Glasgow.
15,429. Socketted Pipe Joints, C. G. Clarke, Hull.
15,430. Ships' Brake, C. G. Clarke, London.
15,431. Boring Tools, T. Bramwell, Manchester.
15,432. Stretcher for Surgical Purposes, R. Stevens, Edinburgh.
15,433. Button-hole Attachments for Sewing Machines, E. S. Pratt, Manchester.
15,434. Metal Case for Tobacco Pipes, J. F. Mason, Edgbaston.
15,435. Metal &c., Window Blinds, S. E. Jackson, Oldham.
15,436. Gulleys and Traps, —. Oates and —. Green, Halifax.
15,437. Refrigerating Apparatus, H. J. Allison.—(*T. L. Rankin and G. W. Coit, United States.*)
15,438. Obtaining Baths of Chloride of Antimony, G. Watson, jun., Glasgow.
15,439. Evaporating and Concentrating Liquids Generally, E. Fontenilles, Paris.
15,440. Open Letter Advertiser, M. A. Brown, London.
15,441. Spring Attachments for Braces, J. Cadbury and F. W. Lambert, Birmingham.
15,442. Hair-curlers, J. Cadbury and J. C. Rollason, Birmingham.
15,443. Bracelet Fastening, L. Emanuel, Birmingham.
15,444. Moulding Hat Dishes, J. Rowley, Manchester.
15,445. Governing, &c., Admission of Steam, the Temple Balanced Slide Valve Company and C. Freeman, Liverpool.
15,446. Filling Barrels, J. R. Heath, Liverpool.
15,447. Fountain Pen-holders, R. P. Cato, Liverpool.
15,448. Apparatus employed in Mules for Spinning, G. Leonard, London.
15,449. Obtaining Gas from Hydrocarbons, A. Gutensohn, London.
15,450. Toilet Mirrors for Invalids, E. J. Houstoun, Glasgow.
15,451. Wheels for Bicycles, &c., C. A. E. T. Palmer, London.
15,452. Double Washing Machine, I. Barnes, Birmingham.
15,453. Velocipedes, W. Phillips, London.
15,454. Liquid Stove Polish, R. and C. Wright, London.
15,455. Electro-motors, &c., J. C. Mewburn.—(*W. Main, U.S.*)
15,456. Connecting Jacquard Cards, P. Ambjorn, London.
15,457. Locks for Doors, F. F. Neuber, London.
15,458. Cleaning Flax, &c., J. Barbour and A. Combe, London.
15,459. Cotton and Wool Drying Machines, J. H. Lorimer, Philadelphia, U.S.
15,460. Hydraulic Lifts, W. A. Gibson and T. P. Ford, London.
15,461. Hydraulic Lifts or Presses, P. J. Davies, London.
15,462. Trouser Straightener or Stretcher, A. Knight, London.
15,463. Socket Stands for Telegraph Poles, W. W. Box, London.
15,464. Lavatories, E. J. Preston and E. W. de Ruset, London.
15,465. Railway Brakes, E. J. C. Welch, London.
15,466. Gas Valve, T. I. Wearden, Bradford.
15,467. Spring Clip for Fixing Window Blinds to their Rollers, M. R. Snowden, Bradford.
15,468. Devices for Carrying Parcels, C. Halsey and C. F. Arnold, London.
15,679. Outside Blinds, A. Haynes, London.
15,680. Burning Liquid Fuel in Furnaces, C. Blagburn, London.
15,471. Making Turpentine, C. D. Abel.—(*E. Schaal, Germany.*)
15,472. Generating Steam, &c., J. C. Williams-Ellis, London.
15,473. Shirt-collars, O. Engau, London.
15,474. Velocipedes, A. M. Clark.—(*La Société Les fils de Peugeot frères, France.*)
15,475. Motor, W. von Ruckteschell, London.
15,476. Bottle Capsules, W. Lawson and J. Burke, London.
15,477. Producing Ornamental Effects on Glass, A. Wilkinson, London.

17th December, 1885.

