THE INVENTIONS EXHIBITION.—WAR MATERIAL.

WALTHAM ABBEY has furnished the electric safety lamps by which the exhibits of the Government manufacturing departments were lighted in a special manner. This is a matter deserving notice. The lamp in its original form was designed by Major Watkin, R.A., when belonging to Waltham Abbey. It owes its present shape to further development in this department under Colonel Brackenbury, since Major Watkin left it. He prefers his original lamps, we believe. Speaking generally, the lamp is designed for buildings of which the interior and immediate exterior is liable to be charged with inflammable particles, especially powder dust. In such cases security is by no means attained by the employment of lamps fixed in the wall and communicating entirely with the outside air. Hence such buildings are usually closed when daylight fails, which is liable to cause considerable inconvenience, especially during the winter months. The lamp being an electric light, no air supply is needed, and danger is threatened mainly in two ways—first, from overheating of the insulating material; and secondly, from fracture of the lamp brought about by any accident. It will be seen in Fig. 1, which represents the lamp as first set up by Major Watkin at Waltham Abbey, that three lamp globes are placed in an exterior globe filled with water beneath a tank or cistern containing a considerable quantity of water, that is, three gallons for each lamp, nine gallons in all in this instance. The opening from cistern to globe is large enough to enable any of the lamps to be removed at will. The water as it becomes warmed by immediate proximity to the lamps mounts to the top of the cistern, so that it in no case rises to such a temperature as to endanger the insulating material employed. On the question of fracture some interesting experiments were made. It was thought probable that the lamp would be extinguished on the destruction of the vacuum by fracture too suddenly to cause an explosion. Repeated trials, however, showed that this was not the case, hence the necessity for surrounding the entire lamp with water, which by the arrangement shown in Fig. 1 is so distributed as not to obscure the brightness of the lamps seriously. The method of securing good contact with the lamp and leads is as follows:—(*a*) The ends of the insulated wire to be attached to the incandescent lamp are bared, and the ends of the copper conductor flattened out. (*b*) A piece of wood is then tied between the two wires to keep the ends at the proper distance apart for joining on to the terminals of the incandescent lamp. (*c*) The copper wires are now well soldered—not tacked—to the platinum terminals of the lamp. The following is the method of securing insulation:—(*a*) Gutta-percha is moulded round the joints and wire, with the aid of a soldering iron; the gutta-percha extending on to the end of the lamp, so as thoroughly to insulate the platinum terminals. (*b*) To insure perfect contact of the gutta-percha the lamp is attached to the dynamo until the heated glass melts the gutta-percha and drives out any moisture. The top covering of the tank is not so air-tight as to prevent the escape of gas, should any arise; but hitherto none has been found in the lamps. The lamp as subsequently altered is shown in Fig. 2. It is arranged so as to be burnt in one gallon of water, which of course enormously decreases the weight, and facilitates hanging it as seen in the Exhibition. The following arrangement is made to obviate the danger arising from injury to the insulation:—The wires receive a first coat of gutta-percha, a second one of plaster of Paris, and a final one of varnish. This insulation has borne a temperature of 130 deg. Wires insulated with gutta-percha only, as in the first lamps, failed when the temperature rose above 100 deg., the gutta-percha becoming soft and the lamp getting out of position. The question is still new. About the gain in convenience there cannot be two opinions. The main object, however, of the lamp is safety, and on this point we should advise any manufacturer who contemplates introducing the lamp into buildings full of combustible dust to obtain the results of such an exhaustive trial as no doubt will be carried out sooner or later before adopting it.

Fig. 1

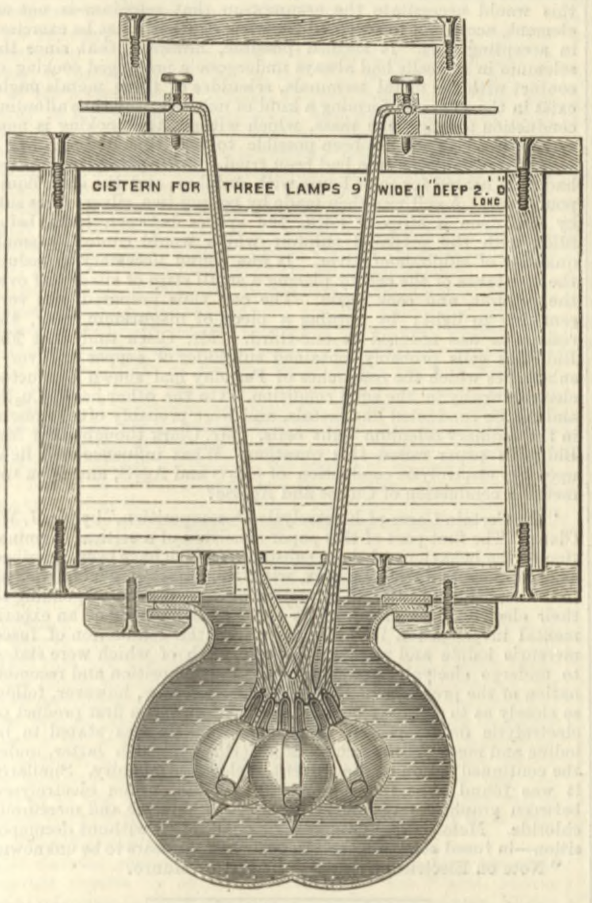
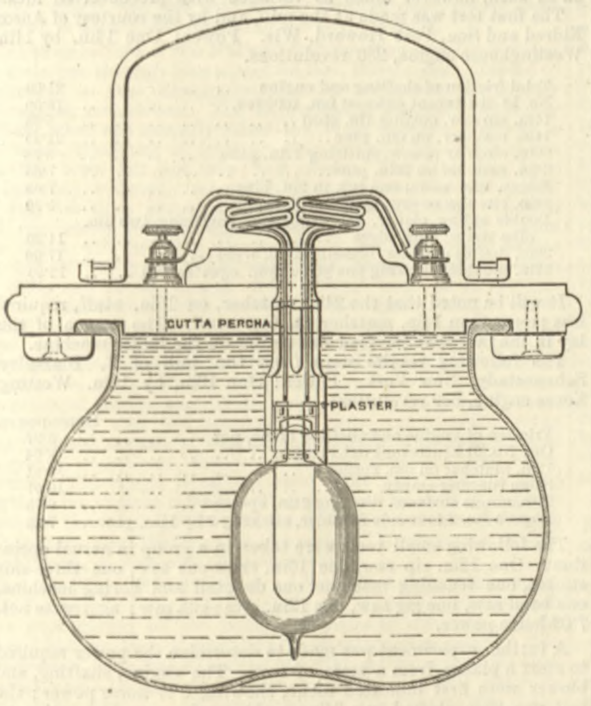


Fig. 2



Messrs. Easton and Anderson, London and Erith, exhibit a model of an 18-ton 10in. gun on a Moncrieff hydro-pneumatic carriage. A few of these carriages only are now in use in our forts. At Shoeburyness is a 70-cwt. 6·6in. gun so mounted. Some have been supplied to Russia. The Popoff carries 40-ton 12in. guns on Moncrieff carriages.

Mr. Anderson, of Wallington, has a model of a muzzle pivoting gun. The muzzle tapers and fits into a pierced ball held in a socket in a shield. It differs from the ball-and-socket arrangement of Krupp—*vide* THE ENGINEER, August 15th, 1879—in the fact that the gun is free to recoil, consequently the shield has not to bear the force of discharge. Counterweights are used to facilitate elevating the gun, and the ball is turned round so as to close the muzzle aperture when the gun runs back. We should be inclined to prefer Krupp's arrangement ourselves, having seen practically that a considerable number of rounds have no perceptible effect on the shield, while owing to the gun remaining stationary, all running up, and nearly all laying, was dispensed with, and the speed and accuracy were remarkable, as well as the safety. This design is neatly carried out, and might be preferred to Krupp's by those who doubted the power of the shield to bear a reasonable number of rounds.

Schultze gunpowder has now been manufactured and sold in England for sixteen years. The name was originally given to a nitro compound explosive formed by cutting wood into small grains or cubes, which were after purification rendered explosive by treatment with nitric acid, &c. This powder from its resemblance to sawdust was popularly known as "sawdust powder." It was the first successful attempt to supply commercially a nitro compound for small arms and sporting powders, and compared with black gunpowder it is a smokeless explosive, cleanly, and with a much reduced recoil. However, difficulties in the way of ensuring perfect purification and regular specific gravity brought about an improved form known as "Granulated Schultze Gunpowder," in which the explosive is purified and granulated. This year, 1885, the powder embodies a long desired improvement. It is treated with a water-proofing, and it is said to successfully resist atmospheric damp, and to be free from the liability to give a high rate of combustion by warming or drying. Its apparent specific gravity is one-half that of Black Powder, No. 4 grain, and its propulsive force is twice that of an equal weight of the Black; therefore equal measure, or one-half weight of Schultze to Black, give the same propulsive force. It claims to be perfectly uniform in its strength, and of such trustworthy purity that it may be stored for any length of time without any change. Good and successful, however, as it has proved as a shot cartridge, we should not employ it or any other substitute for black gunpowder with rifle bullets, unless much more exhaustive experiments had been made on the subject than we have hitherto heard of. Powder itself not being allowed in the Exhibition, Schultze employs a substitute to represent it, and this is so exactly like the real article that we hear a sample was asked for by the authorities, with the object of actually trying its explosive qualities, to make sure that they were not being imposed on by the real article instead of the substitute desired.

THE INSTITUTION OF CIVIL ENGINEERS.—The first annual general meeting of the Institution of Civil Engineers under the revised by-laws will take place on Tuesday next, the 2nd June. The by-law revisions, as confirmed by the special general meeting in April last, include several small matters of convenience and some of more importance. A change of very material convenience is that under which the annual general meeting, instead of being held the Tuesday previous to Christmas Eve, is to be held the last Tuesday in May, or the first Tuesday in June if Whitsuntide should intervene. This change was very much required, and, of course, involves a number of other changes in terms and clauses to meet it, and has the advantage of bringing the annual general meeting and its matters, financial and otherwise, to the end instead of the middle of the session. The changes also modify the by laws as far as they define the qualifications for membership, and make it necessary that qualifications should be in accordance with the profession of a Civil Engineer as defined by the Charter. The change extends the classes embraced by the Institution, and removes several obstacles which would have excluded useful members if they had been strictly observed.

RESISTANCE TO ROLLING.

By PROFESSOR R. H. SMITH.

RESISTANCE to rolling has usually been classed along with friction. This is unfortunate, because it has led to a too common idea that it is really in its nature similar to friction. There is only one point of similarity between the two, namely, that both rolling and frictional resistances always tend to prevent or destroy the relative motion of the one piece over the other. Except with regard to this one common characteristic, the two actions are entirely and utterly different, depending on altogether distinct properties of the materials in contact.

We sometimes also find a notion that rolling resistance has some connection with the "adhesion" between wheels and roads or rails. They are really quite independent of each other, it being impossible to calculate in any way the one from the other. The limit of adhesion also by no means always depends on the coefficient of friction between the tire and the road surface. If the coefficient of cohesion between the upper surface of the road and the layer immediately below it be less than the frictional force per unit of bearing surface between tire and road, then when the locomotive gets into a difficulty and cannot advance it will scrape off the surface of the road before slipping actually takes place between this surface and the tire. This coefficient of cohesion is evidently simply what is more commonly termed the strength, say per square inch, to shear fracture of the material of the road. Thus, when the road is in bad condition, a road locomotive begins to scrape out a pit underneath itself. The remedy is to increase the bearing area so that the area of shear fracture, and consequently the whole force resisting the scraping off the road surface, is increased; or else to improve the quality of the road surface, that is, to increase its shear strength. The advantage of iron rails over common roads does not consist in there being any larger coefficient of friction between the tires and iron than between the tires and macadam or granite; it really lies in the superior shear strength of the iron, which offers a far higher limit of resistance to the scraping off or abrasion of its surface layers by the tires.

In rolling proper there is no slipping. It follows that none of the resistance is due to friction. It is evidently wholly due to the compression of the materials that roll one over the other. Part of this compression is inelastic crushing, giving permanent set to the materials of the road and of the wheel. The work done in producing such permanent set is wholly lost. A portion also of the compression is elastic, and the work done in producing this portion is partially restored as useful work and partially lost in producing waves or vibrations through the wheel and through the road. Let us consider the inelastic crushing first as being the simpler.

The wheel will sink deeper into the road the greater is the load upon it. We may take as a rough approximation to the truth that the volumetric crushing of the road under the wheel as it stands in any one position is proportional to the load. If the road material be of a sluggishly viscous nature, the wheel would under any given load sink only gradually to its full depth, so that the above proportion would be less for high than for slow velocities of rolling, because of the less time given to complete the crushing of each part of the road. If B be the breadth of the tire and D its diameter, and if d be the depth its surface sinks below the normal level of the road, then the volumetric compression of the road under the wheel is proportional to $\frac{4}{3} B D^{\frac{1}{2}} d^{\frac{3}{2}}$, the exact proportion depending on the relative compressibilities of the road and tire surfaces, and it being equal to this if the wheel be taken as incompressible. If W be the load on the wheel, we may therefore write the approximate equation

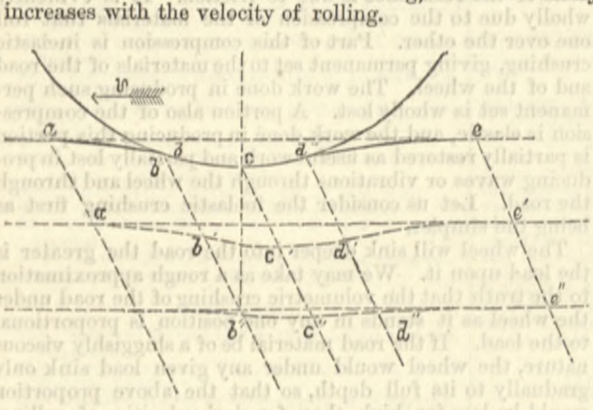
$$W = \tfrac{4}{3}\, E B D^{\frac{1}{2}} d^{\frac{3}{2}}$$

where E is a factor of the nature of a modulus of elasticity which will generally be found to be rather greater for high than for low velocities, and which will be less the greater the depth below the surface to which the compression penetrates. The force necessary to crush down unit area of the road surface a depth d would be, using the same factor E, equal to E d, and the work done in crushing unit area to this depth would be $\frac{1}{2} E d^2$, since the force is taken as increasing uniformly from zero to its full amount. Now, when the wheel rolls forward unit distance, the area crushed down is B, and therefore the work done in crushing the road $\frac{1}{2} E B d^2$. Inserting in this expression the value of d in terms of W, as deduced from the above equation, we find that the work done in crushing road per unit distance advanced = resisting force due to crushing of road

$$= \tfrac{3}{8} \sqrt[3]{\tfrac{3}{4} \frac{W^4}{E B D^2}} = \tfrac{3}{8} \frac{W}{2D} \sqrt[3]{\tfrac{3}{4} \frac{W D}{E B}}$$

where the factor E increases a little with the speed, so as to make the resisting force decrease slightly with increase of speed. To this has to be added a part due to the crushing of the wheel, which would also be proportional to $\sqrt[3]{\frac{W^4}{B\ D^2}}$. But this part may be neglected, since we are just now considering only permanent set, because although the new tire may crush a little at first, it is soon given all the permanent set it will take during its lifetime. This may be called the inelastic resistance to rolling. It increases in a somewhat more rapid ratio than the load; decreases in a somewhat less rapid ratio than the wheel diameter increases; is inversely proportional to the cube root of the breadth of tire; and is slightly less for higher velocities. We have here taken no account of the depth to which the compression penetrates. The sinking of the surface equals the average ratio of compression multiplied by this depth, which depth is, therefore, of very great importance. The area over which the whole load is distributed spreads out conically from the surface downwards. The rate of spreading depends on the ratio of the compressive and sheer moduli of elasticity of the material of the road and increases rapidly with the modulus of shear elasticity—otherwise called the modulus of rigidity. If this modulus be high, the depth at which the compressive strain becomes sensibly diminished to zero is small, and *vice versâ*. This influence then may be taken into account by suitably choosing the factor E in relation to the rigidity of the road material. The greater this rigidity is, the less is the resistance to rolling.

To determine even roughly a formula for the resistance due to elastic compression is much more difficult. In the first place, we observe that if the forward rolling velocity were extremely slow, the elastic resistance to rolling would be zero. The wheel, sinking a certain distance into the elastic road, has contact with it over a certain arc, one portion of which lies in front of and the other behind the wheel centre. The former we will call the forward arc of contact; the latter, the hinder arc of contact. Over each of these arcs the pressure on the tire is nearly vertical, but has also a small horizontal component. The horizontal component of the pressure on the forward arc of contact opposes the rolling motion; that on the hinder arc assists it, pushes the wheel forwards, in fact. If the wheel be motionless, the distribution of pressure is perfectly symmetrical, the forward and hinder arcs of contact being equal, and their horizontal components of pressure being equal and opposite, and, therefore, balancing. If the velocity be very slow, the balance will still be nearly perfect, the road surface springing up behind the wheel, so as to cover an arc equal to the forward arc, and exerting on it an equal pressure. But if the velocity of rolling be great, the vertical momentum of the particles of the road, due to the velocities with which they sink downwards and then spring upwards again, must also be taken into account. In front of the wheel the acceleration of momentum of the road particles is downwards, and to produce this acceleration, the wheel must press downwards with an extra force beyond that due simply to the compressive strain taken by itself. Behind the wheel there is upward acceleration of momentum, and in producing this there is spent part of the elastic or resilient force of the compressed material, which, therefore, does not press on the hinder arc of contact with so great a force as it did when the velocity of the wheel was zero. The opposing horizontal component of pressure on the forward arc is increased; the assisting horizontal component on the hinder arc is diminished. There thus arises a resistance to rolling, which evidently increases with the velocity of rolling.



Shortly expressed, the material of the road takes time to spring up behind the wheel, and the less time it is given to do so the less is the force with which it presses on the hinder arc of contact.

Looking now at the problem more closely, and referring to the accompanying diagram, it is easy to recognise that the compression of the road surface extends ahead of the actual contact between it and the tire. If *a e* represent the normal level of the road, and *b c* and *c d* the forward and hinder arcs of contact, *c* being vertically underneath the centre of the wheel, we have in front of *b* a certain length of the surface drawn down to some such curve as *a b*. Between *a* and *c* the greatest slope of the surface occurs at or near *b*. From *a* to *c* we have downward velocity of the surface particles. The downward velocity of any surface point on the curve *a b c* equals the slope—or tangent of inclination—of the curve at that point multiplied by *v*, the velocity of rolling. The maximum velocity occurs at *b*, and equals $\frac{2\, v . b\, c}{D}$ if D be the diameter of the wheel. From *a* to *b* there is, therefore, downward acceleration of momentum, which is produced by the shear force on transverse vertical sections of the road. The shear is right-handed as viewed in the diagram, and its right-handed amount increases from zero at *a* towards *b*, where it reaches a maximum. From *b* to *c* the downward surface velocity is decreasing, that is, there is upward acceleration of momentum, which is produced by a diminishing right-handed shear—diminishing from *b* towards *c*. The shear is diminished to zero at *c*. Between *c* and *d* we have upward surface velocity, which increases from *c* towards *d*. This upward acceleration of momentum is produced by left-handed shear increasing from *c* towards *d*. Finally the upward surface velocity decreases from *d* towards *e*, and throughout this length, therefore, every portion of the surface material is subjected to downward acceleration of momentum produced by a left-handed shear diminishing from *d* towards *e*.

These different phases of disturbance of the road material at the surface penetrate downwards from the surface as a wave, the energy of which is partly strain energy and partly kinetic energy. This downward penetration of the wave takes place at a certain speed dependent upon the coefficients of elasticity of the road material. The various phases of the wave will appear at each lower level at a later period of time. Thus, simultaneously with the surface wave outline *a b c d e* we have that at the normal level *a'* *e'* in the position *a'* *b'* *c'* *d'* *e'* where the crests *a'* and *e'* and the hollow *c'* are all displaced backwards from the position *a e* and *c*. At the level *a''* *e''* we have these still further displaced backwards. The tangent of the angle between the line *c c'* *c''* and the vertical equals the ratio of the rolling velocity of the wheel to the velocity of transmission of the wave downwards. This angle is in the diagram immensely exaggerated beyond any magnitude it can ever reach in actual roads or rails.

If the road were composed of a number of vertical independent pillars that could slide vertically over each other without friction—that is, if there were no possibility of shear force between the vertical layers of the road then the surface wave curve *a b c d e* would be transmitted downwards with undiminished depth between crest and hollow. The actually occurring shear stresses on the vertical sections, however, have the effect of rapidly spreading laterally each wave impulse as it descends through the horizontal strata. As the wave spreads its amplitude decreases, and at a comparatively small depth the height from hollow to crest is thus diminished to an extremely minute dimension, minute not only absolutely, but also relatively to the surface depression at *c* underneath the wheel. Thus, at no great depth below the surface, the horizontal sections must remain almost perfectly flat, undeformed by the passage of the wheel overhead. The depth at which the absence of sensible deformation occurs rapidly diminishes as the modulus of rigidity of the road structure increases. Beyond such appreciably flat surface, whatever portion of the wave energy penetrates further, is transmitted on as a tremour of exactly the same nature as sound. But these layers that remain almost perfectly undeformed act also to a large extent as reflectors. They throw the wave of strain and kinetic energy upwards again, and indeed it is only in consequence of such reflection that the material springs up at all behind the wheel.

Each horizontal layer below the surface, in fact, assists in this upward reflection of the energy thrown into the road by the wheel through the forward arc of contact. The upper surface of each layer is more deformed, more deeply curved and furrowed, than its under surface; and the difference between the two magnitudes of deformation is a measure of the reflecting action of that layer. If the whole wave energy were transmitted down to a single reflecting surface at a sufficient depth, there would be so appreciable an interval of time before any of it re-appeared at the surface that the hinder arc of contact would be reduced to zero, the road would not touch the wheel at all behind the centre *c*, because the upward velocity part of the wave has only an existence in consequence of this reflection of the energy. If there were no such reflection the surface would remain at the level *c*, and would not rise again at all. But as a portion of the wave energy is reflected upwards by each horizontal layer through which the wave descends, there is always an immediate springing up behind *c*, and contact with the wheel throughout a certain length of hinder arc *c d*, which length, however, diminishes as the speed of the wheel increases.

If we compare the two curves *a b c d e* and *a' b' c' d' e'* it is easy to observe that the vertical distance between them in front of *c* is less than at a corresponding distance behind *c*. There is thus greater vertical compression throughout the material in front of *c* than in that behind *c*. This means greater compressive stress, and greater pressure per square inch on the forward arc of contact *b c* than on the hinder arc *c d*; besides which the area over which this greater intensity of pressure is distributed is also greater. The difference between these pressures evidently increases with the angle of "retardation of phase," *i.e.*, the angle between *c' c* and the vertical; and this angle is sensibly proportional to the speed *v*. The difference also increases with the load, but probably not so rapidly as in simple proportion to the load.

Whether an exact calculation of the elastic resistance to rolling is possible or not, I cannot say. The difficulty of the problem has hitherto baffled my attempts at its solution. Ten years ago I thought that I had calculated a superior limit above which the actual resistance could not lie. The energy of a wave corresponding with the maximum upward velocity of the road surface behind the wheel—which maximum occurs at *d*, the last point of contact—was calculated, this wave being considered to penetrate to a depth dependent on the elasticity of the road material and on the speed of the wheel. The power wasted by being thrown into the road as vibration was taken as proportional to this. It is, however, needless to give the details of this calculation, as I no longer believe it to be an approximation to the truth.

ROBERT H. SMITH.

THE PHYSICAL SOCIETY.

AT the last meeting of the Physical Society, May 23rd, 1885, Professor Guthrie, president, in the chair, Dr. A. H. Fison was elected a member of the Society.

The following communications were read:—"Experiments showing the Variations caused by Magnetisation in the Length of Iron, Steel, and Nickel Rods," by Mr. Shelford Bidwell. The subject of the extension and retraction of bars of iron and nickel under the action of magnetic force has been investigated by Drs. Joule and A. M. Mayer and by Mr. Barrett. In the present experiments the magnetising force has been increased, with the result of bringing out some striking and novel characteristics. The apparatus employed consisted of a vertical magnetising helix, considerably longer than the experimental rod, the latter forming the central portion of a compound rod, the two ends being of brass. The lower end of this rod is plane, and stands on a firm support; the upper end is a knife edge, which bears against a brass lever 18 cm. in length, about 1 cm. from the fulcrum; the portion of the rod to be examined is in the central portion of the helix. The above lever is furnished with another knife edge at the end, which acts in a similar manner on a second lever, at the extremity of which is a small mirror. A lamp and vertical scale being placed at a distance of 470 cm., the slightest motion of the mirror could be read with great accuracy, an elongation of the bar amounting to $\frac{1}{100000}$ mm. being easily detected. A few of the more important results are as follows:—In the case of soft iron, the bar continually increased in length till nearly saturated, up to which point Mr. Joule had traced it, but then it reached a maximum, decreased, and continued decreasing to the limit of the experiments, at which point the retraction was about double of what the extension had been. The effect depended upon the thickness of the bar, an increase of diameter diminishing the maximum extension, and increasing the critical magnetising force, or that force which produced the maximum extension. The results seemed to show that this extension varied inversely as the square root of the diameter of the bar. The general behaviour of steel was the same as that of soft iron, but the critical point varied with the hardness and temper of the metal, appearing to be a minimum for steel of yellow temper. The results of experiments upon nickel coincided with those obtained by Professor Barrett, the effect of magnetisation being to cause a continuous retraction greater than that obtained with soft iron.

In answer to Professor Hughes, who believed that the effect of the coal was always to produce retraction of the bar, the extension at first being due to the molecular arrangement of the particles during magnetisation, Mr. Bidwell further described an experiment showing that the action of the coil was to produce the extension of a magnet. Two thin strips of soft iron fastened together at the ends, their central portions being about 2 centimetres apart, were placed in the coil. On making the current the ends were drawn out, the sides coming together.

Professor Forbes suggested that the effect of thickness was really owing to the irregularity of magnetisation produced by the ends, and that in future experiments the middle of the bar only should be examined.

"On the Spectral Image Produced by a Slowly Rotating Vacuum Tube," by Mr. Shelford Bidwell.

"Note on the Action of Light in Diminishing the Resistance of Selenium," by Mr. Shelford Bidwell. As the result of their investigation upon the behaviour of selenium, Messrs. Adams and Day arrived at the conclusion that it conducted electrolytically. Since this would necessitate the assumption that selenium is not an element, according to accepted theories, caution must be exercised in accepting this. It seemed possible, however, that since the selenium in the cells had always undergone a prolonged cooking in contact with the metal terminals, selenides of these metals might exist in the selenium forming a kind of network, and thus affording conduction through the mass, which without the cooking is non-conducting. It had not been possible to test this directly, but a somewhat analogous case had been tried. Some precipitated silver had been heated for some hours with sulphur, and the clear liquid poured off. A cell was then made by coiling two silver wires side by side upon a strip of mica, the spaces between them being filled with the prepared sulphur which would contain a small quantity of sulphide of silver. It was found necessary to reduce the resistance of the cell by placing a small strip of silver leaf over the sulphur, and cook again. The cell thus prepared was very sensitive to light; by burning a piece of magnesium near, the resistance was reduced to one-third. Mr. Clark said that Mr. Bidwell's cells probably contained sulphides of copper or silver—substances which the researches of Faraday had shown conducted electrolytically in the solid condition. On the other hand, Cu_2Se and Ag_2Se conducted like metals, and were probably often present in the ordinary selenium light cells. Mr. Clark thought that Mr. Bidwell's paper raised this question: What influence had light upon the electrolytic conduction of Cu_2S and Ag_2S, and upon the metallic conduction of Cu_2Se and Ag_2Se?

"On Certain Cases of Electrolytic Decomposition," by Mr. J. W. Clark. The first part of this paper consisted of a critical examination of the behaviour of those substances which have been described as exceptions to Faraday's laws, with the object of generalising as to the condition of internal or molecular structure corresponding to their electrical properties. The second part described an experimental investigation into the nature of the conduction of fused mercuric iodide and mercuric chloride, both of which were stated to undergo electrolytic conduction. Decomposition and recombination of the products of electrolytic action may, however, follow so closely as to simulate metallic conduction. The first product of electrolytic decomposition of mercuric iodide was stated to be iodine and mercuroso-mercuric-iodide (Hg_4I_6), which latter, under the continued action of the current, yields free mercury. Similarly it was found that fused mercuric chloride, when electrolysed between graphite terminals, split up into chlorine and mercurous chloride. Metallic conduction—*i.e.*, conduction without decomposition—in fused compound solids, therefore, appears to be unknown.

"Note on Electrical Symbols," by Mr. J. Munro.

POWER FOR WOOD-WORKING TOOLS.

THE following is from an article in the American paper *Wood and Iron*, by Mr. W. Lee Church. Although the rates at which the sawing was done are not given, the figures are of some value. The writer says:—"I recently had occasion to make some indicator tests of power in planing mills. As there is a very general misapprehension of the actual power consumed by wood-working tools, some of the results may be instructive. The power given is in every instance the net power of the tool itself, exclusive of the friction of the shafting. The power for wood-working tools is usually a vague estimate from the belt transmission, and is liable to great error. The following results are, on the contrary, actual measurements under the conditions obtaining, and may be relied on as such, however much at variance with preconceived ideas.

The first test was made at the mill, and by the courtesy of Anson Eldred and Son, Fort Howard, Wis. Power: One 14in. by 14in. Westinghouse engine, 280 revolutions.

Total friction of shafting and engine	21·00
No. 38 Sturtevant exhaust fan, 1000 rev...	18·06
14in. rip saw, cutting 1in. stuff	5·33
14in. matcher, on 6in. pine	21·25
60in. circular re-saw, splitting 12in. pine	5·38
24in. matcher on 10in. pine..	7·66
Edger, 18in. saws, one cut, in 2in. pine	7·68
24in. circular re-saw, splitting 6in. pine	5·30
Double siding planer, rabbeting and surfacing two 6in. pine strips, both edges	11·20
30in. double surfacer, dressing 24in. wide	17·00
12in. moulder sticking one piece 2½in. ogee batten	12·33

It will be noted that the 24in. matcher, on 10in. stuff, required less power than 14in. matcher on 6in. stuff. The reason of this lay in the fact that the feed was slower on the larger machine.

The following results were from the mill of F. Blakesley, Schenectady, New York. Power: One 10in. by 10in. Westinghouse engine, 339 revolutions.

	Horse-power.
Friction of engine and shafting alone, net	8·97
One No. 31 Sturtevant exhaust fan	8·64
12in. matcher on 6in. spruce	15·21
Same running empty	10·01
24in. single surfacer, dressing 24in. spruce	9·75
Roger's No. 2 four-side moulder, sticking 2 by 1¼in. pine..	7·28

The following small tools were taken in a group in actual operation:—One 12in. rip saw, one 16in. cross-cut saw, one three-side sticker, one tenoning machine, one dovetail and boring machine, one band saw, one gig saw, one 12in. cross-cut saw; aggregate net, 7·02-horse power.

A further experiment was made to determine the power required to start a planer from a state of rest. The engine, shafting, and blower were first indicated alone, showing 8·97-horse power; the belt was then shifted on a 24in. double surfacer, and a continuous curve taken until full speed was obtained. The maximum power required to start the planer was 31·2-horse power net, the difference of 18·72-horse power being the amount of power required to develope the speed of the tool over that required to maintain the speed when reached. The above test was, of course, made with the planer running empty.

The above line of experiments indicates that more power is absorbed in driving ordinary planing mill machinery empty than is required to dress the lumber."

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.—A party of members of this Society visited the works of the new Hammersmith and Putney bridges on Saturday last by the kind permission of the engineer, Sir Joseph Bazalgette, C.B. Messrs. Dixon and Thorn are the contractors for the Hammersmith Bridge, and Messrs. John Waddell and Sons are the contractors for the Putney Bridge. These visits proved most interesting and instructive, particularly the one to Putney, as in these days of iron construction it is seldom an opportunity occurs for witnessing the erection of a masonry bridge upon the scale to be seen there.

RAILWAY MATTERS.

MR. J. HORNER, for some years connected with the Lancashire and Yorkshire Railway Company, Manchester, has been appointed goods manager. Mr. Stirling, of the Great Northern Railway, Peterborough, has been appointed locomotive superintendent of the Hull and Barnsley Railway.

FIRST-CLASS carriages are not much required on some German lines. The statistics have always shown that they are little used. On one of the State railway systems in the year to March 31st, 1883, only three passengers in a thousand travelled first-class, so that most of the trains must have no first-class passengers at all.

A TERRIBLE railway accident occurred near Rostoff-on-the-Don early on the 26th inst. A passenger train for Woronesh ran off the line, the engine embedding itself in the cliff, and the carriages, with the exception of the last three, being piled one upon the other and smashed to pieces. Three of the officials in charge of the train and one other person were killed, and nineteen of the passengers were injured, nine very seriously.

THE railways of New South Wales are the property of the Government. The Southern line is in operation from Sydney to Albury, a distance of 386 miles, and will be opened before the end of the present year to Albury, where it joins the line from the Murray to Melbourne. A branch is also being pushed on from Junee to Hay in a westerly direction. The Western line, which crosses the Blue Mountains previously referred to, is open to Wellington, 248 miles distant from Sydney, and is being extended to Bourke, 504 miles from Sydney, on the river Darling. A suburban line runs to Richmond and Parramatta; while from the important seaport of Newcastle there is a railway communication to Glen Innes, a distance of 399 miles; and to Narrabri, a distance of 320 miles; while numerous other lines are being commenced.

THERE is still running on the Western and Atlantic road in Georgia, hauling a passenger train, the old locomotive General, which—the *Railroad Gazette* says—was the pursued party in one of the most exciting chases on record. The locomotive was carried off by a small party of Federal scouts during the war, while the engineer and firemen were at dinner, and the train was stopping at Big Shanty. The pursuit was kept up for over 100 miles before the engine was finally recaptured, and she was only abandoned when entirely out of fuel and water and the journal bearings had been almost entirely melted out, the supply of oil having also run out. In this chase the General and the pursuing engine probably made the fastest time ever run on a Southern road, although all parties were too much engaged in the business on hand to keep any record of the actual speed.

