OSCILLATION v. ROTATION.

By PROFESSOR OSBORNE REYNOLDS, F.R.S.

No. III.

(11) *The transmission of energy.*—In the last article the kinetics of vibration were treated, so far as the oscillating body was concerned. This is only one side of the subject. To maintain oscillation there must be some action on the body from the outside. Without refining too much, we may say that the energy of motion must be imparted to and taken from the oscillating body twice every revolution by the action of other bodies. What becomes of the energy after it leaves the vibrating body, and whence comes the fresh supply, depend on the circumstances which maintain the motion. These may be divided into two principal classes.

(12) It may be that the whole or part of the work done by the body in stopping is done against the resistance of friction. As much of the energy as is thus spent will be transformed into heat and lost, and to maintain the motion a fresh supply must be drawn from some external source. (2) It may be that the work done by the body in stopping is done upon some body susceptible of energy, which stores the energy as it receives it, and then, when the motion of the body is reversed, returns the greater part of it to the reciprocating body again, thus diminishing the draught to be made upon the fresh supply. The return can never be complete, as there will always be some frictional resistance to motion. Probably the most complete return is made in the case of the balance-wheel of the watch, which does its work in stopping against the hair spring and receives this energy again so nearly in full that the fresh supply added by the escapement bears a very small proportion to the whole. When the oscillation is controlled by a crank, the work of giving the energy of motion is done by the crank, and the crank again receives the work done by the body in stopping. If the crank is connected with a fly-wheel this wheel will absorb and give out energy by a variation of its velocity, and thus the energy of motion is transferred backward and forward between the fly-wheel and oscillating body, just as in the former case it was transferred between the oscillating body and the spring. In both cases there is certain loss inherent on the transmission, and these losses constitute the disadvantage as regards friction of oscillation compared with rotation. They will be different in different cases. Before, however, proceeding to consider these, it will be well to consider shortly the various means of storing and re-storing energy.

(13) *Reservoirs of energy.*—The storing and re-storing of energy is generally accomplished by the variation in the motion of some body, as of the fly-wheel, by the elastic deformation of some body, such as a spring, or by the pressure of a gas; but it may be accomplished by the raising a weight or by magnetic or electric actions. Whichever of these means is used, there is a material reservoir which must have sufficient capacity under the particular circumstance to contain the energy of motion. The capacities of such reservoirs will depend on various circumstances; but one factor will, in all cases, be the amount of material: (1) If the reservoir is the motion of matter, then its capacity will depend on the circumstances of motion; but if u_0 and u_1 are the velocities of the reservoir when charged and discharged, the capacity is—

$$\frac{W(u_0^2 - u_1^2)}{2g}.$$

(2) If the reservoir be a spring, then the capacity will depend on the state of stress and elasticity of the material; but if f be the stress in pounds on the square inch, and e is the modulus of elasticity, the capacity is—

$$V\frac{f^2}{24e}, \quad . \quad . \quad . \quad . \quad . \quad (17)$$

V being the volume of the material of the spring in cubic inches, and f^2 the mean value of f^2 throughout the spring. Where the amount of energy to be stored is large, the weight and size of the reservoir are often matters of the first importance. These depend solely on the weight and velocity of the oscillating pieces, and these being known, the weight of the reservoir, if it is a fly-wheel or a spring, can easily be found.

(14) The case of springs is the only one that need be considered in this respect. In this it will appear that the storage power of steel, or any material, is so small that the size of the reservoir becomes prohibitory for any but very small mechanisms. In a well formed spring f^2 will be $\frac{1}{2}$ or $\frac{1}{3}$ of the square of the greatest stress caused in the spring, according as the spring is spiral or beam. Taking the case of the beam and assuming the greatest stress 20,000 lb. and e = 40,000,000, then the energy must be less than $\frac{V}{7 \cdot 2}$ where V is the volume of steel in cubic inches. Now, if we have a vibrating body making n oscillations per minute, the energy of motion by the previous article is

$$E_0 = \left(\frac{\pi n}{30}\right)^2 \frac{W}{2g} a^2 = \cdot 00017\, W a^2 n^2 \quad . \quad (18)$$

approximately. If, then, we take such an oscillating body as the piston of a locomotive, let W = 300 a = 1 and n = 100.

The energy is 510 foot pounds, and the volume of steel required to store this would be 3672 cubic inches, nearly 1000lb., or about $\frac{1}{2}$ ton of steel would be required for a spring sufficient to store and re-store the energy of motion of each piston and rods of a small locomotive when at full speed. This sufficiently shows why oscillating pieces on a large scale cannot be controlled by springs.

(15) If air or steam be used instead of steel, then the weight required is small, and need not be considered, although the size of cylinder for its storage is important. In most steam engines steam is more or less used for this purpose; but this will be closely considered later on.

There is, however, a physical point with regard to the use of elastic reservoirs, which is important.

(16) *Changes of temperature in reservoirs of energy.*—All bodies which expand by heat have their temperature increased by compression and diminished by expansion.

With such rigid bodies as steel, this change of temperature is small, for possible distortions, but in the case of gases and steam it is very large. If air be compressed to half its volume instantaneously, its temperature rises to 172 deg. Fah.

This change of temperature plays an important part in the loss of energy in transmission which we now come to consider.

(17) *Losses of energy in transmission in the case of a steel spring.*—The loss of energy in transmission to and from the vibrating body will be very small, for the spring may be united with the vibrating body and the supports, so that there is no motion or friction at the joints, and thus the whole loss is in the spring. Even steel may not be perfectly elastic; but the chief loss, which is also very small, is due to the change of temperature. The spring is heated during compression, and cooled during extension, and then, before the restitution takes place, conduction and radiation bring the temperature to equilibrium again, so that the force of restitution is less than that of distortion; but this loss is small, as is shown by the time a spring will continue to vibrate.

(18) *The loss in transmitting energy to steam or gas confined in a cylinder.*—In this case the loss from variation of temperature is considerable, but not easy to estimate, and besides this there is the friction and leakage of the piston. When the compression is carried to several atmospheres, as in the steam engine, these losses cannot be less than from 15 to 25 per cent. during each transmission. If this were not so a piston in a closed cylinder of air would oscillate when disturbed, but as a fact it does little more than spring back to its initial position. Such a loss as this is fatal to the use of steam or air as a means of maintaining oscillation, except in cases, as in the steam engine, where the use of steam is rendered desirable for other reasons. Before going into these, however, there remains to be considered the friction in the important case of the crank.

(19) *The loss of energy in transmission in the case of the crank-controlled oscillation.*—This is the principal means by which oscillating pieces are controlled in machinery, and it is this kind of reciprocation that competes with revolution. Both motions, reciprocation and oscillation, entail certain loss of energy by friction, and it is important to distinguish between those losses that are common to both and those which are peculiar to reciprocation. Now the losses which are common arise mainly from the action of gravity, and the forces of the operation performed—as, in the case of revolution, the tension of the belt or the pressure of the teeth—to cause friction. The losses peculiar to reciprocation are those which arise from the friction caused by the forces due to the inertia of the reciprocating piece. The simplest case will alone be here considered, and the forces which arise from gravity will be left out of account as common to both, reciprocation and rotation. As a simple case we may suppose a crank and fly-wheel on a shaft, the radius of which is r_1, r_2, being the radius of the crank pin, and a the length of the crank, a foot being the unit. The reciprocating piece is supposed to be connected to the crank by a long light connecting rod, so that the whole weight w lies in the reciprocating piece, and the pressure on the guides is so small that it may be neglected.

The forces which arise from the inertia of the reciprocating piece will be transmitted through the crank pin to the bearings. These forces will give rise to friction on the crank pin and the bearings. The forces will be different at different parts of the revolution. Let C be the mean over the whole revolution and f the coefficient of friction at the bearings, then the work (L) spent in overcoming this friction during one revolution is given by the well-known formula—

$$L = 2\pi r f C \quad . \quad . \quad . \quad . \quad . \quad (19)$$

Or, taking into account that this force acts both on the crank pin and bearings,

$$L = 2\pi f C(r_1 + r_2) \quad . \quad . \quad . \quad (20)$$

To find C we have in Fig. 2 the value of p P M for each position of the crank, and to find the mean we have only to divide the crank circle into any number of equal parts, as in R_1 R_2—Fig, 3—find the corresponding values of P_1 M_1 P_2 M_2, and take the mean. This method may be employed whatever may be the shape of the curve

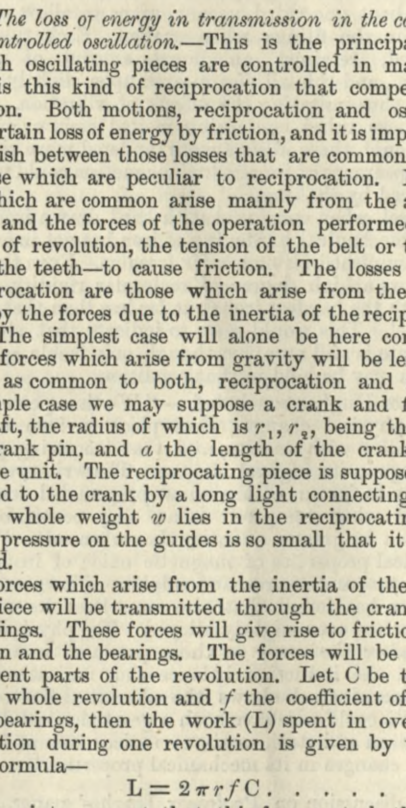


FIG. 3.

A M O N B. In this case it is well known that

$$C = \frac{2}{\pi} p\, A C$$

$$= \frac{2}{\pi} \frac{v_0^2}{a} \frac{W}{g}$$

$$= \frac{4}{\pi} \frac{E_0}{a} \quad . \quad . \quad . \quad . \quad . \quad (21)$$

Where, as before, E_0 is the energy of motion, C is exactly $\frac{2}{\pi}$ times the centrifugal force of a weight revolving on an arm a with velocity v_0. The loss per revolution then becomes

$$L = 8f(r_1 + r_2)\frac{E}{a} \quad . \quad . \quad . \quad (22)$$

This formula gives the loss in any actual case where r_1 and r_2 are known.

The values of r_1 and r_2 will be determined to meet the forces which fall on the crank pin and crank shaft. If we assume that the forces arising from inertia are paramount, then, since the maximum value of these is

$$\frac{W v_0^2}{a g} = \frac{2E}{a},$$

we shall have

$$\left.\begin{aligned} r_1 &= B_1 \sqrt{\frac{2E}{a}} \\ r_2 &= B_2 \sqrt{\frac{2E}{a}} \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad (23)$$

Where B_1 and B_2 are constants, which, according to the practice in steam engines, may be taken to be ·001; therefore

$$L = 008 f \left(\frac{W}{g a}\right)^{\frac{3}{2}} v_0^3 \quad . \quad . \quad . \quad . \quad (24)$$

which gives the loss on the supposition that the machine is designed to stand the reciprocating forces only.

The importance of this value of L would be in proportion to the work done by the machine per revolution, and it is easy to see that since L increase as the cube of the speed, it may be very small at speeds of, say, 100 revolutions per minute, and yet become so large as to be prohibitory at 300 or 400 revolutions per minute.

In the steam engines as they exist, these reciprocating forces are not large enough to affect the size of r_1 r_2, which are larger than they would be as in (23), and yet the loss as given by (22) is insignificantly small. In a reciprocating dynamo, in order to obtain anything like the same duty per weight of material as the present revolving dynamo gives, the weights and speeds of their oscillating pieces would have to bear nearly the same relation to the weights and speeds of the engines which drive them as do the armatures of the present dynamos. This means increasing the number of revolutions, as compared with the engines, by a quantity of the order 10, or increasing L in the ratio 1000. The further consideration of these matters will be undertaken in the next article.

THE INSTITUTION OF MECHANICAL ENGINEERS.

ON Thursday and Friday evenings, the 25th and 26th ult., the Institution of Mechanical Engineers met at the Institution of Civil Engineers. The annual report was read and passed, and some routine business conducted. The president, Mr. Percy G. B. Westmacott, then announced the result of the election of officers for the year, the list showing three changes, namely, the election of Mr. Bernard Samuelson, M.P., and Mr. Ralph H. Tweddell as members of Council, and Mr. T. Russell Crampton as vice-president. It was also announced that the summer meeting of the Institution will take place in Belgium in the latter part of July. A report was then read by Professor F. A. Abel, F.R.S.,

ON FURTHER EXPERIMENTS ON THE CONDITION IN WHICH CARBON EXISTS IN STEEL.

This report described a number of experiments with discs of steel which were annealed under different circumstances between different materials, the experiments showing generally that when steel is annealed between wrought iron plates the steel loses much of its carbon. Further experiments upon cold rolled and annealed steel were made to ascertain the action of slowly oxidising solvents. The results of these experiments with cold rolled steel of a particular composition appear to confirm the view that the carbon in cold rolled steel made by the cementation process exists, not as simply diffused mechanically through the mass of the steel, but in the form of an iron carbide, a definite product, capable of resisting the oxidising effect of an agent which exerts a rapid solvent action of the iron, through which this carbide is distributed. Whether this carbide varies in composition in different steels remains to be seen.

After this paper was read, Professor Hughes pointed out that the use of platinum in contact with iron, described by Professor Abel, might give rise to an electric current that would be a possible source of error.

Sir Frederick Bramwell asked Professor Abel whether he considered that the action which took place when steel was hardened was at all analogous to that which takes place with cast iron when it is made hard by chilling, a hardness apparently arising from the fixture of the carbon by the sudden cooling. He suggested that if hardness was due to preventing the separation out of the carbon, it might be possible by mechanical stirring or agitation to prevent the separation out of the carbon from molten metal just as certain alloys were made by stirring during cooling to prevent segregation of one or more components of the alloy.

Professor Abel in reply dealt with Professor Hughes's suggestion at length, and concurred with Sir F. Bramwell that the condition of carbon in chilled iron as analogous if not similar to that of carbon in hardened steel, and sudden cooling in either metal seemed to have a similar effect on the condition of the carbon. The important difference, however, was that steel was acted upon in the solid condition, while the cast iron was acted upon when melted. He then described some experiments by M. Clemenceau, which showed that heated steel compressed under a powerful pressure became permanently hardened.

A paper was then read by Professor D. E. Hughes, F.R.S., on

THE MOLECULAR RIGIDITY OF TEMPERED STEEL.

During the course of some recent researches the author has proved, by the aid of the induction balance, some remarkable molecular differences between the constitution of iron and of steel. In papers in the *Comptes Rendus*, from 1830 to 1850, it was suggested that tempered steel is a true alloy of iron and carbon, the carbon being present in varying degrees according to the temperature at which the alloy was formed, and being afterwards rendered permanent by sudden cooling. The author pointed out in 1880 the marked difference, as to solubility in dilute sulphuric acid, between softened and tempered steel, and expressed the opinion that tempered steel was a true alloy. He has since continued these experiments to investigate the peculiar molecular structure of tempered steel, as indicated by the induction balance. In order to investigate this phenomenon, the author constructed a special though very simple apparatus, which he described at length, its construction and application depending on Faraday's discovery of electric magnetic induction, namely, that any wire conveying an electric current induces in general a momentary secondary current in any independent circuit whose wires are parallel to it; the effect being at its maximum when two wires are parallel, diminishing as the angle of these wires is increased, and at 90 deg. being absolutely zero. Consequently, when a copper wire is placed in the axis of a coil, and a current passed through this wire, no effect whatever is found, no trace of induced currents; simply for the reason that this copper wire crosses all of the wires of the coil at an angle of 90 deg. No effect, moreover, takes place upon torsion being applied to the copper wire. If a small rod of iron is now placed parallel with the conducting copper wire, no effect is obtained, but if the iron rod is turned at an angle to the wires a current is observed, the force increasing from parallelism to an angle of 45 deg., and decreasing again from this angle to 90 deg., where there is again no effect. The conducting copper wire thus induces electric magnetism in the iron rod, and this magnetism reacts upon the coil; but this only holds as long as the rod is not parallel to either coil. At an angle of 90 deg., although at its maximum of electric magnetism, the iron rod becomes parallel to the coil upon which it reacts; consequently there is again a zero of current. In place of one rod several short rods may be inserted, and if these are all turned together in the same direction we have similar effects. Knowing this, it can be understood that if each molecule of a rod were endowed with separate magnetic power, and if these could be caused to rotate through any angle round the axis, similar reactions to those of the small separate iron rods already mentioned might be expected. "If we replace the copper wire spoken of by an iron wire, and send intermittent currents through it, we still have no induced current upon the coils; but the instant we apply a very slight torsion, say 10 per cent. or 20 per cent. of one turn, we at once perceive strong induced currents. These are positive for right-hand torsion, and negative for left-hand torsion. Thus we can not only produce induced currents, but without changing the direction of the primary electric current, we can charge the induced currents, making them positive or negative, as we please; exactly as would occur if we rotated in opposite directions the small iron bars placed side by side with the copper wire. At this point it becomes important to know if these effects are produced by the twist given by torsion to the whole mass of the wire, or if each molecule turns separately and independently round its axis. There are many proofs that the latter view is correct. For, assuming the former, then, if an iron wire be twisted permanently by thirty or more entire turns, we should expect greatly increased effects as compared with those given by 10 per cent. or 20 per cent. of a single turn. But we find that after the first instant of torsion we have no increase of force in the current, even with a molar twist of thirty whole turns, which must, of course, produce a certain molecular twist; we find that the slightest torsion, say of 10 per cent. backwards, is sufficient to reverse the current, and thus more than neutralise the whole inclination which had been given to the molecules by the permanent torsion. Again, if, whilst the iron wire is under the influence of torsion we bring near it one pole of a large natural magnet, laid in the direction of the wire, we find that the currents gradually diminish, until when the magnet touches the wire we at last produce zero. The polarised molecules, which under the influence of torsion lay at a certain angle with the axis, have thus been caused to rotate back again and become parallel. Again, if we approach the same pole with the magnet at right angles to the wire, we find that the current gradually returns to zero—and therefore the molecules to parallelism—when the magnet is about 2in. distant; but on bringing the magnet still nearer, they pass the zero point, now giving increased reversed currents, until they reach a maximum, when the magnet is close to the wire. We have thus rotated the molecules from their original angle of torsion, say of 45 deg. to the right, through zero to 45 deg. to the left. If this view is correct, we should expect that we might produce electric currents of reversed directions without the aid of any battery by simply giving a to-and-fro torsion to the wire; and this proves to be the case. For we may join the telephone either to the exterior coil or to the simple circuit of the wire, and we shall then hear a sharp click at each movement of torsion to the right and left, thus imitating and reproducing all the effects which would be obtained by rotating a separate magnet through different angles of inclination with the wire." There are many proofs which confirm this view;* but as the object of the author was to show the remarkable difference which exists between iron and steel in this respect, he confined himself to showing the very great apparent rigidity of the molecules of tempered steel as compared with those of iron. He found that at certain degrees of temper—*e.g.* that known as blue or spring temper—there are only slight traces of molecular disturbance of rotation, no matter how many mechanical turns or twists we may put on the wire. "In fact, the molecules here seem fixed and homogeneous throughout the mass. We have perfect molar elasticity, but no traces of rotation of one part over another—in other words, no molecular elasticity. Thus in iron we have an elasticity due solely to the freedom of molecular motion. In hard steel, on the contrary, we have but slight molecular freedom, with great molar elasticity, in which the separate molecules do not rotate separately but all as one mass. It is necessary to point out this difference of molar rigidity, as shown in tempered steel and in iron, because tempered steel is not the only form which thus differs in its mechanical and physical qualities from iron or soft steel. A similar difference is shown also by several known alloys of iron. Assuming the freedom of motion of the molecules to be greater in iron than steel, it occurred to the author that he should be able to free the soft iron from its remaining magnetism by simple vibration of the wire. This was found to be the case. An iron and steel wire are magnetised to saturation, or both may be given the same amount of permanent magnetism. We will suppose that they both deflect the suspended needle through 40 deg. Now taking the steel wire and fastening one end in a brass vice, give its free end a slight pull to set it in vibration; it will be found that the steel has lost but 2 deg., having still 38 deg. of permanent magnetism, which cannot be further reduced by repeated vibrations. The instant, however, that a similar vibration is given to the soft iron wire, its remaining magnetism nearly all disappears; there is left at most 2 deg., or in some cases only a trace. Thus the molecules are seen to be so comparatively free in iron that mere vibration will aid them in rotating. These two wires were again observed vibrating whilst under the influence of the permanent magnet. There was then a greater magnetic effect produced in the iron wire than previously, the vibrations aiding the rotations produced by the natural magnet."

* "Molecular Magnetism," by Professor D. E. Hughes. "Proceedings" of the Royal Society, March 7-17th, and May 10th, 1881.

The instruments employed and the experiments demonstrating his conclusions were described at length by Professor Hughes, who really gave a most interesting lecture on the application of electrical methods to the elucidation of this intricate subject. He was desirous of rendering visible this freedom of iron and rigidity of steel, so that these effects might be actually seen. For this purpose he takes three glass tubes, or ordinary phials, of any length or diameter, say 10 centimetres in length by 2 centimetres in diameter. He then put iron filings in these tubes, leaving about one-third vacant, so as to allow complete freedom in the filings when shaken. Each tube, when magnetised, retained an equal amount of residual magnetism, and this all disappeared upon slightly shaking the tube, thus imitating the effects of vibration. But in one of these tubes containing melted resin or a slightly viscous liquid, these filings were rendered more rigid, and the disappearance of its residual magnetism could no longer be produced by shaking.

Soft steel, when compared with hard drawn iron, shows that the mechanical hardening of iron has not in any great degree diminished its molecular freedom. Even the softest steel shows a high degree of molecular rigidity, as compared with the hardest iron, but far less than that of tempered steel. This would seem to indicate that steel in its softest state is still an alloy, though only feeble quantities of carbon may be held in that condition.

Professor Hughes concluded:—"We thus perceive that a great physical change takes place in iron upon the slightest alloy with carbon, and that tempering produces this change in its highest degree. The writer, therefore, is strongly in favour of the view propounded long since, that steel when tempered is an alloy containing fixed carbon in a far greater quantity than when soft. We know the physical properties of magnetic oxide of iron, of iron and tungsten, and of iron and sulphur. Now, in all these the writer has found that the iron loses its molecular freedom when even slightly alloyed. The physical results are therefore the same as those produced in tempering steel, and the induction balance thus indicates strongly that tempered steel shows the characteristics of a true alloy. We could not have such a great physical difference between iron and steel, as above noticed, except by corresponding changes in its mechanical properties."

In the discussion on Professor Hughes' paper, and the experimental illustration and explanation which he gave, Mr. W. H. Preece remarked that the Institution of Mechanical Engineers seemed to have a more powerful magnetic influence on Professor Hughes than the Society of Telegraph Engineers and of Electricians, to which Mr. Preece seemed to think that such an interesting electrical paper ought to have been sent. Perhaps the long name given to the society is too much for Professor Hughes, or the mechanical instincts of the Institution may be to his mind more congenial to his subjects. He said Professor Hughes had, with the aid of ear and eye, made them practically acquainted with the movement of those infinitesimal molecules, so that they could almost see the carbide of iron spoken of by Professor Abel, which made the difference between iron and hardened steel, held in an enchained condition. For electrical purposes it was very necessary that the essential cause of the difference between iron and steel should be discovered. Electricians wanted to render steel as strongly magnetic as possible, and great improvements had been made, for a magnet only a few years since was considered very good which could hold up its own weight, while a magnet was shown in the Paris Exhibition which would hold up seventy-six times its own weight, and some of the telephone magnets would hold from fifteen to twenty-five times their own weight. In iron used for magnet purposes no improvement had been made by which more rapid and complete magnetisation and demagnetisation could be effected. From the presence of carbon or some other reason, iron could not now be obtained which was pure in this mechanical sense, and there was room for improvement; though electricians did not use much iron, they would be glad to obtain that iron free from the impurities which conferred the coercitive force giving properties, which Professor Hughes had so strikingly brought out. He thought M. Clemenceau's process of hardening steel by compression under a pressure of 15 tons per square inch at a cherry red temperature, or about 1000 deg. Fah., and allowing it to cool under this pressure, confirmed by Professor Hughes. He exhibited a magnet made of this steel, and said the steel so hardened might be forged into different forms and still be hard. It is thus like the Mushet special tool steel, the method of production of which—it was suggested some time ago by a speaker when Mr. Anderson read a paper before the Institution—might afford a clue to the cause of the hardening of steel. Mr. Preece mentioned that M. Clemenceau's steel was also strengthened in the proportion of about 76 to 60 as compared with the uncompressed steel.

Sir F. Bramwell suggested that the hardening was probably due to the cold surfaces of the iron press by which the compression was effected, as the pieces hardened were small, and in this was supported by Mr. Paget; but Mr. Schonheyder pointed out that the hardness produced by the process did not disappear when the steel was again heated to forge it, which was a proof that the hardening was not the temporary hardness produced by sudden change of temperature.

Professor Kennedy asked if the superficial hardening of the wire by the drawing process might not have some effect in bringing about the results Professor Hughes observed.

In reply Professor Hughes said the effect was the same on bars ½in. square as on wires, and the most astonishing thing was that with such a bar they could, by giving it by the hand a slight torsion strain, hear all the molecules turning over. He could quite see that the magnet shown by Mr. Preece should be powerful, for its molecules were closely pressed together making the mass more rigid, and anything that made the steel more rigid would cause it to retain magnetism. A piece of iron might be hammered so hard that it would retain magnetism better than steel, so that it was a question of keeping the molecules as close as possible. He explained that the Institution Committee on Tempering Steel had initiated the inquiry, and this had directed his experiments into the path they had taken, though they had many of them been made before the formation of that committee.