15,478. Rotary Air or Exhaust Pump, W. Maxwell, London.
15,479. Automatic Toy Horse, W. M. Simons, Nottingham.
15,480. Socket for Rain, &c., Pipes, H. Grundy, Liverpool.
15,481. Weaving of Fancy Looped Fabrics, M. Snowden.—(*J. Wilby, France.*)
15,482. Furnaces, J. Settle, Manchester.
15,483. Sight-feed Lubricators, J. Burton, Manchester.
15,484. Electricity, J. Swinburne, London.
15,485. Heating Stoves, A. H. Smith, London.
15,486. Pulley Carriers for Braces, J. Cadbury and J. G. Rollason, Birmingham.
15,487. Sash Fastener, J. Chew, Blackburn.
15,488. Cork-screws, J. Southall, Woodleigh.
15,489. Strap Fasteners, W. R. Harris, Manchester.
15,490. Producing Card Engine Cylinders, G. and E. Ashworth, Manchester.
15,491. Assisting the Driving Power of Tricycles, J. Cheshire, Birmingham.
15,492. Regulating the Supply of Gas to Gas-burners, W. Pollard, Halifax.
15,493. Pendents of Scutchers and Openers, L. Hargreaves, Halifax.
15,494. Reversible Water, &c., Motor, A. J. Jarman, London.
15,495. Cleaning Grain, J. Parkes, Sutton Coldfield.
15,496. Drawing Rollers for Flax, &c., W. Scott, Belfast.
15,497. Four-wheeled Road-carriages, H. F. Lloyd, Liverpool.
15,498. Packing for Steam &c., Engines, H. Field, Liverpool.
15,499. Joints for Steam, &c., Apparatus, H. Field, Liverpool.
15,500. Packing for Stuffing-boxes of Steam Engine Cylinders, J. J. Galloway and G. McFarlane, Glasgow.
15,501. Valves of Vacuum Air Pumps, W. E. Heys.—(*A. B. Worth, United States.*)
15,502. Fastenings for Corsets, F. R. Baker, Birmingham.
15,503. Extracting Corks from Wine, &c., Bottles, R. L. Hickes, London.
15,504. Quartz Crushing Machines, &c., W. McLean, Liverpool.
15,505. Actuating Continuous Brakes, J. H. Stephenson, Liverpool.
15,506. Chimney Cowls, T. Whitehead, Liverpool.
15,507. Automatic Weighing, F. W. Mitchell, Liverpool.
15,508. Pies, J. Whiteley, London.
15,509. Lever Clasp for Fastening Gloves, H. Castar, Beckenham.
15,510. Drawing off Liquids, H. J. Allison.—(*A. A. and R. P. A. Pindstofte, Denmark.*)
15,511. Lawn Tennis Markers, T. W. Goddard, London.
15,512. Screw Drivers, W. McGowan.—(*T. Dussieux, France.*)
15,513. Pocket-sewing Machine, S. A. Rosenthal, London.
15,514. Combination Toilet Rack, M. Gray, London.
15,515. Muzzles for Dogs, M. H. Lowe, London.
15,516. Printing Consecutive Numbers, W. W. Colley and M. Hart, London.
15,517. Stone Crushing Machine, A. G. Mumford, Colchester.
15,518. Ornamental or Useful Woodwork, W. Robertson, London.
15,519. Non conducting Bricks, &c., H. Bonnycastle and T. M. R. Jones, Lee.
15,520. Indicating the Winding up of Watches, L. A. Groth.—(*J. Marzari, Italy.*)
15,521. Combined Steam and Gas Engines, M. P. W. Boulton and E. Perrett, London.
15,522. Gearing for Velocipedes, E. Drew, London.
15,523. Button-hole Attachments for Sewing Machines, A. Anderson.—(*The Singer Manufacturing Company, United States.*)
15,524. Railway Signalling Apparatus, W. King, Glasgow.
15,525. Gas Engines, A. Ashby, London.
15,526. Packing for Piston-rods, O. Imray.—(*J. Partington, Canada.*)
15,527. Shafts and Poles for Carriages, J. A. Caramello, London.
15,528. Explosive Compounds, C. C. Bichel, London.
15,529. Swings, E. Edwards.—(*T. J. Sloan, France.*)
15,530. Extracting Sugar from Saccharine Fluids, L. Sternberg, London.