IN concluding a report on the collision which occurred on the 28th March at Conniberry Junction, near Maryborough, on the Waterford and Central Ireland Railway, Major-General C. S. Hutchinson, R.E., says:—"This collison again draws attention to the want of brake power on goods trains and cattle trains. In the present case the available brake power consisted of a screw brake for the tender wheels and for the wheels of the brake van, *i.e.*, for wheels carrying weights of about 11 tons and 6 tons respectively; these weights probably not amounting together to more than one-sixteenth the total weight of the train. It would be a considerable addition to the available brake power if the engine wheels were supplied with a good steam brake, and I trust that the directors of the Waterford and Central Ireland Railway will be induced to order the fitting of their engines with such a brake with the least possible delay."

THE elevated railways in New York have been the subject of numerous reports by engineers eminent in the States, having special reference to the strength of the railway structures. From one of the reports it appears that the number of passengers carried by the elevated roads the five years ending September 30th, 1878, was only 16,032,778½; but for the five years ending September 30th, 1883, they carried 360,948,688. There were 96,702,620 carried by these roads the year ending September 30th, 1884. The increase of assessed value of real estate for 1885 should be 60,000,000 dols. over 1884. What it will be we shall see when we get the annual report of the Commissioners of Taxes and Assessments. The elevated railroads carried 389,501 passengers one day, and received for fares 29,211 dols.; another day they carried 360,845, and received for fares 29,229 dols. They carried 96,702,620 the year ending September 30th, 1884. They are now carrying at the rate of over 100,000,000 per annum, equal annually to eighty times the inhabitants of the city, twenty times the inhabitants of the State, and more than twice the entire population of the United States by the last census, and yet not half the miles of rapid transit road required, or soon to be required in the city, are built.

THE preparations of the Midland Railway Company for running the main line through New-street Station, Birmingham, instead of continuing to pass Birmingham on the south-east, are rapidly approaching completion. The improvement has been effected by utilising what was formerly called the West Suburban Railway, a line which, branching off from the main line at King's Norton, ran into the town but not into New-street. This line has been straightened, widened, and carried forward into New-street, and on July 1st it is proposed to abolish Granville-street Station and run trains from King's Norton into New street. Main line trains will probably be carried by the new route before the end of the year. The work was begun in the autumn of 1883, and in the course of it several large girder bridges and a viaduct have been erected. One girder bridge covers a road 14 yards wide, and is 160ft. long. It is supported upon twenty-four hollow columns and thirty-four girders, which give a clear headway of 14ft. A new viaduct has been constructed over the canal near Selby Oak. In this viaduct there are two principal girders, each 126ft. long, and each weighing 47 tons. One of these, with the assistance of some armour-plate trucks from Sheffield, capable of bearing 40 tons each, was brought on to the ground from Greek Bridge entire; the other was built up in position. The bridge is carried upon eight piers, and the total length of the viaduct is 800ft. The aggregate amount of the contracts for the whole work is about £200,000, and the quantities include more than 1200 tons of ironwork. The contractor is Mr. Jos. Firbank, of Newport, Monmouthshire.

THE Railway Administration at Frankfort-on-the-Main have, according to the *Journal of the Society of Arts*, recently repeated some experiments on the lighting of trains by electricity, which are said to have been attended by most satisfactory results. The experimental train was composed of a first, second, and third-class carriage, and a luggage van, which contained a special compartment for the dynamo and accumulators. The dynamo was of the Moehring type, and was driven from the axle of the wheels of the van, and at a velocity of 700 revolutions per minute, when the train was running at a speed of eighteen to forty-two miles an hour. When the train is running at full speed, the lamps remain in circuit whilst the accumulators are being charged, but when the speed is less than eighteen miles per hour the current is supplied direct from the accumulators, a specially constructed automatic commutator regulating its intensity. During the day the lamps are thrown out of circuit, and the twenty-six accumulators are charged by the dynamo when the train is in motion. This installation weighs about 12 cwt., and costs £125. The train was lighted by twelve incandescent lamps, of which two were in the luggage van, two in the third-class carriage, four in the first, and the remaining four in the second-class carriage. The cost of fitting each carriage varies from £3 4s. to £4. These experiments are said to demonstrate the practicability of lighting trains by electricity, the light being perfectly steady during the journey, and at variable speed, and even during stoppages at stations; only at starting a slight oscillation was perceptible. As all is regulated automatically, no attendant is required, it is said, except at starting. The experiments were continued for six weeks, at the end of which time everything was found in perfect order. The cost of lighting is estimated at ten centimes per lamp per hour.

NOTES AND MEMORANDA.

IN London last week 2391 births and 1554 deaths were registered. The annual death rate per 1000 from all causes, which have been 18·7 and 19·1 in the two preceding weeks, rose to 19·9. During the first seven weeks of the current quarter the death rate averaged 20·8 per 1000, against 22·1 in the corresponding periods of the nine years 1876-84.

THE deaths registered during last week in twenty-eight great towns of England and Wales corresponded to an annual rate of 21·1 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 Bolton, Halifax, Bradford, Leicester, Bristol, and Salford.

THE iron imports into New South Wales during 1884 included the following:—3025 tons iron castings, 19,387 tons galvanised iron castings, 558 tons galvanised iron manufactures, 9860 tons iron pipes, 1788 iron tanks, 8275 tons iron wire, 34,260 tons iron and steel, and 48,880 cwt. iron nails. This does not include machinery, railway plant, &c.

To test the enamel or tinning of cooking vessels, &c., for lead, M. Fordoz recommends a drop of strong nitric acid placed on the enamel or tinning, and evaporated to dryness by gentle heat. The spot where the action of the acid has taken place is then wetted by a drop of solution of potassium iodide—5 parts iodide to 100 of water—when the presence of lead is at once shown by the formation of yellow lead iodide.

IN his instructions relating to sewer works, Sir R. Rawlinson observes that Portland cement and lias limes make good hydraulic mortar. The proportions of cement, or of lime to sand, should not exceed two and a-half of clean sharp sand to one by measure of ground Portland cement or lias lime. If clean furnace ashes or slag is available, there may be two of sand and one-half of ashes or slag, the whole to be mixed in a revolving pan, each pan-full to have twenty minutes' grinding. When mortar is used with bricks, the beds and joints should be spread thick and full over the entire area of both bed and joint, leaving, when pressed into place, a bed and joint never less than ⅛in. in thickness of mortar. In four cubic yards of completed brickwork there should not be less than one cubic yard of mortar incorporated. In making mortar or concrete it will be of the utmost importance to use clean materials and to preserve them clean. The water used for wetting bricks and for mixing concrete and mortar must be free from salt. Concrete and mortar should also be used on clean surfaces.

FOR constructive purposes in dockyards, piers, bridges, house carpentry, coachmakers' and wheelwrights' work, railway building, fencing, and piles, nearly the whole of the *Myrtacca*, of which New South Wales possesses something like fifty varieties, are extremely valuable, and certain of them incomparably so. For the uses of the cabinet-maker and the house decorator, the timber familiarly known as the black-apple, the Moreton Bay pine, the red cedar, coach-wood, Clarence light-yellow-wood, turnip-wood, rose-wood, Illawarra mountain-ash, tulip-wood, myall, cypress-pine, and others, is capable of being worked up into furniture and panelling, beautiful in grain, rich in colour, and susceptible of a high polish. The timber of the prickly-leaved ti-tree (*Melaleuca styphelioides*) is said to be incapable of decay; that of the white ti-tree (*Melaleuca leucadendron*) is said to be imperishable under ground; that of the turpentine-tree (*Syncarpia laurifolia*) resists the attacks of the *teredo navalis* in salt water; and that of the brush-bastard or white-box (*Tristania conferta*) has been known to preserve its soundness, when employed in building the ribs of a ship, for a period of thirty years. To the carver and wood engraver the cork-wood (*Duboisia myoporoides*), the rose-wood (*Dysoxylon Frasernum*), and the pittosporum (*undulatum*) commend themselves as a serviceable substitute for European box; while the cooper finds in the native ash (*Flindersia Australis*), the silky oak (*Grevillea robusta*), the stave-wood (*Tarrietea actinodendron*), the green and silver wattle (*Acacia decurrens* and *Acacia dealbata*), and the swamp-oak (*Casuarina quadrivalvis*) excellent material for staves. Other kinds of timber are specially adapted for oars, spokes, and naves, tool-handles, telegraph poles, and turners' work.

THE exceptionally heavy rainfall at Bergen on October 25th, 1884, when 74 mm. were registered for the twenty-four hours, was commented on at the time by the Scandinavian press as affording confirmatory evidence of the truth of the popular opinion that this town is the rainiest place in Norway. This notion, however, like many other traditional beliefs, has been dissipated by the test of carefully-conducted scientific observations, for we learn from *Naturen* that the annual mean of its rainfall is exceeded by that of two among the other seventy Norwegian meteorological stations. Thus, while at Bergen 1722 mm. are measured annually, the rainfall at Domsten and Florö amounts respectively to 1951 mm. and 1873 mm. It has further been shown that 105 mm. rain were registered at Holmedal, on the Söndfjord, on the same day that the rainfall at Bergen reached 74 mm., the highest recorded since rain measurements have been made there. There are, in fact, eighteen instances given by the meteorological reports in which the rainfall has elsewhere exceeded the latter measure. Among these the most remarkable have been supplied by Ullensvang and Flesje, at the former of which stations there fell in one day—December 8th, 1884—113 mm. rain; while at the latter 112 mm. were registered for the twenty-four hours on March 15th, 1882. These downfalls, the highest recorded in Norway since the observations were begun in 1875, have been exceeded, according to Dr. Hamberg, of Stockholm, at the Swedish station of Hernösand, where 118·5 mm. rain fell on August 19th, 1878. These facts refute the opinion that more rain falls at Bergen both in the year and in the course of one day than at any other place in Scandinavia. Such, however—says *Nature*—is the character of the annual distribution of rain in this locality, that the chances are about equally in favour of a wet or a dry day.

AT a recent meeting of the Berlin Physical Society, Dr. Kalischer described a new secondary battery, intended to overcome the disadvantage of the usual accumulators—namely, that the sheet of lead used as anode was very soon destroyed. This object he is said to have attained by adopting a very concentrated solution of nitrate of lead as electrolyte, and iron as anode. The iron, on being immersed in the solution of lead, became passive, and resisted every corroding effect of the fluid; in other respects the peroxide of lead on the electric charge became deposited at the anode as a very firm coherent mass, enveloping and protecting the iron on all sides. The charge was continued till the greater part of the nitrate of lead was decomposed, a condition which was marked by the occurrence of a greater development of gas at the anode. At the beginning of the charge all development of gas must be avoided, as otherwise the peroxide of lead, or, more correctly, the hydrate of peroxide of lead, became covered with bubbles. As cathode a sheet of lead was used, but it was attended by two disadvantages. In the first place the lead, during the charge, separated itself at the cathode into long crystal threads, which soon passed through the fluid and produced short closing (of the current.) In the second place the nitric acid, which remained in the fluid after the separation of the lead, acted very powerfully on the sheet of lead. Both disadvantages Dr. Kalischer avoided by amalgamising the cathode. This accumulator of iron, concentrated solution of nitrate of lead, and amalgamised lead yielded, after the electric charge, which could be carried out without any special preparations, a current of about 2 volts; after about six hours' discharge, however, the electro-motive force sank to 1·7 volts, but, on the battery being left to itself for twenty-four hours, it became a little increased. According to the measurements hitherto taken, the functions of this accumulator were satisfactory. An attempt to substitute sulphuric manganese for nitric lead in this battery did not answer the purpose, as the peroxide of manganese separated itself, not in a continuous layer, but in loose scales.

MISCELLANEA.

THE Columbo breakwater has been finished, and the Ceylon *Observer* strongly advocates the construction of a northern arm to the breakwater and of docks.

THE Society of Arts *conversazione* will be held, by the permission of the Executive Council of the International Inventions Exhibition, in the Exhibition-buildings, South Kensington, on Friday, the 3rd of July next.

THE Lord Mayor has signified his intention of receiving and entertaining the members of the Association of Municipal and Sanitary Engineers and Surveyors on the occasion of the annual meeting, which is to be held in London at the end of June.

A FLOWING artesian spring has just been tapped by an Abyssinian tube well, sunk by Messrs. Le Grand and Sutcliff, to a depth of 72ft., at the North Northumberland Aërated Water Manufactory, Alnwick. The boring had reached the upper series of the limestone shales and sandstone when the water was struck, and rose 8ft. above the surface.

NEW showrooms have been opened by Messrs. Crossley Bros. at Renfield-street, Glasgow, in the new building which takes the place of that recently destroyed by fire. The showroom has been tastefully arranged and decorated to show that an engine need not necessarily be accompanied by dirt and smoke. The premises are lighted by Swan-Edison electric lamps.

AT a recent meeting of the Society of Arts, Mr. Parker said that petroleum had been accidentally discovered at a place near Grenoble, by a chance visitor, who had resided for some time in the petroleum districts of America. He bought the whole of the land about the place, and the workings were now going on. He had very nearly arrived at the *couche* of the petroleum, having driven down 139 metres. The quantity of gas was increasing, and he expected to be able to light Grenoble and several of the neighbouring towns with it.

THE Minister of Agriculture opened at Brussels, on Monday last, the first sitting of the Congress on Inland Navigation. M. Somzee, a member of the Belgian Chamber, was elected president. The Congress discussed fifteen questions relating to canals. A member of the Suez Canal Commission explained why an enlargement of the existing canal was preferred to the construction of a second. Afterwards Messrs. Leader and Adamson, of Manchester, described the Manchester-Liverpool Canal, and advocated a project for converting Brussels into a seaport. Finally, a scheme for making Bruges again a seaport was considered.

THE Bath and West of England Society's Show commences on Monday, June 8th, at Brighton, and will considerably surpass any of its predecessors in the number of its stock entries. A department of special interest has been introduced this year in the exhibition of a working dairy. Here lectures and explanatory illustrations will be given, the subjects treated including the most recent improvements in butter-making, the processes of making the soft cheeses of the Continent, and of Devonshire butter and cream. Miss Smithard and Mr. Jas. Long, of Granvelly Manor, leading authorities on dairying subjects, will give explanatory lectures at certain hours on each day of the meeting. There will be a very extensive exhibition of implements, machinery, seeds, &c., all the leading implement firms being represented.

THE Surprise, one of the two steel twin-screw despatch vessels built by the Palmer Shipbuilding Company, Jarrow, has arrived at Portsmouth to be completed. She was launched on the 17th of January, and is intended to replace the Admiralty yacht Enchantress. The Surprise—which is rigged as a three-masted schooner with a clipper bow, and has a handsome appearance—has a length of 250ft. and a beam of 32½ft., with a displacement of 1400 tons. The engines are of the horizontal compound type, having cylinders of 26in. and 50in. diameter, with a stroke of 34in. They are arranged to work with closed stokeholes, into which the air is forced by four fans, 4ft. 6in. in diameter, and working at 500 revolutions. When tried on the Tyne, the Surprise, under natural draught, realised 16·74 knots, with 2260-horse power; and under forced draught, 17·8 knots, with 2700-horse power. The contract was for 2000 horses and 17 knots.

THE report of Mr. William Crookes, F.R.S., Dr. William Odling and Dr. C. Meymott Tidy on the water supplied to London during April, states that "throughout the preceding months of February and March, the water supply manifested, although but in a moderate degree, what may be called its wintry characteristics; which our results show to have been put off altogether in the supply of the past month. Thus, while the maximum proportion of organic carbon in the Thames-derived water furnished in February and March was ·256 part, and the mean proportion ·181 part in 100,000 parts of the water, the maximum proportion in the water furnished during the past month was ·152 part, and the mean proportion ·141 part in 100,000 parts of the water—the seasonal improvement, it is noticeable, being shown as much in the greater uniformity of the samples, as in the mean reduction of the rarely otherwise than small proportion of organic matter present. Of the 167 samples examined, the whole were found to be perfectly clear, bright, and well filtered."

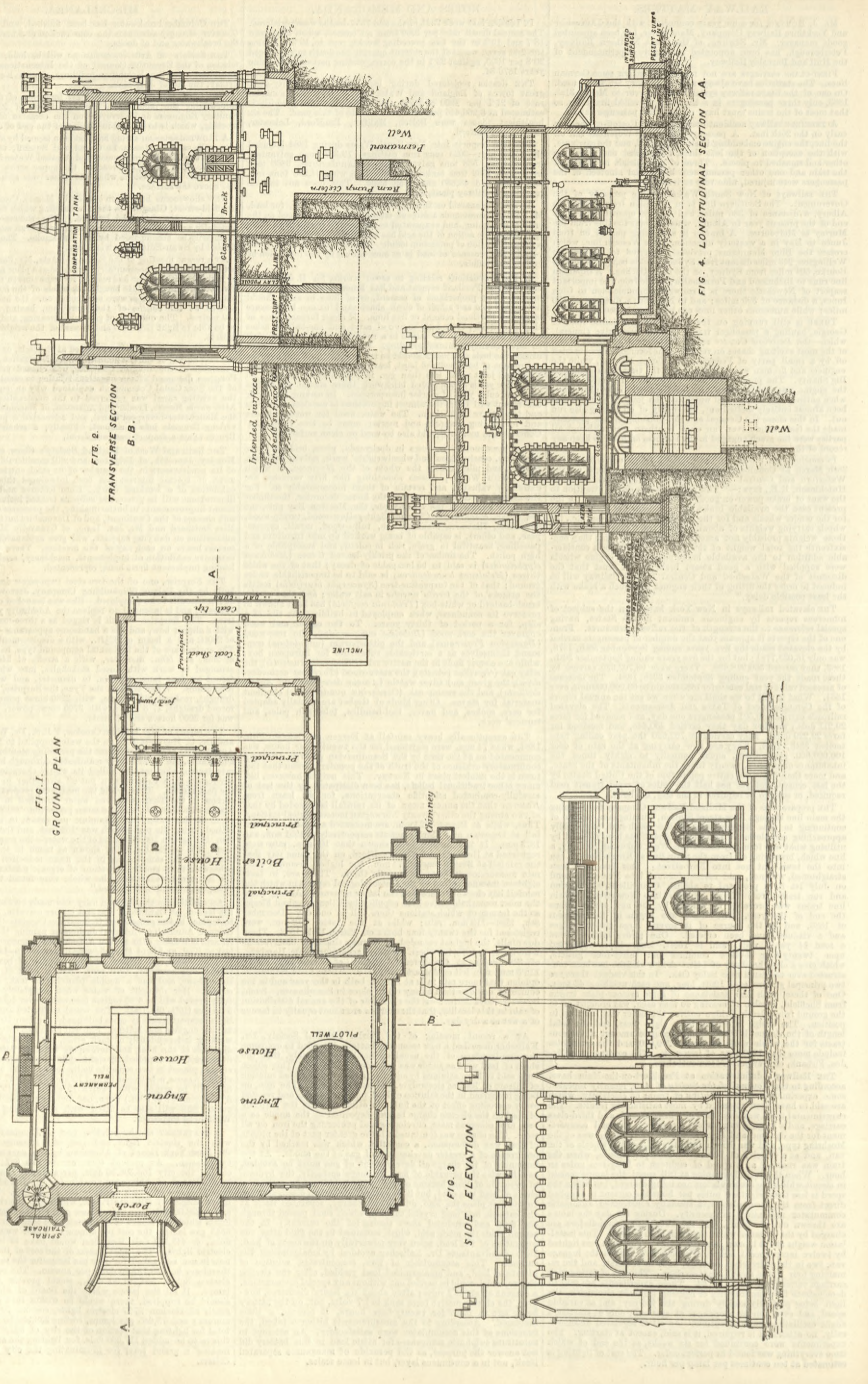
AN addition to the German navy was made on the 18th inst. by the launch, at Dantzic, of the fast cruiser corvette, Arcona, which took place in the presence of General von Caprivi—the chief of the German Admiralty—Admiral Jachmann naming the vessel. The Arcona is a sister ship to the Alexandrine, launched in February last at Kiel, and is of the following dimensions:—Length between perpendiculars, 72 metres (237ft.); breadth of beam, 13 metres (42ft.); displacement, 2370 tons. She is built of iron and steel throughout, and has a double planking of teak, sheathed with copper. Her draught of water when completely fitted up and fully armed will be 4·60 metres (somewhat over 15ft.) forward and 5 metres (16ft. 6in.) aft. The vessel is divided into eight watertight compartments by cross bulkheads, the two largest ones containing engines and boilers. She will have two compound engines, working independently of each other, placed side by side in the direction of the keel, and developing together 2400-horse power. Steam will be supplied by eight cylindrical boilers, four to each engine, placed in two separate boiler rooms. The estimated speed of the Arcona is between 14 and 15 knots (16 to 17 miles) an hour. She will be armed with twelve 15 centimetre (5·85in.) and two 8·7 centimetre (3·39in.) guns, one light gun, and four Hotchkiss guns. She will also be fitted with a launching apparatus for Whitehead torpedoes.

A STATEMENT of the relative cost of illuminating the streets with the electric light and gas was recently placed before the New York Board of Aldermen by the secretary of the Gas Commission. At present there are in use 647 electric lights, costing the city 165,308.50 dols. per annum. Resolutions passed by the Board of Aldermen provide for the introduction of 2093 more, the cost of which would be 534,761.50 dols. The lights now in use displaced 3016 gas lamps, which cost the city 52,780 dols., or 112,528.50 dols. less than is now paid for the electric lights. The lights which the Board of Aldermen have asked for would displace 5345 gas lamps, the cost per annum of which would be 93,537.50 dols., or 441,224 dols. less than would have to be paid for the electric lights. The total excess of the cost of the electric lights now in use and asked for over gas lamps for the same area would, therefore, be 553,752.50 dols. per annum. The cost of the 2093 electric lights, 534,761.50 dols., would provide for 30,557 gas lamps. If all the lamps which the Board of Aldermen ask for should be supplied, there would be within that part of the city south of Harlem 2740 electric lights, costing 700,070 dols. per annum; and 13,685 gas lamps, costing 232,986.50 dols., making a total for lighting that portion of the city of 932,956.50 dols. To this is to be added 117,630 dols. for lighting the annexed district, making a grand total for illuminating the city of 1,050,686.50 dollars.

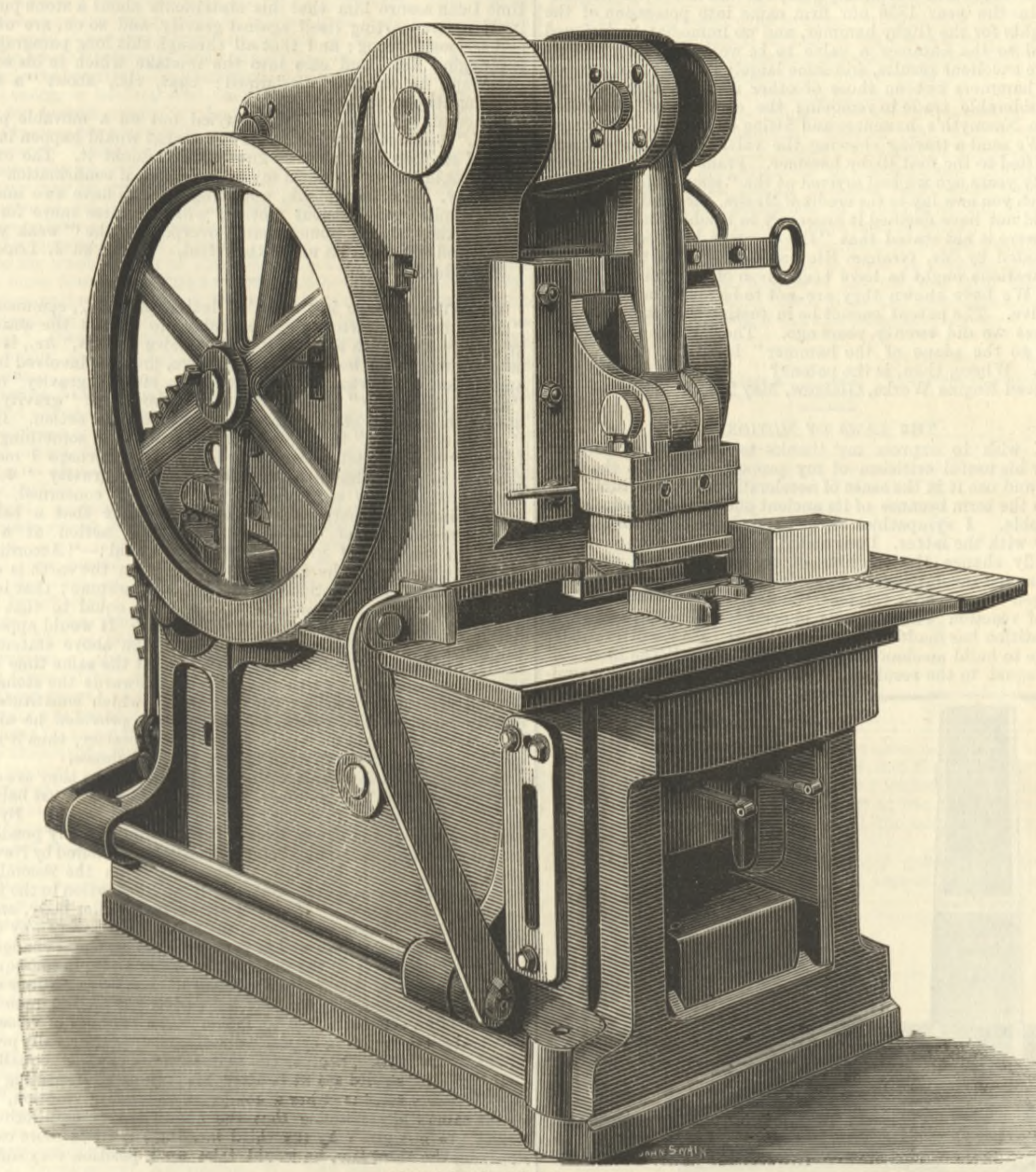
THE ST HELENS WATERWORKS—KNOWSLEY PUMPING STATION.

MR. D. F. M. GASKIN, M.I.C.E., ENGINEER.

(For description see page 419.)



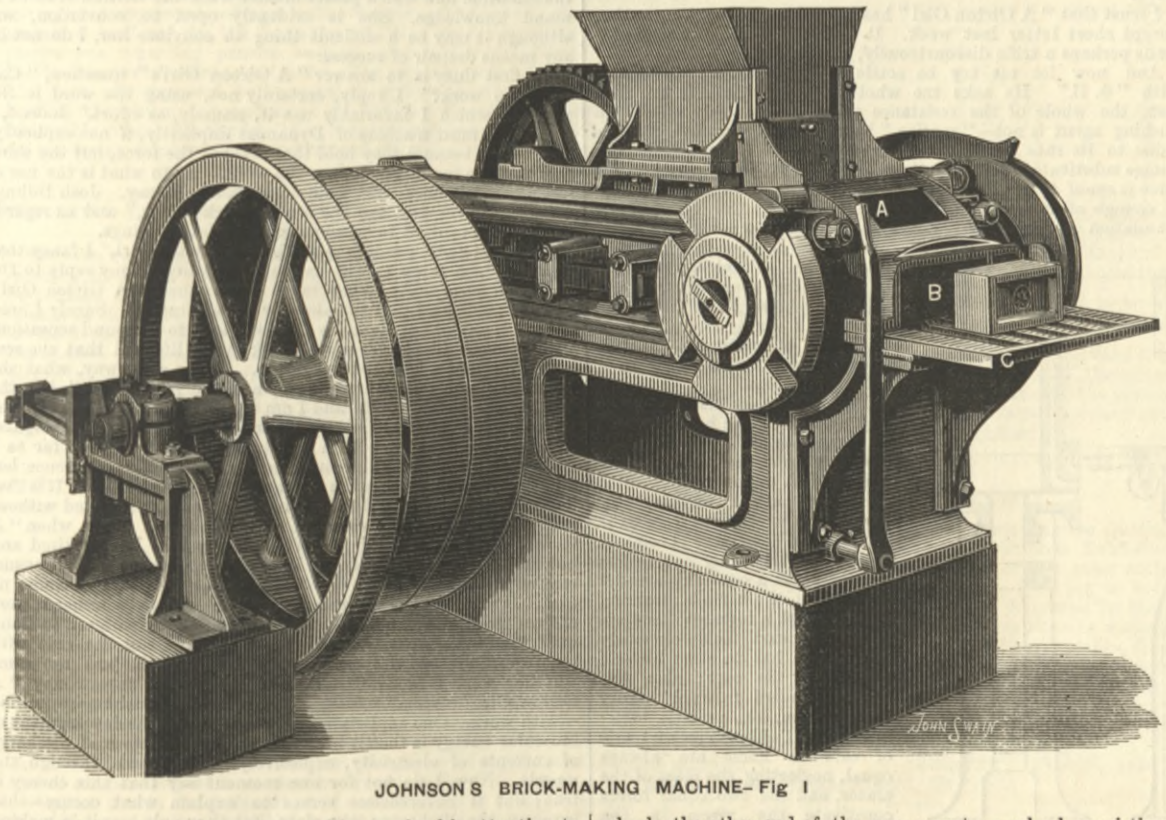
INVENTIONS EXHIBITION—JOHNSON'S BRICK MACHINERY.



JOHNSON'S BRICK PRESS—Fig. 2

THE brick-making machines which we illustrate by the accompanying engravings are exhibited in the South Gallery, North Court, of the Inventions Exhibition, by Mr. W. Johnson, of Cardigan Works, Leeds. They consist of a brick-making and a brick-pressing machine designed to work in conjunction with each other, to produce economically the best quality of pressed fronting bricks. Mr. Johnson is himself one of the largest brick manufacturers in Yorkshire, and it has been the great necessity he has found for improvements so as to work the greatly varying kinds of clay satisfactorily, and also to reduce the costly wear and tear, and to secure more independence of skilled labour, which have caused him to give his attention to the construction of machines. The machines he has arrived at experimentally are adaptable to all kinds of clay, and will produce bricks either in a plastic or in a semi-plastic state, and firm enough, if desired, to be taken direct to the kiln without intermediate drying, and by this saving considerable cost in shedding and in labour. Both machines are strong and simple in arrangement, though they are not heavy and require no foundation.

The brick-making machine, Fig. 1, is provided with a hopper into which the clay is delivered; the bottom of this hopper constitutes a feed-box, one side of which is formed by a die cylinder A, which rotates intermittently; by the action of this cylinder the clay is continually worked, and is prevented from sticking or clogging. Within the feed-box there works a reciprocating ram, which at each forward stroke forces a portion of clay into a die or mould in the cylinder. The action of filling one mould propels the previously formed brick out of the diametrically opposite mould B of the cylinder and delivers it on a table C. The ram is worked from a crank, and is so arranged that its stroke can be regulated to give the pressure required, according to the nature of the clay under treatment. The crank shaft is driven by a spur wheel and pinion from the first motion shaft, upon which are the pulleys which receive the belt from the engine. The mould cylinder is rotated intermittently by an arm worked by a crank pin on the outside of the main spur wheel; the other end of the arm operates a wheel, consisting of a pair of discs and four studs or pegs. For each revolution of the crank shaft the cylinder is turned one-fourth of the revolution. The motion of the cylinder is steadied by a brake strap which spans the shank, and on the opposite side of the cylinder is a disc plate containing dies, which are entered by a sliding rod and pin working in a slot and driven by a pin in a disc plate on the end of the crank shaft, and locks the cylinder in position while the brick is being formed; it then moves out, leaving it at liberty to turn round. The machine, we are informed, is capable of turning out perfectly sound bricks at the rate of from 10,000 to 12,000 per day, two boys only being required for attendance.



JOHNSON'S BRICK-MAKING MACHINE—Fig 1

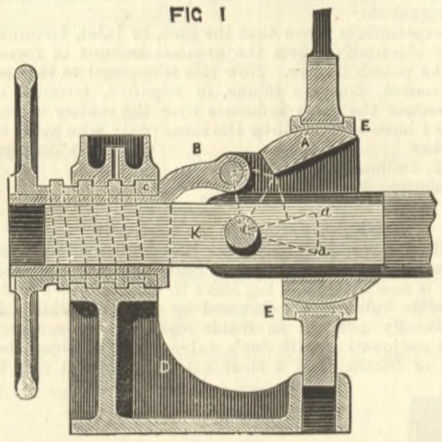
The brick-pressing machine finishes the brick from the brick-making machine, and can also be used singly for pressing both ordinary building, facing bricks, and for white and coloured glazed bricks. The crank shaft, which is driven by a spur wheel and pinion, operates, through a connecting-rod, the main beam, the shorter end of which works the die. By this arrangement a great pressure is obtained in a simple manner. The pressed brick is raised from the die by a plunger worked from a cam on the crank shaft, and is then pushed forward by an arm operated by an excentric on the same shaft. The motions are all direct and rigid, and cannot get out of order.

It is not only for making bricks from clay that the machines are said to do good work, but for making them from colliery and quarry refuse, and from small coal, commonly called patent fuel.

TRIPIER'S SPHERICAL EXCENTRIC.

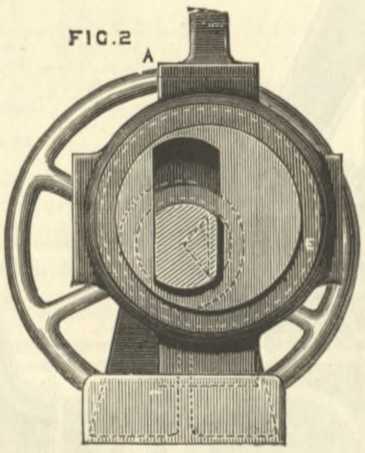
THE accompanying engravings represent an ingenious device for obtaining an adjustable cut-off by means of one excentric of spherical form. On a flattened part of the crank shaft the excentric A is placed, and pivotted at K, Fig. 1, which shows

FIG 1



the excentric in the position at which it gives the largest travel to the valve. At B is an ear, by which the excentric is also attached to and controlled by a projecting arm on a collar which revolves with the excentric, and the position of which is adjustable by the screw C and hand-wheel. By turning this screw the

FIG.2



excentric may be set so that its centre may be in any position between a and a^1, and thus the cut-off may be altered without altering the lead. The mode of application of the excentric is, of course, variable, and may be made to suit different forms of land and marine engines.