THE first paper read on Friday was by Mr. Charles Cochrane, of Stourbridge, Vice-President,

ON THE WORKING OF BLAST FURNACES, WITH SPECIAL REFERENCE TO THE ANALYSIS OF ESCAPING GASES.

The paper was intended to deal with the working of the blast furnace considered by itself, and it was the object of the author to establish the fact that all economy in fuel consumed to make a ton of pig iron, with any particular class or size of furnace, is governed by three conditions:—(1) The temperature of the air introduced into the furnace; (2) The temperature of the escaping gases; (3) The quantity of carbon which can be maintained in the condition of carbonic acid, after it has once been transformed to this degree of oxidation from the carbonic oxide produced in the hearth. It was assumed at the outset of the inquiry that all the carbon of the fuel which reaches the hearth is transformed into carbonic oxide, and that, of the carbon so converted into carbonic oxide, a certain quantity is further converted into carbonic acid for the reduction of peroxide of iron—where calcined ironstone is used—into iron. This amount was arrived at by the chemical formula—old nomenclature—$Fe_2 O_3 + 3 CO = Fe_2 + 3 CO_2$, where 18 parts by weight of the carbon are needed to reduce 56 of iron. It was further assumed that the pig iron contains 3 per cent. of carbon and 3 per cent. of impurities, containing therefore 94 per cent. of pure iron. Thus 20 cwt. of pig iron contain—

Pure iron	18·80 cwt.
Fixed carbon	0·60 „
Impurities	0·60 „
Total	20·00 „

The quantity of carbon needed for the reduction of this 18·80 cwt. of iron from its state of peroxide will therefore be—$\frac{18}{56} \times 18{\cdot}80 = 6{\cdot}043$ cwt. This 6·043 cwt. of carbon converted in this manner into carbonic acid, is the maximum quantity that can be so converted; and the amount of carbonic acid it produces is $\frac{11}{3} \times 6{\cdot}043 =$ 22·154 cwt. per ton of pig iron. Whilst it is impossible for this weight of carbonic acid—if produced from this source—to be exceeded in the blast furnace, it is possible for some of it to be reconverted into carbonic oxide by the absorption of an equivalent of carbon, according to the chemical formula, $CO_2 + C = 2 CO$. The value of the analysis of the escaping gases is that it affords the means of ascertaining the precise ratio of the two, and thence, after making all proper allowances and calculations, enables us to deduce the effective duty of the fuel employed in the furnace. Taking the simplest conditions first, it will be obvious that the quantity of heat carried into a blast furnace with the blast will depend simply on the actual weight and temperature of the blast itself. Thus, if 90 cwt. of air per ton of pig iron be passing into the furnace at a temperature of 900 deg. Fah. = 482 deg. C., this is equivalent in heat to 4·19 cwt. of carbon per ton of pig iron burnt into carbonic oxide inside the blast furnace; or if at 1200 deg. Fah. = 649 deg. C., this is equivalent to 5·65 cwt. of carbon per ton of pig iron burnt into carbonic oxide. One point which cannot fail to strike anyone is the gigantic stride which has been made in the economy of fuel in the blast furnace by the employment of heated blast. Thus, the heating of 145 cwt. of blast from the temperature of the atmosphere to 1500 deg. Fah. = 816 deg. C., would need the combustion of 11·43 cwt. of carbon burnt into carbonic oxide within the blast furnace; whereas this work is now done by what were wont to be called the waste gases passing from the tunnel head of the furnaces. In addition this extra carbon would necessitate the introduction of cold air to burn it, and would so create a larger volume of gases passing away at the tunnel head. No wonder then that to make cold blast iron it needed 40 cwt. or more of coke per ton of pig iron made, and required something like 10 tons weight of blast per ton of pig iron to be introduced into the furnace.

(2) *Temperature of escaping gases.*—The second point proposed to be established is that economy of fuel consumed in a blast furnace is influenced by the temperature

of the escaping gases, which must carry away a greater or less proportion of the heat actually generated in the blast furnace, according as their temperature is higher or lower. It must be obvious that if, by way of illustration, we suppose 5 tons or 100 cwt. of gases to escape in one furnace at a temperature of 700 deg. Fah., and in another at a temperature of only 350 deg. Fah., the saving in the latter case will be found to be about one-half the waste going on in the former. Mr. Gruner deduces a mean of 0·237 as the specific heat of the mixture. The mode of calculation, to arrive at the heat carried away by the waste gases, is simply to multiply the weights in cwts. by their temperature in Centigrade degrees, and again by the specific heat, or 0·237, and finally to divide by 2473, being the number of units of heat developed by the combustion of 1 cwt. of carbon into carbonic oxide. If furnaces are driving fast, and the appliances for hoisting are inadequate, it may need two or three hours after a stoppage at meal times to restore the normal working of the furnace. One case is 1·50 cwt. for each ton of iron made during the period this abnormal condition of things was allowed to last.

(3) *Maintenance of carbon in the form of carbonic acid.*—This, the third point with which we have to deal, is, perhaps, the most important of the three under consideration; at any rate it is the most subtle in its action, and has the most serious influence on the consumption of fuel in a blast furnace. Let it be remembered that 1 lb., 1 cwt., or 1 ton of carbon, burnt into carbonic oxide, will heat 2473 lb., cwt., or tons of water from 0 deg. to 1 deg. Cent., or 1 lb., 1 cwt., or 1 ton of water from 0 deg. to 2473 deg. Cent.—if such a temperature were attainable by water. Let it be further remembered that 1 lb., 1 cwt., or 1 ton of carbon burnt into carbonic acid will develope 8080 such units—that is, will heat 8080 lb., cwt., or tons of water from 0 deg. to 1 deg. Cent., or 1 lb., 1 cwt., or 1 ton of water from 0 deg. to 8080 deg. Cent. It will then at once be seen how important it is, with regard to economy of fuel in a blast furnace, that we should insure the combustion of every unit of carbon, if possible, into the more highly oxidised gas called carbonic acid; and furthermore, when once burnt into carbonic acid, that we should never allow it to pass back again into the condition of carbonic oxide, if such a step be preventible. The conversion of 1 lb. of carbon from carbonic acid into carbonic oxide can only be accomplished by the absorption of carbon, according to the formula: $CO_2 + C = 2CO$; but in the process the heat lost is measured not only by the loss of the carbon so absorbed to convert carbonic acid into carbonic oxide, which carbon never reaches the hearth to be burnt by the blast, but also by the great difference existing between the heat equivalent of the carbon, as burnt into carbonic oxide and carbonic acid respectively; in other words, the carbon burnt in the latter case is practically worth $\frac{8080}{2473} = 3·27$ times as much as the former. To make this point perfectly clear, we may say that it would require 3·27 lb., cwt., or tons of carbon burnt into carbonic oxide, to do the work of 1 lb., 1 cwt., or 1 ton of carbon burnt into carbonic acid. Hence it will readily be seen how important it is that, if any carbon in a blast furnace is once converted into carbonic acid, it should remain in that condition. For the sake of establishing a means of comparison as a basis for the voluminous tables by which the paper is accompanied, the standard of reference which has been adopted was that of a series of ideal furnaces, consuming respectively 10 cwt. to 34 cwt. of carbon per ton of pig iron produced, and rising by successive additions of 1 cwt. In all these ideal standards of reference it is assumed that the chemical action of the furnace is perfect; so that 6·043 cwt. of carbon actually become converted into carbonic acid, and remain as such. In a blast furnace there is a further amount of carbonic acid furnished by the limestone; but this, it is to be feared, is converted wholly or almost wholly into carbonic oxide by contact with red-hot coke, and escapes at the tunnel head as such. Of this fact, however, the author for the present took no cognisance, and assumed for the purpose of this ideal furnace that all CO_2 in limestone will leave the tunnel head in the condition in which it is evolved. It is proposed in fact to deal with the following calculations as if the CO_2 produced by reaction of CO on Fe_2O_3 were alone in question. Now, if 20 cwt. of carbon be the total consumed in the furnace, and if 6·043 cwt. be converted into carbonic acid, there will remain 20 − 6·643 = 13·357 cwt. in the condition of carbonic oxide, and giving $13·357 \times \frac{7}{3} = 31·17$ cwt. of that of gas. The author then went on to explain at great length an elaborate table based on the preceding assumptions.

In like manner, should $1\frac{1}{2}$ cwt. of carbon be transferred, we still find by a reference to a diagram embodying the table in a graphic form, that such a ratio of carbonic acid to carbonic oxide as 0·60 may still hold in a furnace of superior appliances, in which the consumption of carbon per ton of pig iron is only 20·9 cwt. The author maintained that it is impossible, from a mere chemical analysis of the gases emerging from the tunnel head of a blast furnace, to draw any reliable conclusion as to the working of the furnace itself. What, then, is the value of such analyses? Taken in conjunction with the consumption of carbon per ton of pig iron, and other collateral circumstances, analyses are invaluable; but by themselves they are misleading. Hence, in order to form a correct appreciation of the value of the analyses of the gases, it will next be necessary to make an approximate estimate of the quantity of air admitted to the blast furnace and of the gases discharged therefrom, under the same successive conditions as to carbon burnt into carbonic acid in the ideal furnace, and its subsequent transfer to the condition of carbonic oxide by contact with red-hot coke.

The author gave an enormous table showing that the carbonic acid of the escaping gases is simply the amount due to a perfect reduction of all the peroxide of iron by carbonic oxide, plus that supplied by the $12\frac{1}{2}$ cwt. of carbonate of lime. The oxygen needed to be supplied by the blast engine was taken at four-thirds the weight of the carbon to be burned—according to the chemical formula $C + O = CO$—whilst the nitrogen is taken at 3·33 times the weight of oxygen. No account was taken of moisture in the air, as being a refinement of calculation outside his present aim. Another table showed the air passing into the furnace, and gases escaping therefrom, based upon the transfer of $\frac{1}{2}$ cwt. of carbon from the state of carbonic acid to that of carbonic oxide. The result of what has gone before was to enable us to establish a standard of reference for the working of any furnace, under certain conditions of materials. To quote a single case. In November, 1881, the following analysis was made of gases escaping from No. 3 furnace—20,454 cubic feet capacity—at Ormesby Ironworks, Middlesbrough-on-Tees:—

$$
\begin{aligned}
CO_2 &= 13·42 \text{ by weight} \\
CO &= 31·66 \quad " \\
H &= 0·12 \quad " \\
N &= 54·80 \quad " \\
&\overline{\;100·00\;}
\end{aligned}
$$

$$\text{The ratio } \frac{CO_2}{CO} = \frac{13·42}{31·66} = 0·424$$

The temperature of blast was 700 deg. C.; that of the gases was 340 deg. C.; the carbon in coke was 21·95 cwt.; the carbon in limestone was taken at 1·50 cwt.

These figures may correspond to several different conditions as follows:—(1) To the condition of an ideal furnace consuming 34 cwt. of carbon per ton of pig. (2) Of a furnace in which $\frac{1}{2}$ cwt. of carbon has become transferred from the condition of CO_2 to CO, with a modified consumption of 32 cwt. of carbon per ton of pig. (3) Of a furnace in which 1 cwt. of carbon has been transferred from condition of CO_2 to CO, with a further modified consumption of 29·75 cwt. of carbon per ton of pig. (4) Of a furnace in which $1\frac{1}{2}$ cwt. of carbon have been transferred from the condition of CO_2 to CO, with the modified consumption of 27·5 cwt. of carbon per ton of pig. (5) Of a furnace in which 2 cwt. of C. have been transferred, and the corresponding consumption is 25·25 cwt. of carbon per ton of pig. (6) Of a furnace in which $2\frac{1}{2}$ cwt. of C. have been transferred, and the corresponding consumption is 22·67 cwt. of carbon per ton of pig. Obviously it would be impossible by the mere analysis of the gases to ascertain to which of these cases the analysis applied. But let it be known that at the same time that the analysis gave the ratio of CO_2 to CO = 0·424, the consumption of carbon on the ton of pig iron was 21·98 cwt. The conditions of ratio 0·424 and 21·98 cwt. indicate a furnace working with $2\frac{1}{2}$ cwt. or thereabouts of carbon transferred from CO_2 to CO, whilst the ideal furnace should only need 16 cwt. of carbon had no such transfer taken place. Several other cases were then cited by the author to illustrate the use of his tables. Obviously, if the limestone be calcined before entering the furnace, no carbonic acid will be evolved in the region of red-hot coke, and hence no absorption of carbon from this cause can take place. Again, to prevent the large pieces of ironstone from descending into red-hot regions before being perfectly reduced, they may be broken down to a size which will permit their reduction to take place in regions above those where nascent carbonic acid can do harm; or furnaces may be still further enlarged, and pressure of blast increased, to enable the large pieces of ironstone, although unbroken, to be reduced to the core before entering the region of red-hot coke.

Disposal of heat in the furnace.—After considering at considerable length various questions connected with blast furnace working, the author proceeded to point out, from our knowledge of the ratio of carbonic acid to carbonic oxide in the escaping gases, and of the consumption of carbon per ton of pig iron, in what way the combined sources of heat in the blast furnace are disposed of. To this end it would be requisite to premise that the melting of 1 cwt. slag requires 550 calories or heat-units, as stated by Mr. I. L. Bell, and adopted by M. Gruner. Hence, assuming, as is approximately true in the Cleveland district, that 30 cwt. of slag are melted per ton of pig iron made, the quantity of carbon burnt into carbonic oxide to effect its fusion would be $\frac{30 \times 550}{2473} = 6·67$ cwt. In like manner the decomposition of $12\frac{1}{2}$ cwt. of carbonate of lime requires $\frac{12·5 \times 373·5}{2473} = 1·88$ cwt. Lastly, the loss by evaporation of water from the coke, the decomposition of water in the blast, and the losses by radiation, evection, &c., will amount together to about 3·44 cwt. more. The saving by use of primarily calcined lime under favourable conditions of materials and working may be:—Carbon saved in furnace, 4·57 cwt.; deduct loss from diminished heat carried in by blast, less the allowance for diminished heat carried away by escaping gases, 1·43; net gain possible, 3·14. Seeing that this gain would be effected on the already low consumption of 16·60 cwt. of carbon per ton of pig iron, it seemed reasonable that a limit of consumption, in Cleveland blast furnaces, of 13·46 cwt. of carbon may yet be reached, or, say, about 15 cwt. of coke, containing 10 per cent. of ash and incombustible matter.

The discussion which followed the reading of this paper was practically confined to Mr. Cochrane and Mr. Bell. When his paper had been read by the secretary in abstract—it was far too long to read in full—Mr. Cochrane, in response to the invitation of Mr. Rennie, vice president—who filled the chair in the unavoidable absence of Mr. Westmacott—that he would, if he thought proper, supplement the paper by explanations, proceeded at some length to controvert the statements made at the Leeds meeting of the Institute last summer by Mr. Bell, who had sharply criticised a paper then read by Mr. Cochrane. As soon as Mr. Cochrane sat down, Mr. Bell got up and spoke at great length. It would be quite impossible within the limits at our disposal to give even a summary of Mr. Bell's remarks. It must suffice to say that he took Mr. Cochrane's paper from beginning to end, and endeavoured to show that so far as it was good it was purely a copy of what M. Gruner had said before, and in so far as it was new it was entirely wrong. Mr. Bell certainly did not spare Mr. Cochrane, and did all in his power to show that the paper was absolutely worthless. As he made point after point he was received with applause and laughter. There were but few ironmasters or chemists present, and they kept silence. The majority were mechanical engineers, for whom, as a matter of course, Mr. Bell was far too recondite and technical. The study of blast furnace working will occupy a lifetime, and no mechanical or civil engineer can be expected to possess more than general information on the subject, but to follow Mr. Bell properly very precise information was absolutely necessary, and, as we have said, his hearers only saw before them an able and impressive speaker, who, with infinite dexterity and in admirably selected language, tore his opponent's arguments limb from limb. The interest was merged in the speakers; and the manifest enjoyment of the members was that usually present when Englishmen witness a good stand-up fight between able combatants. At last Mr. Bell sat down, and then Mr. Cochrane rose amid a good deal of encouraging applause. It was now very late, and Mr. Cochrane had but little time available, certainly not enough to follow Mr. Bell through his criticism. Mr. Cochrane speaks as well as Mr. Bell, but with more fire and less precision; but his answer, brief as it was of necessity, left nothing to be desired. He took a few of the salient points; and proceeded to show that Mr. Bell was absolutely and completely wrong, and that while most of his arguments were based on theory, that theory was itself no exponent of what actually took place in blast furnaces, while in certain cases Mr. Bell had put a construction on his words which they were not intended to bear. He was applauded when he sat down, and he succeeded in leaving the impression that Mr. Bell was very far from being the victor in a well-fought field. It is very improbable, we may add, that the matter will end here; no doubt either Mr. Bell or Mr. Cochrane will read another paper on blast furnace economics. May we express the hope that if this be the case it will be read before the Iron and Steel Institute, when there will be present an audience fully competent to deal with the case on its merits. We have referred in another page to some of Mr. Bell's statements, which possess general interest.

The business of the meeting was concluded by the hurried reading of a paper on the St. Gothard Railway, by Herr E. Wendelstein, of which we may have more to say at another time.

TRIPLE EXPANSION ENGINES OF THE SS. MILLICENT.

NUMBERS of our readers will remember with pleasure the exhibition of last autumn at the mouth of the Tyne. At the instance of Mr. George Renwick, the honorary secretary, the firm of Wigham, Richardson, and Co., Newcastle, exhibited the engines of the Millicent, of which we give this week a two-page illustration. The engines stood in the centre of the machinery annexe, and attracted great attention. The triplex compound engine has for many years been familiar to engineers, and, indeed, several examples have already been in actual work. To Mr. Alexander Taylor, the consulting engineer, who has always acted as the adviser of the firm of Messrs. Fisher, Renwick, and Co., is due the latest development of the triplex engine. He first had one fitted in the Isa, a steam yacht belonging to Mr. Hugh Andrews, of Felton Park, Northumberland, and subsequently he induced Messrs. Fisher, Renwick, and Co., to fit them on board of the Claremont, the Albertina, and the Millicent, built by Messrs. Kish, Boolds, and Co., of Sunderland. Mr. Taylor clearly grasped the idea that he must do one thing at a time. He did not go in all at once for a novel boiler, a novel propeller, and a novel type of engine. He contented himself with the ordinary marine boiler, and far from aiming at extravagant pressures, he adopted 150 lb., which the experience of the locomotive had marked as the maximum pressure giving good results as regards diminution of weight and efficiency in coal, while glands and joints could be kept tight.

The Millicent's engines, which we illustrate this week in our supplement, were designed by Mr. John Tweedy, of the firm of Wigham Richardson and Co., and reflect much credit on him. The first and second expansion cylinders work through one piston rod. This arrangement gives a minimum range of temperature in the cylinders, together with a minimum of strain upon the crank shaft. The cylinders are $16\frac{1}{3}$in., 22in., and 44in. diameter respectively, and all three have a stroke of piston of 33in. The crank shaft is $8\frac{3}{4}$in. diameter. The boiler is of the ordinary plain cylindrical multitubular type, possessing no feature of especial interest excepting the interest attached to the high-pressure used, viz., 150 lb. per square inch. It is of steel, is 12ft. diameter and $10\frac{1}{2}$ft. long, with 1650 square feet of heating surface, and three furnaces, each 2ft. $9\frac{1}{2}$in. diameter. It is carefully designed and well made, great care having been taken to make every part accessible for examination, cleaning, and repairs. The third expansion or low-pressure cylinder is fitted with variable expansion gear, but this is merely for experimental purposes, and will not be repeated when once Messrs. Wigham, Richardson, and Co. are satisfied what are the proper relative proportions of the three cylinders. To give greater facilities for the temporary removal of the high-pressure cylinder for examination and repairs; or its permanent removal in the event of the boiler pressure being reduced, the builders have, in the engines under notice, supported this cylinder on four columns, in one of which a passage is provided for the conveyance of the steam from the steam stop valve attached to it to the high-pressure steam chest. The exhaust steam from the high-pressure cylinder passes down another of the supports to the intermediate steam chest; the remaining supports are intended to be used as receivers for the water from the jackets and steam chest.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—R. J. W. East, engineer, to the Cambridge, additional, for service in the Bulldog; Charles Platt, chief engineer, to the Asia, additional, for service in the Inconstant; Alfred Lawton, engineer, additional, to the Asia, vice Walmesley; George Tyrer, engineer to the Defence, additional for service in the Redwing, vice Lawton; Henry Coller, engineer, to the Pembroke, additional, for service in the Raven, vice Monk; Harry W. Wilkins, engineer, to the Repulse, additional, for service in the Ariel, vice Coller; Thomas H. Harrup, engineer, to the Asia, additional, for service in the Canada, vice Wilkins; Joseph W. Allen, engineer, to the Pembroke, additional, for service in the Opal; John H. Sampson, George Whitting, Samuel J. Bird, and Robert Hall, chief engineers, additional, to the Vernon; Thomas Hughes, engineer, to the Pembroke; William Hudson, engineer, to the Wasp, vice Babb; George Harding, engineer, additional, to the Excellent, vice Hudson; and Alfred W. Gibbs, assistant engineer, to the Asia, additional, for service in the Rupert; James F. Babb, engineer, to the Flirt, vice Goff; Benjamin R. King, engineer, to the Wasp, vice Babb.

EARLY AMERICAN LOCOMOTIVES.

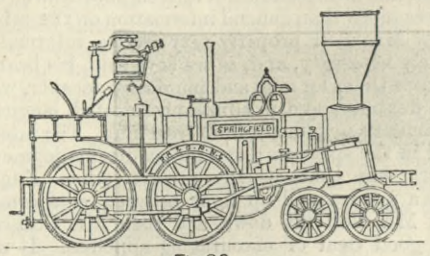


FIG. 20.

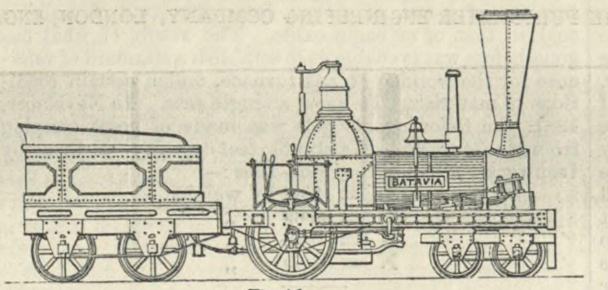


FIG. 16.

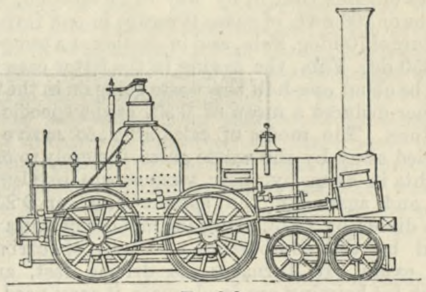


FIG. 20.

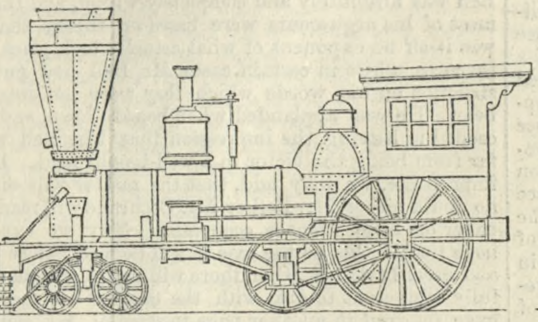


FIG. 27.

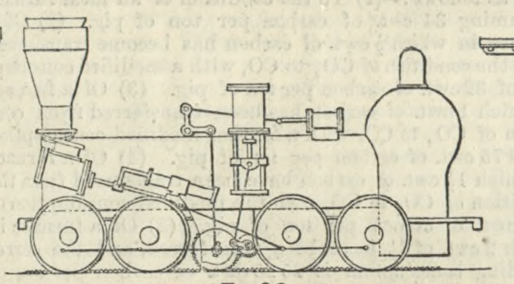


FIG. 26.

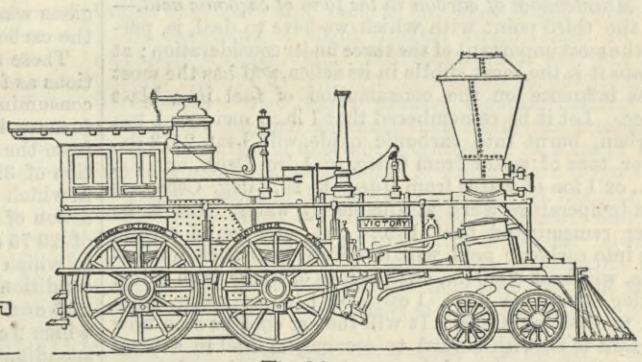


FIG. 24.

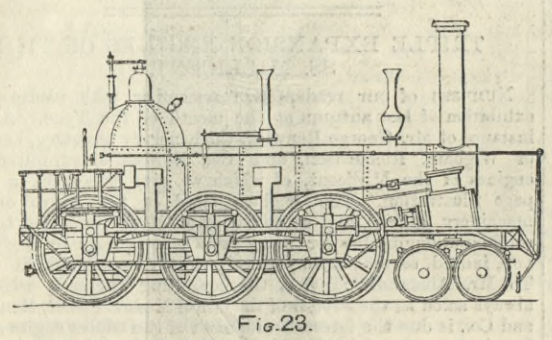


FIG. 23.