15,531. Buttons, R. Elsdon, London.
15,532. Mills for Rolling, &c., C. W. Guy, London.
15,533. Holders for Pencils, &c., M. Sachs, London.
15,534. Regulator for Furnaces, D. Hunter, Glasgow.
15,535. Dynamo-electric Machines, R. P. Sellon and J. S. Sellon, London.
15,536. Tents, J. Y. Johnson.—(*H. R. Stewart, Egypt.*)
15,537. Mariners' Compasses, H. H. Lake.—(*E. Berlingieri, Italy.*)

18th December, 1885.

15,538. Harpoon Spring Fastener, J. C. Whateley, Birmingham.
15,539. Telephone Transmitters, C. E. Allen, London.
15,540. Feeding Wool to Carding Engines, W. Cliffe, Halifax.
15,541. Horseshoes, J. Stead and G. Kaye, Halifax.
15,542. Belt Fasteners, C. T. Powell.—(*N. Qurin, Austria.*)
15,543. Pressure-reducing Valves, J. Lyle, Glasgow.
15,544. Air Compressors, J. Lyle and J. B. Hannay, Glasgow.
15,545. Ventilators or Air Valves, J. McConachy, Glasgow.
15,546. Sleeping Berths, J. H. Lynde and J. O. Holt, Manchester.
15,547. Preparing Cotton, &c., W. and W. Lord, Manchester.
15,548. Opening Fibrous Materials, B. A. Dobson, Manchester.
15,549. Fastening Articles of Dress, J. Smith, Stoke-on-Trent.
15,550. Watch Protector, S. Davey, Birmingham.
15,551. Garden Syringes, R. E. Adams and D. Hearnshaw, Birmingham.
15,552. Soothing and Minding Infants, W. Morris, Birmingham.
15,553. Door Bolt, W. Atkins, Birmingham.
15,554. Ventilation of Sewers, A. E. Harris, Sunderland.
15,555. Purifying Metals, A. M. Clark.—(*H. Harmet, France.*)
15,556. Magic Snuff-box, H. Bate and M. Feldman, Hull.
15,557. Washer for Fastening Buttons, J. Smith, Stoke-upon-Trent.
15,558. Electric Bell Circuits, H. M. Townsend, Peterborough.
15,559. Electric Bell Pushes, &c., H. M. Townsend, Peterborough.
15,560. Knob Bolts for Doors, &c., J. Arnot, Birmingham.
15,561. Draughters for Fire-places, M. Wilson, London,
15,562. Haulage Clips, T. J. Lindsay, Linlithgow.
15,563. Blowing Engines, T. G. Redstone, Liverpool.
15,564. Pantographic Apparatus, B. Thornhill and E. Whitehall, London.
15,565. Soluble Casein-albuminates, W. P. Thompson.—(*G. E. Muth, Germany.*)
15,566. Making Guipure Lace, H. A. Brownsword, London.
15,567. Skates, W. P. Thompson.—(*C. M. and J. Thomson, Canada.*)
15,568. Producing a Rotary Motion, E. Brüncker, London.
15,569. Sewing Machines, E. Brüncker, London.
15,570. Sewing Machines, E. Brüncker, London.
15,571. Sewing Machines, E. Brüncker, London.
15,572. The Easement, T. Pike, London.
15,573. Automatic Sight-feed Lubricator, John Etherington, London.
15,574. Determining the Power of Gas, F. Wright, London.
15,575. Arm-holes for Wearing Apparel, A. M. Wartski, London.
15,576. Flour, G. Epstein, London.
15,577. Batten Nail, R. Brown, London.
15,578. Skeleton Books, A. J. Boult.—(*G. Baum, Germany.*)
15,579. Fastenings for Shanked Buttons, &c., A. Rush, Birmingham.
15,580. Stoppers for Oil-cans, J. Walker, London.
15,581. Casks, H. Ratcliffe, London.
15,582. Gas Stoves and Ranges for Cooking Purposes, T. Greenwood, Halifax.
15,583. Pencil-lead Cases and Holders, O. Bussler, London.
15,584. Dredging Apparatus, C. J. Ball, London.
15,585. Self-acting Coupling and Continuous Brake, &c., J. Collins, London.
15,586. Centrifugal Pump, C. J. Ball, London.
15,587. Regulating Sash Holder, F. Howcroft, London.—(*E. C. Byam.*)
15,588. Administering Injections, M. P. Browne, London.
15,589. Steam Washing Machines, J. Heaton, Glasgow.
15,590. Preparing Filamentous Materials, A. M. Clark.—(*J. Cardon, France.*)
15,591. Packing Case for Large Projectiles, H. J. Haddan.—(*G. Allemano and G. Nicco, Italy.*)
15,592. Embroidering Machines, C. F. E. R. Nagel, London.
15,593. Magic-lanterns, &c., A. E. Murray, London.
15,594. Stretchers for Trousers, &c., W. Edwards, London.
15,595. Ointment, D. W. Williams, London.
15,596. Bedsteads or Berths, R. M'Whirter, London.
15,597. Cooking Utensils, F. A. L. and C. L. Hancock, London.
15,598. Strainer Plates for Hop-backs, &c., H. J. Worssam, London.
15,599. Preserving Alimentary Substances, V. Tribouillett and E. Husson, London.
15,600. Bolting or Dressing Machines, J. F. Stewart, London.
15,601. Holding or Gripping Cables, W. C. Johnson and S. E. Phillips, London.