LETTERS TO THE EDITOR.

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

NEW ELECTRICAL EXPERIMENTS.

SIR,—While experimenting with vacuum tubes on the 23rd inst., I observed a phenomenon of which I have seen no published account. The source of electricity used was a coil machine, the primary coil being excited by a battery. Having by the means of a small insulated gas flame determined the direction in which the current of electricity was passing between the terminals of the secondary coil, I applied the plus or electricity, giving terminal of the coil to the right arm of a V-shaped vacuum tube, and the minus or exit terminal of the current I attached to the left-hand terminal of the V tube. As seen in the dark, the right-hand arm of the tube was full of pink coloured rays of light extending from the platinum terminal at the top of the arm down to nearly the bottom, but not to the very bottom of that half of the tube; the pink rays of light stopped at a horizontal line parallel with the upper edge of the bent part of the tube. The left arm of the tube was filled with a greenish-yellow light, which extended round the turn at the bottom of the tube until it met the horizontal line of pink light in the right arm of the tube. The greenish-yellow light filled all the left arm of the tube except a small inverted pyramid of pink light which was attached to the under side of the platinum disc, which forms the inner end of the terminal of the tube. This small inverted pyramid of pink light was evidently kept in existence by particles of the pink light coming from the right arm of the tube; but these particles of pink light were invisible as they passed up through the greenish-yellow light in the left arm of the tube; it was only on their arriving close to the platinum disc that they became visible as they rushed against it.

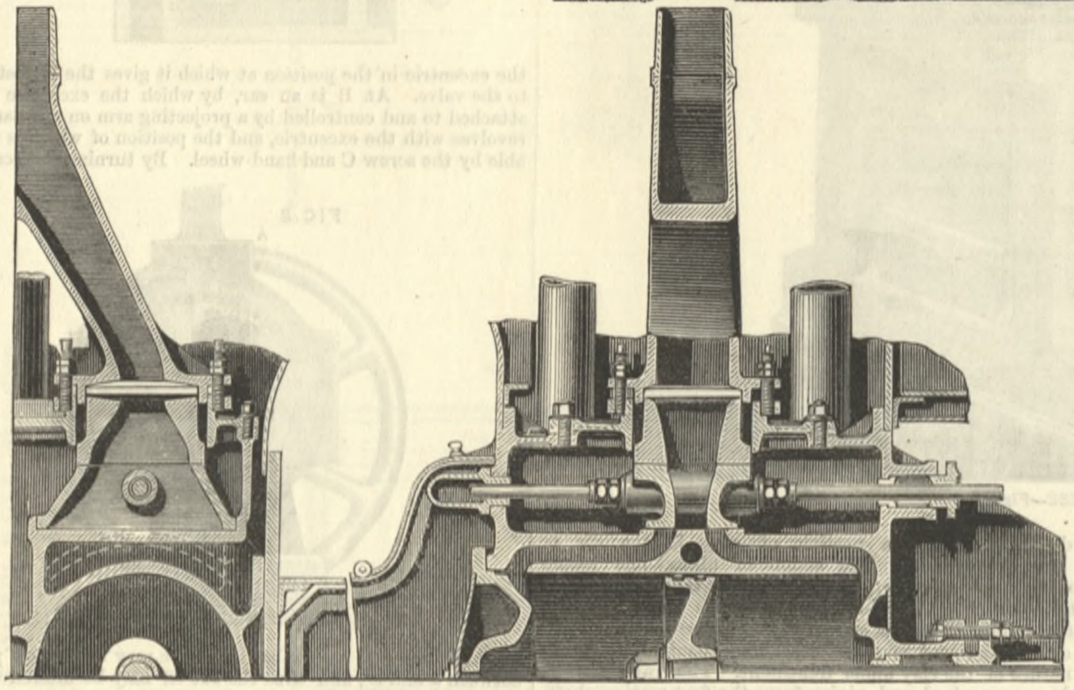
This state of matters led me to think that a change would take place if I inverted the tube and used it like a letter Λ instead of a V. Having inverted the tube, I passed the electricity through it in the same direction as before. The right arm of the tube was again filled with rays of pink light, which now turned the corner of the tube and descended into the left arm, filling it also with the pink light. From this it was manifest that either the magnetism of the earth or the attraction of gravitation had been the cause why the pink light did not freely ascend into the left arm of the tube when it was used like a letter V. To determine this question, I made the following experiment with a straight vacuum tube 13½in. in length between the inside terminals and ⅝in. in diameter, and having at one end of it a small chamber for holding potash, so that when the latter is heated the vacuum may be partially destroyed. When this tube has been undisturbed for some days, and then electricity passed through it, throughout the length of it there is nothing visible but the greenish-yellow light, similar to that which is seen in the V tube. But after the potash has been heated, the tube is filled with striæ of pink light. When about to make the following experiment, I first tested the straight tube with electricity while it lay in a horizontal position, and found that it had not had time to fall back into the state of greenish-yellow light since the time I had previously heated the potash; there were still in the tube striæ of pink light which extended from the end by which the electricity was admitted to the tube to within 3½in. of the outlet terminal. I now placed the tube in a perpendicular position and admitted the electricity to it, so that the current went in by the bottom terminal and went out at the top one. While thus arranged the pink light extended from the bottom terminal to within 3½in. of the top of the tube. These 3½in. were filled with greenish-yellow light, and this part of the tube was quite transparent. The pink striæ in the lower part of the tube were well defined, being much flattened spheres, and the highest of these striæ were so flat on the top that there was a well defined line between it and the greenish-yellow light above. I now reversed the current of electricity, making it to descend through the tube. Immediately the whole appearance was changed. The great mass of the pink light was now at the top of the tube, and the 3½in. of greenish-yellow light at the bottom of it, with this very marked difference, that the pink striæ were no longer well defined; they seemed to run into one another, and there was no defined line between the pink striæ and the 3½in. of the greenish-yellow light at the bottom of the tube, and the latter was no longer transparent—the pink particles were seen descending through the greenish-yellow light. From these facts it is manifest that gravitation must be the force operating on the pink particles of potash, which, as far as is known, are not acted upon by the earth's magnetism.

These experiments prove that the plus, or inlet, terminal of the current of electricity exerts the greatest amount of force in controlling the potash matter. Now this is opposed to the statement of Mr. Crookes, that the minus, or negative, terminal of these tubes exercises the most influence over the matter within them. The tubes I have were made by the same party who made tubes for Mr. Crookes. JAMES JOHNSTONE.

Office, 8, Dalhousie-terrace,
Edinburgh, May 25th.

THE FRICTION OF SLIDE VALVES.

SIR,—Having read with great interest your leader and the following discussion on "The Friction of Slide Valves," and seeing that the latter is now flagging, I beg leave to enclose you a tracing of a relieved slide valve lately designed by me, and which, I think, seems specially adapted to inside cylinder locomotives, when worked in conjunction with Joy's valve gear, its object being the reduction of friction and a clear exhaust, while it may be made

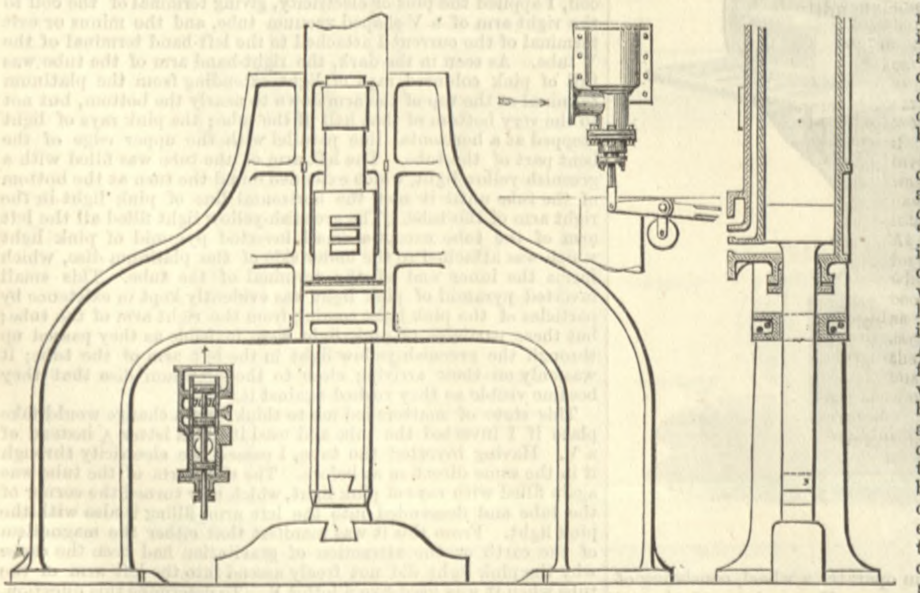


either a single or double-ported valve. The cylinders shown in the tracing are 20in. diameter by 28in. stroke—the largest that can be got between narrow-gauge frames, the distance between the centres being 2ft. 0½in. and the width between frames 4ft. 1in. The steam ports are 1¾in. long by 16in. wide. The construction of the valve is clearly shown in the tracing, and needs little explanation. HENRY R. LEAHY.

Liverpool.

STEAM HAMMERS.

SIR,—In your issue of the 15th inst. we observe illustrations and description of a steam hammer by Messrs. Dick and Stevenson. We have read the description with considerable interest, as it resuscitates old memories of the steam hammer, to which, with your permission, we will shortly refer. More than thirty years ago the late William Rigby, of Parkhead Forge, took out a patent



for "steam hammers and pile-driving machinery." The patent is dated 5th January, 1854, No. 25, and is of course open to the inspection of any one. The patent specifies that the ram or hammer bar is made in one piece with the piston, either a solid forging or hollow casting; it is of large diameter, flat on the sides, and the hammer face does not project over the side of the ram; in, fact, it is almost identical with that now illustrated by Messrs. Dick and Stevenson. For the convenience of those who may be interested in the matter, and who may not be able to refer to the patent specification, we send a tracing taken from the original drawing, from which the first Rigby hammer was made. The drawing is dated 4th February, 1854, and the hammer made was a 20 cwt.

It will be seen that the piston ram is large in diameter—as in Dick and Stevenson's, nearly the diameter of the cylinder—it is flat on two sides, the face is dovetailed into the end of the ram, and made so that it can pass up into the guide on the framing—all as in Dick and Stevenson's. The hammer as at first made was fitted with a slide valve and self-acting gear, but did not work satisfactorily. In the year 1856 our firm came into possession of the patent rights for the Rigby hammer, and we immediately designed and fitted to the hammer a valve to be worked by hand. This valve gave excellent results, and came largely into use, not only on our own hammers but on those of other makers. For years we did a considerable trade in removing the complicated self-acting gear from Nasmyth's hammers and fitting on our simple arrangement. We send a tracing showing the valve, front view and section, as fitted to the first Rigby hammer. From this it will be seen that thirty years ago we had arrived at the "simple thing in valve gear" which you now lay to the credit of Messrs. Dick and Stevenson. We should not have deemed it necessary to trouble you with these remarks were it not stated that "the hammer has been designed and patented by Mr. Graham Stevenson." We certainly think some indications ought to have been given of the points claimed as new. We have shown they are not to be found in the ram or in the valve. The patent cannot be in casting the framing in one piece; that we did twenty years ago. The "placing of the legs obliquely to the plane of the hammer" is an old device often practised. Where, then, is the patent? GLEN AND ROSS.

Greenhead Engine Works, Glasgow, May 20th.

THE LAWS OF MOTION.

SIR,—I wish to express my thanks to Professor Robert H. Smith for his useful criticism of my proposal to define the term reaction and use it in the sense of acceleration of momentum. He objects to the term because of its ancient odour, and because of its first syllable. I sympathise with both these objections, more especially with the latter. I was afraid, however, that the attempt to partially change the meaning of the term *inertia* would be regarded as too revolutionary; but after Professor Smith's letter I am disposed to reconsider this fear. In many ways the term inertia instead of reaction will do well; in some it will sound awkward, until repetition has made us accustomed to it. How will Professor Smith like to build mechanics on this foundation: "The inertia of a body is equal to the resultant force acting on it, both in magnitude and direction?" I, at any rate, must have time to think it over. Let me say, however, that I never thought of proposing to abolish the term "resistance"—a very useful and easily understood word.

I trust that "A Girton Girl" has not taken to heart my rather abrupt short letter last week. It was written hastily, and now reads perhaps a trifle discourteously, for which I am sorry.

And now let me try to settle my outstanding differences with "Φ. Π." He asks me whether, when there is no friction, the whole of the resistance which a free body offers to a pushing agent is not—"motion," he says; but he probably means "due to its rate of change of momentum." If he accepts the phrase substituted, I answer "certainly." I have never denied that force is *equal to* rate of change of momentum, or *measured by* rate of change of momentum. In fact, I call this the one law, the foundation of mechanics. What I objected to was the statement that force *is* rate of change of momentum. Perhaps, however, in the present connection, this is a mere subtlety, and it will be clearer if I simply say that rate of change of momentum is frequently one of the forces in a balanced system.

He further asks me whether a cart pulls back the horse as hard as the horse pulls forward the cart, and once more I answer "Yes, most undoubtedly." But if he had asked whether the cart was pulled back as hard as it was pulled forward, I should have said "certainly not, unless it be going at a constant speed." At starting, the horse is straining forward with a force greater than what the cart feels—obviously because he has to start himself as well as the cart; also, the cart is pulled forward harder than friction, &c., pulls it back; but the pull of horse on cart and of cart on horse are always equal, neglecting the mass of the traces, and the two equal forces constitute the stress in the said traces. The mistake which "Φ. Π." makes when he wrongly says that such a stress cannot start a cart, consists in thinking of the cart's pull back as a force exerted *on itself*. He denies this I know, but if he will do me the favour seriously to consider whether there be any truth in this statement of mine or not, I have hopes of the result.

Finally, he sets me two very easy puzzles—one concerning a thrown-up stone at its highest point, the other about two "young men" and a plank on rollers. His first puzzle is caused by confusing *rest* with *equilibrium*. Rest means no velocity; equilibrium means no acceleration. It is quite possible for a body to be in equilibrium without being at rest—*e.g.*, a body obeying first law of motion; it is also quite possible for a body to be at rest without being in equilibrium—*e.g.*, "Φ. Π.'s" stone at the top of its trajectory. Because the stone is at rest, "Φ. Π." jumps to the conclusion that no force is acting on it, and that it has no acceleration. This is a simple, bald mistake; and if "Φ. Π." is unwilling to admit it as such, I cannot help him. A correction of this mistake is not at all contradictory of his views on gravity, which are not greatly out of accord with my own. At the same time I can assure him that his statements about a stone pushing itself up, supporting itself against gravity, and so on, are utterly and seriously wrong; and that all through this long paragraph he is plunging head and ears into the mistake which in his second paragraph he strongly disclaimed: that, viz., about "a truck resisting its own motion."

Concerning the tug of war carried out on a movable plank, "Φ. Π." does not commit himself as to what would happen in this case; I suppose he thinks he knows, but I doubt it. The experiment would serve to confirm my explanation, if confirmation were necessary. The free plank, not being able to have two unequal forces applied to it without motion, will of course move forward directly the "strong young man" overpowers the "weak young man," and will fly from under their feet. OLIVER J. LODGE.

May 23rd.

SIR,—The passage in "Φ. Π.'s" letter, page 407, commencing, "According to Newton, a stone pushes up against the action of gravity just as much as gravity pushes down upon it," &c., is most astonishing. Two bodies, and only two, must be involved in any application of Newton's third law; thus, either "gravity" or the "action of gravity" must be the second body. If "gravity," we have a body—the stone—pushing up against an action. If the "action of gravity," then this body is the action of something else. I leave "Φ. Π." to tell us which is the body. Perhaps I may be allowed to state that even in the theory of gravity "Φ. Π." has hinted at, the earth, so far as we are concerned, plays a most important part; and it is just possible that a believer in the production of motion by force, and action at a distance, in the case of gravity would have said:—"According to Newton's third law, the action of the stone on the earth is equal and opposite to the reaction of the earth on the stone; that is, the stone pulls the earth upwards with a force equal to that with which the earth pulls the stone downwards." It would appear as though two forces were concerned from the above statement; such is not the case, there is but one which at the same time urges the stone towards the earth and the earth towards the stone. If anyone prefers to consider the two parts which constitute this duality force, as two forces, he may do so, provided he always considers them to act on separate portions of matter, thus it is impossible for them to be in equilibrium, *i.e.*, to balance.

Newton's third law deals with these parts, and as they are equal and opposite, "Φ. Π." assumes, wrongly, that they must balance; he does not notice that they act on different bodies. By this assumption he easily shows that "force cannot by any possibility produce motion," a statement emphatically contradicted by Newton, qualitatively in the first law, quantitatively in the second, and both qualitatively and quantitatively in an illustration to the third. I quote a translation. "If a body strike on another body, and by its force change the momentum of the latter body in any way whatever, its own momentum will in turn undergo an equal change in a contrary direction from the force of the latter body, in consequence of the equality of the mutual pressure. By these actions equal changes are produced, not in the velocities, but in the momenta, *i.e.*, in bodies otherwise free to move. The changes of velocities, which also take place in opposite directions, are reciprocally proportional to the masses, because the momenta are changed equally."

If "Φ. Π." should see fit to alter his statement respecting force to "Probably force is either a condition or mode of motion," and at the same time—noticing that the conditions of equilibrium of bodies are not given by the third law—use a little more care in applying the third law, he would take up a position very difficult to attack.

Professor Lodge's eagerness to administer instruction has led him into error. He has not understood my "objection," and he has credited me with a statement made by Clerk-Maxwell, which I restated; but as he admits that my use of the word inertia, though possibly not the popular use, is strictly correct, I will say no more on this subject. E. LOUSLEY.

Dublin, May 26th.

SIR,—"A Girton Girl" writes like a philosopher and a lady—a rare combination, and like the diamond, valuable not alone for its rarity but for its beauty. Indeed, no experience that I have had in discussion can at all compare with the pleasure it gives me to cross swords with such a foe—a foe, too, who is, I think, within an ace of coming over to my side, for she is not steeped to the lips in the scientific lore which passes muster with the normal student as sound knowledge. She is evidently open to conviction, and although it may be a difficult thing to convince her, I do not by any means despair of success.

My first duty is to answer "A Girton Girl's" question, "Can Force do work?" I reply, certainly not, using the word in the sense in which I invariably use it, namely, as effort. Indeed, I think that most teachers of Dynamics implicitly, if not explicitly, admit this, because they hold that it is not the force, but the thing exerting the force, which does the work. As to what is the use of force unless it does work I am quite unable to say. Josh Billings says, "I never kud see the use of black snaiks," and as regards Force, I am content to be no wiser than Josh Billings.

Concerning other points raised by "A Girton Girl," I fancy that they are to a large extent answered already by my reply to Dr. Lodge on page 407. What takes place when "A Girton Girl" pulls or pushes a truck remains for consideration. Surely I need not tell a student of Berkeley that it is easy to confound sensations with things. She never saw a trunk in her life; all that she sees is the image of a trunk on her retina. In the same way, what she feels when she pushes or pulls is not the push or pull, but the cause of the push or pull; and I am now about to call, not only the attention of "A Girton Girl," but that of your readers, to a singular circumstance connected with physical effort to which, so far as I am aware, no thoroughly complete and competent reference has ever been made by either the engineer or the physiologist. It is that muscular work may be done and nervous energy expended without the production of any external work whatever. Thus, when "A Girton Girl" pulls at a heavy trunk, she makes herself tired and hot, without moving the box. If a locomotive were to pull unsuccessfully at a heavy train, it would lose no steam and consume no fuel. It would make no difference to the engine whether it were chained to a tree, and full steam turned on, or suffered to stand unchained with steam turned off; but this is not the case with manifestations of vital energy. The fatigue is just the same whether work is done or not; and this is one reason why "A Girton Girl" associates force—that is to say, pushing or pulling—with work. One explanation among many of the development of muscular energy is that it is due to the rapidly repeated discharge of currents of electricity, explosively, so to speak, through the muscle. Now, I do not for one moment say that this theory is true; but it nevertheless serves to explain what occurs—that is to say, the discharges take place, but they only result in making the muscle tense; but the fatigue experienced is due, not to the tension of the muscle, but to the discharges of electrical energy. To put this in another form, if we suppose that a locomotive attached to a heavy train is unable to move it, but that instead it slips its wheels round on the rails, then steam will be used and fuel burned just as though the train were drawn. But "A Girton Girl" in referring to the movement of a trunk is wandering a little, for the thing opposing her efforts is not the mass of the trunk, but the friction between it and the floor. Mount the trunk on wheels, and its resistance would be so small that "A Girton Girl" need not either overheat herself or get cross. Furthermore, I never said for a moment that there was no such thing as effort connected with motion. On the contrary, I assert that there is always a stress set up when motion is communicated to boxes, or trains, or garden rollers, or stones, or little birds knocked off twigs. Of course, I do not deny that a stone or a ball thrown through the air can do work; nay, more, it cannot possibly help doing work. Until it can part with its motion to something else it must, in the nature of things, and because there is no other alternative, go on, like Mynheer van Dunk with the cork leg, for ever. This is to say, that a thing moving must go on moving until it stops, but it cannot stop until it has transferred its motion to something else. This is the whole doctrine of the conservation of energy in a nutshell, only I always write it "conservation of motion," for motion is energy, and energy is nothing else than motion. Will "A Girton Girl" try for herself—*pace* Dr. Lodge—and see how beautifully simple this basis is for all calculations and dealings with the conservation of energy. Take, for instance, that *ignis fatuus*, perpetual motion. A man may go on for ever deceiving himself with some notion that energy may be created or stolen; but let him once understand that he cannot get motion unless something else previously moving stops or loses some of its motion, and it is almost impossible for him to deceive himself further. Again, see how this view kills at once the whole theory of attraction. We know that a keeper cannot move toward the magnet unless something else previously in motion parts with some of its motion to move it. What explanation can the doctrine that force causes motion give of such phenomena? Not one that is not flatly opposed to the conservation of energy, and forcibly denounced by the great master, Sir Isaac Newton.

Before I conclude, I would like to ask "A Girton Girl" what would she say if I were to give her an instance of a body acquiring accelerated velocity while no force—effort—at all is acting on it? Will such a fact not go some way to convince her that force is not the cause of motion? We have not far to search for the phenomenon in question. When a heavy body drops freely it ceases to have weight. In other words, gravity exerts no push on it. The most delicate spring balance fails to detect the least token of weight in a body falling and acquiring velocity at the rate of 32ft. per second. That is to say, work is being done, and yet not the slightest trace of effort in the shape of downward push can be detected. Can it be said in this case that force is doing work? The work is done and yet there is no force in operation. This is not the place or the time to draw a mathematical deduction of the nature of gravity from this phenomenon. Has "A Girton Girl" ever before heard of work being accumulated without effort? I think not, because this aspect of the action of gravity has never been even hinted at by any writer on Dynamics, at least by any writer whose books I have read. On the contrary, the student is always told that the force, that is to say, the effort of gravity, accelerates the falling body. Yet it is not only a mathematical truth, but a truth which admits of experimental verification, that no force of any kind acts on a body falling freely in vacuo. The body under such conditions possesses mass, but not weight. Why should such truths as these be kept from the student?

May I conclude with one question, Has "A Girton Girl" ever met with an example of force to which motion was not directly antecedent? Φ. Π.

London, May 25th.

SIR,—"Φ. Π." forgets to say whether the chalk line is to be on the floor of the class-room or on the plank in his new tug of war. One has tried a similar experiment in landing from a small boat, and not always escaped dry shod, and I fear the strong young man risks a bad back fall. But is it not true that the disputants should distinguish clearly between conundrums intended to fog Dr. Lodge, and more serious matters, or we shall be having Achilles and the tortoise and all the rest of the logic-book fallacies brought out to waste the time and confuse the thoughts of Girton Girls and many others besides your obedient servant W. A. S. BENSON.

23, Young-street, Kensington, W., May 26th.

INDIAN PUBLIC WORKS DEPARTMENT.

SIR,—With reference to your issue of 20th February last, and a letter therein from a Mr. John I. de Johgh, C.E., that gentleman will be surprised to hear that there are Government colleges for training civil engineers in India; and besides men who have passed from those colleges, there are others who have worked out here before joining the Public Works Department. All these men joined the Public Works Department as Civil Engineers, and from living a certain time in India before joining, know the language, manners, and customs of the natives. But your correspondent will be greatly surprised to learn that for the very reason of having been appointed in India, the prospects of these same men are much worse than those nominated in England. In fact, the very fact of having been appointed out here by the Viceroy—the Queen's representative—and not by the Secretary of State for India, utterly damns one regarding pension and in some instances furlough, besides favours regarding service, &c. The pay is the same, I grant. The men are supposed to be equal in ability, worth, &c., but because they were not appointed in England they receive less favourable rules. On the face of it, it is an absurd anomaly, which we are trying hard to get abolished, and sincerely hope to.

UNITY.

THE RATIO OF CONTRACTION OF AREA TO ELONGATION IN TESTED BARS.

SIR,—In recording the results of tests of material it is now common to record the percentage of contraction of area and the percentage of elongation as figures valuable in deciding on the quality of the material tested. No one, I suppose, has any clear notion of the relation of these two quantities, and as Mr. Hackney has already pointed out, there are often extremely wide discrepancies between the two percentages. For instance, from the experiments on steel made for a Committee of the Institute of Civil Engineers, on precisely similar bars, we get:—

No. of bar.	Contraction of area per cent.	Elongation per cent.
923	46·6	11·8
943	32·0	10·6
1255	42·3	19·0
1275	34·3	18·8

Where there is not only no agreement in the amount of the percentage, but no correspondence in the way in which the percentages vary for different bars.

While considering that in such materials as wrought iron and steel the bar becomes nearly or quite plastic near the point of fracture before breaking, it occurred to me to work out the relation between the contraction of area and elongation of a plastic bar, and to compare this with results already obtained.

Suppose that in the deformation of a plastic bar the volume does not change. Let l be the initial length and d the initial diameter of a bar which, when plastically elongated, has the length $l + \lambda$ and the diameter $d - \delta$.

From the constancy of volume we get—

$$\frac{\pi}{4} d^2 l = \frac{\pi}{4} (d - \delta)^2 (l + \lambda)$$

$$\left(\frac{d - \delta}{d}\right)^2 = \frac{l}{l + \lambda}.$$

Now the contraction of area is—

$$\frac{\pi}{4} \left\{ d^2 - (d - \delta)^2 \right\} = \frac{\pi}{4} d^2 \frac{\lambda}{l + \lambda}.$$

Hence—

$$\frac{\text{contraction of area}}{\text{initial area}} = \frac{\lambda}{l + \lambda}.$$

So that, for a perfectly plastic material, the percentage of contraction of area is not proportional to the percentage of elongation calculated on the original length of the bar, but to the percentage of elongation calculated on the stretched length of bar.

Further, if a correspondence between the percentage of elongation and the percentage of contraction of area is to be found, the elongation must be measured on the very short length of bar which reaches a plastic, or nearly plastic, condition during the test.

Now a very exact experimental verification of the formula above in tension experiments on iron or steel is not to be expected, even if, as I suppose, these materials become plastic before fracture; for in general the elongation is not measured on a short enough length in the neighbourhood of the fracture, and from want of homogeneousness in the material the length in which the elongation is measured, does not remain cylindrical. Besides this, both the exact measurement of the contraction of area and of the elongation, in a short length, are attended by difficulties. Nevertheless, an approximate check can be obtained from those experiments in which the ultimate elongation in a length of 1in. or 2in. near the point of fracture happens to have been recorded.

From the Report of the committee of the Institute of Civil Engineers, 1868, Tables A, B, C, D, it is possible to get the elongation in 1in. or 2in. lengths of the bar, and also the contraction of area. The following table gives the comparison for seventeen exactly similar bars of rolled and hammered steel:—

Material.	Number of bar.	Length, inches.	Contraction / Original area $\frac{\omega}{\Omega}$	Elongation / Stretched length $\frac{\lambda}{l+\lambda}$
Bessemer steel	943	2	·32	·22
"	1194	2	·55	·31
"	1285	1	·44	·35
"	1028	1	·58	·34
"	1174	2	·56	·36
"	1305	1	·37	·30
"	923	1	·47	·35
"	1038	1	·59	·42
"	1184	2	·44	·32
"	1295	2	·41	·27
"	1275	2	·34	·27
"	1255	1	·42	·30
"	1265	2	·09	·00
Crucible steel ..	873	1	·44	·20
"	1078	1	·37	·25
"	1147	1	·54	·40
"	1068	2	·03	·03

Here the agreement is perhaps as close as could be expected, the numbers rising and falling together, and the contraction calculated from the elongation in one or two inches being generally three-quarters of the actual contraction at the point of fracture. This ratio three-quarters may be called the coefficient of form for this material.

The following results for ordinary qualities of iron are from some measurements of my own, on bars of very different qualities and dimensions.

Material.	Length. in.	$\frac{\omega}{\Omega}$	$\frac{\lambda}{l + \lambda}$
Iron bar	2	·24	·20
"	2	·28	·20
"	2	·42	·27
Angle iron	2	·15	·15
"	1	·19	·23
"	1	·08	·12
Iron plate	2	·02	·03
"	2	·12	·11
Steel plate	2	·39	·29
Delta metal	2	·09	·07
"	2	·27	·32

Where, again, the agreement is probably as close as the nature of the measurements permits. Of course, if for ω could be substituted, not the contraction at fracture, but the mean contraction in the 1in. or 2in. measured, the agreement ought to be exact. The calculation shows that the error of assuming the contraction at fracture to be the mean contraction in 1in. or 2in. length is not great.

The following results are calculated from data given by Prof. Kennedy in the discussion on Mr. Hackney's paper—1884 :—

Material.	$\frac{\omega}{\Omega}$	$\frac{\lambda}{l + \lambda}$
Good iron	·15	·13
"	·23	·17
"	·21	·22
"	·26	·19
"	·35	·25
"	·11	·09
"	·26	·22
"	·10	·07
Iron plate	·09	·05
"	·11	·08
"	·21	·19
"	·19	·17
Basic steel	·51	·31

The elongations were measured in 2in. of length. All the discrepancies, except those which may be due to errors of measurement, show that for the most ductile materials 2in., and even 1in. is a greater length than corresponds to the final yielding, so that the ratio $\frac{\lambda}{l + \lambda}$ is smaller than it would be if measured on a shorter length of bar.

The agreement, however, is close enough to show what the contraction of area really means. It is the measure of the amount of purely plastic yielding, after the stress has reached the pressure of fluidity. It seems also clear what is the relation between the percentage contraction and percentage elongation.

Central Institute, May 25th. W. C. UNWIN.

RAWORTH'S FRICTION GEAR.

SIR,—In your description of the Raworth friction driving gear for dynamos exhibited by us at the Inventions Exhibition, we notice you raise a question about the wear of the paper surface of the friction pulley on the dynamo spindle. We beg to say that, practically, no wear takes place there, as is proved by the great length of time some of these gears have been running without any repairs. We may here mention that one of these plants, driving a 300-light Siemens machine—S D—recently made a continuous run of one month, at the end of which period both engine, driving gear, and dynamo were in as good a state as when started; and when we saw it some time after, we were informed that the engine brasses had not been touched since the run, the engine still running quite silently. BROWETT, LINDLEY, AND CO.

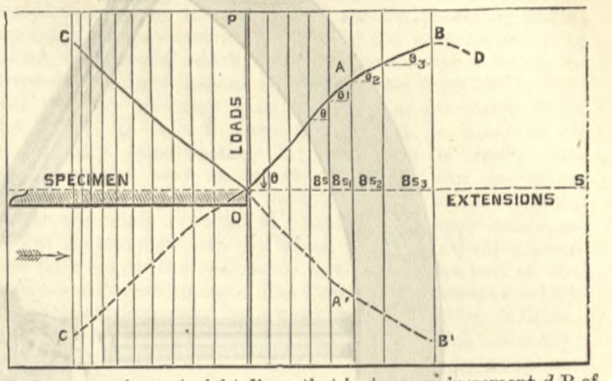
Sandon Engine Works, Salford, May 25th.

STRAIN DIAGRAMS.

SIR,—Being interested in the question of strain diagrams, you will perhaps allow me to add a few remarks in continuation of Professor Unwin's contribution to your last issue.

In the first place, it may be well to draw attention to the fact that it makes no difference whether the extension curve be plotted with extension abscissæ and load ordinates or conversely. In both cases we arrive at the same plane curve, as can easily be seen by referring to the annexed figure, merely illustrative, where the curve O A_1 B_1 becomes the duplicate of O A B when folded upon the axis O S of extensions as a hinge. Similarly, by turning O C over O P as a hinge, we obtain the copy of the compression curve as given by Professor Unwin in the right quadrant, with the difference that his compression curves are concave, though so steep as to require very little tilting to make them convex. The curve O A B is of the kind described by Professor Unwin, being plotted with load ordinates; whereas the copy O A_1 B_1, looked at from the direction of the arrow, is the ordinary extension curve plotted with load abscissæ. The curve only changes with the relative dimensions of the scales chosen for load and length.