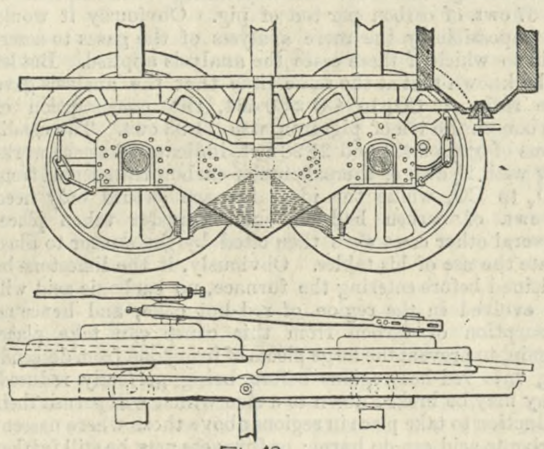


FIG. 18.

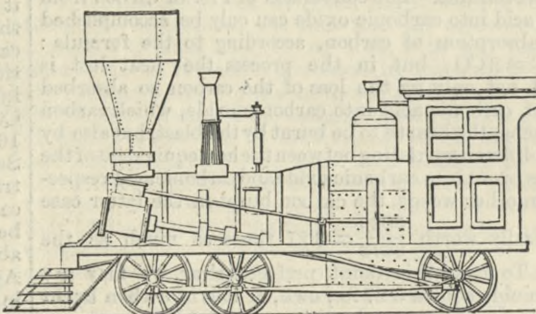


FIG. 17.

IN the series of papers "Links in the History of the Locomotive," appearing from time to time in our pages, we have confined our attention principally to English engines. The last impression of the *American Car Builder* contains an article by Mr. Frank C. Smith, which supplies some links in the history of the locomotive in America, and we reproduce it here with the somewhat characteristic engravings, apparently copied in many cases from old prints.

The first railroad built in America appears to have been at Quincy, Mass., in 1826. It was three miles long. In 1827 another was built for the use of the coal mines at Mauch Chunk, Pa. It was nine miles long and was operated by mules. In 1828, the Baltimore and Ohio, South Carolina, and the Delaware and Hudson Canal Companies, each built a road, all of which were operated by horse-power. In 1812, Colonel Stevens proposed to the Legislature of New York to build a road and operate it with locomotives, but nothing came of it. Horatio Allen was appointed by the Delaware and Hudson Canal Company to purchase three locomotives in Europe. The Stourbridge Lion was the first of the three that arrived, and it was the first locomotive brought to America. This engine is shown in Fig. 1. On the 8th of August, 1829, it was tried on the road at Honesdale, Pa. Its boiler was 16½ft. long, and the two cylinders were 3ft. stroke. Mr. Allen, on the date mentioned, started the engine, running it around a curve and up the road about two miles and then returned to the place of starting. This experiment demonstrated that the track was not sufficiently substantial for so heavy an engine, its weight being 7 tons. It was housed beside the track, where it remained for fifteen years, when the boiler was removed to Carbondale and used for stationary purposes, and the remainder sold for old iron. Thus, the first locomotive was a failure. In September, 1829, one of Geo. Stephenson's engines arrived in New York, and was jacked up clear of the rails and run. The following is Mr. Allen's account of his trip on the Stourbridge Lion:—"The circumstances which led to my being left alone on the engine were these: The road had been built in the summer, the structure was of hemlock timber, and the rails of large dimensions notched on caps placed far apart. The timber had cracked and warped from exposure to the sun. After about 500ft. of straight line, the road crossed the Leckawaxen Creek on a trestle-work about 30ft. high and with a curve of 350ft. radius. The impression was very general that the iron monster would either break down the road, or that it would leave the track at the curve and plunge into the creek. My reply to such apprehensions was, that it was too late to consider the probabilities of such occurrences; that there was no other course but to have the trial made of the strange animal which had been brought here at such great expense, but that it was not necessary that more than one should be involved in its fate, that I could take the first ride alone, and that the time would come when I should look back to this incident with great interest. As I placed my hand on the throttle I was undecided whether I should move slowly or with a fair degree of speed, but believing that the road would prove safe, and preferring if we did go down to do so handsomely and without any evidence of timidity, I started with considerable velocity, passed the curve over the creek safely, and was soon out of hearing of the cheers of the large assemblage present. At the end of two or three miles I reversed the valve, and returned without accident to the place of starting, having thus made the first railroad trip by locomotive in the Western Hemisphere."

The Baltimore and Ohio road had been built to be operated by horses, and to save expense in cuttings, curves were introduced. The English engines were thus ill adapted, with their rigid and long wheel bases, for short curves. Peter Cooper at this period owned some land, the enhanced value of which depended on the successful operation of the Baltimore and Ohio road, and to demonstrate that a locomotive could be built which would run on the short curves of that road, Mr. Cooper in 1829 built the Tom Thumb, shown in Fig. 2. This engine had an upright boiler 20in. diameter by 5ft. high, fitted with gun barrels for flues. It had a single cylinder 3½in. by 14½in. The engine drove a large gear, which meshed into another smaller gear on the axle. The fire was urged by a fan driven by a belt. The driving wheels were 2½ft. in diameter. On the 28th of August, 1830, the first railroad car in America propelled by a locomotive was tested on the Baltimore and Ohio road. The wheels were "coned," and this was the first use of this principle as applied to car wheels, and was suggested by Mr. Knight, chief engineer of the road.

This engine—Cooper's—was coupled to a car in front of it containing a load of 4½ tons, including twenty-four passengers. The trip of thirteen miles was made in one hour and fifteen minutes, the best time for a single mile being 3¾ minutes. The return trip of thirteen miles was made in 57 minutes. While this engine of Mr. Cooper's was built for experiment solely, it was the first locomotive built in America.

In 1830, the South Carolina road had constructed at the West Point Foundry, in N.Y., an engine called the Best Friend, which was the first engine built in America for actual service. It is shown in Fig. 3. The cylinders were 6in. by 16in.; drivers, 4½ft.; weight, 4½ tons. Nichols W. Darrell ran this engine on the South Carolina road for some time, and remained in this company's service as engineer until near his death in 1869. He appears to have been the first regular locomotive engineer in America. In 1831 the West Point, built at West Point Foundry, was started on the same road. This engine is shown in Fig. 4, and had same size cylinder and wheels as the Best Friend. The boiler was horizontal, with 2½in. flues, 6ft. long. With five cars, containing 117 passengers, this engine made 2½ miles in eight minutes.

In 1831 the West Point Foundry built a third locomotive called the De Witt Clinton, for the Mohawk and Hudson Railroad, of New York. It is shown in Fig. 5. In 1831, John B. Jervis, chief engineer of the Mohawk and Hudson road, designed an engine with the truck under the cylinders. This engine was built at the West Point Foundry, but was the first engine in the world on which a truck, or "bogie," was used. Mr. Jervis sent drawings of this device to England, from which Stevenson built the Davy Crockett for the Saratoga Railroad Company.

Mathew Baldwin, a jeweller and silversmith, of Philadelphia, built in 1831 a miniature locomotive for the Philadelphia Museum. In 1832 he built for the Philadelphia, Germantown, and Norristown road, an engine called Old Ironsides, shown in Fig. 6. Its weight was 5 tons, driving wheels 54in. in diameter, cylinders 9½in. by 18in. Wood was used for spokes and rim of the wheels, as well as for the frame of the engine. In 1834, Mr. Baldwin patented the half crank, shown in Fig. 7, which was in use for some time afterwards. It was a much cheaper crank than the ordinary form. Mr. Baldwin's second engine was built in 1834, for the Charleston and Hamburg road. The drivers were cast from bell metal. As they soon wore out, nothing further in this line of wheel was attempted. The cylinders were 10in. by 16in. This engine is shown in Fig. 8. This form of engine was in use for several years. The drivers and axle are shown in Fig. 9. To Mr. Baldwin is due the "ground joint" so universally used now, and which originated with him at this period. In Fig. 10 is shown Mr. Baldwin's combination of pump barrel and guide bar. In 1834, Mr. E. L. Miller patented a method of throwing part of the tender's weight on the engine, and in 1839 Mr. Baldwin bought this patent for 9000 dols. In 1835 he patented the driving-wheel shown in Figs. 11 and 12. In the same year he also patented the use of a copper ferule on the outside of the end of the flue to form a joint with the flue sheet. This form of joint is extensively used at the present day. In 1846, and afterwards, Mr. Baldwin built a large number of eight-wheel connected engines, shown in Fig. 13. They became very popular on account of their great hauling capacity, and the ease with which they ran round curves, this latter being due to the flexible truck. In 1837 Thomas Rogers built the engine shown in Fig. 14, and in Fig. 15 is shown his driving wheels and axle. In 1838 Mr. Rogers built the engine shown in Fig. 16. In 1842 Mr. Baldwin's engines had assumed the form shown in Fig. 17. In Fig. 18 is shown his patent flexible beam truck, which allowed the forward drivers to be formed into a truck to accommodate themselves to curves, and also of being connected by a side rod to the back drivers. This engine became very popular. In 1844, Rogers' engine is shown in Fig. 19, and in 1845 he built the engine shown in Fig. 20. Fig. 21 shows the valve gear used by Rogers in 1845 and 1846. In 1847, his gear had assumed the form of Fig. 22. In 1848, Mr. Rogers built the ten-wheel engine shown in Fig. 23. In 1850, he built the engine shown in Fig. 24, which was fitted with the shifting link motion, and in 1854 Mr. Rogers used the valve gear shown in Fig. 25. To him is also due the credit of first using the expansion plate.

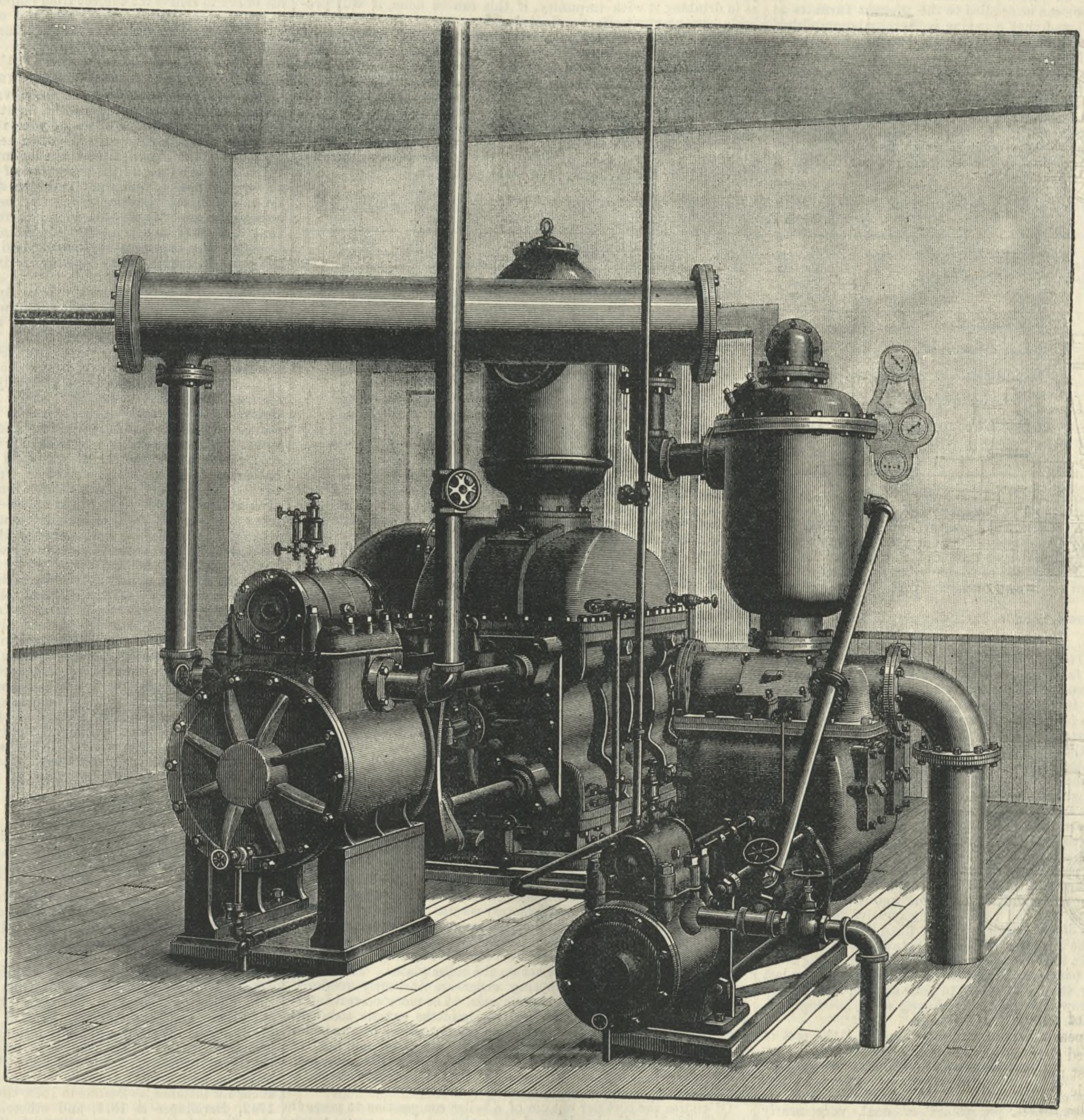
In 1857, Mr. Baldwin built the rack rail engine, shown in Fig. 26, for operating an inclined plane. On a level track the ordinary cylinders were used, while on the incline the upright cylinder drove the gear meshing into the rack between the rails, thus assisting the engine very materially. In 1848, Baldwin built the fast passenger engine shown in Fig. 27, for the Vermont Central road. The contract was for a speed of sixty miles per hour with train. The drivers were 6½ft. diameter, cylinders 17¼in. by 20in. It is stated that this engine could be started from a state of rest and run a mile in forty-three seconds. In 1853 Baldwin used the valve gear shown in Fig. 28.

KING'S COLLEGE ENGINEERING SOCIETY.—At a general meeting held on Tuesday last, the 30th ult., Mr. Percy B. Crowe read a paper "On the Manufacture of Railway Appliances from Bessemer Steel." There was a good attendance.

EXHIBITION OF RAILWAY APPLIANCES.—A national exposition of railway appliances is being organised, and to be opened in Chicago at about the end of May. Although styled a national exhibition, we believe that foreign exhibits will be received. From the circular issued by the English commissioner whose name is given below, the Inter-State Exposition buildings, located near the business centre of the city of Chicago, on the shore of Lake Michigan, and convenient to the depôts of the various railways, have been secured for the purpose. These are the largest Exposition buildings in the country, and are especially adapted to the purpose in question. The main building is 800ft. long and 200ft. wide, has a capacious gallery one-third of a mile in length, and is provided with an abundance of steam power for operating machinery. Railway tracks will be laid the entire length of this building, for the accommodation of cars and locomotives, and for use in making tests, which will be connected with the tracks of the Baltimore and Ohio, Illinois Central and Michigan Central Roads, running within a few feet of its eastern walls. Most favourable rates will, it is said, be given by the railways of the country for the transportation of articles intended for exhibition, and excursion parties desiring to attend. A series of scientific and practical tests, to be made by well-known men and carefully selected committees, extending to every article and every description of material susceptible of trustworthy test, will constitute one of the most interesting as well as most valuable features of the Exposition. The proceeds of the Exposition, after defraying necessary expenses, will, we are told, be devoted to benevolent purposes connected with the railway service. All European correspondence should be addressed to the foreign commissioner, G. D. Peters, Moorgate Works, Moorfields, London.

HIGH-PRESSURE CONDENSING PUMPING ENGINE.

THE PULSOMETER ENGINEERING COMPANY, LONDON, ENGINEERS.



WE illustrate above Deane's patent high-pressure condensing pumping engine for waterworks. The steam end of the main pump is of the ordinary high-pressure type. The exhaust passes first through the heater, which is shown across the engine, then to the condenser. In this way the heat is, of course, utilised for heating the feed-water, which enters and leaves through the two small pipes shown at the left hand of the heater. The main pump is an inside plunger pump provided with numerous small valves, the aggregate area of which more than equals that of the plunger. The condensing apparatus is a patent of the Pulsometer Engineering Company, the sole manufacturers of this pump. The dimensions of the machine are :—Steam cylinder, 24in.; water plunger, 20in.; stroke 24in. It is one of a pair of machines calculated to deliver together 4,000,000 gallons of water per 24 hours, at a pressure of 100 lb. to the square inch. This it has, we understand, been doing successfully in the United States for nearly two years. The feed-water is taken by a pump—not shown—from the hot-well, so that it is at 100 deg. or 110 deg. temperature, before being pumped through the heater. Our engraving has been made from a photograph taken before the lagging was applied.

LETTERS TO THE EDITOR.

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

THE PRINCIPLES OF MODERN PHYSICS.

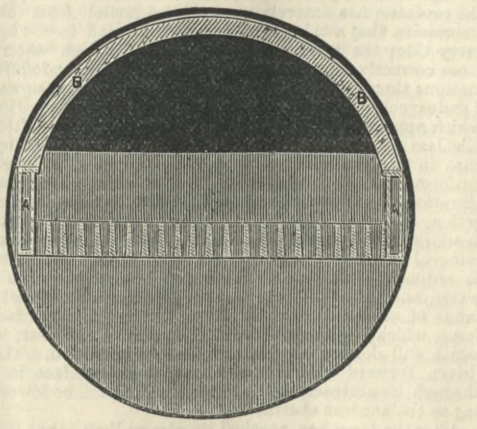
SIR,—I certainly do not mean to trespress on your space by any further controversy with your correspondent "Φ. Π."; but if any of your readers should wish to study a simple case in which effect is greater than resistance, I should recommend him to turn to the account given, in any elementary text-book on mechanics, of what is known as Attwood's machine. WALTER R. BROWNE.

January 29th.

STEAM BOILER FURNACE ECONOMY.

SIR,—I have read with much interest your remarks on the above subject in THE ENGINEER of 19th inst., and in reference to your closing remarks about locomotive furnaces, and your inability to see how the use of fire-brick or fire-clay arches can be applied to an Lancashire boiler, I enclose an extract from an essay which I wrote on 28th April, 1873, for the Association of Chemical Manufacturers, in answer to their advertisement for competitive essays on "The Economy of Fuel as applied to Chemical Manufactures."

"In other cases furnaces with horizontal fire-bars are also formed in front of the boiler; these, by reason of their being surrounded by fire-brick, raise a temperature which it is impossible to attain in a furnace surrounded by iron plates with water at the back of them. These furnaces give good results as to the perfect combustion of coal, but, owing to the intensity of the flame on the end of the boiler and tube, have proved to be very destructive of the boiler. In such furnaces outside of the boiler a large amount of heat is lost by radiation. We believe the same result of high temperature may be attained in an ordinary flue furnace of a Lancashire boiler, by lining the flue over and all the length of the fire with fire-clay arch blocks, as per enclosed sketch. We thus place the furnace under the same conditions as the furnaces referred to above, with this difference, that the heat radiated through the fire-clay arch will be taken up by the flue, and leave the strength of the heat to be taken up throughout the whole length of the tube. An ordinary boiler with Galloway tubes in the flue would take up most of the available heat before the products of combustion reached the far end of the boiler.'



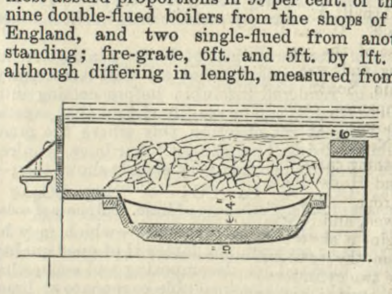
The enclosed sketch shows an arrangement for supporting the fire-clay arch by placing two hollow bearers, A A, at the side of the fire-bars, answering the double purpose of supporting the arch, B B, and preventing "scores" or "clinkers" from adhering to the arch. R. W.

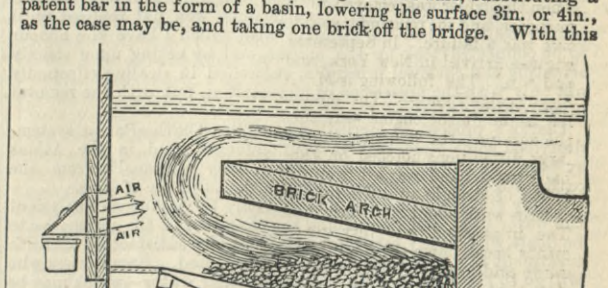
Runcorn, January 24th.

SIR,—I am glad your article "1883" has called forth replies from several inventors of smoke-consuming apparatus, and I hope some practical results may follow. I must apologise for again troubling you, for it seems to me you are unaware of the difficulties we have to deal with, else you would not visit us with such a condemnation.

The man who wishes to succeed in smoke preventing and fuel economising has something else to do than to study Rankine. It is easy work to sit in one's office and figure out theoretical results which have never in practice been carried out, nor can be carried out. We all know what is required, but the difficulty is the application. You treat coal as carbon, but you must be aware that the generality of steam small coal never contains more than 70 per cent. of carbon, and very frequently not even 50 per cent., and the quality varies daily; so that no rule can be laid down which will prove efficacious in all cases.

To make smoke prevention an easy matter, coupled with economy of fuel, you ought to address a leader to boiler-makers, and refer them to James Watt, and see if a century has brought forth any very marked improvement in steam boiler furnaces. The fact is that if you examine the boilers at present in use you will find the most absurd proportions in 99 per cent. of them. I have just seen nine double-flued boilers from the shops of the largest maker in England, and two single-flued from another maker of high standing; fire-grate, 6ft. and 5ft. by 1ft. 6in. All of them, although differing in length, measured from grate-bars to crown 1ft. 6in. The bridge was built to within 6in. of the crown. After stoking, the fuel was within 4in. of the crown in the majority of the boilers, and in others 6in. Under these circumstances, how is it possible to consume the gases and prevent smoke? If you will take the trouble to draw this to a scale, you will see that even James Watt was far in advance of this. In such cases I never attempt a trial unless I make the following alteration :—Without altering the bearers, I change the fire-bars, substituting a patent bar in the form of a basin, lowering the surface 3in. or 4in., as the case may be, and taking one brick off the bridge. With this alteration I arrive at a good result, because I give place for the gases to be consumed. Would it not be more sensible for the boiler-maker to consider this, and not leave space in the ash-pit, where it serves no practical purpose, whilst, on the other hand, the advantage gained by increasing the combustion chamber is enormous?





I made a very successful application for M. Mourot, 21, Rue des Graviers, Paris, similar to that suggested by you as successful on locomotives. A Field boiler, 1 metre diameter, sent forth such clouds of smoke as to annoy the neighbourhood. I stopped it by closing the ashpit all round, leaving a sliding door in front, with one of my doors working. I was able to reduce the air entrance to the ashpit to 6in. square. After each charge all the air was shut off from the ashpit, and admitted after the automatic door had shut off the supply above the fuel.

I also put up for M. Aubert, 226, Rue de Charenton, Paris, a locomotive brick arch, as shown on the preceding page. This was applied to an elephant boiler, and gave splendid results. I got up steam in three-quarters of an hour, in place of two hours by the old system.

My patent of 1871—on which you said: "The results seem to prove that the invention can be applied to the present furnaces at a cost of less than £5, and that a saving is thereby accomplished of about 25 per cent. in fuel"—has for its leading feature the restriction of air to the ashpits.

When I arrived at such good results with my doors as regards the economy of fuel, and having had trials made, as you can see from the testimonials, as to the coal consumed and water evaporated, M. Tresca suggested to me to have an analysis made of the gases to prove the correctness of the economy. I send you the table underneath, in answer to your remarks as to the production of carbonic oxide being promoted by the admission of air instead of checked:—

Composition Comparée des Gaz provenant d'un Foyer de Machine à Vapeur. Les Analyses sont faites par M. Ser, Ingenieur et Professeur à l'Ecole Centrale.

Nombre supérieur de calories dégagées constituant l'économie réele.	Nom de gaz.	Avant la charge.		2′ après la charge.		5′ après la charge.	
		Sans fumivore.	Avec fumivore.	Sans fumivore	Avec fumivore.	Sans fumivore	Avec fumivore.
8080	Acide carbonique	5·72	5·85	5·20	6·52	4·22	5·68
2475	Oxyde de carbone	5·72	5·85	1·58	6·52	2·12	5·68
Difference en faveur	Hydrogène..	5·72	5·85	0·32	6·52	0·76	5·68
du fumivore	Protocarb d'hydro	5·72	5·85	0·16	6·52	0·60	5·68
5607 cal.	Oxygène	14·68	14·55	12·08	11·20	12·57	11·03
—	Azote	79·68	79·60	80·05	82·21	79·76	83·29

The economy is incontestable. I am sorry to have written you such a long letter, but I think you ought to know all that has been done in a practical way to arrive at a result; and I also think that the results obtained by all the systems under your notice ought to be published for the edification of the industrial world. It is as much to the benefit of the public as to the inventor to know what can be done to prevent smoke and economise fuel.

A. HOWATSON.

85, Gracechurch-street, London, E.C., January 25th.

THE PREVENTION OF SCALE IN STEAM BOILERS.