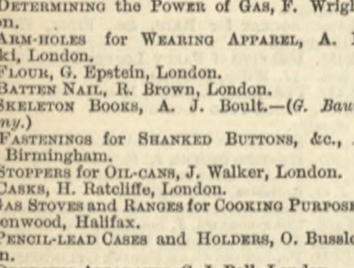
SELECTED AMERICAN PATENTS.

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

328,937. Process of Re-rolling Old Rails, *George Hargreaves, Winton Place, Ohio.—Filed February 18th*, 1885.

Claim.—The herein-described process, which consists in first passing the rail through the first set of rolls, so as to turn the flanges toward the web, and then

328,937

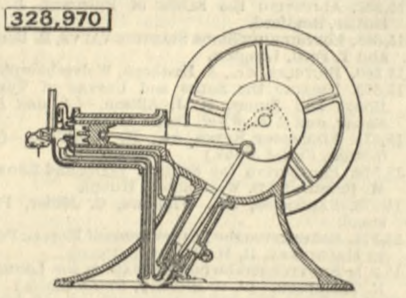


placing in a trough formed by the first pass a suitable welding compound, and afterwards successively passing said billet through suitable rolls, to weld and shape the billet, substantially as described.

328,970. Gas Engine, *James F. Place, New York, N.Y.—Filed September 1st*, 1884.

Claim.—In a gas engine, the combination of the power cylinder, having air passages formed through its walls, with mechanism, substantially as described, for causing the air destined to form part of the explosive charge to flow through said passages, whereby the air is heated, and serves to cool the cylinder, substantially as set forth. In a gas engine, the combination of the power cylinder, having air passages in its head, with a compression cylinder for compressing air, and a compressed-air passage leading therefrom and communicating with the air passage in the cylinder head, and extending thence to the igniting chamber of the power cylinder, substantially as set forth. The combination, in a gas engine, of a power cylinder having recesses extending into its head, a power piston having projections adapted to enter said recesses, a compression cylinder and piston, and a compressed-air passage extending from the compression cylinder, through heating passages in the power cylinder head, to the igniting chamber of the power cylinder, whereby during the first part of the out-stroke of the power piston the space behind it becomes filled with compressed air, which is heated by passing through the passage in the power cylinder head, and is further heated on its entrance to the cylinder by flowing into said recesses in the cylinder head and around said projections on the piston, substantially as set forth. In a gas engine, the combination of the power cylinder and piston, the compression cylinder and piston, the former piston being arranged to move in advance of the latter, a compressed-air passage leading from the compression cylinder to the power cylinder, an inlet valve in said passage near its junction with the power cylinder, and the exhaust passage for the spent gases leading from the power cylinder and extended in close proximity to said compressed air passage, whereby the heat of the spent gases is utilised to heat the compressed air during its passage from the compression cylinder to the power cylinder, substantially as set forth. In a gas engine, the combination of a power cylinder and piston, a compression cylinder and piston, an extended passage for the compressed air extending past heated surfaces, in order to superheat the compressed air and increase its pressure, and terminating