The novelty, however, is what Professor Unwin terms the plastic stage of the experiment; and it is this part of his letter which I find difficult to reconcile with previous ideas. I must therefore be pardoned for being so sceptical as to question whether the plastic period forms, in the strict sense of the term, a proper continuation of the experimental or elastic stage preceding it. I can best explain my meaning by using mathematical expressions. Let us first take the extension curve O A B on the right of the figure. From O to



A the curve is a straight line: that is, to every increment $d\,P$ of load there corresponds a proportionate increment $d\,s$ of length. In plainer terms, load and extension vary in the constant ratio $\frac{d\,P}{d\,s} = \tan.\,\theta$. During this period the increase of length in the specimen takes place at a constant rate, which, for the want of a better term, we may call the velocity of extension; then we have $s = vt$, and if $\frac{dP}{dt}$ be the rate of addition of load, or the rate at which the saddle weight is run out,

$$\frac{d\,P}{d\,t} = \frac{d\,P}{d\,s} \cdot \frac{d\,s}{d\,t} = v.\tan.\,\theta$$

where v and $\tan.\,\theta$ are constant within the limits of the period taken. Beyond these limits the case is totally different, for here we meet with accelerated extension, so that $s = \frac{1}{2} f t^2$ and $\frac{d\,P_1}{d\,s_1} = \tan.\,\theta_1$; $\frac{d\,P_2}{d\,s_2} = \tan.\,\theta_2$, &c. Wherefore—

$$\frac{d\,P_1}{d\,t} = \frac{d\,P_1}{d\,s_1} \cdot \frac{d\,s_1}{d\,t} = \tan.\,\theta_1 \,.\, f_1 t = v_1 \,.\, \tan.\,\theta_1.$$

But, since $d\,P = d\,P_1 = d\,P_2$, we have—

$$d\,s \,.\, \tan.\,\theta = d\,s_1 \tan.\,\theta_1,$$

and therefore—

$$v_1 \tan.\,\theta_1 = v \tan.\,\theta,$$

which leads to

$$\frac{d\,P}{d\,t} = \frac{d\,P_1}{d\,t}.$$

In order, therefore, that the experiment may not lose cast, we must have $\frac{d\,P}{d\,t}$, or the rate of addition of load, constant both in magnitude and sign. This holds with equal force in the case of compression, for then $\frac{d\,P}{d\,s}$ and $\frac{d\,s}{d\,t}$ are concurrently negative, leaving $\frac{d\,P}{d\,t}$ a constant and positive quantity.

But what takes place in the plastic stage? Here, if I interpret Professor Unwin aright, $d\,P$ becomes either actually or implicitly negative; that is, either the load is gradually eased off so as to prolong the life of the specimen, or—which comes to the same thing—the reduced load is found by the formula for plastic extension; otherwise autographically determined. Meanwhile $d\,s$ remains positive; the bar still elongates. In the plastic stage, therefore, $\frac{d\,P}{d\,t}$ is either actually or implicitly negative, proving that the continuity of the experiment has been broken. From this point of view, the plastic stage does not form a proper continuation of the previous elastic period. It is, in fact, a new experiment, beginning definitely at what Professor Unwin appropriately terms the limit of plasticity. Nevertheless, we must admit that the plastic condition of the metal is being prepared and foreshadowed in the second or imperfect stage of elasticity, tending to alter and destroy the complexion of that period, as made manifest in the roundedness of the curve.

I should also like to point out that the plastic curve is of a very singular form, being, relatively speaking, a compression curve, differing probably in most cases from an ordinary compression curve in the sign of its curvature. I am inclined to think, although Professor Unwin's curves do not bear out my views, that the compression curve should be convex, and the extension curve concave, to the axis of extension. Abstract reasoning, however, must yield precedence to actual experiments, where these have been conducted with requisite care and skill and are not in open contradiction to accepted principles. From time out of mind writers on the subject have insisted chiefly upon the unbroken and steady addition of load at a constant rate, the absence of jerks, and the rest. It is, however, open to legitimate doubt whether slight changes in the rate of addition of load would have as disastrous an effect upon the character of a test as a sudden leap from positive to negative increments of load, which is precisely what either actually or implicitly takes place in the plastic stage. It will be granted that so long as the load and extensions simultaneously increase, though it may be at different rates, the phenomenon of elastic extension is predominant; when, however, the curve turns or runs parallel to the axis of extensions, the two phenomena are manifest in equal degree; but when the curve begins to plunge towards the axis, plasticity obtains, and we might therefore call this the plastic stage of the experiment. I must in consequence enter a feeble protest against applying the term "plastic" to a portion of the curve, in which elasticity and plasticity coexist, but where nevertheless elasticity prevails.

May 27th. R. H. G.

THE HEBERLEIN BRAKE.

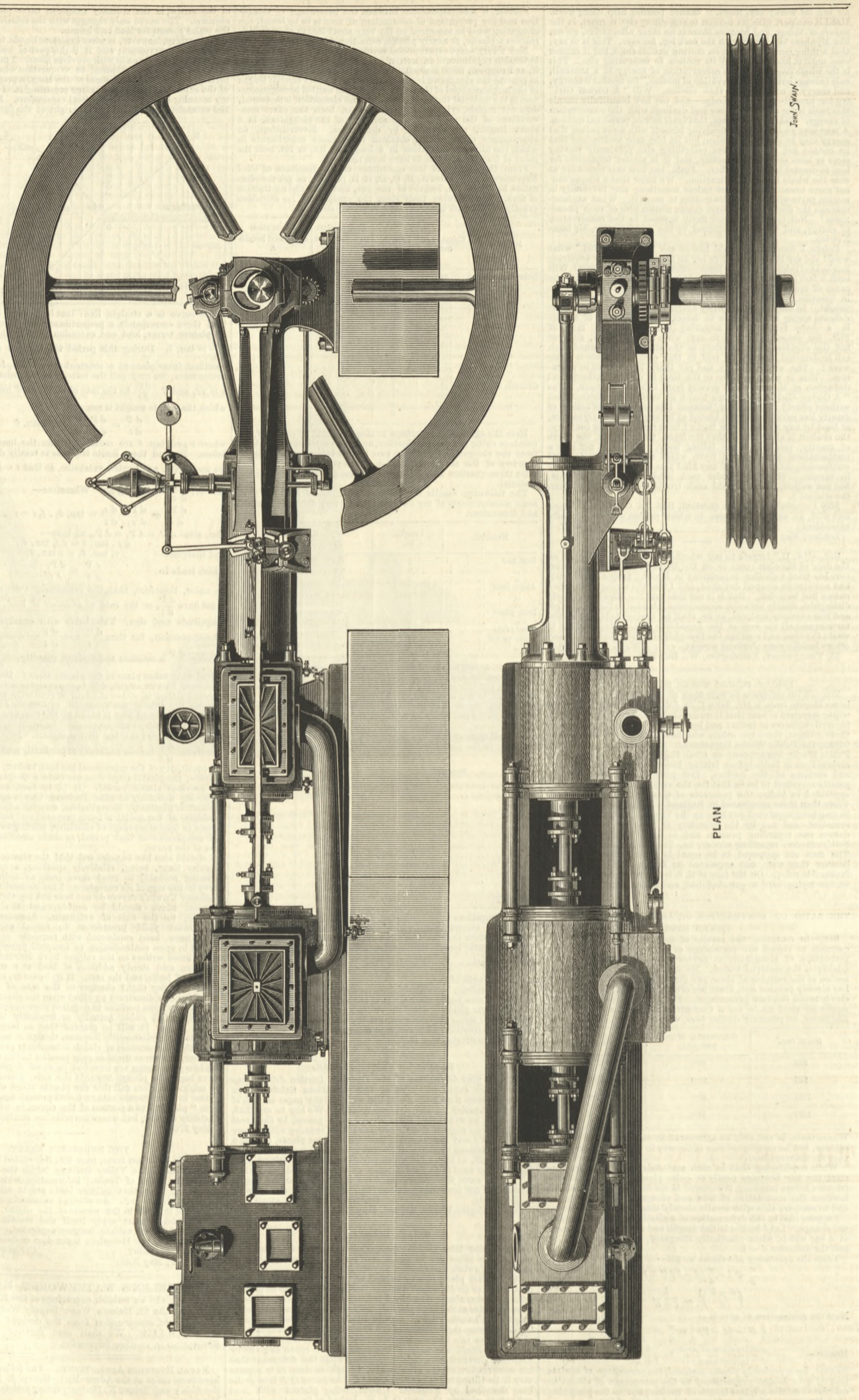
SIR,—In your last issue, page 408, it is stated that the Heberlein brake on the Colne Valley Railway fulfils the well-known conditions of the Board of Trade. Information which has to-day been sent to me from that railway leads me to ask for some further details on the subject. An efficient automatic continuous brake is one which is fitted to the wheels of the engine, tender, and every vehicle, and it must apply itself and remain "on" even if the engine and every vehicle become separated. I should therefore like to know if the Heberlein brake does or does not comply with these requirements? CLEMENT E. STRETTON.

Leicester, May 26th.

ST. HELEN'S WATERWORKS, KNOWSLEY.

ON page 416 we publish engravings of the Knowsley pumping station of the St. Helen's Water Supply Works, which is now in course of construction from the designs of Mr. D. M. F. Gaskin, M.I.C.E. We shall give further illustrations and description in another impression.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Henry J. Loch, engineer, to the Asia; and Robert K. Herbert, acting assistant engineer, to the Hercules.



HORIZONTAL COMPOUND CONDENSING ENGINE.

MESSRS. G. K. STOTHERT AND CO., BRISTOL, ENGINEERS.

(*For description see page 422.*)

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TO CORRESPONDENTS.

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

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

R. P. D.—*Sheath the cable with iron wire like a telegraph cable.*

ENGINEER.—*There is at present no book published on the gas engine which will give you the information you require. Mr. J. Emerson Dowson, of 3, Great Queen-street, S.W., could give you information concerning the use of the Dowson gas apparatus.*

R. E.—*You can not only grant a licence for the working of a sealed patent, but you can bind yourself to grant licences for all improvements you may patent referring to the same invention. As a man may manufacture with comparative safety under a provisional protection, you can grant a licence. Everything depends on the way in which the agreement is drawn up. As to selling or assigning a patent, you cannot sell or assign what you have not got, but you can sell or assign such rights as you may possess under a provisional specification. Consult a solicitor.*

ASBESTOS MACHINERY.

(*To the Editor of The Engineer.*)

SIR,—Will any of your readers inform me of some good firm who are makers of machinery for making asbestos rock into cloth packing, &c.?

H. D.

TIN BOXES.

(*To the Editor of The Engineer.*)

SIR,—Can any reader inform me where I can get small tin boxes stamped out by machinery? The tin-plate workers here to whom I have applied say that they are not made in England, but in Germany.

Herts, May 26th. A. W.

SUBSCRIPTIONS.

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MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, June 2nd, at 8 p.m.: Annual general meeting, under revised bye-laws, to receive the report of the Council, and to elect the Council for the ensuing year. Friday, June 5th, from 9 to 12 p.m.: The President's *conversazione* in the International Inventions Exhibition, by permission of the Executive Council.

SOCIETY OF ENGINEERS.—Monday, June 1st, at 7.30 p.m.: A paper will be read "On Portland Cement," by Mr. Henry Faija, the principal points of which are as follows:—The relation of the qualities of fineness and weight; self-contradictory and vaguely worded specifications; the objects of testing; details and practical working of a cement test; form of specification recommended; some German chemical tests.

ENGINEERING SOCIETY, KING'S COLLEGE, LONDON.—Thursday, June 4th, at 4 p.m.: Paper to be read by Mr. Adams "On Incandescent Lamps."

CHEMICAL SOCIETY.—Thursday, June 4th, at 8 p.m.: Ballot for the election of Fellows. "On the Constitution of the Haloid Naphthaline Derivatives," by Professor Meldola.

DEATH.

On the 20th May, at 56, Lansdowne-road, Notting-hill, PETER WILLIAM BARLOW, F.R.S., Mem. Inst. C.E., aged 76 years, elder son of the late Professor Barlow, F.R.S.

THE ENGINEER.

MAY 29, 1885.

LEAD IN STEAM ENGINES.

WE have received a letter from Mr. S. Yokoi, of Tokio, Japan, which we have not space to print. This letter, however, raises a question concerning which a considerable diversity of practice obtains among engineers; and it is, therefore, worth while to deal here with the points raised, not only for the benefit of our Japanese correspondent, but of many other readers of THE ENGINEER. It appears that Mr. Yokoi has read a passage in the "Journal" of the Franklin Institute which criticises a statement made in Forney's "Catechism of the Locomotive." Mr. Forney advocated lead. The writer in the Franklin Institute "Journal" says of this, among other things: "The original statement, made by good English authority about the years 1830 to 1835, has held its place in all text-books of succeeding dates, has gone to misinform German students on its travels, and has come to America translated to impart error here. As a general assertion, it may be correct that 'it is essential to ensure good action of the steam that the maximum cylinder pressure shall be attained at the very commencement of the stroke,' but as applied to a running engine it is altogether erroneous. For easy motion of an engine, the prevention of shock, and relief of bearings from excessive pressure and subsequent friction and loss of power, it is desirable that as the piston approaches the end of its stroke, the exhaust shall have been closed, so as to form a cushion that will absorb the momentum of the reciprocating parts, and relieve the pressure on the slide valve at its time of opening; and the back pressure will then be just that needed to give to the moving parts their proper velocity in the other direction. And then, *after the centre is well passed*, the pressure of steam should be slowly admitted, reaching a maximum not earlier, perhaps, for high-pressure non-condensing engines, than one-fifteenth or one-twelfth of the motion of the crank, while the cut-off should be effected, both for good action of the steam and for the good action of the engine, instantaneously. It may be possible, with small sizes of ports and inadequate cross areas, or great length of passages, that steam cannot follow a piston at high speeds; but such possibility exists only with improper proportions for high speeds, and should not be remedied by lead."

Our more practical readers will not be slow to see here a curious mixture of truth and error. Mr. Yokoi was, it seems, fairly content to believe that the statement was not to be taken literally until he read Mr. Rich's paper on "Pumping Engines," read before the Institution of Civil Engineers not long since. The objection Mr. Yokoi sees to a quick admission of steam is that pressure is exerted on the crank pin before it has passed the dead point. He writes:—"But what will be the effect of sudden supply of steam before the engine has completed its stroke? Recently, in the paper read last year on 'The Pumping Engine' by Rich, and in the following discussion, it was often spoken of the advantage of the heavy beams and of heavy piston to neutralise the initial elastic blow of steam, so as to avoid the shocks otherwise experienced in the working parts. The theory of lead declares the advantage of the least amount of reciprocating parts and the high authorities recommend the largest mass. No doubt, I think, these high authorities do not adopt the lead, in so speaking, but it may be accepted from these how great the initial shock of the steam admission is; and then it seems curious to apply such a shock to a system of linkwork in opposition to its easy action."

In good engine practice the exhaust is always closed at such a point in the stroke that steam shall accumulate behind the piston, and act as a cushion to retard the advancing piston. The point at which the exhaust port is to close varies with the controlling conditions. Broadly speaking, the larger the number of revolutions per minute made by the engine, the greater ought to be the amount of compression. It is generally laid down that compression should be determined by the piston speed, but this is only partly true. We have to consider not alone the speed of the piston, but the space of time available for bringing it to rest. For example, an engine with a 6ft. stroke makes 60 revolutions per minute. The average piston-speed is therefore 720ft. per minute, and as the piston is stopped twice and started twice in each revolution, we have 120 stoppages to provide for, or two per second; and as the piston is stopping from the moment it has made half a stroke, we may say that the time available for each stoppage is the 120th part of a minute. Now let us take the case of an engine with a stroke of 1ft., making 300 revolutions per minute. We have a piston speed of 600ft. per minute, but the stoppage must be effected in the 600th part of a minute, and the resistance necessary to take the work out of the piston in that time will be much greater in the case of the high speed than of the slow speed engine, other things being equal. To make this clear, let us suppose that in each case the piston weighs 1000 lb. The maximum velocity of the piston, making no allowance for the obliquity of the connecting rod, will be that of the crank pin at half stroke, because during one revolution the piston describes twice the diameter of the crank pin path, while the pin describes the circumference, and for a very minute time about the middle of the stroke the piston moves at the same rate as the crank pin. Omitting fractions, the velocity of the crank pin, the crank being 3ft. long and making 60 revolutions per minute, will be 1130ft. per minute, or 18·8ft. per second and $\frac{1000 \times 18{\cdot}8^2}{64} = 5521$ foot-pounds stored in the piston at the moment it attains its maximum velocity. Now the number of foot pounds is accumulated 120 times per minute, and expended 120 times a minute; therefore, the whole work done during acceleration and that expended during retardation will be equal, and will be found by $\frac{5521 \times 120}{33{,}000} = 20$-horse power. Taking the second case, in which a piston also weighing 1000 lb. makes 600ft. of piston per minute, or 942ft. maximum, or 15·7ft. per second, we have $\frac{1000 \times 15{\cdot}7^2}{64} = 3851$ foot-pounds per minute, which has to be expended in one 600th part of a minute, which is equivalent to 600 × 3851 foot-pounds, or 70 horse-power. Precisely the same amount of power is expended in getting the piston into motion. It is not, of course, to be supposed for a moment that this is all dead loss. Nothing of the kind, because the work accumulated during the first half of the stroke is given up during the latter half to the machinery driven by the engine. In other words, the pressure on the crank pin is not that on the piston, the pressure on the crank pin being less than the gross effective pressure of the steam on the piston during the first half of the stroke, and greater during the second half. There are limits, however, which must not be overstepped, and, broadly speaking, the lighter the parts of rapidly reciprocating machinery can be kept the better. Those who wish to pursue this matter further, we would refer to Professor Osborne Reynolds' admirable papers on "Limits to Speed," in our 52nd and 53rd volumes, and Rigg's "Treatise on the Steam Engine."

There are, it will be understood, three different ways in which the work stored in the piston, piston rod, and connecting rod can be utilised during the latter half of the stroke. Firstly, we may cut off steam very early in the stroke, and so permit the latter half of the stroke to be completed by the momentum of the reciprocating parts; secondly, we may cushion by closing the exhaust early, in which case useful work is done, because the steam compressed does duty instead of fresh steam from the boiler; and thirdly, we may give lead and admit steam from the boiler, in which case useful work is done on it by slightly superheating it; but this is really the most wasteful way in which the work can be taken out of the reciprocating members of a steam engine, whilst the most economical consists in a happy combination of an early cut-off—by which the gross effective pressure falls below the resistance during the last half of the stroke—with cushioning. The Creusot experiments, which were recently reported in our columns, show that cushioning is one of the best possible means of securing economy; but here it must not be forgotten that it is by no means easy to design an engine which shall combine in itself the conditions necessary to the adoption of the most favourable point of cut-off and of compression at one and the same time. Indeed, it is not too much to say that the investigation of this problem has up to the present fairly baffled every mathematician who has tackled it. It would be easy enough to do what is wanted if steam were a perfect gas, but it is not. Under the circumstances, far more rough-and-ready ways of attaining the end most wanted, namely, the production of a good diagram and the elimination of shocks, has compelled engineers to resort to lead, and this cannot possibly be dispensed with to advantage in quick running engines. In these last, unless there is a full pressure of steam in the piston at the beginning of the stroke, the crank has literally, and not by any figure of speech, to drag the piston away from the end of the cylinder, with, of course, jar and thump on the crank pin. It is, however, utterly impossible to lay down any hard-and-fast rule concerning the amount of lead that ought to be given. It will vary not only for every engine, but with the conditions of pressure, &c., under which each engine is working. Noisy engines can be made to run silently, and silent engines can be made noisy by the lead. Broadly speaking, the more lead the better; but it must not be forgotten that cushioning can be made to do duty that lead cannot. Anyone can make a steam engine, but it requires a very skilful engineer to combine to the best advantage, lead, expansion and cushioning; and such sweeping condemnation of lead as that quoted by Mr. Yokoi is quite out of place in an intelligently-conducted journal.

COMBUSTION UNDER PRESSURE.

THE conditions determining the economical efficiency of steam boilers are so complex that they defy the theorist. It is quite possible to lay down certain premises and deduce from them that the efficiency of a steam generator cannot be greater than a given maximum, and this deduction will be true; but it is quite impossible to say what is the minimum below which the efficiency of the boiler, expressed in terms of pounds of water evaporated by a pound of coal, cannot fall. Between the worst and the best possible performance there is a wide tract, and it is in this tract that the engineer finds at once a field for his labours, and puzzles which he can only solve with difficulty. At the present moment the improvement of the marine boiler is a prominent topic, of conversation at least, with marine engineers and shipowners. Hitherto it seems that in only one direction is economy being sought, namely, in the adoption of forced draught. We venture to think, however, that there are more ways than this in which the economic efficiency of boilers may be improved.

There can be no doubt that the relative dimensions of grate surface, tube surface, and calorimeter area—that is to say, the cross section of the tubes—play a very important part in determining the efficiency of a boiler. Numbers of instances of this may be cited. Not less important is a point to which little attention is paid, namely, the thickness of the fires. That is a matter left to the stokers, and settled without any reference to the peculiarities of the coal. Yet turning to the Wigan experiments made in 1867, we said that the reporters, Mr. Thomas Richardson, M.A., and Mr. Lavington Fletcher, say: "The thickness of the fuel on the grates has proved to be an important element in the proper management of north-country coals. We have tried 9in., 12in., and 14in. fires, and in all instances, whatever were the other conditions, the greater the thickness of the fires the more speed and power were obtained from the coals." To illustrate this we may add that "Great 7ft." coal with 9in. fires evaporated 9·779 lb. of water per pound of coal, at the rate of 48 cubic feet per hour, while the same coal with 14in. fires evaporated 10·494 lb. at the rate of 53·3 cubic feet per hour. "Black rod yard," with 9in. fires, evaporated 10·236 lb. at the rate of 44·74 cubic feet, and with 14in. fires, 11·057 lb. at the rate of 45·36 cubic feet per hour. It is sometimes assumed that with a small grate a thick fire must be carried, or the required quantity of coal cannot be burned in a given time; but this is only partially true. However, it is usually the case in practice that the smaller the grate the heavier is the fire.

Concerning calorimeter, there is reason to believe that it is often too large. We wish first, however, to note an experiment made years ago in the United States by Isherwood to determine the effect of various calorimeters on the economic efficiency of a marine boiler. This investigation showed that when the area of tube opening—calorimeter—was in the ratio of 1 to 11 of grate area, the boiler evaporated 8·57 lb. of water per pound of anthracite, but by reducing the calorimeter to $\frac{1}{52}$nd of the grate area the economic efficiency was increased by nearly 15 per cent., but the power of the boiler was greatly diminished, because even with the aid of a steam jet not more than a little over 5 lb. of coal could be consumed per foot of grate per hour. It is to be regretted that the experiment was not pushed further with the aid of a fan. It appears, indeed, to be certain that the calorimeter which will best suit a natural draught is not that best adapted to a forced draught. For example, if the velocity with which the products of combustion are passed through the tubes be doubled, the quantity of air driven through the fire being doubled, no economic advantage can be gained, because the hot gas will not have time to part with its heat; and the proof that this is the case is supplied by the tremendous smoke-box temperatures, from 1100 deg. to 1300 deg., obtained when the forced blast is used. There is reason to think that a direct and considerable advantage can be gained by burning fuel under pressure. Why, is by no means clear. Apparently the proper method of working a boiler with forced blast is to obstruct the smoke-box end of the tubes with thick ferrules. The gases would rush through these at a very high velocity, while in the rest of the tube their motion would be comparatively slow, and some amount of whirling would be set up which would be highly advantageous. One of the great defects of the marine and locomotive boiler is that the products of combustion move in lines parallel with the tubes, whereas under all circumstances the greatest value is got out of heating surfaces when the hot gases strike them at right angles. In no case, however, can too much care be taken to break up the products of combustion and mix them, so that, as Peclet as shown, hot and cold layers may not be formed. The marine boiler is fairly well designed in this respect, because the combustion chamber serves as a mixing chamber before the gas enters the flues. There is reason to think, however, that a type of boiler much used in the United States, and in a modified form by Mr. Holt, of Liverpool, is better adapted for forced combustion than is the ordinary boiler. In the boiler we refer to the products of combustion first pass away to the combustion chamber through a number of tubes about 12in. in diameter, the ordinary 3½in. or 4in. tubes returning above them and the furnace in the ordinary way. It is held, we know, that, space for space, this boiler is not so powerful as the ordinary type, but it must not be forgotten that one result of working with forced draught will be, other things being equal, to augment the absolute as well as the economic efficiency of steam generators; so that the objection just stated seems to fall to the ground.

It is much to be desired that some competent firm shall carry out a series of experiments on the influence of the calorimeter, or, more exactly, on the value of combustion under pressure. There would, for example, be no difficulty in burning fuel under a pressure of 4 lb., or even 10 lb., on the square inch. The conditions necessary are sufficiently powerful blowing machinery and a very small calorimeter, obtained by the use of annular stoppers or tompions in the tubes. Of course, we do not advocate the use of such air pressures as we have just named, at least without due inquiry, because there is some point beyond which the work spent in compressing the air would cost more than the advantage gained. The principal benefit to be obtained would, we believe, be perfect combustion. Mr. Otto has shown that in his gas engine he can explode mixtures of gas and air so diluted that combustion could not be effected at atmospheric pressure. This is done by compressing the dilute mixture to about 30 lb. on the square inch. At high furnace temperatures it is indisputable that there is a strong tendency to dissociation manifested, and this is probably one reason why much carbonic monoxide escapes unconsumed with an unusual waste of fuel. Burned under pressure, it is more than probable that the union of the gases would be more readily effected, and one most important result would be no doubt that the total quantity of air admitted to the fire might be freely reduced. It is not indeed impossible that complete combustion might be effected with as little as 15 lb. of air per pound of coal, instead of the 24 lb. or 25 lb. now found necessary. It may be laid down, however, that concerning the value of combustion under pressure for steam generation, we are quite in the dark; the only thing that can be said, as far as practice is concerned, being that all the indications are favourable in a high degree to the adoption of the system. Perhaps some of the engineers now interested in forced combustion will push their inquiries a little further. The cost of an experiment would be very small. An ordinary portable boiler with a closed ashpan, very thick ferrules in the smoke box ends of the tubes, a Root's blower, and a tank to measure the water pumped into the boiler would suffice. For a very moderate outlay in this way a great deal of very valuable information might be obtained.

THE BRENNAN TORPEDO.

THE English Government has finally purchased the Brennan torpedo. Mr. Brennan is a young Australian, and has succeeded in producing an extremely ingenious engine of war. Its principle is very simple. Inside the body of the torpedo are two reels, on which fine steel wire lines are wound. These reels communicate motion by their revolution to twin screws. The reels are caused to revolve by an engine on shore or on the man-of-war, which engine winds in the lines off the reels, and by running one or other reel a little faster than its fellow, the torpedo can be steered with accuracy, and it has actually performed journeys of 2000 yards, working in and out amongst the shipping, finally to be let go to strike the object aimed at while the wires are drawn in for further use. The operator stands on the top of a fort and directs the course by a wheel or lever, and the same thing could be done from a ship by the commander in the conning-tower. It is even practicable to stop the torpedo in full flight and send it on again. At first sight it might be supposed that the pull of the engine hauling on the wires would prevent the advance of the torpedo, but this is not the case. When a man rows a boat he pushes the boat back by the pressure of his feet on the stretcher, but the loom of the oar in his hand moves at a greater rate than the boat, and the virtual velocity or leverage thus gained causes the advance of the boat. In the same way, if the engine on shore winds in line at the rate of forty miles an hour while the boat advances at the rate of twenty miles an hour, the difference is available for her propulsion. Experiments have for some time past been carried out to test the powers claimed for the new torpedo. The Admiralty granted to the inventor the use of a casemate on the upper tier at Garrison Point Fort, Sheerness, and a torpedo shop was erected outside the fort, with a tramway running down to the sea beach. With these advantages, and ample sea room in front, the preliminary trials have taken place, and the mechanism has been so far perfected as to admit of an official inspection, which has just taken place, and proved so satisfactory that the Admiralty have agreed to adopt the torpedo as a part of the national armament.

DIFFERENTIAL RATES AND COST.

As the question of the rates and charges on railways seems now likely to have a calmer consideration than that which it obtained a few months ago, it may be worth while to look at one fact which has a very considerable bearing upon it. A rough estimate of the cost of the railways has been made of several classes, and the following figures are obtained :—North-Eastern Railway, £32,000 per mile; Midland Railway, £48,000 per mile; and Metropolitan Railway, £461,000 per mile. This is roughly the total cost per mile open down to a recent date. The figures will now slightly vary, but the proportionate cost of the three classes of lines will be substantially the same. It will be seen that there are included a line on which mineral traffic predominates ; one which derives its revenue more equally from goods, minerals, and passengers ; and the little but costly Metropolitan, which is almost exclusively a passenger line. It is, at first, a corollary of the increased cost—the enormously increased cost —to say that there should be differential rates ; but a little examination will show that this is not a fair deduction. The most costly of these lines is the one which has, mile for mile, by far the largest traffic—indeed, the comparative cost is an indication usually of the density or otherwise of the population, and of the extent of the traffic that should flow into the railway coffers. It is thus by the law of compensation that the equal rates even on lines of different cost become fair, because the yield of the traffic should be such as to enable even the dearer line to pay a dividend as large in proportion as others that were cheaper made. Of course the position is altered when lines such as the North-Eastern are compared with others. The railway just named has been formed very largely by amalgamations, and buying up long lengths of line through districts that have increased their population much, its cost per mile is less apparently than that of others. But it will need to continue to improve the small lines, and to add branches to weld the system into a harmonious whole, and thus the relative cost of its line to that of the railways that have been made may be altered in a few years.

TESTS OF ENGINES AT THE INVENTIONS EXHIBITION.

As the Inventions Exhibition is to remain open some months, there should be a good opportunity for testing the engines exhibited, and part of the programme is the testing of small high-speed engines. Steam is, however, supplied to some engines by boilers which supply several engines, and it is moreover conveyed in some instances through long pipes, so that it would be difficult without interfering with the working of some to test others properly. This, however, only applies to some. Of the large engines only the indicated horse-power could be taken, unless the Royal Agricultural Society's large brake, which will work to 300-horse power, be used. This, however, should be done. With the numerous gas engines exhibited the case is different, as there is not one that could not be tested with the greatest facility, and the opportunities afforded by the collection under such favourable circumstances ought to be utilised to the fullest extent. The gas supply is easily measured, and brake as well as indicated power can be taken without any difficulty and at very little expense. There is at present no official record of gas engine trials of importance, and trials by competent men would have great public value. There does not seem to be any reason why gas engines should not be the subject of awards, but it is of course impossible to make awards that can be of any value, or made with any fairness, except as the result of tests.

UNITED STATES CRUISERS.

THE new United States cruisers to which we have so often referred do not appear to be quite satisfactory. The New York *Times* of the 13th editorially remarks :—"Mr. John Roach is not so much the favourite of destiny as he used to be. The oppressive and unreasonable requirement of a trial trip as a preliminary to payment for a naval vessel works very injuriously to him. He could not have foreseen when he built the Dolphin that the Secretary of the Navy would introduce such an innovation. Yesterday, on the second trial trip of the Dolphin, that terror of the seas went ahead for an hour and a-half and lay still for five hours. The average speed for the six hours and a-half can scarcely have been satisfactory. Everybody will sympathise with Mr. Roach, of course, in his affliction, the more that it is doubtful what remedy he has against the cruel wrong of which he has been the victim. Whether he should sue out an injunction prohibiting Secretary Whitney from requiring any more trial trips, or a mandamus requiring him to accept the Dolphin, is a question upon which the wronged and so-called shipbuilder will no doubt take professional advice."

LITERATURE.

Technologisches Woerterbuch in Englischer und Deutscher Sprache. Bearbeitet und herausgegeben von GUSTAV EGER. Technisch durchgesehen und vermehrt von OTTO BRANDES. Zweiter Theil. Deutsch-Englisch. Braunschweig, Vieweg und Sohn. London, Trübner and Co. 1884. 970 pp.

THIS is a comprehensive technical dictionary, the first section of which—English-German—appeared in 1883, when it was noticed at length in our columns. It deals with all the industries, technical arts, manufactures and sciences, and is probably the most complete technical German-English Dictionary published. Some errors which we pointed out in the first part have not been repeated, though others have, but they are of minor importance.

Technological Dictionary of the Physical, Mechanical, and Chemical Sciences. Part II., English-German, German-English. By F. J. WERSHOVEN, D.Sc. London: Symons and Co. 1885.

THIS little dictionary meets an oft-experienced want, and seems on the whole to meet it well. It is rather stronger in the chemical than in the mechanical words, and contains few errors, though it does give mile as the equivalent of a knot; and the old and now disused word excandescent, as well as incandescent ; does not give bolt, or tup, spanner, lock nut, or gland. The English words are given in the commonly used Roman type, and the German in Gothic type, but as it is very clear this is no inconvenience, though the words under a capital V might have been printed with a V and not with a B. The parts are of a handy small size—4in. by 6in.—and form part of a series intended to contain "all the terms employed in physics, meteorology, mechanics, chemistry, metallurgy, chemical technology, and electro-technics," in French, German, Italian, Spanish, and English. This programme is wide, and it is scarcely possible that it can be fully carried out in 222 small pages of rather large type; but the dictionary is sufficiently complete to be of general value, though it must be admitted that there are mechanical terms and names which are not to be found in it.

BOOKS RECEIVED.

Magneto-electric and Dynamo-electric Machines. By Dr. H. Schellen. Translated from the third German edition by N. S. Keith and P. Newman, Ph.D. Vol. I. London: Trübner and Co.

Harbours and Docks; their Physical Features, History, Construction, Equipment, and Maintenance. By Leveson Francis Vernon Harcourt, M.A., M.I.C.E. Text and plates. Oxford: The Clarendon Press. 1885.

Transactions of the Seismological Society of Japan. Vol. VII. Part II.

Technological Dictionary, German-English. Two parts. London: Symons and Co. 1885.

Ten Years' Experience in Works of Intermittent Downward Filtration; with Notes on Results of Practice and Results of Sewage Farming. By J. Bailey Denton. London: E. and F. N. Spon. 1885.

The Winds: An Essay in Illustration of the New Principles of Natural Philosophy. By W. Leighton Jordan. London: David Bridge. 1885.

Workshop Book: Practical Problems and Lines for Working Drawings. London: Simpkin, Marshall and Co. Manchester: A. Heywood and Co. 1885.

Railway Management at Stations. By E. B. Watts. London: McCorquodale and Co. 1885.

Abbott's Stock and Share Almanack for 1885. London: Abbott and Co.

The History of the Literature of Wales from the Year 1300 *to* 1650. By B. C. Wilkins, Ph.D. Cardiff: D. Owen and Co. 1884.

Twenty Years with the Indicator. By Thos. Pray, C.E. Two Vols. London: E. and F. N. Spon. 1885.

Lessons in Elementary and Practical Physics. By Balfour Stewart, F.R.S., and W. W. H. Gee. Vol. I: General Physical Processes. London: Macmillan and Co. 1885.

Notley's Commercial and School Book-keeping. By A. F. Notley. London: Bemrose and Son. 1884.