SIR,—As one who for a number of years has been paying special attention to the question of incrustation in steam boilers and the purification of water for boiler purposes, perhaps you will kindly allow me space for a few comments on the article which appeared in your issue of January 19th.

The article states that the lime salts "will be deposited in the hottest place in the steam boiler, that is to say, just on the surface of the plate exposed to the fire," &c. This is certainly not correct, as any boiler inspector or engineer who has been much inside steam boilers will tell you that the scale is always the thinnest over the furnace crowns, or parts exposed to the action of the fire. The ebullition at these parts drives the water and impurities from the plates, and it is mostly at the lower parts of the boiler, about the back end angle irons and the parts farthest away from the fire where the circulation is most sluggish, that the heaviest deposits are found.

I was called in to advise only a short time ago in a case where the scale at the back end had reached the excessive thickness of 3in. The boiler was of the Cornish—or one-flued—type, and over the furnace plates the thickness of the incrustation was not more than $\frac{1}{16}$in. or $\frac{1}{8}$in. In this instance the firm had been using soda, at the suggestion of their boiler insurance company, for the last nine years! Taking the figures given in your article, a very little consideration will show that the use of caustic soda, as suggested, is simply impracticable on the ground of cost.

You state that with a moderately hard water "the cost of perfectly softening the water will be 8d. per 1000 gallons." Now take the case of an ordinary Lancashire boiler, such as are now in general use. Such a boiler will use on an average in this district about $2\frac{1}{2}$ tons of coal per day, and, taking the very low rate of 7 lb. of water evaporated per pound of coal, very nearly 4000 gallons of water will be used per day. This, at the cost stated of 8d. per 1000 gallons, will be 2s. 8d. per day, or, say, 16s. per week per boiler, so that a mill of average size with three boilers would incur a cost of nearly 50s. per week, or £125 per annum, by purifying the feed-water by caustic soda in the manner suggested.

Accepting the theory of the formation of boiler scale given in the article, and admitting for a moment that all that is necessary is that the salts should be rendered insoluble before coming into contact with the boiler plates, it can be readily shown that caustic soda is not the best re-agent for effecting this where the more soluble sulphate of lime causing "permanent" hardness requires to be dealt with. The following reaction very clearly shows this:—

$$Ca\ SO_4 + Na_2\ CO_3 = Ca\ CO_3 + Na_2\ SO_4.$$

Sulphate of lime. Carbonate of soda. Carbonate of lime. Sulphate of soda.

Put into words, this shows that soda carbonate—which may be introduced as soda crystals or soda ash, the latter if of good quality being preferable—is best adapted for decomposing and converting the soluble sulphate of lime into the insoluble carbonate of lime, and thus causing it to be precipitated in the manner described in your article.

Dr. Angus Smith demonstrated this more than twenty years ago in a number of experiments carried out at the instance of the Manchester Steam Users' Association, but, unfortunately, the full value to steam users of his investigations was not realised until quite recently, when the company with which I have the honour to be connected took up the matter, and by acting upon strictly scientific and chemical principles, succeeded in dealing effectually not only with the prevention of incrustation, but with the removal of scale already formed.

Clarke's process, as carried out in the Clarke-Porter system, described some time back in your columns, and in the Atkins system, undoubtedly purifies water very effectually from the carbonate of lime, but does not touch the sulphate of lime.

I may state in conclusion that it is only by having an analysis of the water used, and ascertaining the character of the impurities to be dealt with in any particular case, that any satisfactory scientific treatment at a reasonable cost may be effected. Steam users who will go to the expense of an analysis of their water—which may be had at a comparatively insignificant cost—may in the great majority of instances be enabled to prevent the formation of new scale, and even to remove with comparative ease the old accumulations already formed, at about one-third the cost of using pure caustic soda, as described in your article.

WILLIAM INGHAM, M.I.M.E.,
Formerly of the Manchester Steam Users' Association for the Prevention of Steam Boiler Explosions.

11, Queen-street, Oldham, January 26th.

SIR,—In the issue of your journal for Friday last, I notice a letter from the Disincrustant Marseillais Company, referring to an article which appeared in THE ENGINEER upon boiler incrustation. I should like to correct them on one or two points.

They say, "If you admit caustic soda removes the iron as well as the lime, what then will become of the boiler which is made entirely of iron?" Why, this is what will happen—the caustic soda will have not the slightest effect on the iron plates. They appear to forget the fact that the iron in the water is in solution, from which it is deposited by an alkali, because the oxide of iron is insoluble in alkaline solutions. Then a statement follows—I think for the first time in print—that caustic soda passes along with the steam into the engine. To this I would say, caustic soda is neither volatilised at a red heat nor does it pass along with steam—a fact which any soda manufacturer will prove. I am unable to speak as to comparative cost, knowing nothing of the company's manufacture; but as to drinking it with impunity, if this can be done, it will probably have no great effect on boiler scale.

I quite agree with the late article in your journal as a general statement that there is nothing to beat pure caustic soda, it being suitable to most waters in a more or less degree. I know of a substance which is rather superior to caustic soda, or anything sold for the purpose; by virtue of its action on the plates, it forms a very thin film of magnetic oxide to which no scale will attach. The only true and scientific method of preventing scale is to do it outside the boiler by softening the water, the first cost of which for plant, &c., is rather expensive, but fully repays anyone for adopting it by the saving in fuel, boiler plates, &c.

In reply to letter from "H. M.," the mixture of oak bark and caustic soda was only at fault in the proportions used. The destructive effect on the cocks was most probably from the oak bark and not the caustic soda, which, of course, if in excess and in contact with brass fittings, would most probably destroy them. If "H. M." cares to write me, I will let him know of a substance that will answer his purpose. Will he please state water used, temporary and permanent hardness, if known to him?

59, Launston-road, South Hackney, January 29th. THOMAS R. DUGGAN.

SIR,—I see two letters on this subject in your issue of the 26th which refer to your interesting article in a previous number. Perhaps some practical experience of the matter may be of use to your readers. I have used the highest strength caustic soda in steam boilers for the last five or six years, in the form of a small quantity carefully added to the feed-water, the result being that, in the first instance, a heavy scale was entirely removed, and none has formed since. The lime passes away as a sediment by the blow-off taps, just as you describe in your article, and the plate and rivet heads are perfectly clean. The brass gauge cocks and fittings have never given any trouble, but then care was always taken to dissolve the caustic soda in a fair quantity of the feed-water, so that the solution becomes exceedingly dilute, and quite as innoxious as the most innocent composition used for this purpose. The high strength and purity is of considerable importance. I have never used 70 per cent. caustic soda, but I should say it was much too impure to give a satisfactory result.

Your second correspondent does not seem to have much chemical knowledge, judging from the inference he draws from your statement, that because caustic soda removes the iron in solution from the water, it would therefore act on the boiler plates. The traces of iron existing in some spring water are instantly rendered insoluble by the addition of caustic soda. The more correct inference, therefore, would be that the action of the caustic soda will prevent the feed-water from acting on the iron plates of the boiler by neutralising the acids that have already dissolved and held in solution some iron which has been gathered when the water has been passing through the ground; and such, I believe, is actually the case.

Of course the cost per annum of a boiler composition to prevent scale depends on the hardness of the water. I do not use as much as you state, and with water of average hardness even much less than the quantity named would be amply sufficient.

January 30th. AN ENGINEER.

ON THE MOVEMENT OF THE WATER IN A TIDAL RIVER.

SIR,—I have read with much interest Professor Unwin's paper in your last issue, which, as far as I am aware, is the first attempt to ascertain the volume of water which oscillates in a tidal river, and is very valuable, yet to some extent fallacious. It appears to me the professor has scarcely emancipated himself from the prevalent impression that a tidal river is filled from end to end and emptied every tide; the fact, I believe, being that high water would be more correctly represented as a very great and indefinite series of stations through which the crest of the tide passes upwards. This I endeavoured to show in the paper on "Tides and Tidal Scour," which appeared in your journal of June 30th, July 7th, and July 21st last year. That view may be further illustrated by assuming that in every tidal basin water has a tendency to stand at an uniform level, being the mean level of the sea, and that only the elevation of the surface above that level is to be ascribed to tidal action, all other fluctuations being caused by gravity. On this assumption the first effect of a tide introduced into a basin by the removal of the barrier will depend upon the age of the tide; that is, to reduce the surface to low-water level, or to raise it to high water, and this, I apprehend, will be accomplished, not by a large influx of water through the breach, but by the transmission of tidal force, which will drive forward a quantity of water, the bulk of which will depend on the net force transmitted. The water so driven forward will be raised above the surface in front, and through its abstraction the surface behind will be lowered, according to the amount abstracted.

After the force has reached its utmost limit, that is, the line at which the level of high water and the surface of the inland water, or of the shore, coincide, of course there is not any further elevation, and consequently the surface of the water is lowered through gravity, because it descends to supply the water which has passed away to the void behind. But tidal action being now constant, that water is turned back by the stream, caused, firstly, by the filling up of the basin to its normal level, and, secondly, by the advance of the tidal force, which may perhaps be termed exclusively the tide, the actual movement of water particles being tidal streams. Now, in this view, there will almost certainly be a volume of water oscillating up and down as it is propelled by the tide, or surrendered to gravitation; and, if there is any continual flow of upland water, that must pass outwards, whenever able to overflow the utmost elevation of the tide. The quantity of what may be called foreign water—in ordinary language sea water—will depend, I apprehend, on the quantity required to fill the basin to the mean sea level; and that quantity will not be uniform in all basins, but dependent on the ratio between quantity of upland water and the size of the basin. This influx of foreign water, however, will not always be required, after the first adjustment of the basin to the tide, seeing that the mean level is always maintained; and the difference in the quantity of water between springs and neaps may be, and perhaps is, usually supplied by the upland water being dammed back by the tide. It therefore appears to me that the volume in oscillation will vary with every basin, and in different parts of the same basin, and can be determined only by careful local examination, and by ascertaining the various specific gravities and chemical constituents of the water, and of the deposits when there are any.

Thus it would appear the subject is not yet ripe enough for mathematical analysis; that there are yet many data to be collected before Professor Unwin's tentative effort will produce better result than to show the necessity for more patient inquiry. Still his effort to relieve the subject from empiricism entitles him to the grateful recognition of those who are conversant with the difficulties with which the subject is at present entangled.

Liverpool, January 30th. J. BOULT.

FLYING MACHINES.

SIR,—In the latest issues of your valuable paper I noticed several communications on artificial flight. If you could find place for these lines, perhaps some of your readers may consider my suggestions worth noticing. We often hear that one of the hardest problems of aerial navigation is the invention of a light and powerful motor, or rather a light generator of power. I do not venture to say that the problem shall never be solved, but we have as yet no practical solutions in view. The second point on which I believe the majority of contemporary aeronauts are of one mind is, that we must not trust too much in schemes for governing balloons, the enormous surface exposed to the wind demanding too great an expenditure of power in driving it across, let alone against a fresh gale.

If we have to wait long for a really perfect flying machine capable of carrying us at a good speed wherever we choose to go, could we not in the meantime consent to a compromise between free flight and no flight at all? If it were possible, instead of flying about promiscuously, to fly only from one place to another, say from town to town, would that alone suffice to reject any plan of that description? People are generally so elated with the idea of free flight, that it scarcely comes into their heads that in practice "flying about" is nearly useless in comparison with flying from A to B, if the last were possible—and I believe it is. It seems to me that M. Tissandier very neary hit the mark with his electromotor and accumulators; if we could only do away with the balloon and accumulators, which last weigh ever so many pounds to the horse-power stored. Cannot one leave generators and accumulators where they ought to be—in good brick houses on *terra firma*—and instead of the enormous weight take a couple of wires aloft? Could one not exchange the unwieldy balloon for a light, stout, plane, shaped like a kite, balanced by a car—with the constructor inside it—and propelled by a screw, driven at a good speed by a dozen or more Trouvè machines arranged in couples along the propeller shaft? Could not a line of stout telegraph wire be led on poles from Berlin to Paris, or from Pekin to Petersburgh, and could not a 100-horse power, sent along the wire by powerful dynamos at stations, say, 100 hundred miles apart, be taken to the flying plane by two light wires, having contact carriages at the lower ends? You may perceive I mean a Siemens' electrical railway, only transformed into a skyway. To conclude, if an enormous power be generated by dynamos and transmitted through a wire, if the aeroplane be light and stout and the propeller of sufficient size and pitch, will the thing fly? If science has nothing to say against it, I am convinced that the technical difficulties of the scheme can be easily overcome. Claiming no novelty for my plan, I yet believe this combination of old ideas has not yet been proposed. N. S.

St. Petersburgh, January 25th.

SIR,—My object in commencing the discussion on the above subject was to take exception to certain statements in your article, which appeared to have an important bearing on the problem of aërial navigation. The only point on which we still differ appears to be the question of the effort exerted by a bird in the air. Even in this matter we are at any rate agreed so far as the mode of measurement of work done, when the bird is relatively at rest to the air, and this is the only part of if on which I have expressed an opinion.

The solution of the problem of artificial flight will be, from the nature of the case, more difficult than that of artificial locomotion, either by land or sea, has been; but not a few writers and observers agree that its most hopeful feature is the assistance derived from the air by a suitably formed body in motion. This is how they account for the soaring of birds; this is how the apparently authentic but otherwise incredible instances of men who have, even for a small distance, managed to fly are accounted for; such, for instance, as Besnier in 1678, the Marquis de Bacqueville in 1742, Berblinger in 1811, and others. The imperfect state of aëro-dynamics renders any statement of the exact amount of this assistance impossible. Until more reliable data and experiments are forthcoming, the matter may well await further discussion.

H. S. HELE SHAW.

University College, Bristol, January 30th.

THE FOUNDERING OF STEAMSHIPS.

SIR,—Your article in this week's number on the above subject apparently contemplates bulkheads and pumping power as being the only available means of protection from foundering in the event of collision, or, at least, of delaying such result. But in view of the oft-repeated failure of these means of protection, the inquiry is natural whether they could not be supplemented by others. A means of checking the force of a collision before the colliding vessel touches the skin-plating of the vessel run into is suggested by the sponsons used in the days of paddle-steamships. A sponson, one-third the width of those formerly carried by ocean steamers, and three times the length—thus being of about equal weight—would stretch over the whole of that portion of the upper works of a steamer which does not already overhang the water-line. The midship section at the bilges might be made to recede inwards towards the keel—in the manner, though perhaps not to the degree, adopted by Brunel in the Great Britain—this in order to provide against the bilge being immediately penetrated through the vessel heeling over when struck. The piercing of the skin-plating by a colliding vessel would, by these means, depend upon the strength of the sponson and the force of the collision, instead of being, as at present, a matter of practical certainty. Such sponsons would virtually add their width to that of the deck of the ship most suitable for passengers' cabins, thus adding to the accommodation of the ship and making the structure remunerative to the shipowner. Extra attention might be required to the matter of the ship's stability when light, but not more than was needed with high paddle-boxes and wide sponsons. R. M. S.

January 27th.

[*For continuation of Letters see page* 91.]

EXHIBITION AT CORK.—It is intended to hold an exhibition on the site of the Corn Exchange, in the city of Cork, and to open it in the first week of July. The objects of the exhibition are:—(1) The exhibition of articles manufactured in Ireland, and of raw materials—mineral, vegetable, and animal—produced in Ireland. (2) The exhibition of articles manufactured, and raw materials produced in other countries, which, in the opinion of the Executive Committee, may tend to the improvement of existing, or the development of new industries in Ireland. (3) The exhibition of machinery suited to Irish industries, the machinery manufactured in Ireland being distinguished from that of other countries. (4) An exhibition of paintings, sculptures, carvings, china, antique furniture, armour, antiquities, plate, lace and other works of art. (5) A general loan collection of similar works and articles. (6) An exhibition of agricultural products and machinery, subject to same conditions as are attached to exhibits in classes No. 1 and 2. (7) An exhibition of appliances used in the culture, capture, and curing of fish, both sea and river. (8) The exhibition will be utilised, as far as possible, as a school for educating the farming, artizan, and working classes, by means of suitable lectures, demonstrations and reports. All necessary information may be obtained of Mr. A. Beamish, Exhibition Buildings, Cork.

RAILWAY MATTERS.

THE *Société d'Encouragement pour l'industriè française* has awarded the sum of 2500f.—£100—to M. Martin for his continuous vacuum brake, patented in 1860 and tried on the Eastern Railway of France in 1862.

THE Emperor of Austria has finally signed the concession giving the right to proceed with the construction of the Elevated Railway in Vienna, to the syndicate represented by Mr. Fogerty. There is to be an English and an Austrian board of directors; but it is not expected that the capital will be obtained in Austria.

THE boring of the Arlberg tunnel, which a short time ago suffered some interruption by reason of the nature of the material encountered, is now progressing at the rate of ten metres a day. At the end of December there remained no more than 3468 metres to pierce, and it is confidently expected that by the spring the heading will be finished.

THE contract for supplying the material to be used in the construction of the Forth Bridge has been assigned to the Steel Company of Scotland, Glasgow. The Steel Company of Scotland is also making the material to be used in the new Tay Bridge, which is being constructed by Messrs. Arrol and Co., Glasgow, who have already begun operations.

MESSRS. WREN AND HOPKINSON, of Manchester, have just completed for the new works of the Metropolitan Railway Company, at Neasden, a couple of travelling cranes for lifting up to 50 tons. These have been specially designed for handling locomotives, and are constructed of 2ft. 6in. box girders, with a span of 58ft., and are each fitted with two 25-ton crabs.

DURING the ensuing year, surveys will be made, says the St. Petersburg correspondent of the *Times*, for the following new lines of railway:—From Samara through Ufa to Omsk, from Ufa to Ekaterinburg, a continuation of the Ural Railway from Ekaterinburg to join the above Samara-Omsk line, and further on, in the direction of Troitsk, from Tmerioka to Novselsk, the east Donetz line; from Lugan to Millerovo, the branch to Novorossisk, from Wioldou to Toukoum, and from Ryieff to Viazma.

AT a meeting of the South-Eastern Railway Company last week Sir E. Watkin said, in reply to the accusation that the South-Eastern Company remains behind the times, that the company was going ahead of the times, because it had abolished express fares and had made all trains first, second, and third-class except the mail and continental trains, and, he added, "We are constantly reducing fares by giving better accommodation." Making all trains third-class is not very new, though the imaginary method of reducing fares may be. Its advantage is that the reduction may in this way be enormous, while the "better accommodation" may only be discernible by Sir E. Watkin.

THE new departure of the Midland Railway Company, in the business of hiring wagons, has so far been successful. Many colliery companies are giving up the keeping of their own wagons, and leasing from the Midland, whose terms are certainly reasonable. For fifty miles and under, on its own line, wagons can be had at 6d. per ton, the rate rising to 9d. and 1s. when other companies' lines are travelled over, and the distance is considerable. The Midland is certainly in a good position for doing a business of this sort on conditions which private firms or even limited companies could scarcely offer. It has the labour to its hand, and beyond the mere cost of making the wagons and keeping them in good repair there is very little left in the way of heavy outlay.

A MEETING of street railway officials was held in Boston, U.S., December 12th, for the purpose of forming a National Street Railway Association. The temporary chairman, Mr. Moody Merrill, in outlining the scope of the proposed organisation, said that there are now organised and doing business in that country and Canada 415 street railway companies. These companies employ about 35,000 men, and run 18,000 cars. More than 100,000 horses are in daily use, to feed which it requires annually 150,000 tons of hay and 11,000,000 bushels of grain. These companies own and operate over 3000 miles of track. The whole number of passengers carried annually is over 1,212,400,000. The amount of capital invested in these railways exceeds 150,000,000 dols. Messrs. C. B. Clegg, of Ohio, and C. C. Woodruff, of New York, were chosen secretaries.

THE question of the necessity of introducing automatic couplings for railway purposes in this country similar to those in use on some American, Colonial, and Continental railways, was brought before the members of the Manchester Association of Employers, Foremen, and Draughtsmen, at their meeting on Friday in a paper read by Mr. J. Nasmith. Models of automatic combined buffers and couplings and of central automatic link couplings as used in the Colonies were exhibited by Mr. Nasmith, who urged that an automatic coupling being proved to be mechanically practicable, the English companies ought to alter their present system without delay. The opinion of the meeting was, however, that an automatic coupling must be of such a character as to admit of gradual introduction to have any chance of adoption in this country. It must be designed so as to be applicable to existing stock without much alteration.

THE Channel Tunnel Railway Bill seeks to empower the Channel Tunnel Company, Limited, to make the following railways in Kent in connection with the Channel tunnel, and for other purposes:—Railway (1) 3 miles 1 furlong 2 chains, commencing in the parish of Temple Ewell by a junction with the London and Chatham Railway and terminating in the parish of Guston, and at the Dover and Deal-road; railway (2) 2 furlongs 3 chains, in Tempel Ewell, commencing at the junction with the London, Chatham, and Dover Railway and terminating by a junction with railway (1); railway (3) 1 mile six furlongs 2 chains, commencing in Guston by a junction with No. 1 and terminating at low-water mark in the parish of West Cliffe. The capital of the company for the purposes of this Act to be £750,000 divided into 37,500 shares of £20 each. The Bill gives borrowing powers to the extent of £250,000, and the works are to be completed within ten years from the passing of the Act.

A TABLE, showing the result of the working of the St. Gothard Railway from June to December, has been published. Excepting June, which was a broken month, August yielded the best returns—993,000f.—and December the lowest—685,000f. On the other hand, while the working expenses were the lowest in August and September, not exceeding 300,000f., they rose in December, owing to the necessity of keeping the line clear of snow, to 426,000f. The excess of receipts over expenses during the period in question makes a total in round numbers of three and a-half million francs. The goods traffic shows a steady increase, the receipts from this source being 500,000f. in December, against 380,000f. in August. The falling off in the winter returns arises exclusively from the diminution in the number of passengers. In August 117,000 passengers travelled over the line; in December only 50,000. The number of passengers carried by the company since the opening of the line last June is 601,000

IN a report by Colonel F. H. Rich on the accident that occurred on the 13th of December, near Brimscombe station, on the Great Western Railway, it is mentioned that the connecting rod between the crank axle and the motions of No. 74 engine, which was drawing the passenger train due to leave Milford at 1 p.m., broke while the train was ascending the incline between Brimscombe and Tetbury-road stations. The connecting rod first broke about the centre. The broken end that remained attached to the crank axle, being flung violently round by the action of the axle, was subsequently broken in two other places, made a hole about 19in. by 18in. in the bottom of the barrel of the boiler, and broke ten of the tubes inside the boiler, which allowed all the steam and water to escape. Mr. Dean, the locomotive superintendent of the Great Western Railway, says that fractures with this class of connecting rod are very rare. The rods generally last as long as the engines, the life work of which is usually from 400,000 to 500,000 miles.

NOTES AND MEMORANDA.

ACCORDING to a German contemporary, a brass capable of being forged hot, may be made with 60 parts copper, 38½ zinc, and 1½ iron.

SPIRIT of turpentine is now made from sawdust and refuse of the saw-mill. It is extracted by a sweating process, and yields 14 gallons of spirits, 3 to 4 gallons of resin, and a quantity of tar per cord.

FOR cutting narrow slots in a hardened steel plate a disc made of Muntz metal, revolving at about the speed that would be used for turning wrought iron of the size of the disc, and using fine quartz sand and water, has been found to work better than discs of other material.

THE following figures relating to the proposed Messina tunnel have been published:—Length, 13,546·17 metres; fall from Sicily to datum, 154·28 metres; length below the level of the sea on this side, 4688·62 metres; length under the strait, 4299·9 metres; fall from Calabrian side to datum, 153·15 metres; length below level of sea this side, 4565·63 metres; fall of straight parts, 35 in 100, and in curves 32 in 100; cost, 71 million francs.

THE mean reading of the barometer last week at the Royal Observatory, Greenwich, was 29·84in. The mean temperature was 38·9 deg., and 0·8 deg. below the average. It showed an excess on Sunday and Saturday, but was below the average on each of the other days of the week; the warmest day was Sunday, when the mean was 45·1 deg. The lowest night temperature was 28·8 deg. on Wednesday, and the highest day temperature in the shade 50 deg. on Saturday.

THE Town Council of Southampton have accepted a tender for continuing the boring in the chalk which was abandoned in 1851, after it had reached a depth of 439 yards bored in the chalk or chalk marl, but its continuation will now probably carry it into the lower greensand in a short time. The boring commences at the bottom of a well 563ft. in depth. Chalk mud now fills about 36 yards of the bottom of the boring. The temperature, at a depth of 1210ft., has been recently found to be nearly 72 deg., that of the outer air being at the time 49 deg.; the increase in temperature being thus 1 deg. Fah. for every 52·6ft. in depth.

To show that there is no loss of matter or weight attending combustion, Professor Hofmann burns a small quantity of phosphorus in a little crucible at the end of a glass tube placed in a flask, the phosphorus being ignited by means of a small piece of heated copper, which, with the rest of the apparatus, is balanced before the combustion commences. A tube with a stop cock is also fitted to the flask, and a small quantity of the air pumped out before igniting the phosphorus. The weights before and after combustion are found to be the same, but when the process is completed air will rush in if the stop cock is opened, and the flask weigh more than at the commencement of the experiment.