328,970

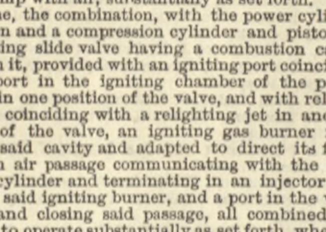


at the power cylinder, and an inlet valve in said passage near its junction with the power cylinder, and mechanism for operating said valve, arranged, substantially as described, to close said valve when the compression piston turns its centre on its in-stroke, whereby the increased pressure of the compressed air which remains in said passage is made effective by reacting on the compression piston on its out-stroke. In a gas engine, the combination, with the power cylinder, of a force pump arranged to discharge gas or liquid combustible into said cylinder, a variable cut-off valve controlling the admission of combustible to the pump, and a relief air inlet valve adapted to remain closed so long as the pump is drawing in the combustible, and to open upon the cutting off of the supply thereof, in order to fill the remainder of the pump with air, substantially as set forth. In a gas engine, the combination, with the power cylinder and piston and a compression cylinder and piston, of the igniting slide valve having a combustion cavity formed in it, provided with an igniting port coinciding with a port in the igniting chamber of the power cylinder in one position of the valve, and with relighting ports coinciding with a relighting jet in another position of the valve, an igniting gas burner fixed opposite said cavity and adapted to direct its flame into it, an air passage communicating with the compression cylinder and terminating in an injector surrounding said igniting burner, and a port in the valve opening and closing said passage, all combined and arranged to operate substantially as set forth, whereby said passage is opened at the beginning of the compression stroke, and supplies air at low pressure to the igniting burner, and the pressure of this injecting jet of air increases up to the instant of the explosion, whereupon the air passage is cut off.

329,004. Hub, *William P. Bettendorf, Peru, Ill.—Filed July 10th*, 1885.

Claim.—(1) A hub made of a single piece of metal, consisting of a main portion A, provided with a series of projections A^1, integral therewith, each having a hole a and a countersink a^1 at its inner end, substan-

329,004

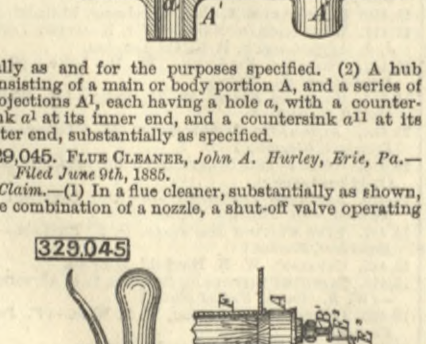


tially as and for the purposes specified. (2) A hub consisting of a main or body portion A, and a series of projections A^1, each having a hole a, with a countersink a^1 at its inner end, and a countersink a^{11} at its outer end, substantially as specified.

329,045. Flue Cleaner, *John A. Hurley, Erie, Pa.—Filed June 9th*, 1885.

Claim.—(1) In a flue cleaner, substantially as shown, the combination of a nozzle, a shut-off valve operating

329,045

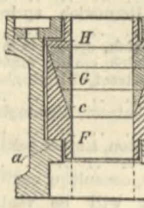


in said nozzle and having an outward extending stem, a steam supply pipe connecting with a flexible hose, a handle connected with said steam pipe, and a hand grip lever on said handle, which is operatively connected with said valve stem, substantially as and for the purposes mentioned. (2) In a flue cleaner, substantially as shown, the nozzle shell A, having conical face a, annular steam passage a^1, chambers A^4 and A^5, with connecting passage, and steam supply entrance into the chamber A^4, in combination with the valve B, with outward extending stem B^1, the steam supply pipe C, flexible hose C^1, handle D, hand grip lever E, and connecting rod E^1, connecting the said lever E with the valve stem B^1. (3) In a flue cleaner, substantially as shown, the combination of a steam nozzle, a shut-off valve within said nozzle, having a protruding stem, a handle connected with said nozzle, and a hand grip lever on said handle, which is operatively connected with said valve stem.