Minutes of Proceedings of the Institution of Civil Engineers. Vol. lxxix. With other selected and abstracted papers. Edited by James Forrest, A.I.C.E., Secretary. London: The Institution. 1885.

Minutes of Proceedings of the Institution of Civil Engineers. Name Index. Vols. i. to lviii. Session 1837 to 1878-79. London: The Institution.

A Treatise on Future Naval Battles and How to Fight Them, and other Naval Tactical Subjects. By Admiral Sir George Elliot, K.C.B. London: Sampson Low and Co. 1885.

PETER WILLIAM BARLOW.

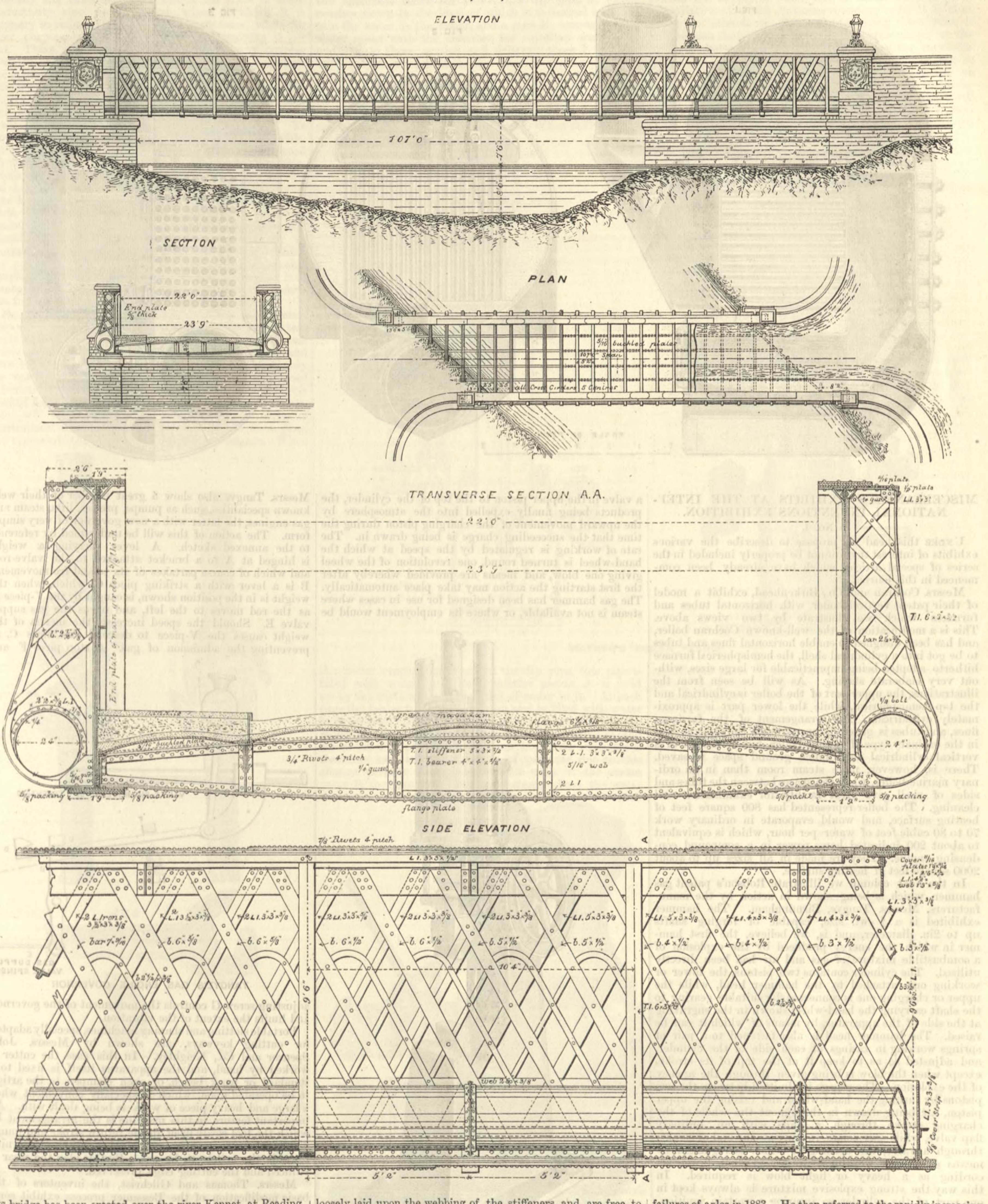
MR. PETER WILLIAM BARLOW, F.R.S., M.I.C.E., died on May 20th, at his residence, Lansdowne-road, Notting-hill. He was the eldest son of the late Professor Peter Barlow, and was the senior member of the Institution of Civil Engineers, having been elected in 1826, or eight years after its establishment, and two years before the Royal Charter was obtained. In the early part of his career he was engaged upon the construction of the Liverpool and Birmingham Canal and the New London Docks. When the demand for railways arose he was engaged under Sir William Cubitt on the South-Eastern system, and subsequently became their principal engineer, and in that capacity carried out the North Kent, the Reading and Reigate, the Tonbridge and Hastings, and other important adjuncts of that system of railways. He afterwards designed and constructed the Lambeth Bridge and the Tower Subway ; the latter work was described in our pages, and from its originality and economy of construction, and the great use made of it by the working classes, excited considerable attention. In 1845 he contributed a paper to the Institution of Civil Engineers, "On the Peculiar Features of Atmospheric Railways," and was awarded a Telford medal. Ten years later he was awarded a council premium for a paper "On some Peculiar Features of the Water-bearing Strata of the London Basin." He contributed numerous other papers to the "Transactions and Proceedings" of the Institute, and was for many years a frequent attendant. He was also a Fellow of the Royal Society, to the transactions of which he contributed several papers. He had retired from professional occupation for several years.

STOTHERT'S COMPOUND ENGINE.

WE give this week an engraving on p. 420 of a compound engine recently constructed by Messrs. G. K. Stothert and Co., of the Steamship Works, Bristol, for the firm of Messrs. W. Perry and Son, of the Bedminster Bridge Tannery, of the same city. The dimensions of the cylinders are, for the high-pressure, 13in., and for the low-pressure, 24in. diameter, the stroke being 24in. The high-pressure cylinder is fitted with an expansion valve controlled by the governor, the latter being driven by gearing in a novel manner, the whole arrangement being very simple and acting satisfactorily, the diagrams being very good, and nearly, if not quite, equal to any with a much more elaborate and complicated arrangement of cut-off. As will be seen from the views given, the engine is of the horizontal compound tandem type, with the piston-rod continued through the end of the low-pressure cylinder for working the air pump, this, together with its bucket, being of gun-metal; the valve seats and guards of the condenser being also of the same, and the exhaust pipe of copper. There is, it will be seen, a neat bed-plate—which is planed both top and bottom—fitted under the cylinders and condenser, and these latter are, in addition, firmly tied together at the top with forged iron stays and cast iron sleeves. The fly-wheel is grooved for four ropes, giving off about two-thirds of the power of the engine, the remainder being given off through the end of the crank shaft. The cylinders are lagged with silicate cotton and East India teak. Amongst other minor points will be noticed that each gland is fitted with an oil reservoir, and the main bearing is adjustable for wear in each direction. In conclusion, we may add that the steadiness of the turning of these engines is very good, and that the consumption of fuel is extremely low, averaging, we are informed, in several instances but little over 2 lb. of slack coal per indicated horse-power per hour. Altogether this engine is a good example of a well-designed, and simple, economical type of small mill engine.

BRIDGE OVER THE KENNET AT READING.

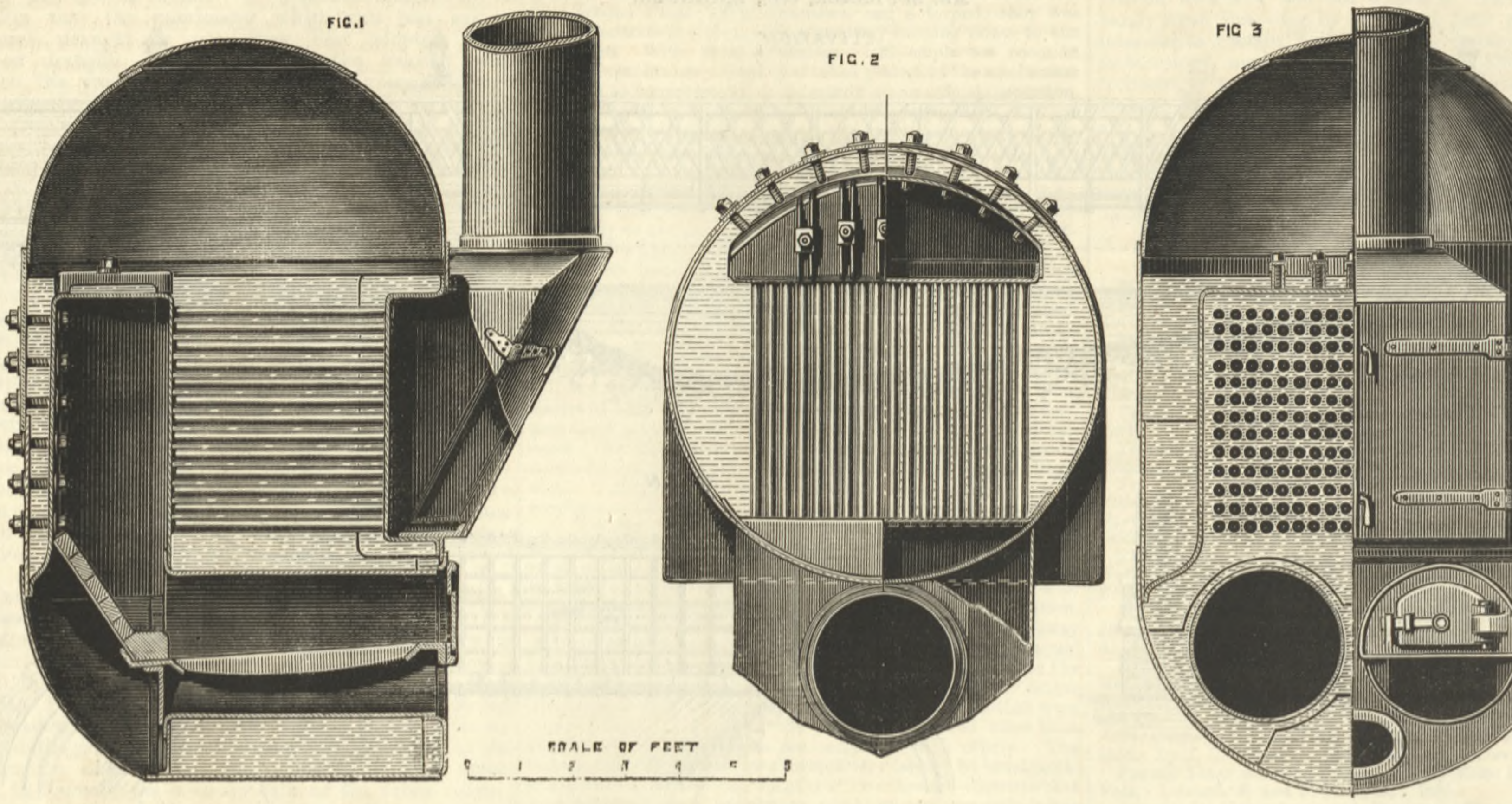
MR. ED. BAKER, C.E., ENGINEER.



THIS bridge has been erected over the river Kennet, at Reading, near its mouth adjoining the Thames, by the Reading Gas Company, for the purpose of connecting its works with a new site of about 13 acres, and for carrying the necessary mains from the present to the new works. The bridge is on the skew at an angle of 42 deg., and the span between the piers from centre to centre is 107ft.; the main girders are 119ft. 8in. long and 9ft. 6in. deep, the top booms being 2ft. 6in. wide and the bottom booms 1ft. 9in. wide and 23ft. 9in. apart, centre to centre, giving a clear way over the bridge of 22ft. The cross girders are 2ft. deep at the centre, placed 5ft. 2in. apart, on the top flanges of which are rivetted the wrought iron buckled plates, which have a rise of 3in. in the centre, the longitudinal joists being supported on T-iron bearers. The ends of the main girders rest upon Bessemer steel rollers and cast iron bed-plates planed on the surface. It will be observed that two 24in. mains, which are of wrought iron with flanged joints, are carried outside the main girders by the stiffening brackets in order to give the regulation height over the river without increasing the level of the roadway of the bridge more than necessary. These mains are loosely laid upon the webbing of the stiffeners, and are free to move with the expansion or contraction of the bridge or with the slight vibration of a passing load, and each main is provided with an expansion joint on both sides of the bridge. In practice these mains are thoroughly gas tight—not always attained on bridge work—and are, of course, at all times exposed to view. The lattice bars and various other parts are of the various dimensions figured on the detail drawings. The bridge has been erected from the specification and plans of Mr. Edward Baker, the engineer to the Reading Gas Company, by Messrs. Handyside and Co., of Derby.

KING'S COLLEGE ENGINEERING SOCIETY, LONDON.—At a general meeting held on Thursday, May 21st, Mr. V. J. Bouton read a paper on "The Construction of Locomotives," in which he described the most recent improvements in the driving gear. He began by describing the leading types of coupling, both English and foreign, and compared their principal advantages. He next proceeded to the subject of crank axles, showing by a tabular statement the failures of axles in 1883. He then referred to the rapidly increasing use of steel for axles, and pointed out its superiority over iron. The next subject dealt with was that of four-cylindered locomotives, embracing a description of Fairlie's, Haswell's, Gouin's, and Shaw's systems. The writer also mentioned the Fontaine locomotive and a new Swiss mountain locomotive. Mallet's system of compound locomotives was next described, special attention being paid to the distributing valve, by means of which the engine can be worked either as a simple or compound one at pleasure; the reducing valve, which is used when the steam enters the large cylinder direct from the boiler, to regulate the pressure of the steam so as to equalise the work done in the two cylinders; and the compound reversing gear, which admits of a difference of expansion in the cylinders. The author next described Webb's system of compound locomotives, explaining the method of admitting the high-pressure exhaust steam to the large cylinder, and noticing the patent reversing gear used for adjusting the expansion in the high and low-pressure cylinders simultaneously or independently at will. A statement was also made of the results of regular working of all the engines constructed on this system. The author expressed a hope that compound locomotives would ultimately be adopted on all English railways.

THE INVENTIONS EXHIBITION—COCHRAN'S MARINE BOILERS.



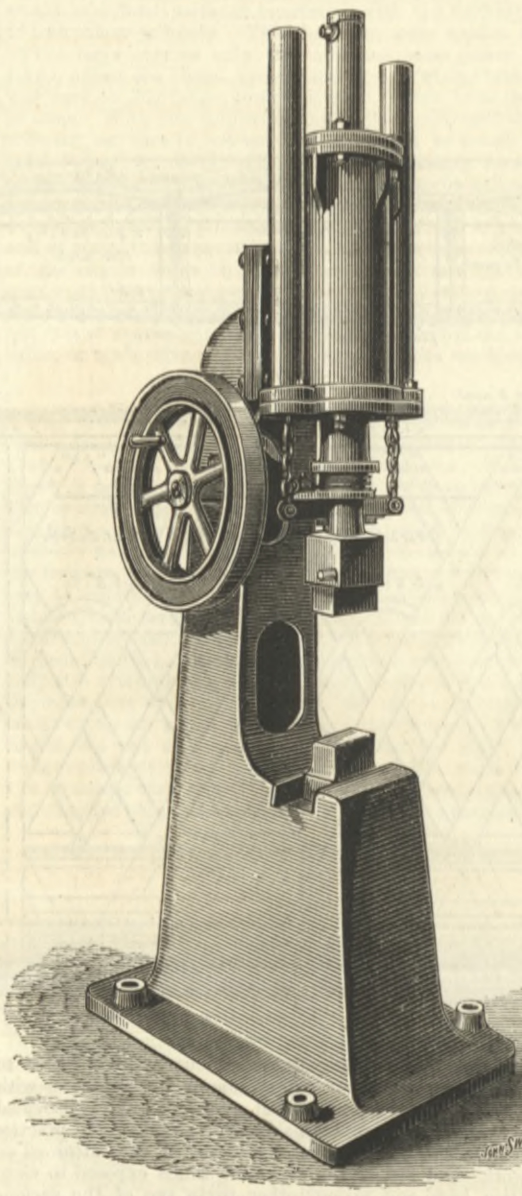
MISCELLANEOUS EXHIBITS AT THE INTERNATIONAL INVENTIONS EXHIBITION.

No. I.

UNDER this head we propose to describe the various exhibits of interest that cannot be properly included in the series of special articles which have already been commenced in this journal.

Messrs. Cochran and Co., Birkenhead, exhibit a model of their patent vertical boiler with horizontal tubes and furnaces which we illustrate by two views above. This is a modification of the well-known Cochran boiler, and has been designed to enable horizontal flues and tubes to be got into a cylindrical shell, the hemispherical furnace hitherto adopted being impracticable for large sizes, without very elaborate staying. As will be seen from the illustrations, the upper part of the boiler is cylindrical and the top hemispherical, while the lower part is approximately cylindrical. The arrangement of the furnaces, flues, and tubes is generally pretty much the same as that in the ordinary type of marine boiler, but by the use of a vertical cylindrical shell much ground space is saved. There is, however, more steam room than in an ordinary marine boiler, while the spaces between the tubes and sides of shell give great facility for examination and cleaning. The boiler represented has 800 square feet of heating surface, and would evaporate in ordinary work 70 to 80 cubic feet of water per hour, which is equivalent to about 200 indicated horse-power in a compound condensing engine. They are made in all sizes up to about 2000 square feet of heating surface.

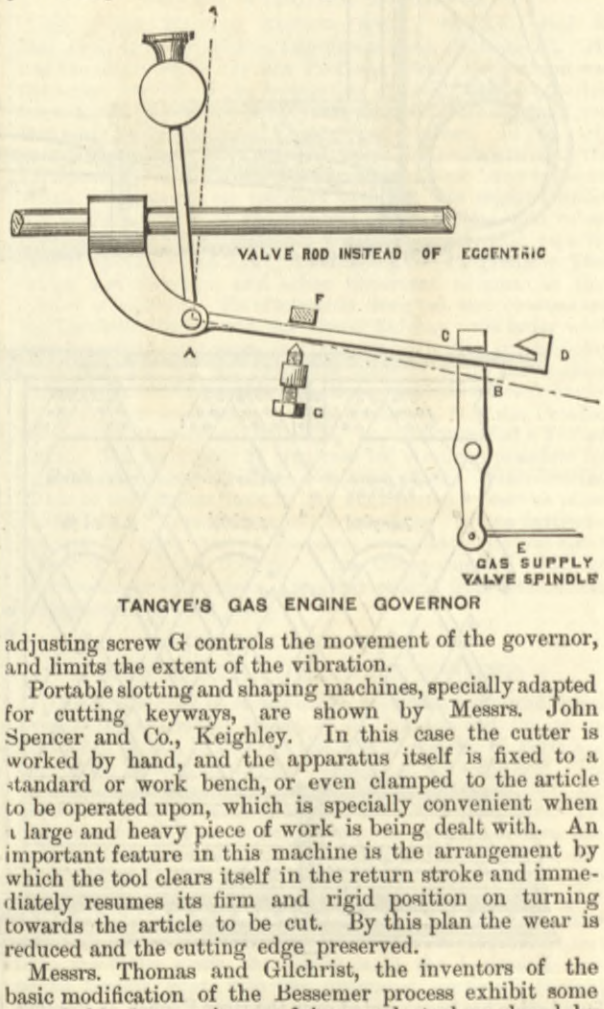
In the next column we illustrate Robson's patent gas hammer, which is being shown in action by the manufacturers, Messrs. Tangye, Birmingham. The hammer exhibited is a ¾ cwt. size, capable of forging shafts up to 2in. diameter, and is, we believe, the first hammer in which the energy produced by the explosion of a combustible mixture of gas and air has been directly utilised. The cylinder contains two pistons, the lower or working one attached to the hammer head, while the upper or charging one is connected by suitable gearing to the shaft carrying the hand-wheel shown in the engraving at the side of the apparatus, by means of which it can be raised. The hammer head is also fastened to a pair of springs working in casings at each side of the cylinder, and adjusted so as to keep it at the top of its stroke, except when the blow is being given through the agency of the explosion. The charge is admitted between the two pistons by turning the hand-wheel and raising the upper piston, air being drawn in throughout the whole of the charging stroke through a pipe with an ordinary flap valve, while gas comes in only at the end of stroke, through a valve, the opening of which is regulated by means of a lever working against a graduated cam, according as a heavy or light blow is required. In this way the strong explosive mixture is always kept in one part of the cylinder, so insuring a certain ignition. The charge therefore consists of pure air next the upper or charging piston, and combustible mixture of gas and air next the working piston and touch-hole, the strength of combustible mixture remaining practically the same, while the volume of it varies according to the length of time the gas supply valve has been opened. Ignition is brought about in a very simple way. Outside the supply pipe, which, as it joins the cylinder, is common to both gas and air, and therefore contains part of the combustible mixture, a small atmospheric gas flame is constantly burning. The pipe has a small hole drilled in it opposite the flame, which, except at the time when ignition is desired, is closed by a finger-piece worked by the action of the charging gear. When the finger is removed the flame is communicated to the charge, and explosion occurs, the hole being instantly closed. The lower piston, after being driven down and delivering a blow, is returned by means of the springs, and in rising forces out the products of combustion through a valve in the upper piston to the top of the cylinder, the products being finally expelled into the atmosphere by the upward movement of the charging piston during the time that the succeeding charge is being drawn in. The rate of working is regulated by the speed at which the hand-wheel is turned round, one revolution of the wheel giving one blow, and means are provided whereby after the first starting the action may take place automatically. The gas hammer has been designed for use in cases where steam is not available, or where its employment would be



ROBSON'S GAS HAMMER.

expensive and inconvenient, but we believe that the consumption of gas has been found to be so small in actual work, that for moderate powers it may be economically used even in districts where the price of gas is at its highest. Compared with hammers driven by belts from even the most economical gas engines, the new apparatus is likely to be greatly superior. Even when forging, it is said to use little more than half the quantity of gas consumed in a gas engine driving a power hammer of similar capacity, and there is the additional advantage that the gas consumption ceases when the work is finished.

Messrs. Tangye also show a great number of their well-known specialities, such as pumps, presses, lifts, steam and gas engines, the latter with a new governor of very simple form. The action of this will be understood by reference to the annexed sketch. A lever carrying a weight is hinged at A to a bracket attached to the valve-rod, and which of course partakes of its to-and-fro movement. B is a lever with a striking piece C, which, when the weight is in the position shown, is caught by the V-piece D as the rod moves to the left, and opens the gas supply valve E. Should the speed increase, the inertia of the weight causes the V-piece to descend and miss C, so preventing the admission of gas. A stop piece F and



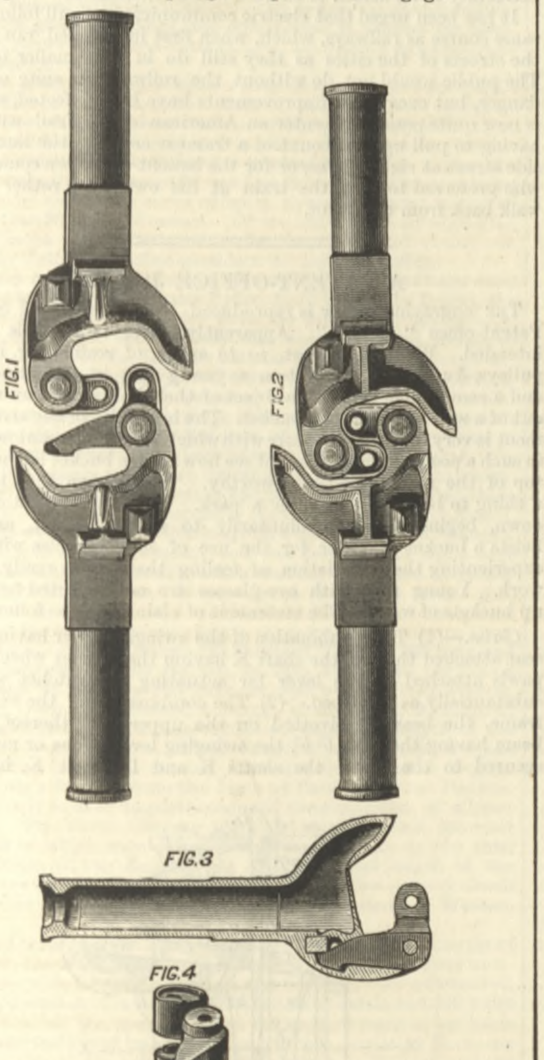
TANGYE'S GAS ENGINE GOVERNOR

adjusting screw G controls the movement of the governor, and limits the extent of the vibration.

Portable slotting and shaping machines, specially adapted for cutting keyways, are shown by Messrs. John Spencer and Co., Keighley. In this case the cutter is worked by hand, and the apparatus itself is fixed to a standard or work bench, or even clamped to the article to be operated upon, which is specially convenient when a large and heavy piece of work is being dealt with. An important feature in this machine is the arrangement by which the tool clears itself in the return stroke and immediately resumes its firm and rigid position on turning towards the article to be cut. By this plan the wear is reduced and the cutting edge preserved.

Messrs. Thomas and Gilchrist, the inventors of the basic modification of the Bessemer process exhibit some remarkably fine specimens of iron and steel produced by their method, the greater portion being from the works of the North-Eastern Steel Company, Middlesbrough. These works were recently erected, under the superintendence of Mr. Arthur Cooper, for the manufacture of homogeneous iron and steel, and the entire make of nearly 3000 tons per week is produced on the basic system. We do not know that a better opportunity of seeing to what perfection the manufacture of iron and steel has arrived has ever presented itself. No doubt special samples for exhibition may be made, but we believe that by the basic Bessemer process the results as shown are obtained with great uniformity in ordinary working. The great and apparently insurmountable difficulty in the original Bessemer process is to get rid of the silicon, which is an extremely deleterious substance, no matter for what purpose the steel is required. By the Thomas-Gilchrist system, however, it is entirely eliminated, or at most there is only a trace. All other impurities are also reduced to a safe limit, and the quantity of carbon is regulated with a degree of nicety which, we believe, is not attainable in the original Bessemer process. The North-Eastern Steel Company has executed large orders for what is called conductivity steel for telegraph wires, in which it is necessary to reduce the carbon to a mere trace, while for other purposes they produce a steel containing ·5 per cent. There does not indeed, seem to be any purpose to which the basic steel cannot be satisfactorily applied. The exhibit includes some very fine samples taken from the ordinary make of shipbuilders' materials, and tested by Lloyd's surveyor, the breaking stress having been 30 tons with an elongation of 23 per cent. in a length of 8in. and a reduction of area at point of fracture of 46 per cent. To show how the material may be punished in working without being injured, a piece of ship angle has been opened out flat and then bent double in the wrong direction. Another piece has been similarly treated after having had holes punched in close to the edge. Quite as severe tests have been applied to plates. One specimen, $\frac{9}{16}$in. thick, has been driven through a block by a spherical-headed punch, and appears as a hollow hemisphere 6in. diameter, and other samples show how holes can be enormously increased in diameter by cold drifting without any apparent injury. There are also some remarkable samples of deep stamping, as well as others, showing how homogeneous iron can be substituted for best Yorkshire iron in rivets and chains, and for other purposes.

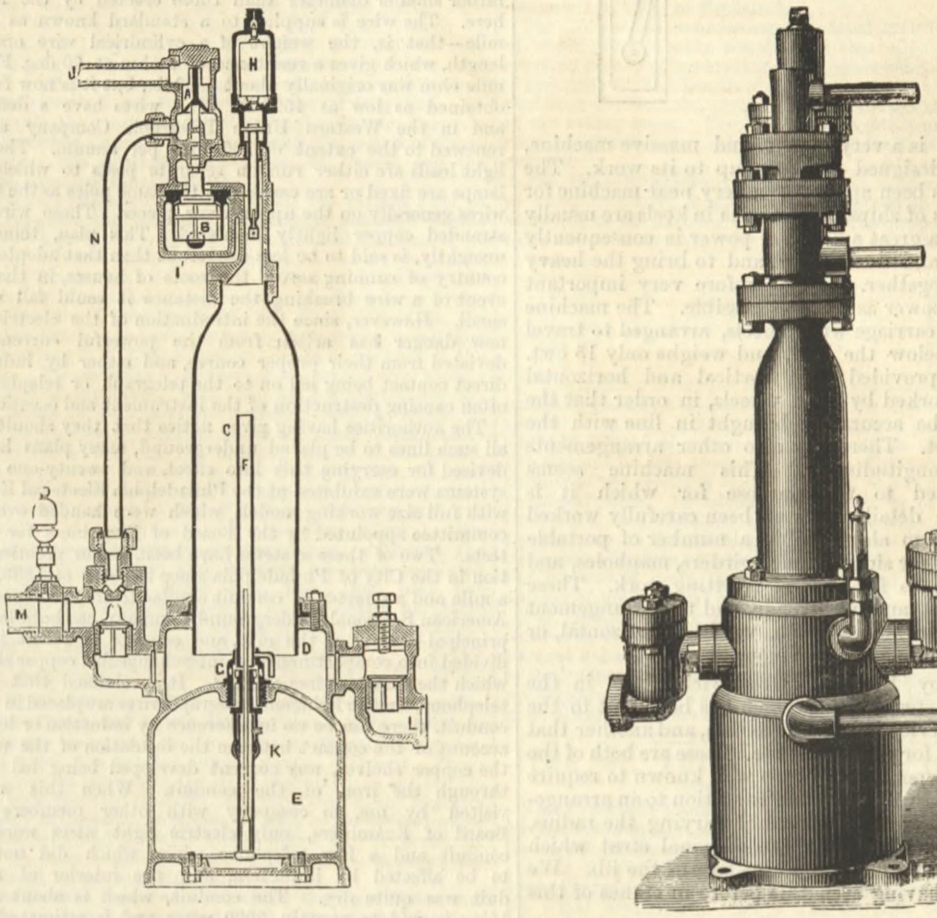
Mr. Alfred Davis, Westminster, exhibits the Janney railway coupling, a device which seems to be very extensively used in the United States. The Janney system embraces a central coupler combined with buffer and draw-bar, so that while existing buffers may be used, they are not actually essential. The coupling is performed automatically, and the uncoupling by means of a lever worked from the outside. The construction of the apparatus will be understood by reference to the series of illustrations which we give below. Fig. 1 is a plan, and represents the coupling in a position to engage. When



JANNEY'S RAILWAY COUPLING.

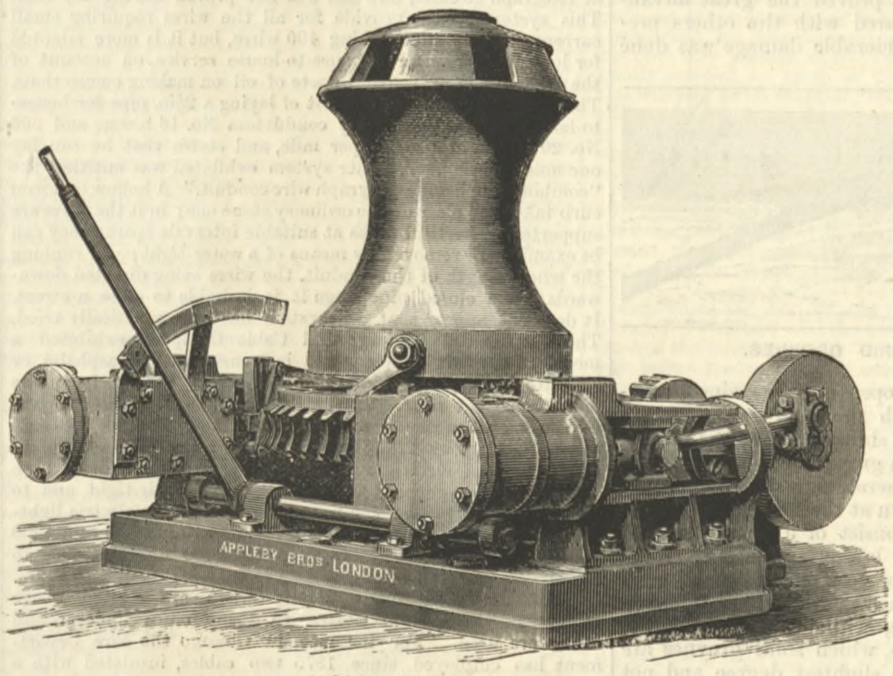
the two pieces are forced together, the bell-crank lever, shown hinged at the end of the left-hand coupling, is carried round into the position illustrated in Fig. 2, and in section in Fig. 3, the gravity pin having locked the long arm of the crank. This pin is raised automatically by means of an inclined plane at the end of the arm, and drops into its place by gravity, as shown in Fig. 3. To uncouple, it is only necessary to raise one of the pins, and release the bell crank, which is then free to swing round, as in Fig. 1. When closed, the coupling gives entire freedom in turning curves, without either lateral or longitudinal play, and it is stated that with couplings of this type a greater load can be started than when slack is allowed, it being only necessary to compress the springs by backing the engine before starting in order to add very materially to the hauling power. The coupling pieces are made deep enough to allow for the greatest possible difference in level between two adjoining vehicles. We believe that in the United States, where it is already adopted by forty-two railway companies, the system has been found to work exceedingly well in practice. Probably we shall soon hear of its being tried in this country.