BEFORE the Paris Academy of Sciences a paper was recently read on "Hydraulic Silica, and on the part it plays in the Hardening of Hydraulic Compounds," by M. Landrin. The pure silica obtained by decomposing a solution of silicate of potash with an acid, and repeatedly washing and drying at a dark red heat, he names hydraulic silica, and he considers it the cause of the final hardening of hydraulic mortars. The aluminate of lime cannot concur in this effect, because of solubility, but at the moment of immersion it facilitates the intimate union of the hydraulic elements, hinders water from penetrating the mass of mortar, and so aids the slow reciprocal action of the lime and hydraulic silica.

OWING to its greater strength, phosphor bronze is used sometimes instead of copper for conducting electricity, since much smaller wire possesses the necessary strength. The resistance offered by phosphor bronze is considerably greater than that of copper, so that while it answers well for telephone wire, it is not adapted to long telegraph lines. Herr L. Weiller, of Angoulême, has recently alloyed copper with silicon instead of phosphorus, and made a silicon bronze, the conductivity of which, the *Scientific American* says, is twice that of phosphor bronze, while its strength is not less, and hence seems well adapted to electric conductors. The relative strengths of copper, silico bronze, and phosphor bronze are said to be as 28, 70, and 90; conductivity as 100, 61, and 80.

THE *Times* Geneva correspondent says an engineer who has just visited the scene of the disaster near Fort de l'Ecluse describes the condition of things as very serious. The entire side of Mont Credo, on which the forts are built, appears to be giving way, and further and more dangerous earthslips are feared. The lower fort is considered past saving, and the garrison has been withdrawn. The rocks on which the forts stand, and which look solid enough to support them for ages, are said to be undermined. If they should fall into the Rhone, which, compressed between lofty cliffs, is exceedingly narrow thereabouts, the course of the river will be completely blocked, and the entire valley, for a length of more than twenty miles, joined to the lake. This is another evidence on the large scale of the great levelling action which is going on continually all over the world, the ever-active tendency on the part of mountain masses to get to a lower level, having plenty to work upon in Switzerland.

AT a recent meeting of the Paris Academy of Sciences a paper was read describing some researches on the relative corrosion of cast iron, steel, and soft iron, by M. Gruner. Various plates, suspended in a frame by their four corners, were immersed simultaneously in water acidulated with 0·5 per cent. of sulphuric acid, or sea water, or were simply exposed in moist air of a terrace. In moist air, chromate steels were corroded most rapidly, and tungsten steels less than carbon steel. Cast iron, even with manganese, is oxidised less than steel and soft iron, and white specular iron less than grey cast iron. Sea water, on the other hand, attacks cast iron more than steel, and with special energy white specular iron. Tempered steel is less attacked than the same steel annealed, soft steel less than manganese steel or chromate steel, &c. Acidulated water, like sea water, dissolves grey cast iron more rapidly than steel, but not white specular iron; the grey impure cast iron is most strongly attacked. These results agree with the complete experiments on the subject by Mallet in 1843.

THE results of a fourth year's observations of periodic movements of the ground as indicated by spirit levels at Secheron, are given by M. Ph. Plantamour in the *Archives des Sciences*, of December 15th. The curves obtained from the east-west spirit level for the four years are strikingly similar in the manner in which they follow the thermal oscillations of the air. Different years show a notable difference in the epoch of maximum descent of the east side relatively to the minimum of mean temperature, and maximum rise of the same side relatively to the minimum of temperature. One is led, says *Nature*, to consider the maximum and minimum of temperature rather as accidents as regards the epoch at which they occur, and to attribute a preponderant influence to the distribution of mean temperatures during the four months November-February, and the four June-September. Probably, too, the degree of moisture influences largely the rapidity with which the deeper ground layers are affected by exterior temperature. The curve for the north-south level is also very similar to the previous ones; but has this peculiarity, that while the south side follows, in general, from October 1st to the end of September, the oscillations of external temperature—descending in winter and rising in summer—the intermediate variations of temperature have no inverse effect. The cause is at present unknown. Colonel van Orff's observations at Bogenhausen reveal oscillations of the ground similar to those at Secheron, only with greater amplitude south-north, and less east-west. M. Plantamour regrets that, excepting Colonel van Orff and M. d'Abbedie, no one, so far as he knows, has undertaken observations of the kind at any other station. They are easily made, and should yield important results.

MISCELLANEA.

THE Emperor of Germany has ennobled Professor Helmholtz.

THERE are in the United States about twenty-eight establishments devoted to the manufacture of matches.

IT is stated that glass pump barrels are bored in Berlin by ordinary lathes and tools specially hardened, aided by dilute sulphuric acid.

THE Leeds Corporation have arranged to light the crossings of the principal thoroughfares of the town with Bray's lamps, each of 80-candle power.

LARGE portions of the rock at Hartland Point have lately been giving way. Hundreds of tons of the cliffs have fallen towards the sea, some portions towards the lighthouse, blocking up the road near it.

THE third annual dinner of foremen and marine engineers of the East of London was held on Thursday, the 26th January, at the George Hotel, Millwall. The company numbered about seventy, and the chair was filled by Mr. Thos. Russell.

THE Hudson River Power and Paper Company has completed a new dam across the Hudson River at Mechanicsville, N.Y. It is 1000ft. long, 16ft. high, 18ft. wide at base and 8ft. at top; with its canal it has cost £40,000. It will furnish 4000 horse-power.

AT a meeting of the provisional committee of the Manchester Ship Canal Company, held at Manchester on the 24th ult., it was unanimously resolved to apply to the Standing Orders Committee to dispense with the standing orders and allow the Bill to proceed.

CARDIFF made holiday on Wednesday in honour of the turning of the first sod of the new docks by the Marquis of Bute, by whom the docks are being constructed at the cost of half a million. The contract has been given to Messrs. Nelson and Son, Carlisle, and the work is to be completed within three years.

HERREN GANZ AND CO. are about to illuminate the National Theatre, Budapesth, by means of a thousand Swan lamps, 200 of which they are also fitting up in a steam corn-mill. The Café Steenassger on the Corso has been lighted by Zipernowsky lamps, supplied with electricity by generators of the same inventor.

ANOTHER of the great blasts for which the limestone quarries of the Glendon, U.S., Iron Company are famous was fired on the 11th. The American *Engineering and Mining Journal* says a total charge of 29,000 tons—pounds is evidently meant—of Judson powder, distributed in six chambers, was fired by Mr. Frank Firmstone, the quantity of rock displaced being estimated at considerably above 100,000 tons.

THE Metropolitan Board of Works' scheme for the reconstruction of Hammersmith Bridge has passed standing orders examination. By the Bill it is provided that the Board of Works may, within certain limits of deviation, construct a bridge at Hammersmith. The time for the completion of the works is limited to six years. During the progress of the re-building a temporary bridge will be provided, which is to be suitable for all kinds of traffic.

THE Wolverhampton Chamber of Commerce has written to the Board of Trade, saying that though the standard wire gauge proposed by the department was not in every respect such as they would have liked, yet they felt it would fulfil the purposes of a national standard wire gauge. They were so anxious to see a workable gauge introduced that they preferred not to make any suggestions lest they should hinder or possibly frustrate its adoption.

THE Dover Town Council are troubled about their waterworks. They have suggested to the War-office that the Royal Engineer officers should co-operate with them in the consideration of the Channel Tunnel Railway Company's scheme, which, it is stated, will seriously affect the borough water supply. The Channel Tunnel Company would probably think little of the responsibility of undertaking to provide Dover with new works if necessary.

A CENOTAPH, bearing the following inscription, was recently placed in the new cemetery at Otago:—"Erected by the Australasian Institution of Marine Engineers in memory of Alexander Munro, chief engineer; Alexander Livingston, 2nd engineer; Andrew Sutherland, 3rd engineer, who were drowned at the wreck of the s.s. Tararua, 29th of April, 1881. Also David Rintoul, 2nd engineer, s.s. Wakatipu, who was accidentally killed at sea, 22nd July, 1882."

THE Palermo journals record a fatal landslip which occurred at Lercara in a mine called Arciprete Colle Freddo. The cause of it was some excavations, made under the steps leading to the mine, bringing down about 1400 cubic metres of soil, and burying sixteen people. The engineers declare it to be impossible to make any attempt to recover those who are buried, as the precise point where they lie is unknown, and a fresh landslip is expected every moment.

"WOODEN shipbuilding is not yet an extinct industry down east," a fact which comforts the *New York Com. Bulletin*. "During the past year, in Maine alone, 62,567 tons were launched, which is about 50 per cent. in excess of the tonnage built in Maine during the fiscal year ended June 30th, 1881. The statistics for the district of Bath, which includes Phippsburg, show that the tonnage is more than 40,000, and the number of vessels launched nearly sixty."

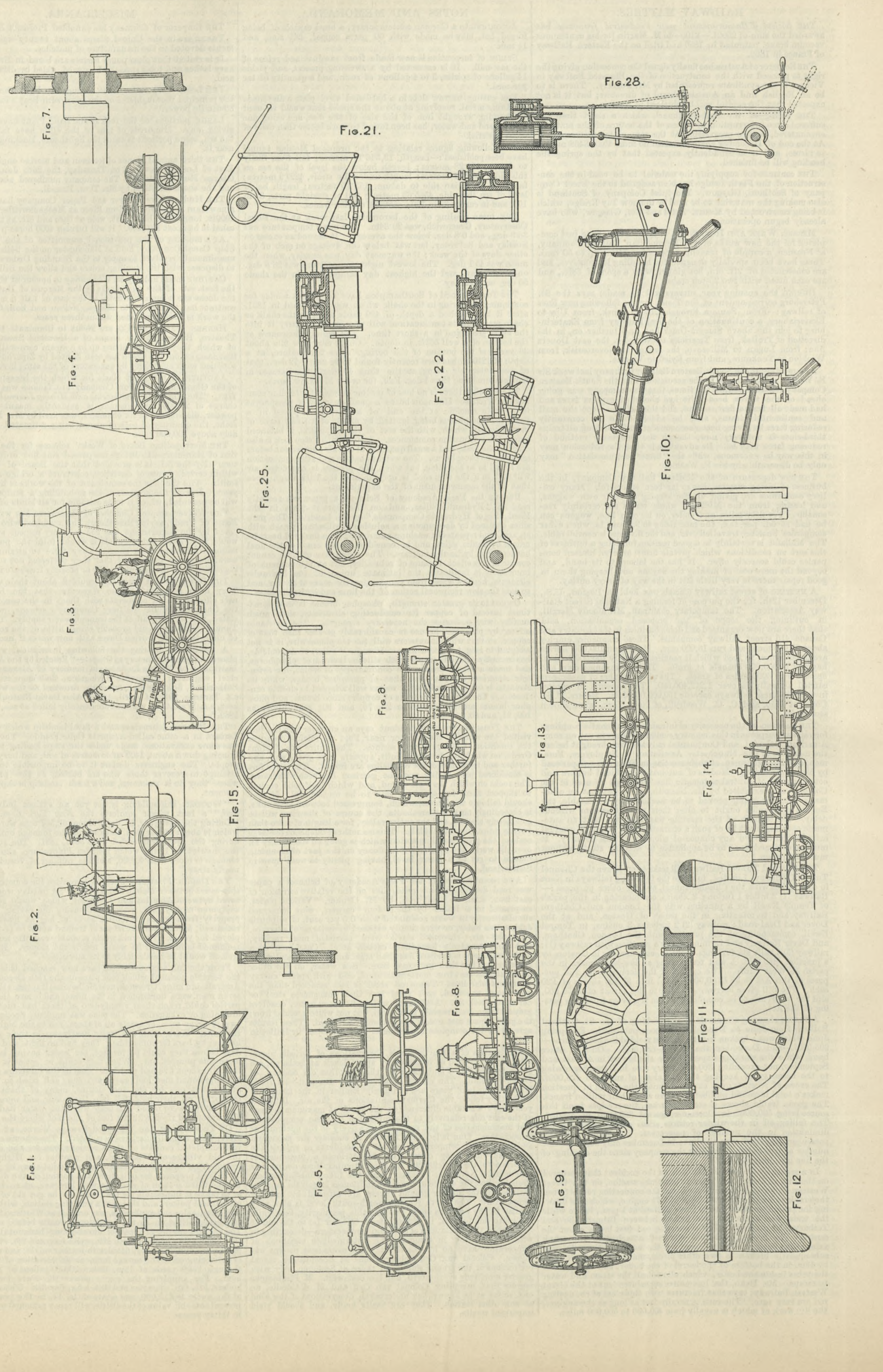
THE Dublin *Freeman's Journal* advocates the construction of a ship canal between Dublin and Galway. "A full day would thus be saved between America and Liverpool, which would represent an enormous money gain, without estimating the saving of life and property from wreck; a million acres of bog at least would be reclaimed, and the surplus labour of Ireland would be profitably employed for years. The work would probably cost fifty millions; the reclaimed land would be worth nearly the money. Its effect on Ireland would be incalculably to its advantage."

FROM the full accounts which have now reached this country of the terrible accident which took place on the 11th December at the Australasian mine, Creswick, near Melbourne, it appears that twenty-seven men were imprisoned in the mine, and before the exploring parties could reach them twenty-two of them had died either by drowning or exhaustion. The mine was suddenly flooded, and the twenty-seven men, or nearly all of them, ran to the highest part of the mine. Here, with the water nearly up to their chins, they held on by bars for some time. They had no light, and it was two days before they could be reached, the water having been in the meantime pumped out. When they could be got at it was found that all except five had perished. One of the survivors stated that the imprisoned men had prayed and sung and tried to cheer each other; but one by one the victims, many of them struck by cramp, let go their hold, fell into the water, and were drowned. Their bodies were found in a heap when the water had subsided. The water had risen within a foot of the roof where the men were.

ON Tuesday last the Whitwood Sewage Works, at Whitwood Mere, were formally declared completed. The scheme of drainage just completed consists of three sections, one for the drainage of the old village of Whitwood, and another for Hightown, the sewage from both these districts being carried away by gravitation on to land prepared for irrigation; the portion of the district joining the third section of drainage was, however, at so low a level as to make it impossible for the sewage to be got rid of except by mechanical power, and therefore a pumping station, with all necessary receptacles and appliances, was erected at Whitwood Mere, and the sewage lifted on to the irrigation grounds before referred to. The engines consist of a pair of direct-acting horizontal high-pressure condensing engines, with 12in. cylinders, and 2ft. stroke. The pumps are double-acting, fitted with leather valves, and are capable of delivering on to the sewage farm, at an elevation of 68ft., and through 2300 yards of 12in. mains, 30,000 gallons of sewage per hour. For supplying the engine power there are two Cornish boilers, 5ft. 6in. diameter and 20ft. long, flue 3ft. The entire cost of the works is £15,000, and a rate of 1s. 4d. in the pound on the present rateable value of the district will repay principal and interest in thirty years.

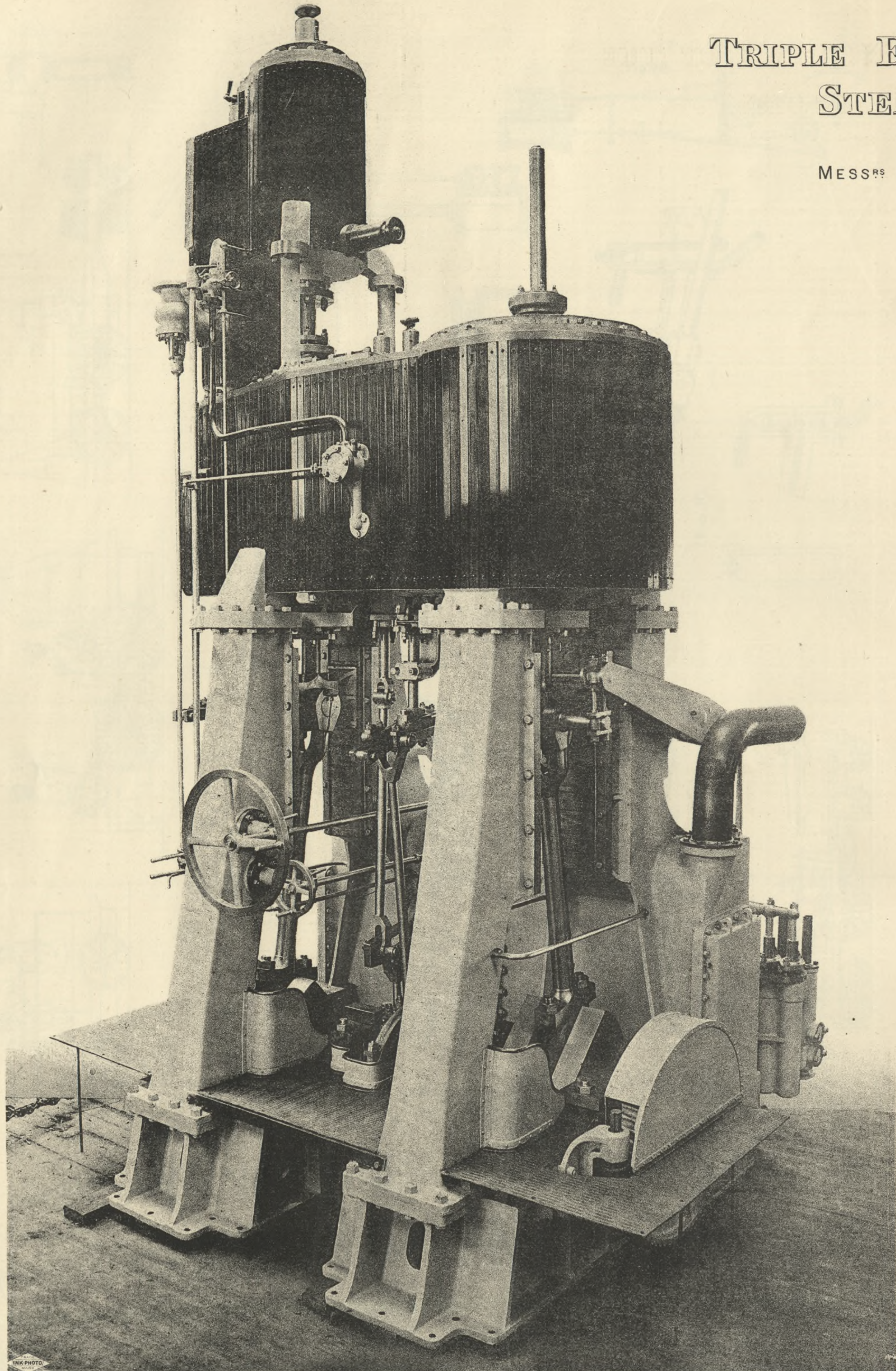
EARLY AMERICAN LOCOMOTIVES.

(For description see page 84.)

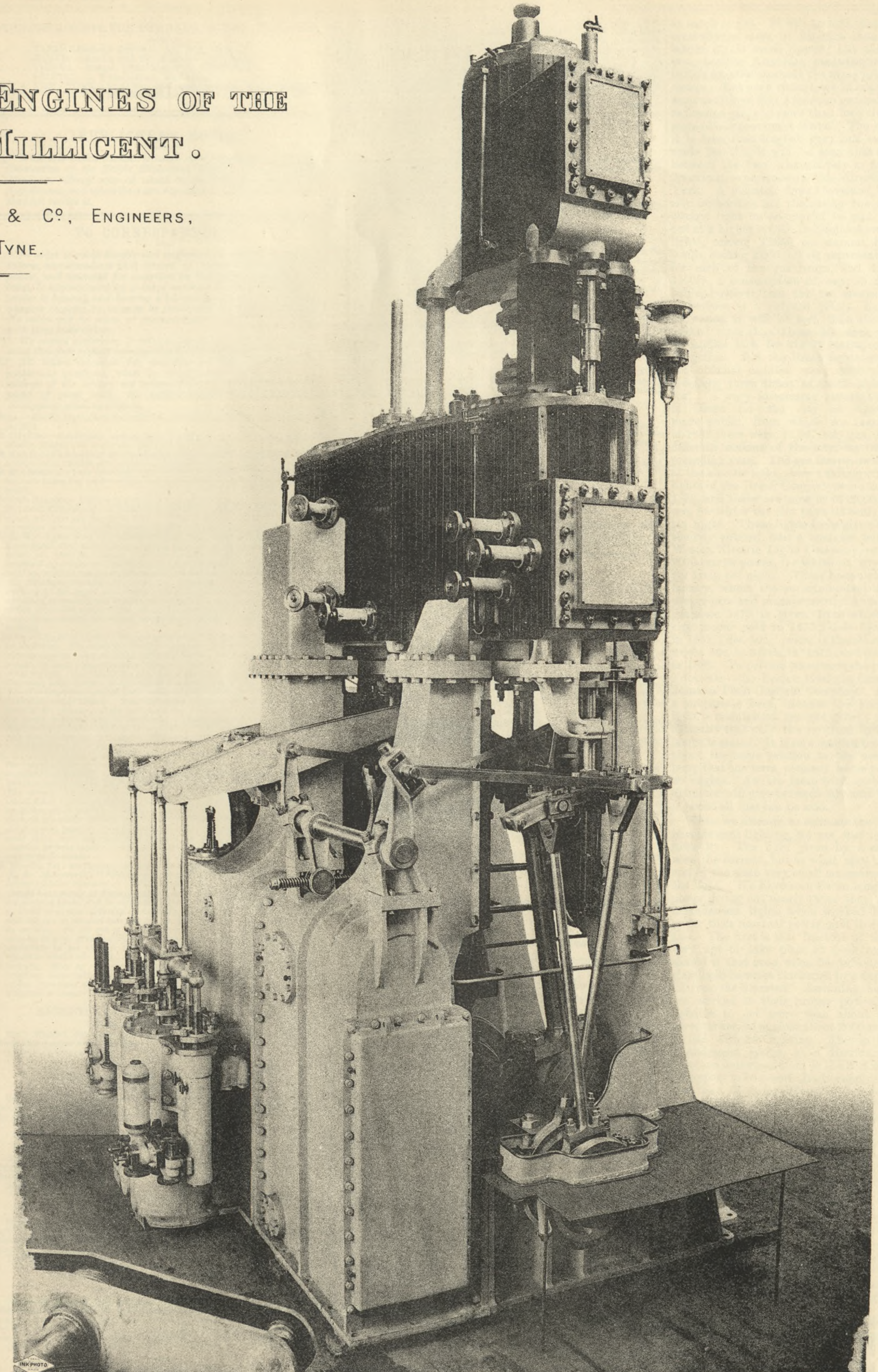


TRIPLE EXPANSION ENGINES OF THE STEAM SHIP MILLICENT.

MESSRS. WIGHAM RICHARDSON & Co., ENGINEERS,
NEWCASTLE ON TYNE.



Sprague & Co. 22 Martins Lane, Cannon St. EC.



Sprague & Co. 22 Martins Lane, Cannon St. EC.

FOREIGN AGENTS FOR THE SALE OF THE ENGINEER.

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

PUBLISHER'S NOTICE.

**** With this week's number is issued as a Supplement, a two-page illustration of the Triple Expansion Engines of the Steamship Millicent. Every copy as issued by the Publisher contains this Supplement, and subscribers are requested to notify the fact should they not receive it.*

TO CORRESPONDENTS.

**** 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.*

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

**** 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.*

SODA.—*Kindly state where the boilers are to which you refer in your letter of the 30th.*

R (Tipton).—*Concerning archimedean screws for raising water, apply to Messrs. Easton and Anderson, Erith Ironworks, Kent.*

B. AND G.—*We ought not to insert your letter. There may be differences of opinion as to whether one patent anticipates another or not.*

G. E. (Bristol).—*Your letter referring to the use of brake blocks pressing on the rails instead of on the wheels, suggests nothing that has not been often tested.*

JUNIOR READER.—*There are very small dynamo machines made and sold for about £2 by dealers in electrical apparatus, which, if driven at a high speed, will give you one small light. There is no book which will give you drawings in complete detail from which you could make such a machine.*

C. E. W.—*A good deal of railway work is just about to be commenced in Queensland that will involve a great deal of collateral work, and he for whom you make the inquiry ought to be able to find employment if his practical experience will enable him to put his hand to such work as may turn up until he can get employment in the branch he most prefers.*

T. C. (Burngrove-road).—*We have no practical acquaintance with the working of the smoke preventing apparatus to which you refer, and are unable to pronounce any opinion on its merits. It appears to be a modification of an old device, which has not been successful, because it drives a fierce flame against the boiler plates just beyond the bridge and causes leakage.*

CRANE.—*Consult the little "Treatise on Cranes" in Weale's Series, published by Lockwood. Fly ropes for driving cranes are run at a very high speed; in some cases as much as sixty miles an hour. The arrangement is very simple, an endless rope running along one side of the gantry, on which the crane travels. One side of the rope takes into a grooved pulley which works the crane, being thrown in and out of action by clutch gear.*

S. L.—*The resistance against your pump plunger working with a head equal to* 1000 *lb. will be* 2300 *lb. What the power expended will be depends on the speed of the plunger, which you have not stated. At* 14·5*ft. per minute, the power required will be one-horse, a small allowance being made for stuffing-box friction—that is to say, if the plunger had a stroke of* 1*ft. and made* 29 *strokes per minute. The return stroke not being made against a resistance is not to be counted.*

H. C.—(1) *We really find it impossible to give you any information regarding the remuneration paid to inventors by manufacturers. It is generally a question of bargain. The inventor has something to sell which he thinks worth so much, and he finds that it is worth no more than it will fetch. The value of the invention, other things being equal, depends on the point which it has reached in its development. A crude idea is worth less than an invention which works well in the shape of a model, and that is worth less than an invention the result of which is already in the market. Firms must be well paid for bringing inventions to perfection.* (2) *If you have a good thing and advertise for a maker, you will have no difficulty in meeting persons ready to hear all you say and take it up if they see their way to make money.*

J. W.—(1) *Yes; see the last volume of* THE ENGINEER. (2) *Take the mean.* (3) *See Moleswort's "Pocket-book," page* 369. (4) *Use an engine with a larger cylinder running at a slower speed.* (5) *Yes; boilers for launches should have plenty of heating surface, hold a good deal of water, have a large steam space, and be very small, light, cheap, and durable. We fear you will have some difficulty in combining these qualities.* (6) *Steel-makers will tell you to use steel tube plates; the Low Moor ironmakers will tell you to use iron. To get out of the difficulty of choosing between the two we, were we in your place, would use copper.* (7, 8, *and* 9) *We really cannot undertake to say whether the boilers of which you enclose rough sketches would or would not work, or whether they would or would not infringe patents. Were we in your position we should consult a competent engineer, whose business it is to give advice and instruction. It is no part of our functions to act as consulting engineers, although we are always delighted to answer reasonable questions.*

MACHINERY FOR MAKING SUGAR FROM GRAIN.