329,202. Stuffing Box, *Thomas Murphy, Detroit, Mich.—Filed March 18th*, 1885.

Claim.—(1) In a stuffing box, the combination, with the sleeve F, conically recessed at one end and having a shoulder a near the other, of the conical packing rings G, fitting within the conical recess of the said sleeve, and a follower, as H, these parts having free lateral play in the stuffing box, and the sleeve and

329,202

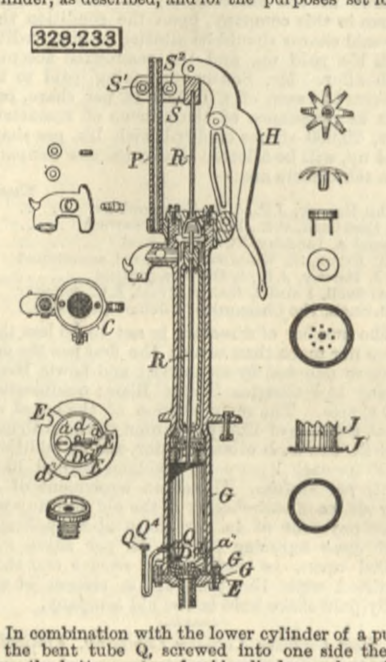


follower having cylindrical necks, which extend to the exterior of said stuffing box, as set forth. (2) In a stuffing box, the combination, with the sleeve F, having a shoulder a near one end and a conical recess near the other, terminating in a small shoulder c, of the conical packing rings G and the follower H, all arranged and confined within the stuffing box, so as to have a free lateral play therein, substantially as and for the purposes described.

329,233. Non-freezing Force Pump, *William M. Stevenson, Cleveland, Ohio.—Filed August 13th*, 1884.

Claim.—The cylinder G and the piston J, in combination with the check valve E^1, consisting of the leather E, hinge E^{11}, and flap E^1, provided with metal plate E, having a lug d and projecting pin d^1, the opening a, and auxiliary drain valve a^1, having wire d^{11} and spring a^{11}, as described, and for the purposes set forth. (2) In combination with handle H, secured to the top of a pump cylinder, the piston-rod R, the guide arm S, having friction rollers s^1 s^2, and guide bar P, secured to the opposite side of said pump cylinder, as described, and for the purposes set forth.

329,233



(3) In combination with the lower cylinder of a pump G, the bent tube Q, screwed into one side thereof above the bottom valve of said cylinder, and provided with reduced aperture Q^1, opening into said cylinder, the bent portion of the tube extending below the bottom of said bottom valve, then upwardly to a level with said aperture Q^1, the outer end of said tube being provided with a perforated cap Q^{11}, the perforation therein being of less internal diameter than the internal diameter of the tube, substantially as described.

329,241. Vacuum Pump, *Burchard Thoens, New Orleans, La.—Filed December 27th*, 1884.

Claim.—(1) In apparatus for producing high vacua, the combination of a main ejector pump, to which the vessel to be exhausted is connected, and one or more auxiliary ejector pumps, each having its suction pipe connected to the drop or discharge pipe of the preceding ejector pump, substantially as described. (2)

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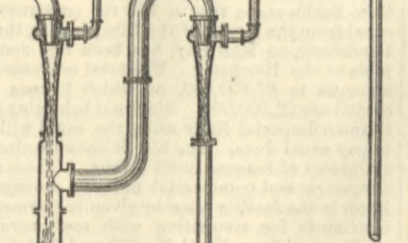
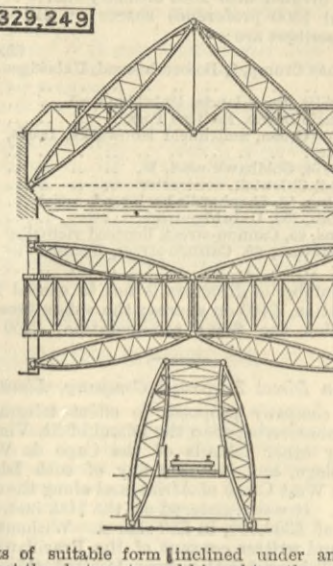