Among appliances for feeding boilers, the automatic feeder, exhibited by Mayhew's Patent Boiler Feeder Company, Westminster-chambers, S.W., is almost the only novelty, except as regards such improvements as refer to mere details of construction. This apparatus is perfectly automatic in action, starting as soon as the level of water in the boiler is lowered to the proscribed limit, and stopping when the deficiency is made good. The two illustrations on this page will serve to render clear the mode of working. The feeder must be placed above the boiler, to which it is connected by a steam pipe I, joining the apparatus below the valve B, a dip pipe J, which reaches down to the level at which it is desired to maintain the water in the boiler, and a pipe K, connecting the water space with the chamber for injection water. In addition to these, suction and delivery pipes L and M, with valves, are provided, the same as for an ordinary donkey pump. A is a regulating piston, B a steam valve, C a copper chamber, and E a casting forming a reservoir for condensing water, which is supplied from the boiler. This casting has an upper chamber D, to which the suction and delivery valve boxes are bolted. When the water in



MAYHEW'S BOILER FEEDER.

the boiler reaches the mouth of the dip pipe, this pipe is filled with water, and the regulator piston A is held up by the suction due to the head of water in it. At such time the feeder is in a state of rest, and is filled with water in every part. When the water level is lowered below the mouth of the dip pipe, the column in it is released and steam takes its place. The suction above the regulator is therefore lost, and the increase of pressure due to this change permits the regulator, and with it the steam valve B, to descend, so admitting steam above the water

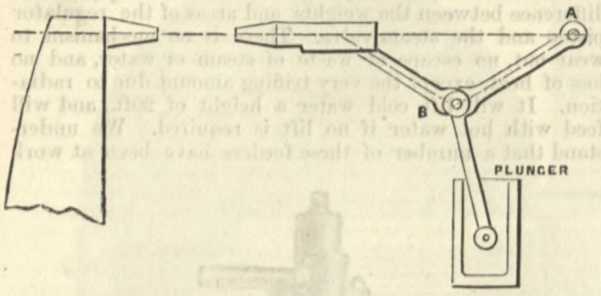


APPLEBY'S STEAM WINCH.

in the copper chamber C, which is therefore free to gravitate into the boiler through the delivery valve and pipe, steam passing in to take its place. When the steam reaches the enlarged space D it suddenly expands, and this causes a sufficient increase in the velocity of supply to close the valve B. As soon as this occurs a partial vacuum forms in C, and as the chamber E is at this time filled with water under the full boiler pressure, a small stream immediately passes through the injection pipe F and completes the vacuum, when the chamber is again charged through the suction pipe L. The quantity of injection water admitted is regulated by a valve G, which is closed automatically by the action of the water passing through it as soon as the velocity reaches a given amount. Should the water be still too low the steam valve again falls, and the operation is repeated until the level rises to the bottom of the dip pipe and charges it. The valve H is for the purpose of getting rid of the air before the water enters the boiler. For preventing any deposit which might interfere with the action of the regulator, a pipe N is introduced. This causes a circulation through the dip and delivery pipes when the apparatus is at rest, as well as a scour past the regulator at each stroke. Should the supply of water fail, an alarm whistle gives immediate notice, and continues sounding until it is shut off by the attendant. From the foregoing description it will be seen that the Mayhew feeder works simply on the difference between the weights and areas of the regulator piston and the steam valve. There is no mechanism to wear out, no escape or waste of steam or water, and no loss of heat, except the very trifling amount due to radiation. It will lift cold water a height of 20ft., and will feed with hot water if no lift is required. We understand that a number of these feeders have been at work in different parts of the country for several months, and have given great satisfaction.

In the Gallery Messrs. Appleby Bros. are extensive exhibitors. We may mention a steam capstan adapted for use on board ship, on a pierhead, or in a goods yard, which we illustrate on this page. The crank shaft has a disc plate at each end, and on it are two sets of gear, giving two speeds to an intermediate shaft, which carries a worm gearing into a large worm wheel at the base of the capstan head. The wheel is not rigidly connected to the head, but can be put in and out of gear by raising and lowering certain pawls, so that, when required, the steam driving gear may be detached and the head worked by handspokes in the usual manner. The engines are horizontal, and are fixed to a strong cast iron bed-plate of box section, which carries all the gear. The arrangement is therefore self-contained, and can be boxed in, as would be required on shipboard, or sunk in a pit when fixed on land. This capstan is a neat and compact job, and is, we believe, the only machine of the kind in the Exhibition. Another machine shown by this firm is a well finished model of their gold quartz crushing mill, with wrought iron frames, revolving heads, sectional mortars and heads, and enamelled amalgamating boxes. The mill is complete with tables and all accessories, and being one-eighth full size, gives a very fair idea of the actual apparatus.

Messrs. Hugh Smith and Co., Glasgow, exhibit patent hydraulic machinery, principally consisting of rivetting machines for boilers, ships, bridges, and other kinds of ironwork, which are shown in operation, together with a combined steam engine and pumps, with accumulator, for supplying the pressure water. The principal machine is a patent fixed boiler rivetter, with 7ft. gap, capable of putting from 30 tons to 100 tons on the rivet, in which the pressure is applied through the medium of a toggle joint, as shown in the annexed sketch. It is claimed that by this arrangement the work is done with an expenditure of only one-third of the water that is consumed in machines with direct-acting rams, the increased pressure gained through the action of the toggle enabling a much smaller ram to be used than would otherwise have been required to give the closing pressure. Another advantage claimed is that by merely moving the fixed centre A in one direction or the other, the pressure on the rivet may be varied at pleasure, a sliding scale worked from this centre showing the distance there will be between the snaps when the full pressure is on. As, when other things are equal, the angle of the lever A B will always define the pressure that is being exerted on the snaps at the time, an indicator is supplied, worked from this lever, which shows on a graduated scale, at a glance, what that



pressure is. This is a very strong and massive machine, and seems well designed and fully up to its work. The same principle has been applied to a very neat machine for rivetting the keels of ships. The rivets in keels are usually of large size, and a great amount of power is consequently required to close and flush them, and to bring the heavy plates properly together. It is therefore very important to economise the power as much as possible. The machine is mounted on a carriage with wheels, arranged to travel on timbers laid below the keel, and weighs only 15 cwt. The carriage is provided with vertical and horizontal screws, readily worked by hand wheels, in order that the steel snaps may be accurately brought in line with the centre of the rivet. There are also other arrangements for travelling longitudinally. This machine seems admirably adapted to the purpose for which it is designed, and the details have all been carefully worked out. The same firm also exhibits a number of portable machines, suitable for ships' frames, girders, manholes, and flue ends, as well as for general rivetting work. These machines are light and well made, and the arrangement for turning them to any position, vertical, horizontal, or diagonal, is very simple and ingenious.

Messrs. Appleby Brothers, Greenwich, show in the grounds an 8-ton steam crane, which has been lent to the Commission for service in the Exhibition, and another that has been purchased for permanent use. These are both of the usual horizontal type, which is too well known to require description, and we will only draw attention to an arrangement for providing an easy means of varying the radius, by lengthening or shortening the diagonal strut which forms the compression member at the base of the jib. We do not remember having seen this before in cranes of this kind.

In the Main Gallery Mr. A. Dowson exhibits a piece of one of his openwork groynes, and a model showing their employment. In The Engineer of the 26th October, 1883, we gave an account of these groynes, as erected on the foreshore of St. Anne's, near Blackpool, and gave reasons for expecting very satisfactory results from their use. Experience has fully justified our anticipation, and this has been further confirmed elsewhere. The Corporation of Brighton have erected some of these groynes on a portion of their foreshore, and they have been subjected some of the heaviest seas ever experienced on this very exposed coast. The result has proved the great advantages of the open system compared with the others previously adopted, for while considerable damage was done

DOWSON'S OPEN GRID GROYNES.

to adjoining solid groynes, the open ones remained uninjured. At the same time, with the solid groynes there was much scouring away of the shingle, whilst the level of the beach protected by the open groynes was not lowered. Our engraving only gives a general view of the groynes, but the part of a groyne shown at the Exhibition shows the construction in detail to consist of a simple grid of vertical rods attached to a lower and upper main member. The groynes must be very cheap, and there is no doubt that their action is much more effective in heavy seas than that of solid groynes, while they prevent the washing away of the foreshore, which solid groynes are often incapable of doing in the slightest degree and not unfrequently promote. Solid groynes return the water at a high velocity; open groynes completely dissipate the energy of a wave.

The Meteorological Society.—At the meeting of the Meteorological Society on the 20th inst. the following papers were read:—(1) "The Temperature Zones of the Earth considered in relation to the Duration of the Hot, Temperate, and Cold Period, and to the Effect of Temperature upon the Organic World," by Dr. W. Koppen. (2) "Velocities of Winds and their Measurement," by Lieut.-Col. H. S. Knight. The author, after describing the various ways of ascertaining the direction and velocity of the wind, makes several suggestions for the improvement of Robinson's anemometer. (3) "On the Equivalent of Beaufort's Scale in Absolute Velocity of Wind," by Dr. W. Koppen. The author refers to Mr. C. Harding's paper read before the Society on the anomalies in the various wind velocities given by different authors as equivalents for the numbers in Beaufort's scale, and calls special attention to the want of agreement between the velocities obtained by Mr. Scott, Dr. Sprung, and himself. (4) "Note on a peculiar form of Auroral Cloud seen in Northamptonshire, March 1st, 1885," by the Rev. James Davis.

OVERHEAD v. UNDERGROUND WIRES IN THE UNITED STATES.

By Killingworth Hedges, M.S.T.E.

So much attention has recently been devoted in Parliament to the overhead wire question, that some information regarding American practice in this direction may interest readers of The Engineer. In most cities of the United States the electric wires which are used for the telegraph, telephone, fire department, and electric light, are chiefly carried on posts running along the side walk, the wires being about the level of the first floor. The number of wires supported is very large; 200 have been counted supported on two lines of poles in one street. In Broadway, New York, there are no less than six distinct lines of poles.

For the telegraph service iron wires are usually employed of rather smaller diameter than those erected by the Post-office here. The wire is supplied to a standard known as the ohm mile—that is, the weight of a cylindrical wire one mile in length, which gives a resistance of 1 ohm at 60 deg. Fah. The mile ohm was originally about 5500 lb., but it is now frequently obtained as low as 4520 lb. The wires have a definite life, and in the Western Union Telegraph Company alone are renewed to the extent of 100 tons per annum. The electric light leads are either run on separate posts to which the arc lamps are fixed or are carried on the same poles as the telegraph wires generally on the upper cross pieces. These wires are of stranded copper lightly insulated. This plan, though most unsightly, is said to be less dangerous than that adopted in this country of running across the roofs of houses, in that in the event of a wire breaking the distance it could fall would be small. However, since the introduction of the electric light a new danger has arisen from the powerful currents being deviated from their proper course, and either by induction or direct contact being led on to the telegraph or telephone lines, often causing destruction of the instrument and occasioning fire.

The authorities having given notice that they should require all such lines to be placed underground, many plans have been devised for carrying this into effect, and twenty-one different systems were exhibited at the Philadelphia Electrical Exhibition with full size working models which were handed over to the committee appointed by the Board of Examiners for practical tests. Two of these systems have been also in practical operation in the City of Philadelphia since the end of 1883. About a mile and a quarter of conduit similar to that exhibited by the American Sectional Underground Company has been laid in the principal streets of the city, and consists of a cast iron pipe divided into compartments of interchangeable copper shelves on which the various wires are laid. It is claimed that although telephone, electric light, and telegraph wires are placed in the same conduit, there can be no interference by induction or leakage on account of the contact between the insulation of the wires and the copper shelves, any current developed being led to earth through the iron of the conduit. When this work was visited by me, in company with other members of the Board of Examiners, only electric light wires were in the conduit and a few telephone wires, which did not appear to be affected by induction, and the interior of the conduit was quite dry. The conduit, which is about 10in. by 15in., is said to contain 3000 wires, and is estimated to cost 15,000 dols., or £3000 per mile. Seven miles of conduit on this system have been laid in Chicago since 1883, and had been a success with telephone and telegraph wires. Another plan which has been tried in the city of Philadelphia is that of Mr. Brooks, by which the telegraph or telephone wires are placed in pipes, which are afterwards filled with a heavy oil. A telephonic line, about 7½ miles long, which terminated in the Exhibition, was often used, and found to be fairly free from induction, although eighteen telegraph wires in different circuit were also working, and seven telephone wires also passed through the same 2½in. pipe. It is claimed that electric light wires can also be laid in the same pipe without interfering with the telephone or telegraph circuits, but this was not proved during my visit. This system would provide for all the wires requiring small currents, a 2½in. pipe taking 400 wires, but it is more adapted for long lines than for a house-to-house service, on account of the difficulty in preventing waste of oil on making connections. The patentee estimates the cost of laying a 2½in. pipe for house-to-house supply, with forty conductors No. 16 b.w.g., and 360 No. 20 b.w.g., at £16,000 per mile, and states that he can lay one mile in a day. Another system exhibited was entitled the "combined curbstone telegraph wire conduit." A hollow cast iron curb takes the place of the ordinary stone one; in it the wires are supported by vertical racks at suitable intervals apart; they can be examined or removed by means of a water-tight cover running the whole length of the conduit, the wires being directed downwards into a closed pipe when it is desirable to cross a street. It does not appear that this system has been practically tried. The Continental Underground Cable Company exhibited a model of conduit which would be constructed of asphalte or asphalte blocks, and contain shelves which extend from one manhole to the next. The wires would rest on these shelves in pockets. The size of a conduit to take 7200 wires was said to be 1ft. 11in. by 2ft. 3in. To prevent the leakage due to moisture from electric light wires carrying currents of high tension, it was proposed to make the conduit air-tight, and to pump in dry air, using the power available at the electric lighting station. The price estimated for a conduit to contain 1200 to 2400 wires, according to size, was 8000 dols.—£1600—to 10,000 dols.—£2000—per mile.

Although, as a rule, electric wires are carried above ground in the United States, in many cities underground cables are used. For instance, in Chicago the Fire Department has employed since 1875 two cables, insulated with a material known as Kerite, each about half a mile in length, placed in tunnels under the river; these have given every satisfaction, although the tunnels are very damp. In other parts of that city Kerite cables drawn into 1in. gas pipes have been employed since 1878. In Pittsburgh also the two cables, each of fifty wires, have been in use since 1881; only 3 per cent. of these wires have failed since that time. The proposition that all electric wires should be placed underground has met with very severe opposition in the United States. In New York the only system of underground conductors on a large scale is that of the Edison Company, which has a network of tubes laid in New York whose united length is about sixteen miles. These actually supply current for about 5000 incandescent lamps, but are connected to over 10,000. Much trouble was experienced at first on account of leakage of current and interference with the wires by workmen taking up the road for repairs. These difficulties have been overcome by employing thicker insulating material and by strengthening the pipes in which the wires are buried, so that the system is now so far perfect that its employment is rapidly being extended. The greater part of the electric lighting in New York, as well as in other American cities, is carried out by the arc system, some 400 aerial wires extending all over the city in circuits which are even ten miles in length, and form a total of some 400 miles, supplying about 1800 arc lamps of about 500 candle-power each. No decision has yet been arrived at as to the best plan of carrying these wires underground, but the Committee on Underground Communication appointed in 1883 having considered some 600 patents and plans, have reported that a conduit for an inclusive system of all electric wires could be constructed at a cost of about 10,000 dols., or £2000 per mile. They recommend its construction to be of terra-cotta, thoroughly coated with asphalte, then protected by an outer covering of creosoted wood, the central part to consist of a series of passages for the reception of cables for telegraphic and telephonic purposes. Surrounding this central box on all sides a layer of asphalte may be fixed, in which perforated strips of paraffined wood might be placed, to hold the insulated conductors for electric light; the conduit to be laid in a trench and embedded with asphalte, and the top of box to be covered with same. The magnitude of such work may be gathered from the fact that it is estimated that 285,000ft. of conduit would be required per square mile, and the city of New York contains about twenty square miles. The total cost per square mile would be about £108,000.

Several accidents have been reported in New York from the fall of electric light wires through which high tension currents were passing at the time. On inquiry it was found that all the accidents were greatly exaggerated; the damage was similar to that which might be looked for if an ordinary telegraph or telephone wire fell in the streets, and no injury was experienced by reason of the electric current. In some instances firemen have obtained severe shocks when cutting away electric light wires; to prevent this, a very beneficial clause has been introduced into the rules of the Fire Underwriters' Union,—"that a cut-out which is easily accessible to the firemen or police must be placed in circuit." One of the electric wires therefore passes through this instrument on entering the building to be lighted, and enables the current to be switched off from the street.

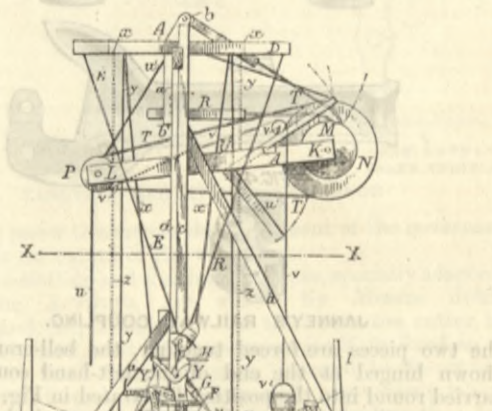
Although the need of legislation on the subject of overhead wires is greatly felt in the principal cities of the United States, the attempt to force the wires underground is being vigorously resisted. The date for the removal of wires in New York is November 1st. Opposition has now set in from a new quarter, namely, the medical authorities, who deprecate the excavations necessary to lay the underground conduits, supposing that the possibility of an attack of cholera will be increased.

It has been urged that electric communications will follow the same course as railways, which, when first introduced, ran along the streets of the cities as they still do in the smaller towns. The public would not do without the railways in spite of the danger, but every year improvements have been effected, and it is now quite possible to enter an American city by rail without having to pull up on account of a tramcar crossing the line by a side street at right angles, or for the benefit of a town councillor who preferred to stop the train at his own door rather than walk back from the depôt.

A PATENT-OFFICE JOKE.

The engraving below is reproduced from the United States Patent-office "Journal." Apparently there is a subtle joke intended. We have a forest, so to speak, of scaffolding, ropes, pulleys, &c., and at the bottom a young man in plaid trousers and a remarkable hat. The object of the whole is to draw water out of a well by means of a bucket. The ingenuity of the arrangement is very finished. The care with which the young man is seated in such a position that he cannot see how far the bucket is from the top of the scaffolding is noteworthy. We imagine that this is a thing to be put up, say, in a park. The unwary visitor sits down, begins almost involuntarily to swing himself, and so hoists a bucket of water for the use of some one else without experiencing the humiliation of feeling that he has really done work. Young men with eye-glasses are not expected to wind up buckets of water. The statement of claims runs as follows:—

Claim.—(1) The combination of the swinging lever having the seat attached thereto, the shaft K having the ratchet wheel, and pawls attached to the lever for actuating the ratchet wheel, substantially as described. (2) The combination of the vertical frame, the beam B pivotted on the upper side thereof, said beam having the arms b^1 b^2, the swinging levers—one or more—secured to the beam, the shafts K and L, shaft K, having



ratchet wheel M, pulley N, and drum O, shaft L, having drum P, an endless belt connecting pulley N with drum P, and pawls pivotted to arms b^1 and b^2 and engaging with the ratchet wheel, substantially as described. (3) The combination of the vertical frame and the horizontal frame, the beam B, pivotted on the vertical frame, said beam having arms b^1 b^2, the swinging levers—one or more—secured to the beam, shafts K and L, journalled in the horizontal frame, shaft K, having ratchet wheel M, pulley N, and drum O, shaft L, having drum P, belt T, connecting drum P with pulley N, pawls pivotted to arms b^1 b^2 and engaging with the ratchet wheel, and rock shaft U, journalled in the horizontal frame and having tappet arm u and brake arm u^1, substantially as described. (4) The combination of the frame, the pivotted beam B, the swinging levers—one or more—secured to the beam, a cross beam x^1, secured to beam B, pivotted foot-levers X, pivotted below the beam B and connected to the beam x^1, substantially as described. (5) The combination of the frame, the pivotted beam B, the swinging levers—one or more—secured to the beam, cross beam x^1, secured to beam B, pivotted foot-levers X, connected to beam x^1, and hand-levers Y, pivotted above the foot-levers and connected to beam x^1, substantially as described. (6) The combination of the swinging lever, the seat pivotted thereto, and the spring boards, substantially as described.

The number of the patent is 316,542. Mr. T. K. Hansberry is the patentee.

THE INSTITUTION OF CIVIL ENGINEERS.

INLAND NAVIGATIONS IN EUROPE.

THE fourth of the course of lectures on "The Theory and Practice of Hydro-mechanics" was delivered on Thursday evening, the 19th of March, by Sir Charles A. Hartley, K.C.M.G., M. Inst. C.E., the subject being "Inland Navigations in Europe." The chair was occupied by Sir Frederick J. Bramwell, F.R.S., the President.

The lecturer premised that his professional experience being mostly in connection with the great rivers of Continental Europe, his remarks on the inland navigations of Great Britain would be brief. The lower parts of the chief rivers of the United Kingdom were mostly arms of the sea, navigable at high water by ships of the largest burden. The principal waterway, the Thames, was navigable for about 194 miles, and was united by means of a network of canals with the Solent, the Severn, the Mersey, the Humber, and the Trent, being thus in direct communication, not only with the English and Irish Channels, but also with every inland town of importance south of the Tees. Other river and canal navigations were briefly noticed, among them Telford's masterpiece, the Caledonian Canal; and the estimated length of inland waterways in the United kingdom was given at 5442 miles, which had been constructed at a cost of £19,145,866.

Turning to the Continent, Russia next claimed attention as having the greatest extent of water-communications. Its principal highway was the Volga, the largest river in Europe, which in a course of more than 2000 miles, drained an area of 563,000 square miles, and afforded, with its tributaries, 7200 miles of navigation, but of very unequal capacity, owing to the shallow depth of some portions.

Hitherto no permanent works had been undertaken to improve the navigation of the Volga, but dredging had been resorted to in the lower part of the stream, and recently a system of scraping by iron harrows had been employed, which was stated to have doubled the depth of water over certain shoals in a few days. In the lecturer's opinion the Russian Government would hesitate a long time before embarking in costly improvement works the effect of which would be very uncertain. Other important water communications in Russia were the Caspian—an inland sea of 160,000 square miles extent; the river Don, 980 miles in length, and draining 170,000 square miles; the Dnieper, draining 204,000 square miles and with a course of 1060 miles. Of secondary rivers, the Bug, the Dniester, the Duna and the Neva were all navigable; in the case of the latter short, but most important means of communication, a maritime canal 18 miles in length had recently been completed to unite Cronstadt with St. Petersburg. About 900 miles of canals had been constructed in European Russia. In most instances they had been formed with but little difficulty across the gentle undulations of the great watershed, the object being to connect the head-waters of rivers which had their outlets at opposite extremities of the Continent.

Sweden abounded with lakes, which covered more than 14,000 square miles of its surface, but none of the rivers were navigable except those which had been made so artificially, nearly all of them being obstructed by cataracts and rapids. Nevertheless, Sweden possessed remarkable facilities for internal navigation during the seven months that the country was free from ice, intercourse being carried on by means of a series of lakes, rivers, and bays, connected by more than 300 miles of canals. Of the latter the most celebrated was the Gotha Canal, designed under the auspices of Count von Platen, by Telford, the first president of this Institution.

Germany owned parts of seven river valleys and three large coast streams, viz., the Niemen, the Eyder, the Vistula, the Pregel, the Oder, the Elbe, the Weser, the Ems, the Rhine, and the Danube. Of these, the Weser was the only one which belonged wholly to Germany, while of the Danube but one-fifth part ran through her territory. The hydrography of all these rivers was briefly described. The inland navigations of Germany were of the most advanced character, an immense trade being carried on upon them by means of barges and rafts. In the case of the Elbe, the system of towing by submerged cable had taken a large development. As early as 1866 chain tugs were running on 200 miles of its course, and in 1874 this mode of traction had been so increased that there were then 28 tugs running regularly between Hamburg and Aussig. These tugs were 138ft. to 150ft. long, 24ft. wide, with 18in. draught. On the Upper Elbe the average tow was from four to eight large barges, and taking the ice into consideration, there were about 300 towing days in the year. It was found that large vessels paid best; thus in the case of the Hamburg-Magdeburg Navigation Company, the cost of transporting a cargo from Hamburg to Dresden—a distance of 350 miles—for barges of 150 tons, 300 tons, and 400 tons, was respectively 11s. 6d., 9s. 9½d., and 9s. 4d. per ton up stream, and 4s. 4½d., 3s. 2½d., and 2s. 9½d. per ton down stream. Although Germany possessed a length of nearly 17,000 miles of navigable rivers, or more than double the combined length of the navigable streams of the United Kingdom and France, it could not be said to be rich in canals. In South Germany the Regnitz and Ludwig's Canals, from the Main at Bamberg to the Danube, were the only ones of importance until the annexation of Alsace-Lorraine. The North German plain had several canals, the most important of which were referred to in the remarks on the chief river systems of the Empire. In 1878 the total length of the seventy canals of Germany was only 1250 miles—a very small extent when compared with the other canal systems of Western Europe.

Holland possessed the great advantage of holding the mouths of the Rhine, the Maas, and the Scheldt. Her means of river communication with Germany, France, and Belgium were unbounded, and the possession of a length of 930 miles of canals and 340 miles of rivers enabled her, apart from her railways, to carry on her trade with greater facility of transport than, perhaps, any other European country. One of the principal artificial works in Holland was the North Holland Canal, constructed by Blankén in 1819-25, at a cost of nearly £900,000, and esteemed the greatest work of its day. It was fifty-two miles long and 18ft. deep. It had now been almost superseded by the Amsterdam Canal, constructed by Sir John Hawkshaw, and of which a detailed account was to be found in the "Minutes of Proceedings."

Belgium shared with her northern neighbour the advantages of an elaborate system of waterways. The principal were the Meuse and the Scheldt. The total length of the Meuse, which was canalised at difficult places, was 580 miles, of which 460 miles were navigable; but by far the most important river of Belgium was the Scheldt. Thanks to its unique position at the head of a tidal estuary, to the abolition of the Scheldt dues, and to the foresight and liberality of the Belgian Government, which had spent £4,000,000 on dock and river works since 1877, Antwerp had now become in many respects the foremost port of the Continent. Besides her 700 miles of navigable rivers, Belgium possessed about 540 miles of canals, by means of which communication existed between all the large towns and chief seaports of the kingdom.

France had built up, and was constantly extending, an elaborate system of canals and canalised rivers. Of the latter the Seine was the most important in regard to the artificial works undertaken for its improvement, and for the tonnage of the traffic, which was in 1872 more than one-eighth of the whole water-borne traffic of France. The lecturer successively passed in review the Loire, the Garonne, and the Rhone, all of which important rivers had been largely benefitted by the art of the engineer. The canal system of France was historic, one of the earliest of these artificial cuts being the celebrated canal of Languedoc, 171 miles long, and built by Riquet in 1667-81, and now forming part of the Canal du Midi. From its summit-level, 600ft. above the sea, it communicated with the Garonne, and therefore with the Atlantic, by twenty-six locks, while its southern slope descended by seventy-three locks to the Mediterranean. Statistics were given showing that, up to 1878, on 7069 miles of waterways, France had spent upwards of £43,000,000, or considerably more than double spent by the United Kingdom up to 1844. Nevertheless, it was intended still further to extend, improve and systematise this means of communication, at an estimated further cost of £40,000,000.

Spain and Portugal possessed partly in common eight principal rivers, of which five, the Minho, Douro, Tagus, Guadiana, and Guadalquivir, drained the western valleys and flowed into the Atlantic, while the other three, the Ebro, Incar, and Segura, discharged into the Mediterranean. The characteristics of these rivers were described. As a rule they were only navigable for a limited portion of their course, and were chiefly remarkable for the exhibition of peculiar natural phenomena and of extremes of flood discharge, a velocity of 16 knots an hour having been noted in the Douro under certain conditions of tide. The canals of the Iberian peninsula were unimportant; Spain possessed a length of 130 miles in 1875.

Italy was not rich in waterways except in the valley of the Po, the navigable portion of her rivers only attaining an aggregate length of 1100 miles. Of these the Po, the Adige, and the Tiber were the chief, and their principal points were discussed by the lecturer. Although the total length of navigable canals in Italy was only 435 miles, the Italians were the first people of modern Europe that attempted to plan and execute such artificial waterways. As a rule, however, they had been principally undertaken for the purposes of irrigation. Of the Italian canals the most important were the Cavour Canal in Piedmont, the Grand Canal in Lombardy, and the canals of Pavia and Martesana. The provinces of Venice, of Padua, and the Emilia had all excellent canal systems.

Austria-Hungary possessed in the Danube the largest river in Europe, as regarded the volume of discharge, although it was inferior to the Volga in the length of its course and the area of its basin. This great stream first became navigable for flat-bottomed boats at Ulm, 130 miles from its source. In its total length of 1750 miles it was fed by at least 300 tributaries, many of them large rivers, such as the Inn, the Drave, the Save, the Theiss, the Olta, the Sereth, and the Pruth. Indeed, the seven tributaries mentioned had a combined length of 2900 miles, and drained one-half of the Danube basin. The navigation interests of this grand river system were of the highest importance, both from the commercial and the engineering points of view, and the lecturer dwelt at length on the works of improvement executed under different Governments and Administrations, dividing his remarks under three heads, namely, the Upper and Middle Danube, the Lower Danube, and the Mouths. After leaving Bavaria, the upper and middle section of the river passed through Austro-Hungarian territory, and had been the subject of continuous and unceasing effort in the direction of improving its capacity for navigation. Although the Danube between Vienna and Old Moldova had been regulated in numerous places and at great cost, there had been but little appreciable improvement effected in its general navigable depth. On this account, projects having in view the permanent acquisition of a sufficiently wide channel of from 6ft. to 8ft. deep at every point between Passau and Basias, had lately been prepared by Government engineers, which involved an outlay of £2,000,000 to effect the desired improvements. Traffic on the Upper and Lower Danube was mostly carried in about 800 barges belonging to the Danube Steam Navigation Company, of which the greater number gauged 250 tons. Much valuable information respecting the mode of traction on the Middle Danube had been procured from Mr. Murray Jackson, the engineer of the company in question, to whom, as well as to several other correspondents who had likewise kindly aided him in procuring information on other matters connected with his discourse, the lecturer tendered his acknowledgments.

The Lower Danube began at the foot of the Iron Gates, and terminated at the outfall in the Black Sea. The principal features of this section of the river were described, and it was stated that between the Iron Gates and Ibrail there was frequently a depth of 40ft. at low water, but at seasons of very low water this depth was not more than 9ft., and at the Nicopoli, Sistov, and Tchernavoda shoals it was reduced to 7ft., 6ft., and 4½ft. respectively.

In conclusion, an account was given of the works undertaken by the International Commission, to which body the lecturer was appointed engineer in 1856, and had designed and carried out the works at the Sulina mouth, now on the eve of completion. The achievement of the programme of the Commission had resulted in there being everywhere a navigable depth of from 17ft. to 20ft. at the season of high water, and a minimum depth of 14ft. at low water. In the Sulina branch nine of its worst shoals had been successfully dealt with, and three cut-offs had been made, by which the river had been shortened two miles, and eight of its worst bends entirely suppressed. The total cost of these river works, including maintenance and dredging, had not exceeded £300,000. At the Sulina mouth, where there was only a depth of from 8ft. to 10ft. before the construction of the piers, the depth for many years past, unaided by dredging, had not been less than 20½ft. The cost of the piers, including their maintenance to the present time, had been about £220,000. The effect of these improvements had been to increase the trade from 680,000 tons gross in 1859 to 1,530,000 gross tons in 1883, and to lower the charges on shipping from an average of 20s. per ton for lighterage before the deepening of the Sulina mouth and the improvement of its branch, to 2s. per register ton at the present time for Commission dues. As a commentary on the hostile criticism evoked when the scheme was initiated, the lecturer drew attention to two facts, namely, that the works so unsparingly criticised in 1857 had already effected a saving of £20,000,000, and that experience had abundantly proved that the predictions of a rapid silting-up to seaward of the Sulina piers had been completely erroneous.

GERMAN RAILWAY COUPLING AND BRAKE POWER REGULATIONS.

IN a letter on safety appliances for goods and mineral trains, Captain C. Fairholme, of the Heberlein Brake Company, says:—"Whether the coupling selected be one of the legion of newly invented automatic ones or only the ordinary screw coupling, it must be quite clear that, with the present loose chain couplings, it is utterly impossible to use any system whatever of brakes, either continuously or in groups, more especially so long as wagons without buffers are allowed in the trains. Unfortunately, however, an idea is still very generally prevalent that the present system of loosely coupled trains, with all its attendant jerks and jars, and smashing together of the rolling stock, is a necessity of the case, and that long trains cannot be started without it, to say nothing of the delays which it is supposed would result in shunting operations were the present chain couplings done away with.

"That both these ideas are utterly fallacious is clearly shown by the simple fact, patent to everyone who crosses the Channel, that goods and coal trains, with from sixty to seventy wagons, and even more, are in constant traffic, without loose couplings, in every part of the Continent, and without creating the smallest difficulties either in starting or in shunting operations.

"As it may interest your readers to see in how practical a manner both the questions here under notice have been disposed of by the Association of German Railways, which now comprises more than a hundred lines in Germany, Austria, Switzerland, Belgium, and Holland, I append a translation of some of its latest regulations, including those relating to couplings and brake power, premising only, however, that those printed between commas are obligatory, whilst those not so printed are merely as it were recommendations of the technical committee of the association. Nos. 147, 150, and 153 are specially interesting, as it is by the general introduction of continuous drawbars and screw couplings that the evils of the loose couplings system has been got over."

Extracts from the rules and regulations of the Associated German Railway Directions, as revised and agreed to at the General Assembly held at Gratz in May, 1882:—

Par. 145.—"The brakes of all vehicles must be so constructed that, with loaded vehicles, an effect almost sufficient to skid the wheels must be attainable." Continuous brakes and also brakes in groups have proved efficient.

Par. 146.—"The brake handles of all screw brakes must be so made as to turn to the right when the brake is being put on. When an automatic or continuous brake is adopted, arrangements are to be made that the proportionate number of brakes applicable by hand shall not be less than that ordered by Par. 185."

Par. 147.—"Elastic drawbars and buffers are to be fitted at both ends of all vehicles, except ballast wagons. All new vehicles ordered are to be supplied with continuous drawbars."

Par. 150.—"The drawbars must be so constructed as to permit of their being drawn out not less than 50 millimetres—1⅞in.—nor more than 150 millimetres—5⅞in."

Par. 153.—"Every vehicle must be fitted at both ends with a coupling. For passenger carriages and guards and postal vans screw couplings only are to be used. For goods wagons the universal adoption of screw couplings is also necessary. Any chain couplings still in use are to be replaced by screw couplings by January 1st, 1886, at the latest."

Par. 155.—"All vehicles must be fitted in such a way as to admit of their being doubly coupled, so that should even the main coupling break, no separation of the train shall take place."