(*To the Editor of The Engineer.*)

SIR,—Wanted, the name and address of manufacturers of machinery for making sugar out of mealies or any other grain. SUGAR.

Lincoln, January 30th.

PREPARING GANISTER FOR FURNACE LINING.

(*To the Editor of The Engineer.*)

SIR,—I will be greatly obliged if any of your readers will kindly furnish me with particulars, and probable cost, of the plant necessary for preparing ganister for furnace lining, &c. F. L.

PURIFYING FEATHERS.

(*To the Editor of The Engineer.*)

SIR,—Can any of your readers give me the address of a known firm of engineers who make machinery for purifying, curling, and dressing poultry feathers? W. J. A.

January 25th.

HIGH-SPEED HORIZONTAL ENGINES.

(*To the Editor of The Engineer.*)

SIR,—Can any of your readers give me the address of makers of high-speed horizontal engines of light construction, suitable for model cigar boats of the torpedo type? The diameter of hull is 14in., and the pressure for motor 100 lb. per square inch. TORPEDO.

London, January 25th.

MOISTURE UNDER GALVANISED ROOFS.

(*To the Editor of The Engineer.*

SIR,—Could any of your readers suggest any plan for getting rid of the sweat which comes on the inside of galvanised iron roofs? We have some roofs of this material over machinery, and any night there is frost we find great trouble from water dropping. We should like to know the best treatment for the outside, whether tar or paint. R. AND F. K.

Cappoquin, January 24th.

REMOVING GREASE FROM TIN-PLATE.

(*To the Editor of The Engineer.*)

SIR,—Could any reader tell me through your correspondence column the best means to remove grease from tin? I wish to use tin cases for packing tea. The tea should, properly, be packed when hot. The heated leaves of the tea absorb the scent of the grease used in preparing the tin, and thereby become tainted. Soda in boiling water removes the grease partially. Is there anything better which will neither injure the tin nor the tea? G. L. C.

London, January 29th.

STEAM HAMMER FOUNDATIONS.

(*To the Editor of The Engineer.*)

SIR,—Can any of your readers inform me what would be the best foundation for a steam hammer of 6 cwt., having a cylinder 9in. diameter by 27in. stroke? The present foundation is a concrete base about 3ft. 6in. thick by 4ft. square, on which there are two rows of pitch pine timbers 14in. square bolted together, but the substratum is of a shaly nature and permits vibrations, and an unpleasant thud-like sound to travel to the adjacent buildings, which are separated from the shop by a street about eight yards wide. A trench of 9ft. deep has been cut on three sides of the hammer to intercept the vibrations and break the sound, but the object desired is not attained, as complaints are still made of the ground and buildings shaking. The side on which the trench has not been cut is the one nearest the workshops and farthest from the buildings. Would that cause the vibrations and sound to travel to the adjacent ground? STEAM HAMMER.

Leeds, January 31st.

SUBSCRIPTIONS.

THE ENGINEER *can be had, by order, from any newsagent in town or country at the various railway stations; or it can, if preferred, be supplied direct from the office on the following terms (paid in advance):—*

Half-yearly (including double numbers) .. .. £0 14s. 6d.
Yearly (including two double numbers) .. .. .. £1 9s. 0d.

If credit occur, an extra charge of two shillings and sixpence per annum will be made. THE ENGINEER *is registered for transmission abroad.*

Cloth cases for binding THE ENGINEER *Volume, price* 2s. 6d. *each.*

A complete set of THE ENGINEER *can be had on application.*

Foreign Subscriptions for Thin Paper Copies will, until further notice, be received at the rates given below:—Foreign Subscribers paying in advance at the published rates will receive THE ENGINEER *weekly and post-free. Subscriptions sent by Post-office order must be accompanied by letter of advice to the Publisher. Thick Paper Copies may be had, if preferred, at increased rates.*

Remittance by Post-office Order.—Australia, Belgium, Brazil, British Columbia, British Guiana, Canada, Cape of Good Hope, Denmark, Egypt, France, Germany, Gibraltar, Italy, Malta, Natal, Netherlands, New Brunswick, Newfoundland, New South Wales, New Zealand, Portugal, Roumania, Switzerland, Tasmania, Turkey, United States, West Coast of Africa, West Indies, Cyprus, £1 16s. China, Japan, India, £2 0s. 6d.

Remittance by Bill in London.—Austria, Buenos Ayres and Algeria, Greece, Ionian Islands, Norway, Panama, Peru, Russia, Spain, Sweden, Chili, £1 16s. Borneo, Ceylon, Java, and Singapore, £2 0s. 6d. Manilla, Mauritius, Sandwich Isles, £2 5s.

ADVERTISEMENTS.

**** The charge for Advertisements of four lines and under is three shillings; for every two lines afterwards one shilling and sixpence; odd lines are charged one shilling. The line averages seven words. When an advertisement measures an inch or more the charge is ten shillings per inch. All single advertisements from the country must be accompanied by a post-office order in payment. Alternate advertisements will be inserted with all practical regularity, but regularity cannot be guaranteed in any such case. All except weekly advertisements are taken subject to this condition.*

Advertisements cannot be Inserted unless Delivered before Six o'clock on Thursday Evening in each Week.

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

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, Feb. 6th, at 8 p.m.: Paper to be discussed, "Mild Steel for the Fire-boxes of Locomotives in the United States," by Mr. John Fernie, M. Inst. C.E.

SOCIETY OF ENGINEERS.—Monday, Feb. 5th, at 7.30 p.m., the statement of accounts for 1882 will be read, the President for 1882—Mr. Jabez Church—will present the premiums awarded for papers read during that year, and the President for 1883—Mr. Jabez Church, who has been re-elected—will deliver his inaugural address.

SOCIETY OF TELEGRAPH ENGINEERS AND ELECTRICIANS.—Thursday, Feb. 8th, at 8 p.m., the following papers will be read:—"On the Magnetic Storm of Nov. 17th, 1882," by Mr. James Graves, Member—communicated by Mr. H. Weaver, Member. "On a Magnetic Storm in India," by Mr. E. O. Walker, Member. "On Earth Currents in India," by Mr. E. O. Walker, Member. "Earth Currents—third paper—Sun Spots, and Electric Storms," by Mr. Alex. J. S. Adams, Associate.

THE CLEVELAND INSTITUTION OF ENGINEERS.—The annual dinner will be held, by the permission of the President and Committee of the Erimus Club, in the large hall of the Club, Queen's-square, Middlesbrough, on Friday evening, the 9th of February; Mr. Edwin F. Jones, President, in the chair.

SOCIETY OF ARTS.—Monday, Feb. 5th, at 8 p.m.: Cantor Lectures, "Solid and Liquid Illuminating Agents," by Mr. Leopold Field, F.C.S., A.S.T.E. Lecture II.—Primary, or unmanufactured materials—tallow and lard. Waxes. Spermaceti. Palm and cocoanut oils. Candles from the foregoing. Night-lights. Tuesday, Feb. 6th, at 8 p.m.: Foreign and Colonial Section, "Social Conditions and Prospects of Madagascar," by Rev. J. Peill. Sir Donald Currie, K.C.M.G., M.P., will preside. Wednesday, Feb. 7th, at 8 p.m.: Tenth ordinary meeting, "The Modern Lathe," by Mr. J. H. Evans. Mr. T. W. Boord, M.P., will preside.

THE ENGINEER.

FEBRUARY 2, 1883.

THE COST OF ELECTRIC LIGHTING.

CHAMPAGNE has not yet been sold for the price of beer; but there can be no doubt that money is made by champagne growers, and there is good reason to believe that the demand for it is practically unlimited. We may regard electric lighting as representing champagne, while gas stands for beer, and feel confident that the public will willingly use the former even though the price should be higher than that of gas. But electric light companies refuse to find consolation in this argument, and insist on proving that the electric light can be supplied at as cheap a rate as gas, and in doing this they are, we think, mistaken. No doubt arc lamps can be used to supply light at nearly the price of gas, if not at a smaller cost; but we have no reason to think incandescent lighting can be made to compete with gas in this direction at present. Of course it is quite on the cards that important improvements may be made which will modify conditions in favour of incandescent lighting; but we have only to do with things as they are. We are quite willing to admit that in isolated cases great successes have been achieved, and incandescent lighting has been satisfactorily effected at a very moderate cost; but these cases must be regarded as experimental, whether they can be repeated on a large scale being very doubtful.

It will perhaps be admitted that Mr. Edison is an authority on electric lighting. It is well known that an extensive installation has been constructed in New York by the Edison Company, which now supplies light in much the same way as the gas companies supply gas, and it makes a fixed charge of one dollar per 1000-candles per hour. Thus, for example, if a houseowner had twenty 16-candle lamps burning five hours per night for seven nights, his bill would be 11·2 dols. or, say, £2 5s. 6d. In London, with gas at 3s. per 1000ft., the same amount of light would cost a fraction over 8s. 4d. But in New York the electric light has to compete with gas at 9s. per 1000ft., and the figures would stand—electric light £2 5s. 6d., gas £1 5s. An American contemporary has worked out the calculation from figures obtained from actual experiments at the printing works of Messrs. E. P. Coby and Co., and arrives at nearly the same result as we have done. The gas with which the comparison was made is about 26-candle power, and its cost is 2·25 dols. or 9s. per 1000ft., and the incandescent light costs as nearly as may be twice as much as gas. It will be said that the Edison Company must charge more in America than in England, because labour, &c., is much dearer; but this can be only partly true, because American manufacturers can sell dynamos in this country at about the same price as English makers charge. But even though we admit that this was true, we must not forget that American gas costs three times as much as London gas, and more than four times as much as gas in some of our provincial towns. The American gas is better, it is true, than English gas; but even after allowance is made for this, it will be seen that the difference in price between the two is excessively in favour of gas. Nor is American experience in this direction confined to New York. A dispatch from Cleveland, Ohio, states that the city authorities are discussing the abandonment of the electric light on account of its cost. More light is given, but at a higher price. In Euclid Avenue, eight mast Brush lights, costing £2650 per annum, have replaced 75 gas lamps, costing £660. This represents about 6d. per night for each of the gas lamps, and, taking gas at 9s. per 1000ft., a consumption of, say, 55 cubic feet. It is probable, however, that the gas company supply gas to the authorities at a reduced price. Even if we make this allowance, it will be seen that the lamps could not have burned more than about 6ft. each per hour, giving, say, 30 candles each for the 75 lamps, or about 2250 candles altogether. But the Brush lights would give, at 850 real, not nominal candles, each, 6800 candles, or, in round numbers, three times as much light at four times the cost. A very interesting report by the superintendent of lamps for the city of Boston has just been made public, from which we learn that at the close of 1882 there were 12,967 oil, gas, and electric lamps in different sections of the city, an increase of 71 over the preceding year. The gas lamps, owing to the introduction of the electric light, show a falling off of 149. The electric lights of the Brush Company were introduced in February, 1882, and there are now 59 of 2000 candle power each in use, for which the city pays 65 cents, or 3s. 1½d., per lamp per night. These lights have given satisfaction. In May the city entered into a contract with the New England Weston Electric Light Company, so now has 57 lamps of 2000 candle power, for which it pays 58 cents, or 2s. 5d., per lamp per night. These have not, however, been satisfactory, which the superintendent attributes to want of proper care and management. A table of prices paid for gas since 1875 is given, from which it appears that the city proper paid in 1875 2 dols. 8½c. per 1000 cubic feet; in 1882, 1 dol. 50c.; prices in the other districts ranged from 2 dols. 50c. to 3 dols. in 1875, to 1 dol. 87½c. to 2 dols. 25c. in 1882. To private consumers the price now ranges from 1 dol. 80c.—the Boston Gaslight Company—to 3 dols—the Jamaica Plain Gaslight Company. It is difficult to draw a comparison here, because the hours during which the light is maintained are not given; and there is also the difficulty that only the nominal light supplied by the arc lamps is stated. It is now known that "2000 candles" bear about the same relation to the actual performance of a lamp that the term nominal horse-power does to that of an engine. An arc lamp with carbons 11 millimetres in diameter will give between 800 and 900 candles, and that is about all that can be said.

When we attempt to estimate the relative cost of gas and incandescent lighting, we are met by a somewhat similar difficulty. The light given by a carbon filament varies with the current, but at what may be termed the hottest end of the scale very small accessions will greatly augment the light. We have seen Swan lamps nominally 20-candle power giving out nearly twice that light. But as a rule incandescent lights when worked by companies are run under their nominal power, and there are two reasons for this. The first is that fracture of the carbon filament is very apt to take place at high temperatures, and the second is that even when fracture does not take place the glass bulb becomes blackened by a deposit of carbon thrown off from the filament. Assuming, however, that the lamps are worked to their proper power, it does not appear possible to get more than about 180 real candles per horse-power, as against about 2000 real candles which may be had with arc lighting. This in itself would place the incandescent system at a disadvantage as regards gas. Another important item is the cost of the lamps. It does not appear to be practicable to supply them in any quantity at less than 2s. each, although it was rumoured that Edison made them at a cost of about 6d. If the average duration be taken at 1000 hours—and this is too high as far as our experience goes—then the cost of a lamp alone would be equivalent to 750ft. of gas in London. This would give 20 candles for 150 hours; or to put it another way:—One thousand cubic feet of gas will supply 20 candles for 200 hours. If we add to this the price of the lamp, we have gas for 350 hours; so it will be seen that the cost of the lamp is a most important item. In 1000 hours a 20-candle gas flame would use 5000 cubic feet, costing 15s., from which it appears that the cost of the incandescent lamps alone will represent two-fifteenths of that of gas, or 13·4 per cent. The percentage would be much higher in towns where gas is cheap. It is evident, therefore, that there would be a considerable advantage gained by a cheapening of the lamps. In what way this is to be effected remains to be seen. In the United States a patent has been secured for the use of human hair as the filament, Chinese hair being preferred, because it is coarse. Horse-tail hair might perhaps be found to answer well, and even the fine bones of certain fish. But it is not so much in the preparation of the filament as in the securing of it in the lamp that expense appears to be incurred.

It is an encouraging circumstance that, notwithstanding its cost, electric lighting continues to make rapid progress in certain directions. It does not get on as quickly as was anticipated, but it does get on; and we think that electricians are now justified in stating boldly that although they are prepared to admit that it is a costly light, the advantages which it manifests over gas make it better worth having. The electric light will be freely used, even though it should cost twice as much as gas, provided it is trustworthy. It will never become popular until reliance can be placed on it. So long as there is the least chance that a house or a district may be left in darkness, as Holborn has been recently, no form of the electric light can command public favour. Once its trustworthiness has been demonstrated, its cost will, within reasonable limits, become quite a minor consideration. If only a good secondary battery could be supplied to regulate electric currents, the success of incandescent lighting, even at a high price, would be secured. This is *the* necessity of the moment, and to its production every energy of the electrician ought to be devoted. Nothing like success has, however, been achieved. It has been demonstrated that powerful secondary batteries can be made, and this is really about all. The charged secondary battery can hardly yet be said to have any marketable existence. The experience obtained in Holborn, at Victoria Station, and in several other places goes to show that incandescent lighting is not suitable for streets or large outdoor places. All the beauties of the light are wasted in such situations; and it cannot compete with gas either in cost or efficiency. On the other hand, the arc light has shown that it is quite unrivalled for illuminating yards, quays, docks, railway stations, engineering and building works in progress, and so on. When improvements have been effected, which will certainly come, and by which diffusion of the light will be effected and the blackness of shadows will be softened, the popularity of the system will extend. That there is a great future before electric lighting we do not doubt; but it is well to look facts in the face, and admit that while arc lighting can be made to compete with gas in cost, incandescent lighting cannot. What the future may bring forth no one can say; but the present and the past teach the lesson we have tried to place before our readers.

BLAST FURNACE ECONOMY.

It is probable that there are not in existence two more competent authorities on blast furnace management than Mr. I. Lowthian Bell and Mr. Charles Cochrane. The reputation of the first-named gentleman may indeed be said to be world-wide; while the latter possesses the largest blast furnace in the world, and has spared neither time, trouble, nor expense to master every detail of the process of converting iron ore into iron. On Friday evening Mr. Cochrane read before the members of the Institute of Mechanical Engineers a paper on "Blast Furnace Working," a very full abstract of which will be found in another page. The discussion which followed was virtually a passage of arms between Mr. Bell and Mr. Cochrane; and it was impossible for the dispassionate listener to arrive at any other conclusion than that the true theory of the action of a blast furnace has yet to be enunciated. It is not too much to say that on no point was there agreement between the speakers; and each was able to adduce overwhelming theoretical proof that he was right and his opponent was wrong. The discussion was indeed but the renewal of a combat previously partly fought out at Leeds last summer. Mr. Cochrane then read a paper, it will be remembered, on blast furnace temperatures, and to that paper Mr. Bell took exception. Then Mr. Cochrane wrote the paper read last Friday, and with the result, as far as Mr. Bell was concerned, which we have stated. We have no doubt that the combat will be renewed, and it is fortunate that such contests are not wasted, because each of the disputants is compelled by the other to draw on all his sources of information, and facts and theories are placed freely at the disposal of the world which might otherwise remain the property of individuals.

The discussion on Friday night turned principally on the nature of the chemical processes which produce heat within a blast furnace; and much was stated of extreme interest, not alone to ironmasters, but to every one who has to do with furnaces of any kind. It is to be regretted that there were no ironmasters present who were disposed to speak. The case would no doubt have been different had the paper been read before the Iron and Steel Institute—its proper sphere. It may be well to give a few words of explanation to such of our readers as are not familiar with blast furnace practice, to enable them to comprehend better what follows. A blast furnace is a tall cylindrical brick structure, at the bottom of which is a contracted space, known as the hearth. On a circumference at a fixed point above this hearth are fixed a number of tuyeres or nozzles, through which air is forced by a steam engine, at a pressure of from 1½ lb. to as much as 6 lb. or 7 lb. on the square inch, the practice in this respect varying with the district, the coal, the ore, &c. The blast is heated to a very high temperature before it enters the furnace. The furnace is charged at the top from time to time with barrowfuls of coal, coke, ore, lime or limestone. In some districts raw coal alone is used; in others coke alone; in others a mixture of both; sometimes lime is used, sometimes the unburned limestone. The result is in all cases the same. The lime, uniting with the siliceous and earthy impurities of the ore, forms a fusible slag or glass. The oxygen is taken away from the metal, and this last becoming liquid, runs down to the bottom of the furnace and accumulates in the hearth, from which it is run off every few hours, assuming the well-known form of pig iron. A large quantity of carbonic oxide (CO) is discharged from the top of the furnace, and being caught by suitable appliances in the shape of a hood to the furnace, and pipes, is led down to the ground, and being passed under boilers or into the stoves used for heating blast, is ignited and supplied with more air and burned to carbonic acid (CO_2), giving out a great deal of heat in so doing. A moment's reflection will show that the temperature within a furnace from 50ft. to 70ft. high must vary under the stated conditions. Thus at the top, where the cold fuel and ore are put in, it will be coolest. In the hearth, again, will be the melted iron, below the level of the blast tuyeres, and, therefore, not very hot. But at some point in the furnace above the tuyeres, the combustion of the coal, urged by the fierce rush of the heated air driven in by the blowing engine, will be complete, and the temperature will be very high. Now, on the precise locality of this zone of maximum temperature, and on what goes on there, a wide diversity of opinion exists, and the same may be said of every other point in the furnace. Continual chemical changes are going on during every step of the downward progress of each barrowful of coal, ore, or lime, and the precise place and nature of these changes have always formed a fruitful source of discussion, if not of dispute, among blast furnace investigators.

So much premised, we may proceed to indicate—we can do no more—the nature of the contest between Mr. Bell and Mr. Cochrane. In few words, the latter laid down the thesis that if we know what weight of blast goes into a furnace, and its temperature, and what weight of gas and its composition left the top, we ought to be able to tell pretty well what goes on within the furnace, and his paper is accompanied by tables containing literally thousands of figures, and intended to be used by blast furnace managers as a kind of ready reckoner. Thus, for example, the weight and temperature of blast being known, we can tell from the tables at once of how much coal it is the equivalent. Without using Mr. Cochrane's precise system of notation, we may explain that if 10 tons of air are raised in temperature from 32 deg. to 1300 deg., the total heat units represented by that air will be $2240 \times 10 \times 1500 \times \cdot 23 = 7{,}728{,}000$; and as a pound of coke may be taken to represent 13,000 units after allowance has been made for ash and incombustible impurities, we have $\frac{7{,}728{,}000}{13{,}000} = 595$ lb. of coke represented by each 10 tons of air. In other words, heating the air to this temperature is equivalent to putting 595 lb. of coke into the furnace. Now Mr. Bell argued, among other things, that these tables are simply useless, because the specific heat of air was taken by Mr. Cochrane as that proper to 32 deg., while it was different at 1000 deg. We can only say that if this be the case, Mr. Bell's experience is different from that of Regnault, who found that its specific heat is practically constant, between, at all events, — 30 deg. and 225 Centigrade, being in the former case 0·2377, and in the latter 0·2376. If Mr. Bell is right, then, of course, Mr. Cochrane's tables are worthless. Again, Mr. Bell contended that the temperature in a blast furnace varies up to a certain point. Thus, in a furnace with a capacity of 6000 cubic feet the temperature of the escaping gas at the top will be 900 deg. Fah.; in a furnace of 11,500 cubic feet it will be 610, in one of 15,000ft. it will be 595, and in one of 25,000ft. it will be 587 deg., and practically no further reduction can be effected by enlarging the furnace; to which statement Mr. Cochrane replied that as a matter of fact, and not of opinion or theory, Mr. Bell was wrong, because the temperature at the top of his 35,000ft. furnace was but 300 deg. We shall not just now attempt to follow the dispute as a dispute, but proceed to call attention to certain statements made by Mr. Bell, to which we have alluded as of general and not particular importance. They forcibly illustrate the truth of the views which we have recently put forward concerning smoke-preventing devices.

According to Mr. Bell, carbonic acid (CO_2) cannot exist at a high temperature, dissociation taking place. Thus, if carbonic acid is in the first instance produced, it is at once broken up again, and we have CO + O. If the gases be taken to a locality of less temperature, union may again take place, and we shall then have CO_2 carbonic acid. Whenever we require a higher temperature we must, according to Mr. Bell, discharge from the furnace unburned carbonic oxide, and as a matter of fact all blast furnaces do give off this gas, and if Mr. Bell be right, it is impossible that it can be otherwise. If we want a large quantity of heat at a low temperature, then we can burn our carbon to carbonic acid. It has long been known that carbonic acid was readily broken up at high temperatures in the presence of carbon, which, to use Rankine's words, it "dissolves." It was also known that at some very high temperature dissociation would take place. But we believe we are correct in saying that Mr. Bell is the first chemist who has enunciated the most important statement that carbonic acid cannot exist at comparatively moderate temperatures. He pointed out that carbonic oxide will not burn *in* a coke fire in an ordinary domestic fireplace, but it will burn freely to carbonic acid a little *above* the fire as soon as it has been cooled down. We may, in further illustration, cite the well-known fact that when steam was shut off from locomotives burning coke a blue flame some yards long came from the chimney, due to the ignition of the carbonic oxide coming away from the coke. It has been hitherto held that the carbonic oxide burned under these conditions only because it got air there which it could not get in the fire-box after the draught caused by the escape of steam up the chimney ceased; but, according to Mr. Bell's explanation, the reason why combustion did not take place there was simply because the heat was too great. We have here furthermore an explanation of the hitherto all but unaccountable fact that slow combustion has, as a rule, proved more economical than quick combustion. Thus, in the good old days of the Cornish engine, the boilers were always worked with a very sluggish draught and a low furnace temperature. These were just the conditions most favourable to the combustion of the carbonic oxide. The lesson to be drawn is that if we would burn coal to advantage, we must produce carbonic oxide at a high temperature in one place, cool it down, and burn it to carbonic acid in another. Thus, for example, we may construct a locomotive boiler, with a combustion chamber about the centre of its length, united with the fire-box by tubes at one end, and with the smoke-box by tubes at the other; then the carbonic oxide would be burned in the combustion chamber, while the coal was burned in the fire-box. We need hardly tell our readers that modifications of this scheme have been patented over and over again. Boilers of the kind have been tried on English and American railways. They have been generally successful as smoke-preventers and steam-makers; but they have been expensive and inconvenient to repair to the last degree, and so they have never come into favour. But we have much the same thing in the fire-box virtually divided into two separate chambers by the brick arch, in one of which coal is burned, while in the other carbonic oxide is consumed. Our readers will no doubt not be slow to draw their own deductions. If it is really a fact, as stated by Mr. Bell, that at high temperatures the evolution of large quantities of carbonic oxide cannot be prevented, then steam boiler furnace practice will require modification in many respects. It also opens up a door for new types of smoke-preventing apparatus; and it casts a good deal of light on certain hitherto obscure facts connected with the results—usually disappointing—attending the introduction of hot air into furnaces, which, by exalting the temperature, did the very mischief it was intended to avert.