In apparatus for producing high vacua, the combination of a main ejector and one or more auxiliary ejectors, each connected with the discharge or drop pipe of the preceding ejector at a point below the discharge nozzle thereof, and above a point representing the barometric height of a column of the fluid used, substantially as described. (3) In an apparatus for producing high vacua, the combination of a main ejector pump, one or more auxiliary ejector pumps, connected as described, supply tubes or branches leading thereto, a reservoir or tank for the fluid, and a pump or forcing apparatus for supplying the liquid therethrough under pressure, substantially as described.

329,249. Bridge, *Emmerich A. Werner, New York, N.Y.—Filed October 10th*, 1884.

Claim.—(1) The combination of two struts united at their upper ends, and inclined to each other, and resting on abutments or analogous supports, and two ordinary girders or beams, both having their inner or adjacent ends supported by rods from the top of the struts, the land ends of the beams or girders resting on abutments or analogous supports, and said beams or girders being otherwise independent of said inclined struts, substantially as described herein, and for the purposes set forth. (2) The combination of two ordinary beams or girders of any description with two

329,249



struts of suitable form inclined under any angle against the abutments, and hinged together at the top to support by suitable means the two beams carrying any road over an opening of given length, without the aid of intermediary supports resting on the ground, the struts being inclined to the vertical planes of the girders, substantially as described herein and for the purposes set forth.

329,417. Cut-off for Hydraulic and other Engines, *Lily M. Tubbs, Philadelphia, Pa.—Filed February 4th*, 1885.

Claim.—(1) In combination with the prime motor C, having pistons c, piston-rod c^3, and valve D, and the supplemental motor A, having pistons a and rod a^1, the levers d^6, connected at one end to the rod a^1, and links b^5, connected at opposite ends to the lever d^6 and valve-rod d^3, substantially as described. (2) In combination with the prime and supplemental motors C and A, the slide valve D, controlling flow of liquid in prime motor, rod d^3, links b^5, levers d^6, oscillating

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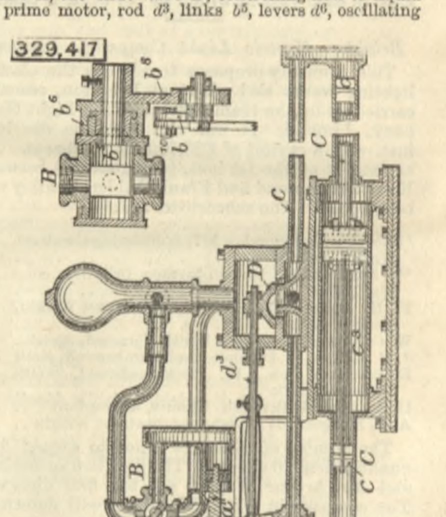

valve B, controlling flow of liquid in supplemental motor, arm b^8, link b^{10}, lever b^{11}, bar b^{13}, link b^{14}, and pin f, carried by rod f^1, and actuated by piston of prime motor, substantially as described. (3) In combination with the cylinders and pistons of the prime motor C, the slide valve D, supplemental motor A, and connections, such as described, intermediate the supplemental motor and slide valve, the oscillating valve B, actuated by the prime motor, and governing the inlet and exhaust of the supplemental motor, said valves D and B being connected to the same supply pipe, substantially as described, whereby when the valve B is reversed to admit the liquid to the supplemental motor, the pressure on the valve D is temporarily relieved.

329,459. Brake-shoe, *John J. Lappin, Toronto, Ontario, Canada.—Filed March 2nd*, 1885.

Claim.—A brake shoe A, constructed with thick chilled parts and thin projecting chilled parts, alternately, in the face of the shoe, the thin chilled parts having one or more circular veins of soft metal pro-

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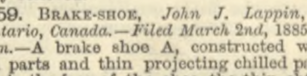

jecting through the chill and cast with the face down, thereby providing for the coarse and inferior metal rising to the top and making the back of the shoe, and the pure metal to fall to the bottom and make the face thereof, substantially as described, as a new manufacture.