Par. 184.—"The length of the trains is to be governed by the profile of the line, the arrangement of the stations, and the state of the rolling stock. The number of axles running in any single train shall not, as a rule, exceed 150, and shall in no case be over 200."

Par. 185.—"Besides the brakes on the tender, or on the engine, so many powerful brakes must be served in every train, that according to the inclines on the line the proportion of the train axles shown in the following table must be under brake power":—

Inclines.	Passenger train.	Goods train.
1 in 500	$\frac{1}{8}$	$\frac{1}{12}$
1 in 300	$\frac{1}{6}$	$\frac{1}{10}$
1 in 200	$\frac{1}{5}$	$\frac{1}{8}$
1 in 100	$\frac{1}{4}$	$\frac{1}{7}$
1 in 60	$\frac{1}{3}$	$\frac{1}{5}$
1 in 40	$\frac{1}{2}$	$\frac{1}{4}$

"The number of brakes may be also calculated on the same proportional scale by the dead weight of the train instead of by the number of axles. Mixed trains which run at passenger-train speed are to be treated as passenger trains. If an incline between any two stations be less than 1000 metres—1100 yards—in length, the number of the brakes is to be calculated on the basis of that for the next less incline. In calculating the number of brakes necessary for a train, each unloaded axle is to count as half a loaded one. For passenger trains running 75 kilometres—45 miles—per hour or more, one additional brake is to be added to those above given. For inclines of more than 1 in 40 special regulations as to the number of brakes must be issued.

Par. 186.—"In forming the trains, the proportion of brakes ordered by No. 185 are to be so placed that behind the last brake no more axles shall run than are allowed for one brake, according to the incline of the line. On all inclines longer than 1000 metres—1100 yards—and steeper than 1 in 200, the last vehicle of a train must always be a served brake wagon."

THE ST. PETERSBURG AND CRONSTADT MARITIME CANAL.

THE Cronstadt Canal, to which we referred in our impression for the 2nd January last, was opened on Wednesday, this being the second anniversary of the coronation of the Czar.

After a religious service the Emperor and Empress went on board the magnificent yacht Dershava, anchored at the spot where the canal commences. At a quarter past twelve o'clock the Dershava proceeded to Cronstadt. Near Cronstadt the entire Baltic fleet was assembled, numbering 111 vessels and torpedo boats, where the forts of Cronstadt thundered forth a salute, and announced thus that the ceremony of opening the canal had been performed.

Although it was a leading idea in the mind of Peter the Great that St. Petersburg was to be a seaport, it has never been fully realised till the present day. Cronstadt has been the real port all this time. No vessel drawing over nine or ten feet of water could float over the bar of the mouth of the Neva and reach the capital; all vessels requiring a greater depth of water than this had to deliver their cargoes at Cronstadt. The goods were then put into barges, which were either poled or tugged up to St. Petersburg. All commercial operations were carried on at a great disadvantage under such a mode of operations. This will be best understood by stating that goods can at the present day be sent from London or Hull in about a week, but the transhipment of them at Cronstadt, with the short but slow passage to St. Petersburg, and the delivery there, usually occupied as much as three weeks, at times even more. This will now be all changed; sea-going vessels of almost any size will now be able in the future to proceed direct to St. Petersburg by the new canal, at the end of which docks have also been constructed and connected with the railways. Cronstadt is to remain exclusively a port for the naval marine. It will henceforth be the Portsmouth of Russia.

In 1872 Count Bobrinski, then Minister of Ways and Communications, issued a report on the subject of the canal, and a Commission was appointed under the presidency of the Engineer Kerbeds to study the question. This led to two projects being evolved. One was produced under the triple authorship of Cotard, Champoulion, and Janicky, and the other by a councillor named Poutiloff. This last was the one finally adopted in 1874, when it received the sanction of the Emperor. It was about three years later before the works were commenced. This was owing to the necessary machinery—such as dredgers, &c.—having to be made in Finland and England, and many of them were damaged, and some were lost on their way to the Neva.

The whole length of the canal is about seventeen miles. It starts from the island of Goutouieff, on the southern side of the Neva, where the river enters the Gulf of Finland, and it extends westward along the south side of the gulf, terminating at Cronstadt. The canal, after leaving the islands of Goutouieff and Wolnoy, and the low marshy ground known as the Isle des Cannoniers, passes all the rest of the way, which is nearly its whole length, through the waters of the gulf. On this account, instead of calling it a canal, the work might be described rather as the making of a channel through a shallow portion of the sea. At the eastern end a few miles of it had to be embanked to prevent the deposit of sand and mud which produces the bar at the mouth of the Neva. The longer portion on the west, which is not liable to this deposit, is simply a channel which has been dredged out, and its course will be indicated by means of buoys. A large dock has been formed on the island of Goutouieff, to which the railways have been connected. As the traffic increases, there is ample space on the islands for the construction of more docks. By the Neva, Schlusselburg on Lake Ladoga is reached, where the vast canal system of Russia begins. This system was another of Peter the Great's schemes in relation to his new capital, by which the city was to be connected with the great rivers of Russia, such as the Marinskaya, the Tichwinshaya, the Wishnevolodjskaya, and the Volga, the last being 2500 miles in length; these form, with the canals, a communication between the Baltic and the Caspian. The steamers which are sailing at the present moment on the Caspian were built either in England, Sweden, or Finland, and were floated in pieces by the canal and river system from St. Petersburg to Astrakan.

A NEW AUTOMATIC BRAKE, the invention of Messrs. Sloan and Hawks, Edinburgh, which is said to meet all the requirements of the Board of Trade, has been under trial at the works of the North British Railway Company. It is guaranteed to insure the prevention of "skidding" under all changes of load or rail pressure, of speed, and of the condition of the rails.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, May 15th.

THE industrial situation throughout the States is steadily improving, but the improvement is accompanied by strikes and threatened lock-outs. The reductions in wages last year were made in many cases under the assurance that an advance would be given when trade improved. While there is a moderate improvement, it is not of such force as to warrant higher compensation to wage workers. To-day's reports from Western Pennsylvania indicate a general lock-out, which will affect over 50,000 ironworkers, and probably lead to a long contest of three or five months' duration. As to the probable effects of such a lock-out upon the iron trade there is but little difference of opinion. The manufacturers of specialities will suffer most, but even they can meet a moderate demand by using slab steel. The leading brokers here believe but little inconvenience will result. As it is, but little over one-half of the iron-producing capacity of the country is engaged. The nail mills, both iron and steel, continue to run. The sheet mills also will remain in operation. The bar and plate mills will shut down. The rail mills are not affected, as labour there is controlled by a yearly agreement dating from the first of each year. Hence the only stringency will be in merchant bar iron, and the mills not controlled by the Amalgamated Association, which are about 40 per cent. of the capacity, will be able to meet the urgent requirements of the market for the next three months. The demand of the workers was for old wages, viz., 5.50 dols. for puddling with iron selling at from 1.50 dols. to 1.75 dols. The manufacturers are resolute in their determination not only to not pay this high price, but to break the power of the Association which has controlled them for twenty years. The contest would have been entered upon last year but for the fact that too many of the manufacturers were loaded with orders. The demand for material of all kinds is light.

The lock-out it is said to-day will precipitate a large number of orders for building material of all kinds, because of the policy which buyers now pursue of carrying moderate stocks.

The situation outside of the iron trade is unchanged. The coal producers expect to market two and a-half million tons of anthracite this month. The bituminous competition from West Virginia and in the interior of Pennsylvania is being felt more and more keenly every day. New bituminous regions are being opened up through railroad development, and an unusually large supply of soft coal is in sight. The five railroad companies composing the bituminous coal pool are likely to disagree, because of the policy of one of the number, viz., the Pennsylvania, in capturing more of the New England trade than it is justly entitled to. The manufacturing demand is still backward. Steamship and railroad demand is held in check in view of the break in prices.

Building operations of all kinds throughout the city and the New England and Middle States are being pushed with the greatest vigour.

The supply of logs in the North-West is 25 per cent. below last year's supply, and in the North-East the supply of spruce is reduced. Hence wholesale dealers are anticipating a slight improvement. The agricultural area in the North-West will be reduced this year over last. The cotton area of the south will be slightly increased.

The exporting interests are anticipating a sluggish demand for all kinds of staple products, owing to the loss of the anticipated foreign market.

There is much idle capital awaiting employment in the banks. Commercial failures continue frequent, but nine-tenths of them are made up of small traders whose disappearance from trade circles improves the opportunities of the heavier concerns, who have been interfered with during the past two years by this small competition.

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

(*From our own Correspondent.*)

BIRMINGHAM iron market to-day—Thursday—and Wolverhampton market yesterday were attended by a much smaller number of traders than is usual, consequent upon the holidays; and the business transacted was meagre. Ironmasters reported that perhaps half the works in South Staffordshire are this week wholly idle, and the other half will only make three days. There is no inducement to curtail the holidays, and the men are therefore allowed full play. Vendors rather welcomed to-day the postponement of buying until next week, since the effect should be to give a better tone to business after the holidays.

Some hoop, strip, and bar makers state that for six weeks past they have had as many orders as they could execute, notwithstanding that they have refused to file nearly as many more, consequent upon the prices offered being unsatisfactory. Certain of these firms are expressing freely this week their opinion that much better prices than at present prevail might be obtained in some departments, were not manufacturers over anxious to prevent customers from going elsewhere.

The official basis of £7 10s. for marked bars, with Round Oak quality at £8 2s. 6d., remains without change, and is likely to continue. Ordinary merchant bars are saleable at £5 10s. to £6, but where quality is not insisted on £5 5s. is accepted as the minimum. Common hoops are quoted to £5 15s., and strips £5 10s.

The Australian and New Zealand demand, at date, for bars and hoops is good, and India and South America are also buying in moderately heavy quantities. Simultaneously the foreign demand for Staffordshire bars of best quality is brisker than several houses have experienced for some months past.

A large out-turn of sheets is going on. In many instances, however, buyers who have orders to place solicit so many quotations that it is almost like putting up the work to auction. A considerable trade is recorded in common black sheets at £6 10s. to £7 for 20 gauge; whilst best thin sheets are quoted £10 10s. upwards, according to gauge.

Deliveries in the pig iron trade are mostly suspended this week. Native prices are quoted at 57s. 6d. to 60s. for hot-blast all-mines, but 55s. is nearer the selling figure of any but special brands; part-mines are 40s. to 45s., according to mixtures, and cinder pigs, 33s. to 36s. 3d. per ton. Midland makes are unaltered in price.

Ironmasters are not unanimous upon the wisdom of getting the rollers in the sheet mills to make concessions in the matter of payments for rolling long lengths. Such concessions get to the ears of buyers, and these make the most of the new arrangements in their bargaining for a price. In short, all reductions in wages give consumers an additional chance of bearing the market; and when the reduction is but small, ironmasters are not compensated.

Sugar machinery engineers view with much satisfaction the improved prospects of the West Indian planters. Already, indeed, local merchants are receiving an increased number of orders for sugar-making machinery from Cuba and other adjacent islands.

Engineers here are hoping to get some of the ironwork for bridges, and a portion, at least, of the contract for wheels and axles, for which the Director-General of Stores for the India-office is at present inquiring.

The Darlaston concern known as Messrs. Ford, Stathan, and Co., has changed hands, and in future will be known as Messrs. Timmins and Co.

The present is the busiest month of the year with some of the heavy ironfounders, but the severe competition for all business offering makes prices very unsatisfactory. Some of our local pipe founders will tender for the 22,500 tons of pipes and special castings which the Cardiff Corporation are needing for their waterworks.

Fair orders are arriving at date from the antipodes for galvanised sheets, netting, tools, and general machinery.

Makers of cultivating and edge tools in Birmingham are doing a good business with Australia, and, in some descriptions of tools, with India also; but the South American demand is much below the average. Generally speaking, the shipping demand is reported small. The competition of the Wolverhampton and Black-country makers is complained of. Certain of these latter firms are at present busier than they have been for some months past.

The chain cable makers in the East Worcestershire and Staffordshire districts threaten to come out on strike unless the employers concede an advance in wages. They now claim a return to the original list prices, which is equivalent to an increase of from 10 to 15 per cent.

A conference of delegates from various branches of the Amalgamated Society of Engineers commenced in Nottingham on Monday. Mr. Horne, of London, presided, and there were present 240 delegates from all parts of the kingdom, as well as two from New York. The president said that starting thirty-four years ago with 9000 members, they had now reached a total of over 51,000, forming 430 branches situate in the United Kingdom, Australia, the East Indies, Canada, the United States, and France. Two and a-quarter millions sterling had been expended for charitable purposes alone. The object of the conference is the revision of the rules of the Society, and the sittings are expected to continue for nearly a month.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—There has been very little real attempt at business during the past week. Many of the engineering works have been closed for the whole, and others for the greater portion, of the week for the usual Whitsuntide holidays, whilst at the collieries in the neighbourhood of Manchester work ceased on Wednesday, and will not be fully resumed until about Wednesday in next week. With actual operations at works and collieries so generally suspended there has, of course, been very little buying going on, and any business beyond what has been absolutely compulsory has been held in abeyance until the holidays are fairly over.

Tuesday's meeting was the only Manchester iron market held this week, but it brought together only a very thin attendance, and resulted in very little actual business being done. The keen competition of one or two of the district brands of pig iron has forced a little giving way on the part of the Lancashire makers, and at the reduced rates, averaging about 39s. for forge, and 39s. 6d. for foundry, less 2½, delivered equal to Manchester, that they are now prepared to accept, some small weight of business which was previously being held back has been secured. Local makers are, however, still undersold by Lincolnshire iron, which, although not being actually offered at quite such low figures as were being taken last week, is still to be bought at fully 1s. per ton under the lowest price quoted for Lancashire iron. For delivery equal to Manchester the prices quoted for district brands range from 38s. 6d. and 39s. to 40s. 6d. and 41s., less 2½ per cent.; but so far as there is any actual business doing at these figures, they may be regarded as little more than nominal. The large consumers of pig iron are, in fact, so fully bought, that so far as real requirements are concerned, they are not in the market at all at present as buyers, and when they are tempted to give out orders, it is only at extremely low prices. In fact, where business of any weight is being done, I may say that it is only at prices that practically have no relation to the nominal list rates quoted in the market, and I hear of buyers having placed orders at prices which, to use their own words, would scarcely be credited if they were mentioned.

In the manufactured iron trade there is only a very small business being done. For the better qualities of Lancashire and North Staffordshire bars makers still hold to £5 7s. 6d. per ton as their quoted basis for delivery into the Manchester district. A want of firmness is, however, to a large extent apparent, and buyers who have good orders for prompt delivery to give out have not much difficulty in placing them at 1s. to 1s. 6d. per ton under the above figure. For hoops the average price remains at about £5 17s. 6d., and for sheets, £6 17s. 6d. to £7 per ton, delivered into the Manchester district.

Recently I had an opportunity of inspecting one or two improvements that are being introduced by Messrs. W. Collier and Co., of Manchester, in tools for cutting twist drills. One of these is a specially designed tool, combining both wheel-cutting and the cutting of twist drills, which is quite a novelty in the combination of operations that are embraced. This machine is adapted for cutting wheels up to 18in. diameter, whilst it will admit 18in. in length between the centres, and is arranged for cutting skew, spur, bevel, or worm wheels. In addition, there is an attachment for cutting twist drills with increasing twist, as required, and other similar work. In construction this machine may be described as follows:—The body consists of a strong base, fitted with transverse slides, each having an adjustable motion for any angle of tooth, and long traverse to admit different diameters, a worm wheel and worm and dividing motion are attached, as is usual with ordinary wheel-cutting machines. For cutting twist drills, rymers, &c., an additional slide and headstocks are provided, with motions for cutting the increased twist in Morse drills, and when the machine is not required for cutting twist driils, this attachment can be removed, and wheel cutting resumed, or the operation reversed when twist drill cutting is required. In connection with this plant, Messrs. Collier have also a small machine adapted for cutting the clearances behind the cutting edge required in twist drills. This machine is arranged to admit any size of drill, from the smallest to the largest that are now in use; the twist drill to be operated upon is placed between centres and revolved. The clearance behind the cutting edge is cut away by means of a cutting tool, placed vertically, and having an excentric motion, which gradually cuts the clearance from the cutting point to the back of the thread, and thus ensures a uniform clearance in all the drills passed through the machine. This tool, it may be added, can be applied either to regular or to increased twists. Another special tool is a twist drill pointing machine. This consists of a light frame, carrying a horizontal spindle, which is fitted with a quick-running emery grinding wheel. The base of the frame is also fitted with a compound slide, with longitudinal and transverse adjustment, so as to admit any length or diameter of drill required to be pointed. The special arrangement of the machine consists in a top rest with a powerful chuck, having a cam motion so as to allow for the interval of space, and make the requisite graduating face on the point of the drill.

In the coal trade there has been a little extra push for house fire classes of fuel in anticipation of the stoppage of the regular supplies during the holidays, but with this exception business continues very dull, with common round coals for steam and forge purposes a drug in the market, and engine classes of fuel also plentiful and slow of sale. So far as any further announced reduction is concerned, prices are unchanged, and in the Manchester district they are steady at the present list rates, but generally the tendency is downwards, and to a large extent it is becoming a question more of what buyers will give than what sellers are quoting. At the pit mouth best coal averages 8s. 6d.; seconds, 7s.; common house fire coal, 5s. 6d. to 6s.; common coal for steam and forge purposes, 5s. to 5s. 6d.; burgy, 4s. 6d. to 4s. 9d.; the better qualities of slack, 3s. 9d. to 4s.; and common sorts, 2s. 9d. to 3s. per ton.

In the shipping trade there has been a moderate business doing, but the prices at which sellers are willing to accept orders are very low, good ordinary qualities of Lancashire steam coal not averaging more than 6s. 9d. to 7s. per ton delivered at the Garston Docks or the High Level, Liverpool.

Barrow.—The week has been chiefly spent in holiday making, not only by workmen, but by business men generally. No new feature can be noted in the condition of trade, and sales during the past few days have been comparatively few and inextensive. The best prospects of trade are generally shown by the spirit of consumers to buy iron for forward delivery; but there is not much doing in forward sales, although iron can now be bought for forward delivery at little more than the price at which sales for prompt delivery can be effected. It is generally believed that the attitude of the market at present will not be disturbed, and any hope of an early revival in demand has been abandoned. It is always noticeable that when the spring passes without any additional spurt in trade, nothing but extraordinarily exceptional circumstances will bring about any improvement, and there are no indications of such circumstances arising so far as the hematite iron trade is concerned. Prices are unchanged at 44s., No. 1 mixed Bessemer samples net prompt delivery, and 45s. forward delivery; No. 2, 43s. 6d.; No. 3, 43s. per ton net; forge and foundry qualities, 42s. to 42s. 6d. per ton. Stocks remain very large at all the works, and also in warrants on the docks and in store yards at Barrow, Workington, and Maryport. Steel makers have not many orders in hand, and it is probable they will experience a dull state of things, both as regards the industrial and commercial aspects of trade during the year. Shipbuilders are busier than they have been, but no new orders have been booked. Marine engineers are still working overtime. Iron ore very dull at from 8s. 6d. per ton at mines. Coal and coke firm. Shipping in a less active state than ever. The tramways at Barrow are now ready for the inspection of the officer of the Board of Trade.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THE great strike, as I anticipated, is slowly but steadily coming to an end. Lundhill, Waleswood, Corton Wood, Wombwell Main, and Mitchell Main Collieries have followed the example of other pits and accepted the masters' terms. Darfield Main will probably be added to the list before the week is out. The men at Rockingham Colliery returned to their work on the 28th inst.—Thursday—and now Messrs. Newton, Chambers, and Co., who employ over 3000 pit hands, have the whole of their men at work. On every side the men seem thoroughly tired of the struggle, though at the Nunnery Colliery a defiant attitude is still maintained. The pits of the Nunnery Company are at Sheffield, and the men have a ready means of applying for the aid of the benevolent, which they do incessantly. From Denaby Main similar deputations in the form of brass bands, and now of colliers' wives with begging books, are energetically canvassing for subscriptions, the former in the public thoroughfares, and the latter from house-to-house. The result cannot possibly be large, as the general public have themselves been severely pinched by the long depression, and the applications are now wearisomely frequent.

At Manvers Main, the deputation appointed to wait upon the employers and intimate the willingness of the men to resume work at the 10 per cent. reduction found the management quite ready to reinstate all the men who occupied places prior to the strike. A suggestion was made that the question of wages should in future be settled according to a sliding scale on a principle similar to that in Durham and Northumberland, but no definite action was taken on the point. The miners appear to be very thankful to get back to their employment, and the joy of the miners' wives and children was unmistakeable.

The great dispute at Denaby Main must terminate within a week. I learn that the men, from the result of an interview with the managers, have come to the conclusion that the pits will be closed unless an arrangement is made on or before June 3rd. Preliminary to this being done the colliers from Cornwall have been sent home, and the colliery management appears thoroughly determined to bring this disastrous affair to an end. They state that they cannot continue to carry on the concern at a loss, and are still more unwilling to keep up a warfare with workmen who will neither work themselves nor allow others to do so, and if they are not to do their business in their own way, they will prefer not to do it at all until the conditions are altered. The closing of Denaby Main Colliery will be a serious affair for the village, practically depriving not only the miners, but tradesmen and others, of the means of support. There is no place in Yorkshire or adjoining coal-fields where the men will find work.

In one or two quarters I find a strong opinion expressed that we are nearing the end of the depression in the American market. Very little evidence of revival can be found here, but it is certainly believed by one or two competent judges that the long-continued adversity is about to be broken. A friend who has recently returned from the United States says that he believes next August or September will witness a change for the better. If prosperity should begin there, it would be a good sign for the old steel trade of Sheffield, and the large houses, who still largely look to the States for their business.

The Whitsuntide holidays have been more thoroughly enjoyed this season, perhaps, than on any former occasion, except in the colliery districts. There has rarely been such glorious weather, and this has caused both employers and employed to take advantage of the "play" time. Several works were reopened on Wednesday morning; but there has been very little done this week. No pressure in any departments, except armour-plates, heavy ordnance, and steel castings for marine purposes, leads to longer rest than would otherwise have been permissible.

A trial trip was run on the Hull and Barnsley Railway on Monday, a train conveying about one hundred persons having been engineered from the Hull docks to the Stairfoot junction.

The accident to the express for London near Shireoaks station, noticed last week, was not owing to the failure of a crank axle on the engine, but to the snapping of a coupling rod. No further damage was done, and the train was only slightly delayed.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

OWING to the Whitsuntide holidays the Cleveland iron market was this week held on Wednesday, instead of Tuesday. The state of trade, which has been very quiet and weak for some time, is now worse than ever, business being literally at a standstill. It is a difficult matter to fix prices, because no sales have recently been made. For prompt delivery merchants are quoting No. 3 g.m.b. at 32s. 9d. per ton, being 1½d. less than they accepted a week ago. For forward delivery they ask 33s. 3d. per ton. Makers are not pressing their iron for either prompt or forward delivery, and will not take the low prices with which merchants seem to be content. Their quotations range from 33s. 6d. to 34s. per ton. The price quoted for forge iron by merchants is 32s. 9d., and by makers 33s.

No improvement has taken place in shipments of pig iron from the Tees. The home ports are taking average quantities, but there is a great falling-off in the consignments abroad.

Nearly all the finished ironworks are closed this week for the holidays, alterations, and repairs. There is a lull in the demand for ship plates, angles, and bars, and prices are not so firm as they were. Quotations are as follows:—Ship plates, £4 17s. 6d. to £5 2s. 6d. per ton; angles, £4 12s. 6d. to £4 15s.; and common bars, £4 15s. to £5—all free on trucks at makers' works, less 2½ per cent. discount.

The accountant to the Board of Arbitration has issued his report for the two months ending April 30th. It shows that the average net selling price of finished iron of all kinds was £4 17s. 11d. per ton. The lowest point reached in the depressed times ending December, 1879, was £5 3s. 3d.; the present return is, therefore, 5s. 4d. per ton below the minimum of that period. The fall of prices which has taken place during the first four months of this year is only 1s. 10d. per ton, but when the fall which took place during last year is added the total becomes £1 for the sixteen months. In 1883 the fall in price was 10s. per ton.

The output of rails, plates, bars, and angles for the two months ending April 30th was 65,283 tons.

The North-Eastern Steel Company, of Middlesbrough, has been utilising the Whitsuntide holidays by making sundry alterations and extensions to its plant. The alterations affect mainly the blowing engines for the converters. These have latterly been troublesome, because somewhat under power. Frequent breakages occurred, and consequently stoppages and interruptions in the blowing department. These evils will be entirely remedied by the alterations which have just been made. The extensions referred to consist of a new 20in. mill, for billets, and other light sections of various kinds. The company has experienced a large demand for such work, and it does not find it can meet it advantageously without a mill specially adapted to it.

The death of Mr. Henry Moore, of Glasgow, formerly one of the firm of Shaw Thompson and Moore, has been much regretted in Cleveland, where he was well known. In company with other capitalists he was owner of certain landed property on the banks of the Tees. He was also closely connected in various ways with the Cleveland iron trade.

The North-Eastern Railway Company is spending no small amount of money in improving its line between Darlington and Redcar. A new station is nearly complete at Grangetown, and another at North Ormsby. They are both of the "island" type, and will be a great accommodation to the inhabitants of the localities in which they are situated. Near Fighting Cocks, the branch line to Bank-top, Darlington, was commenced some time since, and the works are already considerably advanced. The Middleton-one-row new station is built and will soon be ready for use. At Bank-top a greal deal of work has already been done to the new station and approaches, but according to present appearances this will be the portion last completed. The traffic returns of this line for last week show an increase of £1932 over the corresponding week in 1884. This is a gratifying change from the decreases which have been announced weekly without intermission for a long time.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE iron market has been unusually quiet this week on account of the holidays. Pig iron speculation is in a backward state, but as the warrants are well held the quotations do not show much change. The tendency is, however, downward this week. The week's shipments of pig iron were 9130 tons, as compared with 9223 in the preceding week, and 16,240 tons in the corresponding week of 1884. During the holidays, the stocks of pigs have been accumulating to a greater extent than before. Messrs. Connal and Co.'s Glasgow stores now contain 596,898 tons, as against 590,994 at the same date last year.

The warrant market was closed from Wednesday of last week till Tuesday forenoon. At the close on Wednesday, sellers stood at 41s. 10d. cash. The market opened on Tuesday at 41s. 9d. cash, and 41s. 11d. one month, and remained almost stationary throughout the day. Business was done on Wednesday at 41s. 8d. cash. To-day —Thursday—the market was very depressed, with a further decline to 41s. 6½d. cash.

For makers' iron the demand is very quiet, and the best brands are offered by merchants at about 3d. below the prices of last week. Free on board at Glasgow, Gartsherrie, No. 1, is quoted at 50s. per ton; No. 3, 46s.; Coltness, 51s. 6d. and 49s. 6d.; Langloan, 51s. 6d. and 49s. 6d.; Summerlee, 49s. 6d. and 45s. 6d.; Calder, 52s. and 45s. 6d.; Carnbroe, 48s. and 45s. 6d.; Clyde, 46s. 9d. and 42s. 6d.; Monkland, 42s. and 40s.; Quarter, 41s. 9d. and 39s. 6d.; Govan, at Broomielaw, 42s. and 40s. 3d.; Shotts, at Leith, 50s. and 49s. 6d.; Carron, at Grangemouth, 52s. 6d. and 47s.; Kinneil, at Bo'ness, 44s. and 43s.; Glengarnock, at Ardrossan, 47s. 6d. and 42s.; Eglinton, 42s. 3d. and 39s. 6d.; Dalmellington, 45s. 6d. and 42s.

There is a steady demand for Cleveland pig iron, the arrivals of which to date are 46,920 tons greater than twelve months ago.

Considerable surprise was caused by the announcement made this week by Messrs. H. M'Intyre and Co., of Paisley, that they were obliged to suspend payment. The firm has of late years built a considerable number of the smaller class of vessels, and when other shipyards were dull, they had been generally full of work. The Govan Shipbuilding Company have discharged a large number of workmen, and they have now only about 300 men in the yard engaged repairing the Allan liner Hibernian.

At a meeting of the steel trade a few days ago the recent advance in prices was confirmed, but no further increase was made.

The shipments of iron and steel manufactures from the Clyde in the past week were smaller than usual, consisting of £2380 worth of machinery, £698 sewing machines, £4200 steel goods, and £19,500 iron manufactures, the latter comprising sleepers, bars, and sheets, with £5120 for Calcutta, and £4500 goods for Canada.

The shipping trade in coals has been active during the week, and from some of the ports large quantities have been despatched. At Glasgow, 18,302 tons were despatched; Greenock, 1392; Ayr, 7653; Troon, 6909; Irvine, 2845; and Grangemouth, 16,064 tons. In some cases an increase of about 3d. a ton has been got, but even that rise is by no means general. The supplies are large, and all orders are therefore met with promptitude. To date, the total shipments of coal at Scotch ports show an increase of about 153,000 tons.

Meetings of colliers have been held in different localities in the course of the week. At a meeting at Hamilton Mr. John Clyde, the chairman, stated that by the opening of the Baltic ports the trade had been brisker, and he urged the men to combine in order to get back the last 6d. a day that was taken from their pay. In Colville the Kilmarnock delegate and Mr. Hutchinson, of Galston, who represented Ayrshire, said that 2300 of the miners in the country were now working on the restricted day of eight hours, their wages being 3s. a day. The meeting resolved to recommend that the hours be restricted to eight, with a darg of 2 tons 10 cwt. in close places and 3 tons at the stoops.

The Executive Board of the Fife and Clackmannan Miners' Association met at Dunfermline on Saturday, and resolved that an effort be made to obtain an advance of wages to the extent of 10 per cent.

At the fourth annual meeting of the Burntisland Oil Company, held in Edinburgh this week, the chairman, Mr. John Waddell, stated that during the year they had raised 125,000 tons of shale, of which 116,000 had been used, producing 3578 odd gallons of oil, equal to a yield of about 31 gallons per ton of shale. The dividend paid to the shareholders is at the rate of 20 per cent.

WALES & ADJOINING COUNTIES.

(*From our own Correspondent.*)

WITH the exception of a little break about Monday and Tuesday, the flow of coal trade has been brisk and gratifying. Last week the pressure was very great in anticipation of the stagnation of Whitsuntide, Cardiff sending away 171,000 tons of coal; Newport, Mon., 57,000 tons; and Swansea, 39,000 tons. Men worked well in every direction, and the way the railways cleared off accumulations was very noteworthy. The Roath sidings, for instance, at the Taff Vale, on Thursday looked, with its five or six lines half a mile in length, one dense mass of coal—house, steam, and small—but in a few hours the clearance was almost complete. Saturday's shipments at the Bute Docks showed a remarkable list of large cargoes. There were a large number over 2000 tons, and the great majority over 1000 tons. The arrivals of registered tonnage at Bute Docks during the last four weeks have been the greatest on record. In two days 110,000 tons came in. Last week's clearances at the Bute Docks amounted to 150,000 tons, and despite excellent and most energetic work, the coal tips had all their work to do. Penarth is equally active, and 12,000 to 14,000 tons a day clearance there is an ordinary event.

We seem to be really in for another good spurt of coal trade, and prices, which are rapidly stiffening, may soon be expected to advance. Steam, large and small, maintains its firmness, and house coal, which has seen a long period of inaction is getting quite active.

Good work is being done at Merthyr Vale, Cyfarthfa, and Dowlais collieries. Harris's Deep Navigation is decidedly improving in output, and the same may be said of Penrhiwceiber. Arrangements are being made at this place for adding a new pumping engine and air compressor to the present machinery, and, like some of the other large collieries, it is to have the electric light for surface operations. The daily output varies between 1300 and 1400 tons.

The new sinking at Navigation progresses well, and at Ynysybwl coal is expected to be reached in another week or two.

Cyfarthfa sent off its first make of steel rails last week, and a very satisfactory cargo they appeared. The manager, Mr. Wm. Evans, has been most energetic in the matter, giving personal direction at every point unremittingly night and day, and the result is an excellent make, and one that should command a trade.

At present, however, orders are by no means plentiful. Last week a few thousand tons of rails were sent away chiefly from the Monmouthshire works, including a fair cargo for the Cape towards the completion of railways at East London and Port Alfred. Italian orders are held by some of our ironmasters, also Canadian and Indian, and inquiries from Russia are floating about. The skill of managers is well exercised in the manipulation of the small business in hand, the aim being, and really well carried out, to keep mills quietly going.

Pentyrch Works seem as if following the track of Treforest, but it is to be hoped trade will revive, as there is a large population dependent upon them.

The make of steel sleepers at Dowlais is satisfactory, but I do not hear of any movement at the other works, putting up new rolls, or so, to compete with Dowlais. When the railways waken up to the superiority of the steel sleeper to wooden, competition, and a lively one, may be expected.

There is at present no great activity in bar, wire, or any branch of the iron trade; a moderate business only is done at low prices. The new wire works at Merthyr with its splendid machinery continues idle, and Plymouth works are being speedily dismantled. An old inhabitant states that in the time of an ancestor, 150 years ago, fine corn fields occupied the site of Plymouth Works. To all appearances we are going back to the cornfields again.

The tin-plate trade is not very satisfactory. Some makers, principally in the Swansea district, are well occupied, but, viewed broadly, there are reasons for disquietude. Make keeps ahead of demand. April totals were not encouraging. The consignment to America in April was in round numbers 21,000 against 23,000 tons in March, and a decrease is shown in the totals to France and Australia.

Inquiries for sheets are numerous, but buyers want them for 12s. 6d. free at Liverpool, and against this makers very properly protest.

The fact is, and it cannot be concealed, that there are too many makers, and until the weak ones are weeded out the trade will not be satisfactory. Weak men in the trade are compelled by necessity to accept low terms, and thus the others are doubly injured.

There has been a suggested stoppage of works two days a week, but this is regarded as promising only a partial relief, and the probability, as far as I can now see, is that traders will go on struggling as at present until the weak go to the wall.

Swansea is shipping this week pretty well. Last week over 4000 tons went to New York and Philadelphia.

Patent fuel is brisk. Swansea sent close upon 9000 tons away last week.