THE AFFAIRS OF THE BRITISH ASSOCIATION.

Last month a conference of the members of the British Association was held at the rooms of the Geological Society, Burlington House. At this meeting a memorial to the Council of the Association was adopted, setting forth that at the meeting of the General Committee at which the resolution to meet in Canada in 1884 was carried, a previous resolution to the same effect, but for the year 1883, was lost; and there is reason to believe that a number of members of the committee, regarding the question as settled in the negative, had left the place of meeting before the subject was again brought forward. The memorial also states that whatever may be the object of the Association with regard to promoting "the intercourse of those who cultivate science in different parts of the British Empire with one another and with foreign philosophers," it was never contemplated by its promoters that it should hold its meetings beyond the limits of the United Kingdom; and that it is highly desirable that some further steps should be taken in order to ascertain the general feeling of the members of the Association upon the subject before allowing their kind and liberal friends in Canada to incur any further trouble or expense. It is most desirable that the question should be reconsidered, and that the Association should not be committed to carrying out such a step through any hasty vote. To judge, however, from a letter which recently appeared in the pages of a daily contemporary, there are curious and unworthy forces at work in the Association. The letter was headed "Wanted, an Explanation," and asks several questions. It asks: "Will not some of your readers kindly tell us the truth about the British Association and Oxford? As one who is jealous of the honour of my ancient University, I am anxious that this should be cleared from the charge of bad faith, and worse, which the men of science are bringing against her, and bringing with too good reason, if all that rumour says is true. Some time back an invitation was sent to the British Association to meet at Oxford in 1883, after one or two public meetings, and after a memorial had been largely signed, I myself, as far as I remember, having been one of the many who signed it. Suddenly, at the recent meeting of the Association, it was announced that next year the meeting would take place, not at Oxford, but at Southport. What is the reason of this? I should like some person in the secret to answer these questions: Is it true that, when the Council of the Association informed some persons at Oxford that Professor Cayley, of Cambridge, was to be President, those persons answered, 'No; it must be . . . . not a man of science at all, but our honoured Lord and Chancellor, Lord Salisbury'? Did the Council of the Association indignantly refuse? Did certain mediators then propose that Professor Henry Smith should be President, and did the Professor promptly decline to put such a slight on his illustrious *confrère?* On this, did 'Oxford' withdraw the invitation? and if so, who was 'Oxford'? If the facts are as I have too great reason to fear, it does really seem that Oxford is becoming, not less, but more than of old, the home of political manœuvring, small jealousies, and petty intrigue." This letter was signed "Quidam," and no one vouchsafed an answer.

"WELL" DECKED VESSELS.

An attempt is to be made to test in the most practical manner the truth of the objections that have sometimes been raised against well-decked steamers. The contention of the opponents of this class of vessels is that they are less safe in certain trades than those built with flush decks, whilst on the other hand their advocates urge that they are far more safe. The latter are now getting up a marine insurance company exclusively for well-decked vessels, so that its experience will fully test the contentions on both sides. It is worth notice that at one of the prominent shipbuilding ports there has been an attempt to compile a list of the vessels belonging to the port that have been lost and their description. So far as it goes the statement is as follows: At the end of the year 1881 there were owned at West Hartlepool 170 well-decked steamers and 17 flush-decked steamers. In the last nine years five well-decked vessels had foundered and two flush-decked vessels belonging to that port. In other words, the loss of the well-decked vessels had been over that period about ·44 per cent. per annum, whilst that of the flush-decked vessels had been 1·7 per cent. per annum. It may be said that this illustration is local in its application and confined in its area, and this is correct; but it is at least a curious commentary on the statement of the opponents of this class of steamers. By the establishment of an insurance society aiming only at the insurance of steamers of the type specially named, and that general in its working, a very complete commercial test will be applied. That test is one that will be looked for with very great interest by both friends and opponents of the class of steamer. It shows, moreover, one of the needs that there is at the present time in connection with our system of inquiries in the case of the loss of vessels. There is a need for some compilation of tables which would show at a glance the class of vessels that had been lost, the build, and other particulars, so that there might be official records which would be of value in the future in the determination of the relative safety of different types of vessels in different trades. In part, and on one subject, the experience of the new northern insurance society will supply local facts; but it is a pity that it cannot be made more general.

THE BRADFORD CHIMNEY.

The inquiry into the fall of a mill chimney at Bradford ended on Wednesday, when the jury, after a long deliberation, returned a verdict finding that the deceased had been accidentally killed. They found that the owners did all that men could reasonably be expected to do under the circumstances, and, therefore, they did not attach any blame to them, or find them guilty of negligence. They were of opinion that the foundation was good, and that the fall of the chimney was partly due to the cutting, aided by the strong wind on the morning of the accident, and they regretted that the works were not stopped during the repairs. A great deal of evidence was given, and the verdict having been pronounced, we are now free to deal with the various questions raised, which we shall do in an early impression. We may say that the chimney was an octagonal stone structure, with a cylindrical brick lining, and that it failed by the bulging outwards of the stonework, which it would seem was not sufficiently tied to the brickwork within.

LITERATURE.

A Treatise on the Comparative Commercial Values of Gas Coals and Cannels. By DAVID A. GRAHAM. 8vo., pp. 101. London: Spon, 1882.

THIS is a short treatise on a special subject, namely, the valuation of coal and cannel for gas-making purposes, and will be found useful to those engaged in purchasing coals for use in gasworks or in making mixtures for carbonising. The author illustrates the application of his methods by numerous examples, which are treated arithmetically; but in addition the manner of constructing diagrams, by which the problems may be solved graphically, are given. In the second section is a paper treating on the method of ascertaining the cost of augmenting the illuminating power of gas by one or more standard candles. The work must necessarily appeal only to a comparatively small number of readers; but a table of analyses of coal and cannel at the end will be of more general interest.

In the detailed calculations some difficulty may be experienced by the casual reader from the arbitrary method in which units and hundreds, and decimal points and millesimal commas are used. Thus on p. 60, immediately following this sentence, "I shall here also use logarithms as being simpler and not so likely to prove inaccurate," we find that 10·333 × 43 = 444330. This, or rather the more accurate quantity, 444319, of course, means that the decimal point should have been a comma; but as the same interchange of symbols appears irregularly throughout the detailed computations, the result is most puzzling at first sight.

BOOKS RECEIVED.

Useful Rules and Tables, by W. J. Macquorn Rankine, *with Appendix of Formulæ, Tests, and Tables for the Use of Electrical Engineers.* By Andrew Jamieson, C.E. Sixth edition. 1882.

American Foundry Practice. Treating of Loam, Dry Sand, and Green Sand Moulding. By T. D. West. New York: John Wiley and Sons. 1882.

Technologisches Woerterbuch in Englisher und Deutscher Sprache. Von Gustav Eger. In zwei Theilen. Erster Theil, Englisch-Deutsch. Technisch durchgesehen und vermehrt von Otto Brandes. Brunswick: Frederick Vieweg und Sohn. 1882.

The Gas Engineer's Diary for 1883. Birmingham: John Wright and Co.

Our Iron Roads: Their History, Construction, and Administration. By F. S. Williams. Second edition, revised. London: Bemrose and Sons. 1883.

Transactions of the Institution of Naval Architects, 1882. Vol. xxiii. Edited by G. Holmes, secretary. London: H. Sotheran and Co.

Practical Mechanics. By John Perry, M.E. London: Cassell, Petter, Galpin, and Co. 1883.

Proceedings of the Institution of Mechanical Engineers of November, 1882. No. 4.

The Electric Lighting Act, 1882, *and the Acts therewith Incorporated, and the Rules of the Board of Trade.* By W. C. and A. Glen, Barristers-at-law. London: Knight and Co. 1882.

The Electric Lighting Act, 1882, *the Acts Incorporated therewith, the Rules of the Board of Trade, together with Notes and Cases.* By Clement Higgins, M.A., and E. W. W. Edwards, Barrister-at-law. London: W. Clowes and Sons. 1883.

The Metropolis Management and Building Acts (Amendment) Act, 1882, *forming a Supplement to the Law Relating to Building Leases, Building Contracts, &c.* By A. Emden, Barrister-at-law. London: Stephens and Haynes. 1882.

Transit Tables for 1883, *giving Greenwich Meantime of the Transit of the Sun and of certain Stars for every day in the year, with an Ephemeris of the Sun, Moon, and Planets, and other information.* By Latimer Clark, M.I.C.E. London: A. J. Frost, 6, Westminster-chambers, S.W.

Journal of the Iron and Steel Institute for 1882. Vol. ii. London: E. and F. N. Spon. 1882.

JOSEPH SHUTTLEWORTH.

WE announce with much regret the death of Mr. Joseph Shuttleworth, of the firm of Clayton and Shuttleworth, Stamp End Works, Lincoln. Mr. Shuttleworth was born on the 12th of July, 1819, and died on the 25th of January, 1883. Thus he was only 64. Mr. Shuttleworth had been unwell for some time past, but no danger was apprehended until recently. He expired at his house, Hartsholme Hall, Lincoln, and he was interred at Old Warden, Biggleswade, on the 31st ult. Mr. Shuttleworth may be regarded as the leading improver of the portable engine, for which he did as much, perhaps, aided by his partner, Mr. Clayton, as Stephenson did for the locomotive engine. It is quite true that the portable engine was not invented by the Stamp End firm, but Messrs. Clayton and Shuttleworth were the first to reduce it to its present form. If our readers will turn to THE ENGINEER for Jan. 27th, 1879, they will find there a brief history of the portable engine. In the year 1842 Messrs. Clayton and Shuttleworth built but two portable engines. Between that date and 1878 they turned out no fewer than 17,000 portable engines, or an average of 448 engines per annum. Up to the year 1848 it was the practice to build portable engines with vertical cylinders. In that year the Stamp End firm produced a portable engine with two horizontal cylinders 6in. in diameter on top of the boiler; the fly-wheel shaft was geared to the crank shaft. In 1851 the firm built their first single cylinder engine. From that date the progress of the firm became extremely rapid, and we need hardly add that their engines took prizes and medals all over the world. The racing portable engines of the firm have seldom been beaten in economy by the racers of any other firm, and in excellence of workmanship and beauty of design, the engines of Messrs. Clayton and Shuttleworth have never been surpassed. It is to this excellence that the enormous business done by the firm is mainly due.

Mr. Shuttleworth died of inflammation of the heart and congestion of the lungs. He was twice married, and leaves issue by his first wife two sons. His death will be much felt in Lincoln, which he and his partner have done much to make a manufacturing town. Forty years ago Lincoln was a quiet cathedral city, with a trade confined to the agricultural district of which it was the centre, but the works at Stamp End, established in 1842 by Mr. Clayton and the deceased, grew with marvellous rapidity. The Stamp End Works had a small beginning, but the skill, industry, energy and integrity of the founders overcame all obstacles, and in a few years the names of Messrs. Clayton and Shuttleworth were known in every quarter of the globe, and their manufactory became the most extensive of the kind in the kingdom. In the forty-one years which have elapsed since these works were established, the inhabitants of Lincoln have tripled in numbers, hundreds of houses now cover wide districts which were once green fields, and the city has advanced as rapidly in material wealth and prosperity as it has done in population. Other great works have sprung up, and grown with amazing rapidity, but there is every reason to think that the success which attended Messrs. Clayton and Shuttleworth was the incentive to emulation, and the initial cause of the prosperity of the town.

LETTERS TO THE EDITOR.

(*Continued from page* 86.)

RAILWAY SPEEDS.

SIR,—The distances given upon page 317 of "Bradshaw" refer to the Glasgow and South-Western Company's main line which runs *viâ* Dalry and Johnstone, but it is specially stated that the express trains due to leave Glasgow at 10.15 a.m., 2.30 p.m., 5 p.m., and 9.15 p.m., run *viâ* Barrhead. If Mr. Barcroft will refer to page 320 of "Bradshaw" he will find these trains booked in the Glasgow, Barrhead, and Kilmarnock Joint Line Table. The Glasgow and South-Western Railway Company has furnished me with a copy of its "Working Time Table," from which I find that the distance from Glasgow, St. Enoch, to Kilmarnock is 34 miles 45 chains *viâ* the main line, but only 24 miles 28 chains *viâ* the Barrhead Joint line; the important through trains between Glasgow and Carlisle run by the shorter route.

40, Saxe-Coburg-street, Leicester, January 30th. CLEMENT E. STRETTON.

SIR,—Your correspondent, Mr. Barcroft, was perfectly correct in his original statement that the distance between Glasgow and Kilmarnock is thirty-three and a-quarter miles—as it is so by the main line of the Glasgow and South-Western Railway—but the Midland Scotch expresses and all through fast trains travel *viâ* the Glasgow, Barrhead, and Kilmarnock joint line, which saves, I think, about eight miles. This would sufficiently account for the apparent very high speed between the above two stations. Taking the distance to be twenty-six miles, and the booked time of the Midland day express being thirty-five minutes, the speed would be about forty-four miles per hour. The highest speed attained by this train is between Normanton and Trent, a distance of seventy-four miles, and the time allowed one hour twenty-four minutes, an average running speed of fifty-two miles per hour.

CHAS. M. TUCKER.

Drayton Rectory, Bletchley, Bucks, January 31st.

CHILLED CALENDER ROLLS.

SIR,—"Paper Maker" again figures in your last issue as the champion of American chilled rolls, and says, "They are never soft when sent here." How can a paper maker know that they are never soft unless we can assume he has been the solitary buyer of these American rolls? In our letter in your issue of 5th inst. we offered, "If 'Paper Maker' is a paper maker, and will furnish us with his real name and address, we undertake to direct him to where several calenders of American chilled rolls have been rejected, and where our make of these rolls is giving entire satisfaction."

"Paper Maker" has not accepted our challenge, and yet repeats his unsupported assertion and his groundless assumption under cover of his assumed name. We can therefore only inform him, through the medium of your journal, that the American rolls we alluded to were rejected on account of softness. We ourselves never had a roll returned for softness, but have had on account of being too hard to finish. "Paper Maker" is, however, correct in stating that English rolls are uncertain or variable. This applies also to the American, and for the same reason. Both are made on the old traditional "rule-of-thumb" method of "ringing the changes" on brands, which, as every smelter knows, are liable to alter more or less each cast of the furnace; while for years past we—alone we believe—have worked on a purely chemical basis, knowing nothing of brands, but analysing daily raw materials and products, and hardening or softening at will.

We have just been shown a letter by a well-known American firm, who, in reply to a complaint respecting the softness of their rolls, says: "We certainly don't know how to make them harder." This we believe accurately represents the general state of knowledge of English as well as American makers, and if so the Americans will no doubt have less variation than those similarly placed on this side, if they work with charcoal-made pig, which, as is well known, has a smaller range of quality than iron made with fossil fuel. MILLER AND CO.

London-road Foundry, Edinburgh, January 31st.

STEAM ON TRAMWAYS.

SIR,—We have read with some interest the letters which have appeared in your issues of last week and the week before with reference to the working of tramways by means of mechanical power, and as we have devoted considerable attention to this subject, a few remarks from us may not be without interest to your readers.

We have now constructed over eighty of these engines, a large proportion of which are still working in this country, and after three years' working at home and a longer period abroad, we are more than ever convinced that steam on tramways is able to hold its own against any other form of mechanical power, and is also capable of leaving the horse far in the background where the traffic is sufficiently heavy or the gradients severe. It will suffice for us to mention a few facts to prove the above statement.

On the Vale of Clyde railways there are eight engines constructed by us, which are run at intervals of from five to seven minutes throughout the day. The traffic is very heavy, which is proved by the receipts, being 21d. per mile, and in order to accommodate this traffic the engines and cars are continually stopped and started to take up and set down passengers.

From the report of the directors, which is just published, it will be found that the maintenance of the engines and cars the previous half-year amounted to 5¼d. per mile run, and that the last half-year it had been reduced to 5⅛d., showing that the wear and tear of the engines had not increased.

To the Blackburn and Over Darwen Tramways Company we have supplied seven engines for working the traffic, which, at times, is very heavy, and at the same time the gradients are very severe. These engines, during the year ending the 30th June, 1882, ran a distance of 151,000 miles, and worked at the rate of 5·55d. per mile, including all working expenses and maintenance; also 10 per cent. depreciation and 5 per cent. interest on the capital outlay. We have not been able as yet to obtain a complete statement of the working expenses for the half-year just ended; but we believe that it will show a mileage rate below the above figure. We have now worked the Wortley section of the Leeds tramways for over two years, and our experience on this line corroborates the statements made above that engines can be worked at a rate varying from 5d. to 5·5d. per mile run, according to the gradients which have to be mounted.

Previous to engines being adopted on the Wortley tramway the traffic was worked with horses, at a rate of about 9d. per mile. These figures speak for themselves and need no comment from us. We could, if necessary, mention numberless instances which would go to prove the above statement, but we think that what we have said will be sufficient to show your readers that where engines are properly designed and worked by competent engineers they will prove themselves vastly superior to horses, and anything but a disastrous failure. KITSON AND CO.

Airedale Foundry, Leeds, January 29th.

SIR,—We notice on page 75 of your last issue an editoria remark inviting figures bearing on above, inasmuch as the subject is one of general interest we beg to hand you a statement as made up and signed by the manager and secretary of the Wigan Tramway Co., showing actual working expenses of four of the Wilkinson locomotives, which have been running on their lines, which by the way are not of the best to work, as there are gradients of 1 in 16, 1 in 19, and 1 in 21, with scarcely any level parts in the entire length.

Total distance run during nine months, ending October 31st, 1882, 37,564 miles.

	£	s.	d.
Cost of maintenance, including fitters' wages, one new set of wheel tires and returning old ones, &c., or equal to 0·42d. per mile run	65	1	10

Working Expenses for One Week of No. 3 *Engine.*

Miles run in seven days, 410.

Driver's wages	1	10	0
Cleaner's wages (half) one man to two engines	0	12	0
Coke, 32½ cwt. (common furnace) at 13s.	1	1	1½
Water, 2000 gallons at 1s. per 1000	0	2	0
Oil, seven pints at 3s. 6d. per gallon..	0	3	0¾
Tallow, 6 lb. at 6d. per lb.	0	3	0
Waste for cleaning, 10 lb. at 2d. per lb.	0	1	8
Depreciation at the rate of 15 per cent. on first cost of engine at 5s. 9d. per day (being 5 per cent. on first cost, and 10 per cent. depreciation)	2	0	3
	£5	13	1¼
Repairs on 410 miles at 0·42d. per mile (or say 3·75d per car mile run)	0	14	4¼

(Signed) J. Y. MAWSON.

Wigan. Manager and Secretary.

P.S.—No repairs of any kind have been required to be done to the boiler up to date, and from all appearances none will be required for a long time.

Mr. Mawson has also written to Messrs. Wilkinson and Co., as follows:—"I have reason to believe that the cost of working the Hindley line will be one halfpenny per mile run less than the Wigan and Pemberton line, as the gradients are not so steep, and the line generally is more uniform in levels."

This engine has been inspected by almost all the leading tramway engineers in this country, and many from abroad, and as a proof of the belief of practical men in the success of steam on tramways, the following companies have adopted the "Wilkinson" engine, viz.:—The Wigan and Pemberton Tramway Company; the Wigan and Hindley Tramway Company; the Manchester, Bury, and Rochdale Tramway Company; the Birmingham and South Staffordshire Tramway Company; the Birmingham and Aston Tramway Company; the North Staffordshire Tramway Company; the Tynemouth and North Shields Tramway Company; the Gateshead-on-Tyne Tramway Company; the Leeds Tramway Company; the Nottingham Tramway Company; the Portrush and Giant's Causeway Electrical Tramway Company; the Huddersfield Corporation Tramway.

It is only reasonable to assume that the directors of the above-mentioned companies went fully into the question of steam *versus* horse traction, and gave out their orders only when thoroughly satisfied that it was for the interests of their shareholders to adopt steam. MARPLE AND CO.

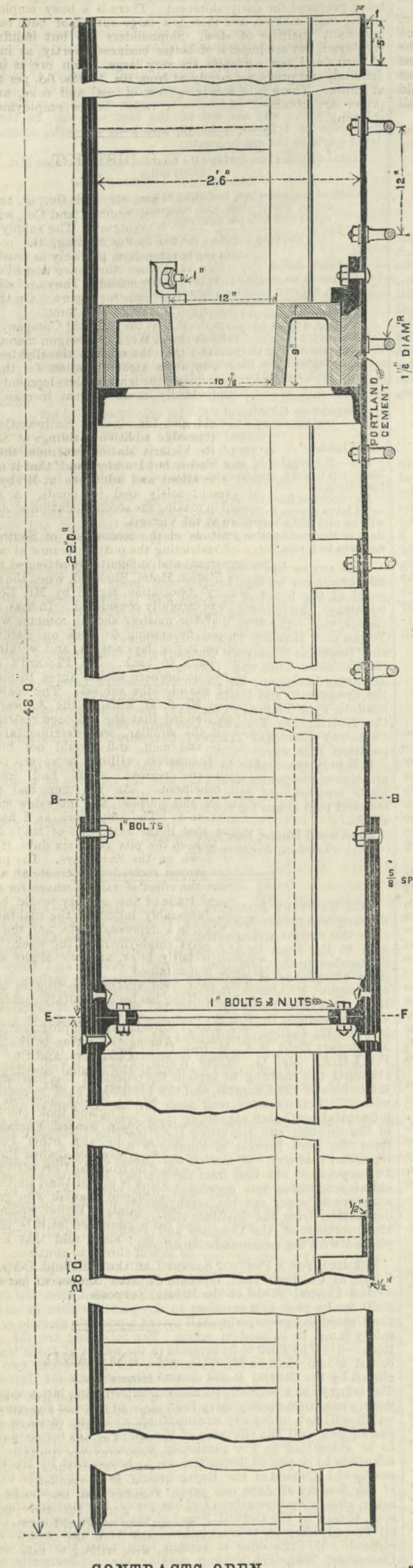
Dashwood House, New Broad-street, London, January 30th.

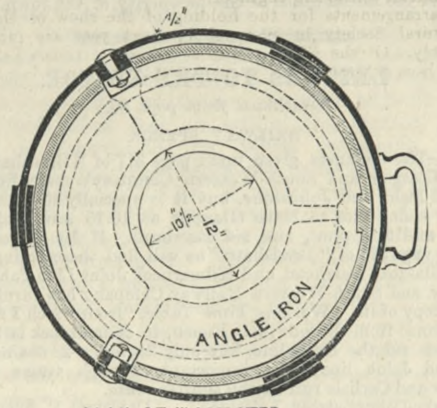
THE SANITARY INSTITUTE OF GREAT BRITAIN.—An important meeting was held in Glasgow on Thursday, the 25th inst., to consider the various arrangements to be made for the Congress to be held in the town by the Sanitary Institute of Great Britain in September next. The Lord Provost presided, and there was a large attendance of gentlemen representing the various interests of Glasgow, Edinburgh, Greenock, and adjacent towns. A deputation from the Sanitary Institute, consisting of Professor F. de Chaumont, M.D., F.R.S.; Professor W. H. Corfield, M.A., M.D.; Mr. H. H. Collins, F.R.I.B.A.; Mr. W. Eassie, C.E., F.G.S.; Mr. Rogers Field, B.A., M. Inst. C.E.; Mr. E. C. Robins, F.S.A., F.R.I.B.A.; Mr. G. White Wallis, F.M.S., F.S.S. (secretary), attended the meeting to explain the objects of the Institute and the nature of the Congress, and the exhibition held in connection with it. Letters were read from Dr. A. Carpenter and other influential gentlemen expressing their sympathy with the objects of the meeting and regretting their inability to attend, and also from the Lord Provost of Edinburgh who sent a deputation to represent that city. A motion was passed expressing gratification at the prospect of a visit from the Sanitary Institute, and an influential committee was appointed—with power to add to their number—to carry out the arrangements for the Congress. The deputation from the Institute visited the buildings proposed for the meetings of the Congress and exhibition, and were much pleased with the accommodation offered.

PREMIUM FOR A PERFECT SAFETY LAMP FOR MINERS.—Mr. Ellis Lever, of Culcheth Hall, Bowdon, Cheshire, agrees to hand over to the Central Board of the Miners' National Union the sum of £500, to be paid as a premium to any person, either in or out of the United Kingdom, who shall invent a portable electric or other safety lamp, to be used in mines. The following are the conditions:—(1) The £500 to be invested in the names of three trustees, one of whom shall be Mr. Thos. Burt, M.P., the other two to be chosen by the Central Board of the Miners' National Union. (2) The lamp to be a perfectly portable electric or other lamp which the miners can conveniently carry from place to place in the mine, and which will not, under any circumstances whatever, cause an explosion of gas. (3) The efficiency of the lamps put in for competition to be submitted to five gentlemen, composed as follows:—Three scientists to be named hereafter, one to be selected by Mr. Lever, one by the Council of the Royal Society, and one by the Council of the Society of Arts, one person representing the mining engineers, chosen by themselves, and one person representing the workmen, chosen by the Central Board of the Miners' National Union. (4) The adjudicators to meet in London after the allowed time has elapsed. (5) The offer to remain open until the 31st day of December, 1883. If a lamp meeting the requirements herein stated has not then been invented, the £500 to revert back to Mr. Ellis Lever. Any further particulars may be obtained on application to the president, Miners' National Union, 35, Lovaine-crescent, Newcastle-on-Tyne.