IN a single decade the population of New South Wales has increased nearly 30 per cent., the number of children receiving instruction has more than trebled, the number of mills and manufactories has been quadrupled.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

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

Applications for Letters Patent.

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

19th May, 1885.

6089. Harmoniums, American Organs, &c., J. Robinson, Swansea.
6090. Lubricating Cups and Washers for Spinning, C. Brigg, Bradford.
6091. Mattresses, D. R. Gardner, Glasgow.
6092. Appliance for Playing Games, G. P. Lemprière, Birmingham.
6093. Fire-escape Tower, W. P. Thompson.—(*C. Clarke, United States.*)
6094. Hinges, Kettles, Teapots, &c., P. Gill and T. Lock, Liverpool.
6095. Slubbing and Roving Fibrous Materials, W. Tatham, Manchester.
6096. Rifle Vernier, H. Greener, Birmingham.
6097. Pipe Couplings, G. O. L. Leprévost-Bourgerel, Paris.
6098. Portable Folding Music Stand and Desk, J. E. Peene, Kington.
6099. Letter-file, J. A. Fresco, Paris.
6100. Wrought Taper Tubes, J. Hughes, E. Johnson, and J. T. Blakemore, Birmingham.
6101. Boots and Shoes, W. Freeman, Leicester.
6102. Pistons, J. H. Mitchell, Halifax.
6103. Stationery, J. Linkleter, Tynemouth.
6104. Utilising Peat Fibre, E. T. Reed, Newcastle-on-Tyne.
6105. Building Tall Chimney Shafts, W. Thompson, Stratford-upon-Avon.
6106. Fastenings for Trunks, &c., W. H. and B. Jones, Wolverhampton.
6107. Facilitating the Teaching of Needlework, S. Lawton, Manchester.
6108. Chimney Spark Arresters, J. Hornsby.—(*J. Martin, New South Wales*)
6109. Rollers for Printing Floorcloths, &c., G. Parker, Glasgow.
6110. Steam Boiler, J. N. Paxman and H. G. Plane, London.
6111. Duplex Strung Violin, J. and J. A. Taylor, Lower Edmonton.
6112. Automatic Double-acting Window Holder, H. Chancellor, Battersea.
6113. Combining Rush and Willow in Basket Work, G. W. Scott, London.
6114. Weighing and Measuring Grain, &c., W. Oakley, London.
6115. Fire Stoves and Grates, M. Schneider, Halifax.
6116. Indicating Apparatus for Omnibuses, &c, J. Hope, Liverpool.
6117. Iron Sleepers and Fastenings, W. E. Pedley, Sind, India.
6118. Electrical System of Signalling, H. P. F. and J. Jensen, London.
6119. Portable Apparatus for Boiling Liquids, &c., H. Vernon, London.
6120. Egg Boiler and Poacher, J. Taylor, London.
6121. Door Springs, J. W. Weston, Illinois, U.S.
6122. Banjos, W. Temlett, London.
6123. Seed Drills and Cultivators, J. G. Smith, London.
6124. Reducing Ores, J. K. Griffin, London.
6125. Pistol Holster, A. J. Boult.—(*Annener Gussstahlwerk Actien gesellschaft, Germany.*)
6126. Fire-arms, A. J. Boult.—(*T. Ericksen, D. Scholberg, and O. T. Johnson, U.S.*)
6127. Stills for Concentrating Sulphuric Acid, C A. Bartsch, London.
6128. Fire-extinguishers, J. A. House and C. H. Dimond, London.
6129. Automatic Fire-extinguishers, J. A. House, London.
6130. Grippers for Cable Railways, G. B. Bryant and E. D. Dougherty, London.
6131. Standards or Uprights, C. H. Fitzmaurice, London.
6132. Rotary Engines, W. Mather and T. Thorp, London.
6133. Bricks, E. Cammiss, London.
6134. Naphthol-carbonic Alkaline Salts, J. H. Johnson.—(*Dr. F. von H. Nachfolger, Germany.*)
6135. Loaf Sugar, J. H. Johnson.—(*E. M. J. B. Etienne, France.*)
6136. Fountain Pens, H. T. Brueton, London.
6137. Working Short Cotton, W. R. Lake.—(*C. W. Simmons, U.S.*)
6138. Washing Ore, E. Scott, London.
6139. Starch, W. R. Lake.—(*W. T. Jebb, United States.*)
6140. Grape-sugar or Glucose, W. R. Lake.—(*W. T. Jebb, United States.*)
6141. Lawn Tennis Courts, J. Eaton, London.
6142. Cutting Envelope Blanks, &c., T. B. Kendell, London.
6143. Condensing Apparatus, A. W. L. Reddie.—(*J. L. Alberger and T. Sault, United States.*)
6144. Closing Railway Carriage Doors, C. D. Douglas, London.
6145. Pencil-holders, H. J. Haddan.—(*B. Kollisch, Bavaria.*)
6146. Timekeeper, H. J. Haddan.—(*R. Bürk, Germany.*)
6147. Clothes Button, H. J. Haddan.—(*H. Fuhr, Germany.*)
6148. Wheels, J. Taylor, London.
6149. Enamel Paint, D. McCowan, Glasgow.
6150. Gas Motor Engines, R. Pollock, Glasgow.
6151. Ships' Lamps, J. Gilchrist.—(*D. Ballardie, U.S.*)
6152. Pressing Material into Mould Boxes, C. Schlickeysen, London.
6153. Boxes, P. Jensen.—(*J. Scherbel and C. T. Remus, Saxony.*)
6154. Heating Air and Gas, J. Lewis, London.
6155. Fireless Working of Steam Engines, A. M. Clark.—(*M. Honigmann, Germany.*)
6156. Steam Engines, T. T. Tucker, London.
6157. Cutting Bricks and Tiles, C. Schlickeysen, London.
6158. Metallic Cartridge Cases, R. Morris, London.

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6159. Pike's Combined Automatic Bread-cutting and Butter-spreading Machine, J. G. Pike, Norwich.
6160. Road Locomotives, A. E. Wynn, Grantham.
6161. Spindle Grease, J. Rider, Leeds.
6162. Knitting Machines, R. H. Lendrum, Halifax.
6163. Stockinette Fabric, R. H. Lendrum, Halifax.
6164. Wheeled Carriages, A. Dickinson, Wednesbury, and L. C. Clovis, West Bromwich.
6165. Keyless Watch, J. Phillips, Birmingham.
6166. Hearth-rugs, &c., J. Greenwood and J. Moore, Halifax.
6167. Bicycles, I. Briggs, F. Holloway, and H. D. Kendall, Birmingham.
6168. Ice Houses and Refrigerators, W. Higginbottom, Manchester.
6169. Weighing, &c., Seed, &c., J. Cheevers, Birmingham.
6170. Crimp or Pleat, T. Adams and Co., Nottingham.
6171. Banjoes, H. Spratt, London.
6172. Hangers or Droppers, A. Sparrow and F. Hoyer, Liverpool.
6173. Resin-box, A. Cary and A. Stradling, Newbury.
6174. Gas Motor Engines, S. Clayton, Bradford.
6175. Attaching Reins to Vehicles, &c., G. J. Harcourt and E. Shaw, Bristol.
6176. Bicycles, &c., H. W. C. B. Cave and F. W. Baker, Birmingham.
6177. Spring Mattresses, &c., W. Gadd, Manchester.
6178. Rope Couplings for Railway Vehicles, R. C. Sayer, Newport, Mon.
6179. Collecting Dust from Air, J. Ritchie, Liverpool.
6180. Wind Valve or Pallet for Organs, A. S. Hamand London.
6181. Facilitating Transit of Boats, &c., H. Shaw, London.
6182. Constructing, &c., Explosive Projectiles, J S. Williams, U.S.
6183. Constructing Explosive Projectiles, J. S Williams, Riverton.
6184. Constructing Explosive Projectiles, J. S. Williams, Riverton.
6185. Constructing Explosive Projectiles or Receivers, J. S. Williams, Riverton.
6186. Evaporation Pan, J. Egglestone, London.
6187. Electric Targets, G. F. Redfern.—(*F. Gladel, France.*)
6188. Bearings for Velocipedes, W. Bown and J. H. Hughes, London.
6189. Protectors for Spokes of Velocipedes, G. J. Stevens and H. W. Turner, Finsbury.
6190. Extracting Gold from Ores and other Products, J. Noad, London.
6191. Bearings and Axles, H. J. Haddan.—(*L. Leirer, Hungary.*)
6192. Bearings for Shafts and Axles, H. J. Haddan. —(*A. W. Spatzier, Saxony.*)
6193. Positive Expanding Comb, G. R. B. Kempton, West Ham.
6194. Cutting Grooves on Rollers, A. F. Link.—(*V. Philippot, F. Schneider, and C. Jaquet, Germany.*)
6195. Electric Currents, O. E. Woodhouse, F. L. Rawson, J. H. Davies, and Sir D. Salomons, London.
6196. Slow Speed Electro-motor, J. H. Adams, London.
6197. Bearings or Brasses for Rolling Mills, W. E. Harris, London.
6198. Military Water Bottles, P. B. Barnard, Hamilton.
6199. Roller Skates, W. R. Lake.—(*H. W. Libbey, United States.*)
6200. Bogies, J. Brown and T. Midelton London.
6201. Slubbing Intermediate and Roving Frames, S. A. Luke, London.
6202. Solitaires for Cuffs, W. E. Patterson and G. Slater, London.
6203. Lever Pedals for Driving Machine Tools, W. H. Beck.—(*A. Tiersot, France.*)
6204. Ornamenting and Preserving Photographs, E. Lloyd, London.
6205. Operating on Large Forgings in Iron or Steel, G. Siddell, London.
6206. Telephone Transmitters, A. M. Clark.—(*The Long Distance Telephone Co., United States.*)
6207. Table or Easel, W. Lichfield, London.

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6208. Cleaning Fallers and Gills, J. V. Eves, Belfast.
6209. Sight Feed Lubricator, J. T. Hailwood, Rochdale.
6210. Getting Coal, W. Pickard and E. Dickinson, Manchester.
6211. Producing Steel from Pig Iron, J. McRobie, Tradeston.
6212. Joint for Water, &c., Pipes, W. Mitford and G. Pettigrew, Darlington.
6213. Horseshoes, W. H. Denham, London.
6214. Supports for Side-leaves of Tables, H. Sefton and G. H. Wood, Liverpool.
6215. Wire Bottle Basket, G. Baker, Birmingham.
6216. Picture Hangers, C. A. Bullock, Bristol.
6217. Fixing Tiles, T. Heaps, Halifax.
6218. Dating and Stamping Railway Tickets, J. B. Edmondson, Manchester.
6219. Grinding and Polishing Sheet Metal Plates, W. Paschke, Manchester.
6220. Moulds, J. G. Lawrie, Glasgow.—*1st November*, 1884.
6221. Compound Steam Engines, W. Hargreaves and W. Inglis, Glasgow.
6222. Time-keepers, C. E. Kelway, London.
6223. Rifle Sight Elevators, H. Bates, Birmingham
6224. Groove Cutting and Drilling Machine, G. F. Thomson, Chester.
6225. Latches for Gates, &c., E. Bellow, Liverpool
6226. Railway Station Indicators, S. Mason, Leicester.
6227. Concrete Mixing Machine, S. Mason, Leicester
6228. Candle Extinguisher, W. W. Brereton, Dublin.
6229. Recording Signals on Siphon Recorders, J. H. Carson.—(*W. Dickenson, Newfoundland.*)
6230. Propeller for Boats, J. Howorth, London.
6231. Watches, I. Hermann, London.
6232. Winches, C. H. Cook and J. E. Warner, London
6233. Apparatus for Weaving Gauze, T. R. Ashenhurst and J. T. Lishman, Bradford.
6234. Carriages for Twist Lace Machines, J. R. Hancock, London.
6235. Sheep Dipping, J. Myatt, Hanley.
6236. Automaton Seat for Dog Carts, G. Heath Farnham.
6237. Ornamental Frames for Cards, M. Wirths London.
6238. Trimmings, R. and E. McLintock, London.
6239. Teapots, L. Brown, Falmouth.
6240. Electric Meters, F. W. Corden, Datchet.
6241. Posts for Carrying Lamps, F. W. Corden, Datchet.
6242. Printers' Galleys, W. P. Byles and G. Allan, London.
6243. Treating Waste Products, J. C. Mewburn.—(*G. Noback and W. Gintl, Bohemia.*)
6244. Tiles, G. E. Smart, Tunbridge Wells.
6245. Velocipedes, T. Bierau, London.
6246. Portable Beds, W. P. Thompson.—(*F. R. Rétif, France.*)
6247. Receptacle for Fruit, &c., G. D. Terry.—(*J. W. Leslie, United States.*)
6248. Treating Ramie, &c., H. J. Haddan.—(*E. Frémy, France.*)
6249. Tiles, G. F. Redfern.—(*Le Comte B. d'Abbadie, France.*)
6250. Meters, R. I. Barnes and H. S. Heath, London.
6251. India-rubber Tires, &c., C. Moseley and B. Blundstone, Manchester.
6252. Ring Spinning Machinery, P., R., and J. Eadie, Manchester.
6253. Lamps, E. Raffalovich.—(*L. Chandor, Russia.*)
6254. Valve Gear for Steam or other Engines, T. Swan, London.
6255. Hydrate of Baryta and Sulhide of Sodium, W. Black and W. L. Rennoldson, London.
6256. Lighting Railway Carriages, Sir F. Bolton, London.
6257. Hydraulic Mains for Gasworks, C. D. Abel.—(*F. A. M. Alavoine, France.*)
6258. Mechanical Piano, P. Jensen.—(*Gavioli and Co., France.*)
6259. Brakes, G. Wilson, Anerley.

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6260. T-square and Set-square Clamp, G. A. Barnard, Winchester.
6261. Sights for Billiard Cues, J. Tufnail, Reading.
6262. Tramway, &c., Engines, A. Johnson and G. G. Rhodes, Manningham.
6263. Thermometers, G. Heisch and C. W. Folkard, Clapham.
6264. Carriage Lamps and Holders, H. E. Brown, Dublin.
6265. Hydropathic Hood, T. Segger, London.
6266. Doffer Condensing Machines, R. H. Lendrum, Halifax.

6267. Drum or Can Lid or Stopper, J. Clare, Ditton-by-Widnes.
6268. Lawn Tennis, &c., Boots and Shoes, H. C. Pretty and J. Hewitt, Leicester.
6269. Forming the Necks of Bottles, &c., J. Blocksidge, Birmingham.
6270. Lubricants, S. Banner, Liverpool.
6271. Wringing and Mangling Fabrics, J. Kenyon, J. Barnes, and R. W. Kenyon, Liverpool.
6272. Lids or Covers for Drums or Packages, G. H. Bolton, Liverpool.
6273. Ventilating Apparatus, B. Boothroyd, Liverpool.
6274. Corrugated Metal Tubes, D. B. Morison and H. Cheesman, Hartlepool.
6275. Fastening Boots, &c., J. Smith and F. Langford, Stoke-upon-Trent.
6276. Retort Lid Fittings, C. C. Carpenter, London.
6277. Metal Healds or Harness for Looms, P. Crossley, London.
6278. Printing Machines, G. Walker, Halifax.
6279. Oilcans, P. J. Kenyon, London.
6280. Compressing Air, I. Shone and E. Ault, Liverpool.
6281. Spare or Jury Rudders, J. Wall, Liverpool.
6282. Rollers, W. Carnelly and G. W. C. Kirkham, London.
6283. Transmitting Motion between Pulleys and Drums, J. K. Starley, London.
6284. Ladies' Safety Saddle, H. Nicoll, London.
6285. Taper Box, G. F. Andrews, East Dulwich.
6286. Telescopic Swinging, &c., Switch for Incandescent Electric Lamps, A. Grundy and G. W. Ready, London.
6287. Automatic Valve Vent Plug, J. Everard, London.
6288. Yeast, W. S. Squire, London.
6289. Combined Tressle Socket and Clamp, G. W. Zeigler, London.
6290. Telescopic Coal Shute, A. J. Christey, London.
6291. School Desks and Seats, W. Taylor, London.
6292. Drying Fuller's Earth, &c., T. C. Gregory, London.
6293. Tipping Vehicles, J. Eddy, London.
6294. Brick Pressing and Moulding Machine, M. and M. Shearer and J. Smith, East Dulwich.
6295. Dyeing Fabrics and Yarns, J. Reffitt, London.
6296. Dyeing Fabrics and Yarns, J. Reffitt, London.
6297. Screening Coal, &c., H. E. Newton.—(*H. F. C. Glaser, Germany.*)
6298. Metallic Sheathing, W. Stobbs and E. L. White, London.
6299. Resonator Piano, F. Bing, Saxony.
6300. Adjustable Seats for Dogcarts, &c , A. Diss, London.
6301. Attaching, &c., Traces of Vehicles, A. Diss, London.
6302. Machinery used in Getting Coal, T. W. H. Turnbull and R. Pearson, London.
6303. Valves, J. List, London.
6304. Gauging the Depth of Water, &c., J. Hooker, London.
6305. Electric Guns, J. C. Mewburn.—(*The American Electric Arms and Ammunition Company, U.S.*)
6306. Generating Gases, G. F. Redfern.—(*P. Prat, France.*)
6307. Regulating the Supply of Gas, G. Bray, London.
6308. Middle Bits of Umbrellas, &c., W. A. Bindley and W. J. Gell, London.
6309. Ornamental Metallic Tubes, L. Brierley, London.
6310. Brass-covered Cart Hames, T. P. Marsh, London.
6311. Mouth Gag, J. W. Cousins, London.

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6312. Canisters, &c., W. Parnall, Bristol.
6313. Lighting Gas by Electricity, C. L. Clarke and H. J. Coates, Manchester.
6314. Linoleum Floor Cloth, T. J. Flynn, Manchester.
6315. Adjustable Safety Fishing Reel, J. Burne, Gosport.
6316. Weft Stop-motion of Power Looms, G. Brown, Galashiels, N.B.
6317. Safety Saddle Bars, W. H. S. Aubin, Bloxwich.
6318. Spindle for Door Knobs, T. Birbeck, Bishopwearmouth.
6319. Bolts, J. Skinner, sen., T. Skinner, and S. Skinner, Eastbourne.
6320. Gas-burners, E. Fahrig, Manchester.
6321. Valve Apparatus, E. Holt, Radcliffe.
6322. Knobs, A. Doman, London.
6323. Portable Lathes, W. J. Spurrier and W. A. Carlyle, Birmingham.
6324. Fastening for Trunks, &c., H. H. Chilton, Wolverhampton.
6325. Dynamo-electric Machines, T. Parker, London.
6326. Safety Window Checks, B. J. Saunders, Brighton.
6327. Fire-grates, D. Rogers and D. Rogers, jun., Liverpool.
6328. Polishing Pastes, W. A. Carlyle, Birmingham.
6329. Boots and Shoes, L. O. Michael, Birmingham.
6330. Machine Vices, G. E. Sherwin, Aston.
6331. Decolouring Water, E. Taylor, Manchester.
6332. Guard for Tram Engines, J. Rawnsley, Bradford.
6333. Drying Silk, &c., W. H. Thorpe and G. Pepper, Halifax.
6334. Bread-cutting Machine, J. Harrower, Glasgow.
6335. Holder for Lamps, &c., J. Harrower, Glasgow.
6336. Bearings, J. Harrower, Glasgow.
6337. Tables, J. Harrower, Glasgow.
6338. Spoons, H. Vaughan, London.
6339. Razor Strop, T. M. Ford, London.
6340. Metallic Rings, A. A. Rickaby, London.
6341. Feeding Cover for Stoves, T. Roberts, London.
6342. Circular Tube for Pipes, A. J. Litras, London.
6343. Making Match Splints, G. E. Norris and W. E. Hagan, London.
6344. Door Mats, &c., C. N. Gregory, London.
6345. Waste Preventing Tap, W. H. Tylor, London.
6346. "The Needy," F. Ballinger, Croydon.
6347. Treating, &c., Mineral Ores, G. M. Edwards, London.
6348. Obtaining Motive Power, G. and J. Rusp, London.
6349. Casks, J. Y. Johnson.—(*E. Lacroix, France.*)
6350. Steam Traps, I. S. and J. T. McDougall and T. Sugden, London.
6351. Separating Solid Impurities from Water, A. Howatson, London.
6352. Rotary Blowers, &c., J. W. Restler, London.
6353. Coating, &c., Metal Plates, H. J. Haddan.—(*J. Wezel, Saxony.*)
6354. Lawn Tennis and other Bats, A. J. Altman, London.
6355. Steam, &c., Engines, J. Davies and W. Vawdrey, London.
6356. Tea Kettles, &c., W. Topham and E. Snushall, London.
6357. Oil Feeder for Machinery, W. C. Allen, London.
6358. Extracting Juices, Syrups, &c., L. Lefranc, London.
6359. Producing Plates for Surface Printing, B. C. le Moussu, London.
6360. Lubricating Hydraulic Machinery, F. W. Thornton, London.
6361. Extensible Bracket Arm, A. M. Clark.—(*G. Hollweg, Germany.*)
6362. Making Casks and Barrels, &c., G. D. Terry, London.
6363. Fastenings for Jewellery, &c., A. Combault, London.
6364. Thermometers, R. K. Boyle, London.
6365. Telegraphic Apparatus, R. K. Boyle, London.
6366. Core-bars, H. H. Lake.—(*F. Shickle, U.S.*)
6367. Universal Joints for Screw Propellers, S. Orlando, London.
6368. Photographic Apparatus, J. and D. Robertson, Glasgow.
6369. Device for Holding Screws, &c., W. Allaby, Glasgow.
6370. Trousers, H. Vaughan, London.
6371. Electric Arc Lamps, P. Jensen.—(*V. V. Golitzinsky and P. O. Rymascheffsky, Russia.*)
6372. Constructing, &c., Explosive Projectiles, J. S. Williams, U.S.
6373. Repeating Fire-arms, H. H. Lake.—(*C. F. Mannlicher, Austria.*)
6374. Signal Lights for Use at Sea, J. Pain, London.
6375. Ornamental Fabric, E. P. Alexander.—(*P. V. Renard, France.*)
6376. Fastenings for Carriage, &c., Windows, A. E. Bingeman, London.

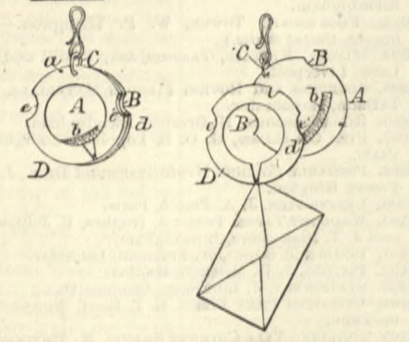
SELECTED AMERICAN PATENTS.

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

314,801. Combined Letter Scale, Envelope Opener, and Cigar Cutter, *Adler C. Clausen, Minneapolis, Minn.—Filed November 18th, 1884.*

Claim.—(1) In a combined letter scale, watch charm, &c., the plate A, provided with the scale *b* and the pivot C, in combination with the pivotted open ring D, provided with one or more indentations, substantially as and for the purpose set forth. (2) In a combined letter scale, watch charm, &c., the plate A, provided with the graduated scale *b*, the pivot C, and one or more indentations, in combination with a flat open spring steel ring having its inner periphery sharpened and provided with one or more indentations, substantially as and for the purpose set forth.

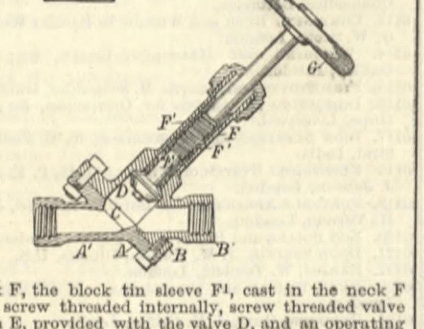
314.801



315,234. Valve Cocks, *Henry J. K. Brooks, Bloomfield, N.J.—Filed May 8th, 1884.*

Claim.—A valve cock consisting in the disc A, formed with aperture C and the oblique neck A¹, the disc B, formed with the oblique neck B¹ and the neck F, the block tin sleeve F¹, cast in the neck F and screw threaded internally, screw threaded valve stem E, provided with the valve D, and an operating handle, substantially as set forth.

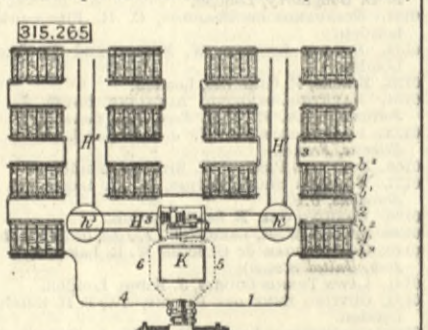
315,234



315,265. Apparatus for Refining Copper by Electrolysis, *Moses G. Farmer, New York, N.Y.—Filed November 12th, 1884.*

Claim.—(1) A plant of electro-deposition consisting of a series of vats arranged in rows, tracks extending between the different rows, an electric generator having its opposite poles connected with the several vats in series, an electric motor, a car moved upon said track and driven by said electric motor, a pump also carried upon said car and actuated by said motor, and electrical connections from said generator with said electric motor. (2) The combination, substantially as hereinbefore set forth, of a series of vats, an electric generator supplying current thereto, the track extending into proximity to each of said vats, the car moving upon said track, the electric motor carried upon said car, the pump actuated by said motor, and circuit connections from said generator to said electric motor, whereby currents are supplied thereto.

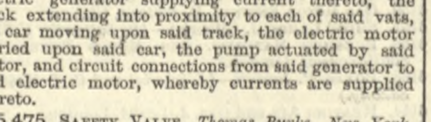
315,265



315,475. Safety Valve, *Thomas Burke, New York, N.Y.—Filed May 9th, 1884.*

Claim.—In a safety valve for kitchen boilers and heaters, the combination, with a metallic tube A, of a piston C, which fits closely in said tube, and provided at the lower end with a valve disc which operates in a valve-box, a pressure spring inserted between the screw cap B and the upper end of said piston, an adjusting cap B, adapted to regulate the pressure on the piston valve, and the valve-box G, all combined and arranged substantially as and for the purpose set forth.

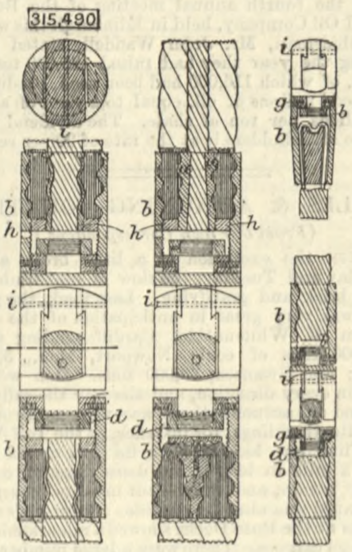
315,475



315,490. Coupling for Hemp and Wire Ropes, *Anton Engelmann, Hanover, Prussia, Germany.—Filed June 17th, 1884.*

Claim.—A shell provided with coarse internal screw threads for engaging with the end of a rope, and internal threads for holding a collar, in combination with said collar, a coupling eye or link, and a collar *d*, detachably fastened on the bolt of said eye within said shell in order that said eye may be held by collars, substantially as set forth. (2) The collars or discs *d d*¹, having interlocking ratchet teeth which allow them to turn in one direction only, in combination with a coupling eye having one of said discs or collars fast on its bolt and the other loose thereon, and the shell *b*, which is screw threaded on the latter collar, and provided with coarse internal screw threads for holding a rope, substantially as set forth. (3) In a rope coupling, the combination of the shell *b* and the inner coupling-box *a*, with the collar *h*, whereby they are connected, substantially as set forth. (4) The removable dovetailed insertion pieces, in combination with the eyes or links and the screws *i*, which fasten them thereto.

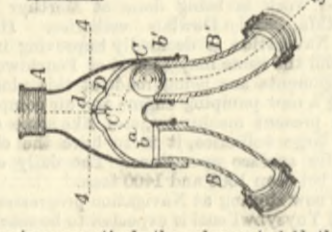
315,490



315,521. Inlet Nozzle for Stand Pipes, *Simeon Lord and William H. Dailey, St. Louis, Mo.—Filed July 7th, 1884.*

Claim.—(1) The combination, in a stand pipe, substantially as described, of the chamber *a*, the inlets B B¹, having respectively the valve seats *b b*¹, the ball valve C, and the guard D. (2) The combination, substantially as described, of the chamber *a*, the inlets B B¹, having respectively the valve seats *b b*¹, the ball valve C, and the guard D, curved upward in the chamber. (3) The combination, substantially as described, of the chamber *a* in the pipe, the inlets B B¹, having respectively the valve seats *b b*¹, the ball valve C, and the guard D, curved upward, and also having the pocket *d*.

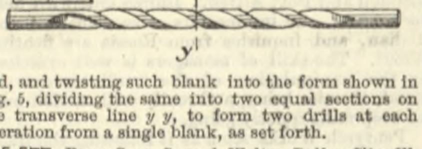
315,521



315,530. Manufacture of Drills, *Samuel Moore, Providence, R.I.—Filed January 23rd, 1885.*

Claim.—The method described of manufacturing twist drills, the same consisting in rolling a blank into the form shown in Figs. 1 and 3, with a shank at each end, and twisting such blank into the form shown in Fig. 5, dividing the same into two equal sections on the transverse line *y y*, to form two drills at each operation from a single blank, as set forth.

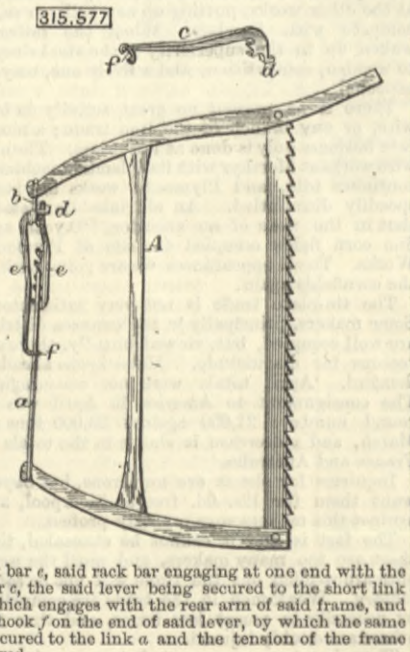
315,530



315,577. Buck Saw, *Samuel Walter, Dallas City, Ill.—Filed October 17th, 1884.*

Claim.—In a buck saw frame, the combination, with the two arms of the frame, of the long link *a*, secured at one end to the forward arm and at the other to the rack bar *e*, said rack bar engaging at one end with the lever *c*, the said lever being secured to the short link *b*, which engages with the rear arm of said frame, and the hook *f* on the end of said lever, by which the same is secured to the link *a* and the tension of the frame secured.

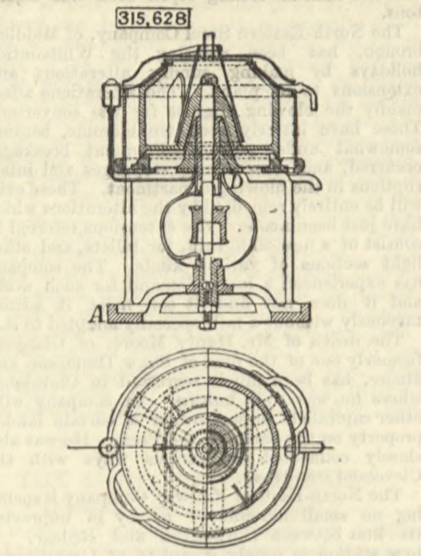
315,577



315,628. Centrifugal Creamer, *Niels Jacobsen and Hans Peter Jensen, Aarhus, Denmark.—Filed September 20th, 1884.*

Claim.—(1) In a centrifugal creamer, the combination of the stand having a central conical and vertical bearing, the drive shaft journalled in the said bearing, the milk receptacle provided with a central conical portion having a conical recess in its under side and secured upon the upper end of the shaft, the vertical diametrically-opposite flanges or wings, the channels having perforations opening at the foot of the flanges in the bottom of the receptacle passing as secants across the bottom of the receptacle and opening at the edge of the same, the cream tubes opening horizontally at the upper end of the receptacle, the conical feed funnel fitting over the conical portion of the receptacle, the feed tube, the jacket surrounding the receptacle and having an outlet spout, and the annular cream receptacle surrounding the upper portion of the milk receptacle having an outlet spout and having the cream tubes opening into it, as and for the purpose shown and set forth.

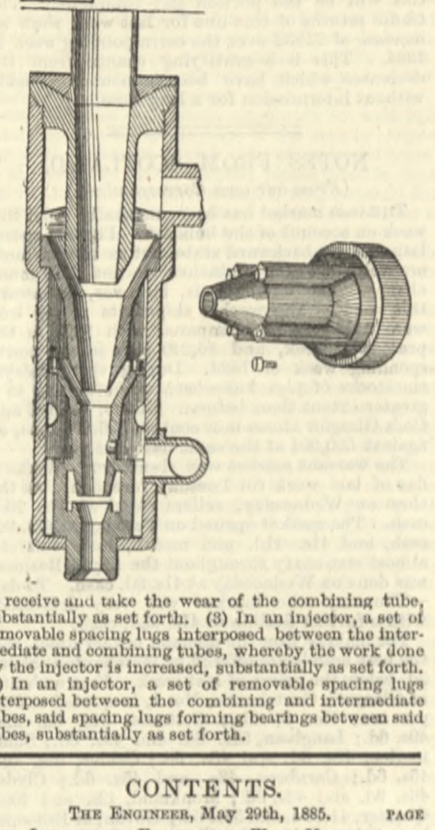
315,628



315,630. Injector, *William Johnston, La Junta, Colo.—Filed October 15th, 1884.*

Claim.—(1) In an injector, the combination, with a combining tube and intermediate tube, of removable bearings adapted to form a rest for the end of the combining tube, substantially as set forth. (2) In an injector, the combination, with a combining tube and an intermediate tube, of a set of removable bearings secured to shoulders on the intermediate tube, adapted to receive and take the wear of the combining tube, substantially as set forth. (3) In an injector, a set of removable spacing lugs interposed between the intermediate and combining tubes, whereby the work done by the injector is increased, substantially as set forth. (4) In an injector, a set of removable spacing lugs interposed between the combining and intermediate tubes, said spacing lugs forming bearings between said tubes, substantially as set forth.

315,630



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