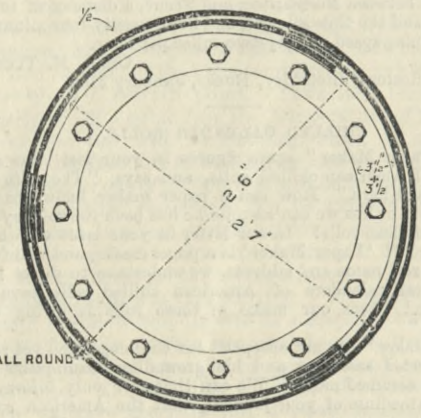
THE ELECTRIC LIGHT.—The Vestry of St. Martin's-in-the-Fields has decided to oppose the granting of provisional orders by the Board of Trade, chiefly on the general ground that the applying companies seek to set aside the provisions of the Electric Lighting Act of 1882, and the rules of the Board of Trade in relation thereto, and to extinguish the right to control the public streets now vested in the local authority. The Electric Lighting Committee of the Marylebone Vestry, having had before them the terms of the provisional orders applied for by the Brush and Swan Companies, have decided that, as the science of electric lighting is at present in an immature condition, it would not be expedient that the vestry should be committed for fourteen years to a particular system of supply. They consider that any arrangement with an electric light company should be tentative only. A special meeting of the Kensington Vestry was held in the council chamber at the Town-hall on Monday night, to receive a report of the Works Committee with respect to the applications of two companies to supply electricity to the parish. The committee suggested a number of objections, and were of opinion that the Act of last year was premature. The report was unanimously adopted.

CONTRACTS OPEN.—WROUGHT IRON CYLINDER BEACONS.

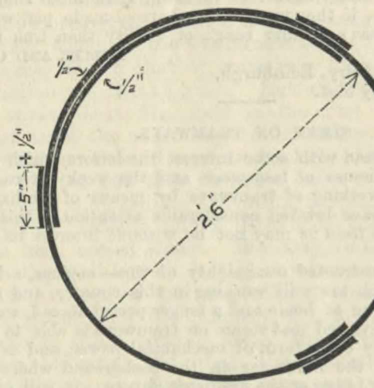




PLAN OF MAST STEP



PLAN OF JOINTAT E.F.



PLAN AT B.B.

CONTRACTS OPEN.

WROUGHT IRON CYLINDER BEACONS.

THE Trinity House requires tenders for wrought iron cylinder beacons, as illustrated in the accompanying engraving. The work included under this specification is the finding of all materials and labour in the construction of three wrought iron cylinder beacons. The work is to be fitted together and finished complete on the contractor's premises, and, after the same has been approved by the engineer to the Corporation, the whole of the ironwork is to be thoroughly cleansed from rust. In this state it is to be slightly and uniformly heated, and, while hot, coated with boiled linseed oil, inside and outside, and after it has cooled and the coat hardened the whole is to be painted with two good coats in pure red lead paint. The different parts are to be figured or marked; and, upon the contractor's receiving a written order, the whole to be carefully taken down and weighed in the presence of the superintendent, and to be delivered at the Trinity Buoy Wharf, Blackwall. The pattern of the mast step to be submitted for approval before being cast from, and any work that may appear of a doubtful quality is, when required, to be subjected at the expense of the contractor to such proof as shall be considered sufficient by the engineer; any defective parts are to be made good, and the whole s to be completed in the best and most workmanlike manner. The wrought iron is to be of the best and toughest quality of S. C. Stourbridge iron, or of equal and approved quality, to bear a tensile strain of 23 tons per square inch of original area. The threads of the screws and bolts to be cut to Whitworth's standard.

The cylinder to be 48ft. long by 2ft. 6in. inside diameter by ½in. thick, and to be constructed in two lengths, as shown, and connected together by a socket-joint and two 3½in. by 3½in. by ⅝in. welded angle iron rings, and to be securely bolted together with twelve 1in. bolts and nuts, and the socketed portion to be secured with bolts and nuts, as shown. The plates are to be neatly bent to the required radius, and to break joint throughout; the horizontal joints are to be rivetted to single joint strips on the inside, and the vertical joints to double joint strips, as shown. The joint strips to be 5in. wide by ½in. thick. The upper edge of each length of the cylinder to be strengthened by a hoop 5in. deep by 1in. thick, to be shrunk on and rivetted. The lower edge to be bevelled, as shown, to facilitate the sinking of the cylinder. Twenty steps, or handles, of wrought iron, 1⅛in. diameter, forged, and secured to the cylinder, are to be provided, as shown. The mast step, or socket, to be of cast iron, to rest on a ring of 3½in. by 3½in. by ⅝in. angle iron, the ring to be rivetted to the inside of the cylinder, and in the position shown, the mast step being secured by three cast iron dogs, as also shown. The rivetting to be as follows, viz.:—The vertical joints to be rivetted with ⅝in. rivets, and 3in. pitch, centre and centre; the horizontal joints with ⅞in. rivets, pitched as may be directed. The whole to be carefully executed. The hoop round the upper portion of the cylinder to be rivetted with 1⅛in. rivets, countersunk on both sides. The whole of the external rivetting to be countersunk, the countersinks being well filled. Before leaving the contractor's premises, the ends of each length of the cylinder to be covered by a temporary flanch, or to be plugged, and then tested to a pressure of 20 lb. per square inch with water, and in the presence of the superintendent.

Tenders to be delivered at the Trinity House, London, E.C., on or before February 5th, addressed to the Secretary of the Corporation of Trinity House, and endorsed outside, "Tender for Wrought Iron Beacons."

WHEEL AND RAIL FOR COMMON ROADS.

THE combination of a wheel to be used on common roads and on a rail alternately, which we are about to describe, is already in extensive use. Though of recent introduction, in Germany it has been applied for tramways in mines, for stone quarries, brickyards and similar purposes, wherein tram-cars are propelled by horses or human power. The plan is extremely simple, and it will at once occur that there are very many cases in this country where it could render excellent service. It is the invention of Herr Friedrich Hoffmann, of Berlin, the inventor also of the celebrated circular and regenerative kilns now used all over the world.

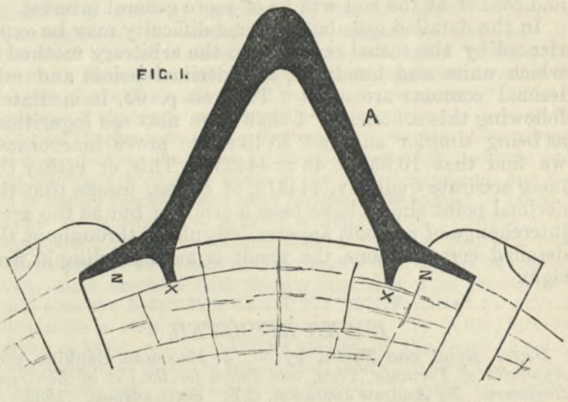
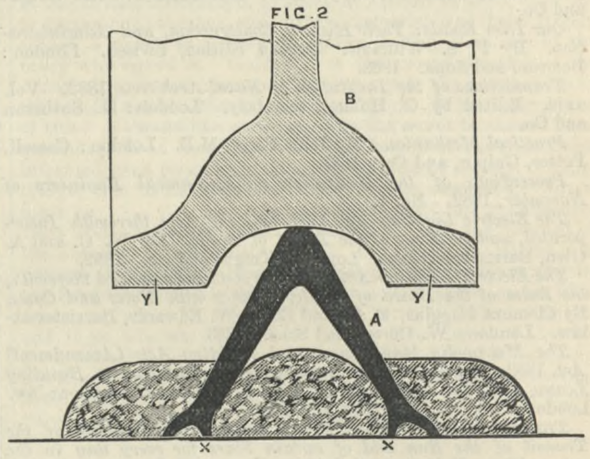
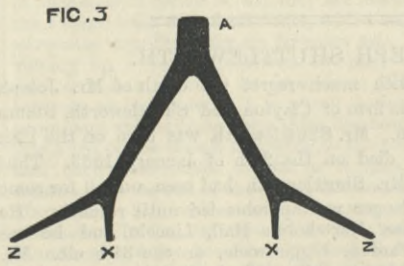


Fig. 1 shows a cross section of the rail used for light tramways. It is shaped approximately to an equilateral triangle, with the base left open. The feet Z Z rest on longitudinal sleepers or any other continuous support, and the clamps X X hold the rail firmly down. The wheels to be used in combination with this kind of rail are, as shown in Fig. 2, made with a



flange on either side, and they are left loose on the axle, as with the ordinary cart or carriage wheel. The figure shows the cross section of a rail A, and the tire of a wheel B running thereon. The flanges Y Y of the wheels are made sufficiently wide to allow the trams to be used alternatively on a common road without rails. The feet of the rail are, in this instance, bedded in concrete laid on brickwork. For railways worked by locomotives, the rail is to be provided with a broad head A, as shown in the cross sectional Fig. 3, drawn to a smaller scale.



The considerations which have led to the design of this shape of rail are indicated in the sketch—Fig. 4—of an ordinary foot or Vignoles rail, in which the arrows point to the principal modes in which the vertical and lateral impulses tend to deform

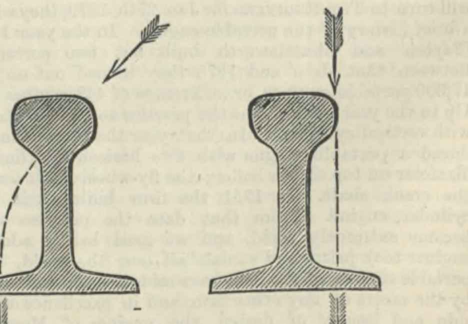
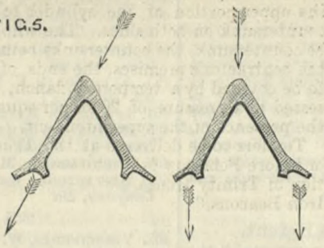


FIG.4.

it. In Fig. 5 is seen how these stresses act upon the Hoffmann rail. There can be little doubt that this new form of rail is better adapted to withstand such pressures than the old shape. Consequently for the same work the new rail may be made much lighter. The rails of our ordinary rail and tramways, resting on transverse sleepers, must be made of such strength as not to be bent between the two adjoining sleepers by weights passing over them. With the Hoffmann rail resting on longitudinal sleepers, or on any other continuous support—as, for instance, a brick pavement, on which the rail may be fastened with Portland cement—there is no tendency to deflection, as the pressure on the rail is transferred directly to the ground. Experience shows that this rail may be made much lighter for the same load.

FIG. 5.



It is well known that the inventor of the foot-rail, the late Mr. Vignoles, originally designed it with the intention of using it on longitudinal sleepers, and his first railways were laid down on this plan. It was mainly the necessity for keeping up the exact gauge that led to the adoption of transverse sleepers. Wheels with one flange require an exact gauge and a firm union with the axle. It is evident that tramcars with wheels left loose on the axle are much easier moved than if the wheels were fast. This is, of course, more especially the case on curves, where one of a pair of common railway wheels must necessarily slip on the rail. The same, in a less degree, takes place on the straight line, and consequently the wear of the wheels as well as of the rails of ordinary railways is very considerable. There is almost constant torsion in the axles, and a resulting continuous vibration of the carriages. Such strains all absorb tractive power. These disadvantages must in time be universally acknowledged, and it is only the enormous outlay involved in radical changes that could outweigh the resulting advantages. For the very different case of narrow gauge lines, or of tramways, &c., adoption is easy. A Hoffmann rail for tramways, suitable for carriages weighing about one ton, weighs only about 4 lb. to the yard. An actual trial has shown that on a level line of draught one horse is able to pull a net load of from 20 to 30 tons. Nine trucks, each laden with $\frac{3}{4}$ of a ton of sand, were easily pulled up an incline of 1 in 60 by one horse. A net load of $9 \times \frac{3}{4} = 6\frac{3}{4}$ tons, taken up a gradient of 1 in 60, is equivalent to about 30 tons on the level.

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

(*From our own Correspondent.*)

The orders to hand for rolled iron are not materially increasing either from merchants or consumers. Some works are now beginning to get short of contracts, and the men are being put upon part time. The knowledge of this state of things made the traders yesterday in Wolverhampton give the more ready credence to a report which was circulated with a considerable show of authority, that Messrs. Wm. Barrows and Sons were on the eve of declaring a reduction in prices of 10s. per ton.

Their price for bars would thus become £7 10s. per ton, which is the figure that the New British Iron Company and Messrs. Phillip Williams and Sons have long been quoting, in opposition to the remainder of the "list" houses, who quoted £8. It has, however, been patent for some time past that the £8 figure was scarcely more than nominal.

In Wolverhampton it was taken for granted that, should Messrs. Barrows take the initiative, the Earl of Dudley and the other list houses would have to follow. Such a course would bring Earl Dudley's bars down to £8 2s. 6d. per ton.

A reduction of 10s. in the quotation of sheets and plates rolled by the list houses other than those two who have been quoting £7 10s. for bars, would also, it was pointed out, naturally ensue, if £7 10s. should be made the standard for bars. With these reports in circulation it was no wonder that the new business in Wolverhampton was very small. The market preferred to wait until some definite announcement—which they assumed would be forthcoming on the following day—was made before committing themselves.

On 'Change this afternoon, yesterday's report as to the bars, sheets, plates, and hoops of those firms who had previously been selling on the basis of £8 for bars, was officially confirmed. Bars thus become £7 10s., sheets and plates £9, and hoops £8, with 12s. 6d. extra for Earl Dudley's brands. Firms previously quoting £7 10s. made no change. Hingley's best rivet iron £8.

Second and third class qualities of finished iron sympathise with the easier rates for the best descriptions. Yet makers decline to give way to the extent which some buyers ask, declaring that in the face of the easy prices that have been prevailing for three or four weeks past there is absolutely no room left for further concession. Common bars vary from £6 10s. down to £6, and hoops from £7 to £6 10s. Gas strip may be bought at £6 5s.

Sheets of the sorts needed by the galvanisers, and by merchants for ordinary export purposes, are still very weak. The output of this iron continues decidedly in excess of the market's requirements, and competition amongst makers is severe. Singles are from £7 15s., and doubles from £8 10s. upwards.

Galvanisers this—Thursday—afternoon reported the demand for corrugated sheets as very quiet, although some makers are still in receipt of a fair number of orders from Australia and South Africa, and Jamaica has lately bought well. There was complaining as to the competition from the joint stock concerns who are engaged in this industry, yet the representatives of the Birkenhead Galvanising Company spoke of their prices as 5s. advance upon a month ago. Quotations were scarcely more than nominal. Good makers refused to quote less than £13 15s. to £14 for 22 to 24 gauge, delivered at out-ports.

Native all-mine pig makers had to report an increase in stocks, consequent upon the limited demand. Prices were easy. Makers asked 65s., but buyers would not generally consent to give more than 62s. 6d. for hot-blast sorts. Native part-mine pigs were 55s. to 50s., and cinder pigs about 40s. Foreign pigs were on the basis of 48s. 6d. to 50s. for Derbyshire sorts, delivered at stations.

This week there has taken place in Wolverhampton a two days' Government examination for mine managers' certificates; and there were twelve candidates, all from the South Staffordshire district. The subjects were: (1) Chemistry and ventilation; (2) mechanical engineering; (3) surveying; (4) practical mining. The examiners were Messrs. William Fairley, Beaudesert, Rugeley; John Williamson, Cannock and Rugeley Collieries, Hednesford; and Jonah Davies, C.E., Wolverhampton. The examiners' report will be forwarded to the Home-office.

At the Midland Wagon Works, Shrewsbury, a strike of some 250 men has occurred in consequence of a notice which has been posted at the works for a reduction in the prices paid for overtime. Several of the men are to be summoned.

In the report of the Birmingham Tramways and Omnibus Company, Limited, which recommends a dividend of 15 per cent. per annum, the directors state that much attention has been directed to the working of tramways by steam and other means of mechanical locomotion, and also to the several companies projected for developing the tramway system throughout Birmingham and the district. The interests of the shareholders in these matters are receiving careful consideration.

The directors of the South Staffordshire Waterworks Company propose to declare a dividend for the past half year at the rate of 4 per cent. per annum on the ordinary stock, carrying forward a balance of £1500.

The application of the Birmingham Corporation to the Local Government Board for power to borrow £250,000 to extend their gas undertaking is to be opposed by the local board of Wednesbury. These authorities have decided to memorialise Government against the granting of the application until the corporation shall have transferred to the gas undertaking a sum equal to the profits applied by them for the improvement of the town of Birmingham, and not for the benefit of the petitioners or other gas consumers outside the district of Birmingham.

Plans of a new scheme for the deep drainage of Wolverhampton have been prepared by Mr. G. Eastlake Thoms, M. Inst. C.E., the engineer to the corporation, who aims at draining not only the borough, but several outlying parishes, on to common land distant some six miles to the south-west of the town as the crow flies, but along the pipes a distance of some eight miles. This scheme would involve a heavy expenditure, and hence the determination to call in an eminent consulting engineer.

The arrangements for the holding of the show of the Royal Agricultural Society in Shrewsbury next year are progressing favourably. Of the £5000 required to meet expenses £4200 have already been subscribed. The site selected is the racecourse, which is close to the town, and also adjoins the London and North-Western and Great Western joint railways between the town and Wellington.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—As reductions in price apparently fail to give a stimulus to the market, makers are showing a disposition to abandon further efforts to meet the views of buyers by offering repeated concessions, and although there is comparatively only a small weight of business coming forward, sellers during the week have been averse to entertain offers at under their present minimum rates.

The Manchester market on Tuesday was well attended and there were a few inquiries stirring, but these did not result in much actual business being done. Lancashire makers of pig iron were not able to follow up the fairly satisfactory sales of last week, but as they are now tolerably well supplied with orders for the present there is no great anxiety to push business, and they are not disposed to go at all below 46s. 6d. to 47s., less $2\frac{1}{2}$, for forge and foundry qualities delivered equal to Manchester. In district brands transactions are confined chiefly to a few sales of Lincolnshire foundry, for which makers quote 47s. 10d., less $2\frac{1}{2}$, delivered equal to Manchester, but for forge qualities, notwithstanding a further reduction at the close of last week of 1s. per ton, bringing quotations down to 45s. 10d., less $2\frac{1}{2}$, there is very little inquiry. For Derbyshire brands quotations remain at about 48s. 6d. to 50s. per ton, less $2\frac{1}{2}$, delivered here, but there is little or nothing doing.

Finished iron makers who have a large output are feeling severely the scarcity of orders, and the recent reduction in pig iron has a tendency to keep back buying in the expectation of lower prices. Some of the local makers report a fair inquiry, but the actual business doing is small, and although list rates nominally remain on the basis of £6 10s. for bars and £7 for hoops delivered into the Manchester district, yet for actual sales makers have to take 2s. 6d. per ton under these figures, and in some cases local bars can be bought at £6 5s. per ton.

In the general ironfoundry trade business continues in a very unsatisfactory condition, and any work coming into the market is competed for at extremely low figures.

Brassfounders, although there is less work coming in from engineers generally, are fairly engaged. For locomotive fittings especially there is a good demand, which, with the large amount of locomotive work in the hands of the principal firms in the district, is likely to continue for some time to come.

The engineering trades generally continue fairly busy, and in some departments orders are reported to have been coming in rather more freely of late. Except, however, in one or two branches—such as locomotive building already referred to, shipbuilding, and tool making, which are all well supplied with orders—there does not appear to be any very great weight of new work in prospect. In fact since October last trade has shown a tendency to recede, and the development of the opening quarter of the present year is being watched with some anxiety.

Wheelwrights generally seem to be getting plenty of work, and I hear that a good many steel pinions of the helical tooth pattern are being made for rolling mill purposes.

Business throughout the Lancashire wire trade continues very dull; there is an absence of any orders of importance in the market, and the reduction in list rates already announced by Messrs. Rylands and Sons, of Warrington, is being followed by other Lancashire makers who for some time past have been selling under the list rates.

Very slow progress is being made towards the settlement of the standard wire gauge question, and from what I hear there appears to be little expectation of any satisfactory result being obtained.

The heavy floods during the week have afforded an opportunity of fairly testing the automatic action of the new weir just erected on the Irwell at Throstle Nest. The complete test of the weir has been secured in a somewhat singular manner. The whole of the tilting sluices of which it is constructed have been connected except one near the centre, which the recent heavy water in the river has prevented. With the heavy floods during the week the connected sluice gates were lifted by means of the crabs attached, but the unconnected gate had to depend upon its own action. The result was that when the head of water reached a point at which the engineer had calculated the back pressure would be sufficient to raise the gate, this automatic action commenced, and the gate was lifted precisely in the manner which Mr. Wiswell, the designer, had anticipated.

With a continued dull demand prices in the coal trade show a tendency towards weakness. Although there has not with the commencement of the month been any general reduction, here and there prices for round coal have given way a little, and in most cases sellers are open to make special quotations for quantities. At the pit mouth the average prices are 9s. 6d. to 10s. for best coal; 7s. 6d. to 8s. 3d. for seconds; 6s. to 7s. for common round coals; 4s. 9d. to 5s. for burgy; and 3s. 6d. to 4s. for good ordinary slack.

There are fair orders in hand for shipment, but the scarcity of vessels has interfered with the execution, and steam qualities have been offering at Liverpool or Garston at 7s. 6d. to 7s. 9d. per ton.

The proposed restriction of the output is already being carried out at some of the Lancashire collieries, but as the men wish not only to limit the working days to five, but also the working hours to eight from bank to bank, which really means only about four and a-quarter days, it is scarcely likely the colliery proprietors will be willing at the same time to pay the day men for five days, and here will be the difficulty in connection with the colliers' scheme.

The men in the Ashton and Oldham district are so dissatisfied with the last making up of the books under the sliding-scale, which leaves wages unaltered, that an agitation has been commenced for abandoning the present arrangement.

Messrs. Andrew Knowles and Sons, of Manchester, after sinking down to the Doe Mine at one of the collieries at Radcliffe, have had to abandon the working of the seam owing to the unsafe character of the roof, and are now sinking to the lower mines.

Barrow.—In all departments of the hematite pig iron trade there has been a marked business quiet during this week, but it is gratifying to note that in many instances where makers have been compelled to blow out furnaces, they are re-lighting them, an action which must be regarded as a sign of their hopefulness of future better trade. Deliveries not being large at present, this may, indeed, be taken as a general feeling of a speedy revival of business. Bessemer iron is not in large consumption, but the demand is likely to increase, as indications are presenting themselves that steel makers will before long increase their consumption to a considerable extent, and on continental and general foreign account there can be no doubt there will be a much better trade done in the spring and summer than is the case now. Prices remain unchanged, but it is to be noted that while mixed parcels of Bessemer are offering at 54s. per ton net, three months' delivery, makers are anticipating better prices all round, and are not anxious to accept business for forward delivery. Stocks are somewhat large, but the rough weather stopping the export of metal is in some degree accountable for this, and large consignments are being prepared for early shipment. There is a busy employment among steel makers, and there is a large output of both rails and merchant qualities of steel. Shipbuilders are but indifferently employed, but are hopeful of better business shortly, as inquiries of terms and new contracts are very large. Iron ore is in good demand, and prices are steady at from 10s. to 12s. 6d. per ton net at mines. There is a steady request of coal and coke, and full prices are obtained. There is a rather better employment for shipping.

THE SHEFFIELD DISTRICT.

(*From Our Own Correspondent.*)

At Dronfield, Messrs. Wilson, Cammell, and Co., or, to speak more accurately now, Messrs. Charles Cammell and Co., will soon have completed their exodus to Workington. The supply of pig iron from Cumberland is perceptibly diminishing, the company evidently calculating their requirements as precisely as possible, so as not to have much stock in hand when they have turned out the last rails they mean to make at Dronfield. They are still producing a fairly large output of steel rails for export. On the 29th one order of theirs for Liverpool was some 1600 tons.

The suggestion has been made that the Midland Company should take the site of the Dronfield Steel Works for wagon manufacture and storing, but I understand that there is not the slightest prospect of its doing so, the company's accommodation for that purpose being already very complete, though the development of the hiring business will undoubtedly cause a great increase of its existing facilities.

The Manchester, Sheffield, and Lincolnshire Railway Company has been recently asked to provide additional sidings at Sheffield station. The position of its Victoria station precludes the possibility of its doing much there; but I understand that it contemplates very important alterations and additions at Bridgehouses station, which is at present solely used for goods. A sum of £50,000 is to be expended in making the accommodation so complete as to relieve the pressure at the Victoria.

All doubt as to the attitude of the coalowners of South Yorkshire, on the question of restricting the output, is now at an end. On the 30th ult. an important and influentially-attended meeting was held at the Victoria Station Hotel, Sheffield, when the circular from the Yorkshire Miners' Association, signed by Mr. Benjamin Pickard, the secretary, was carefully considered. In that circular the request was made that the masters should combine with the men to restrict the output by ceasing to work on Saturdays—limiting the labour in mines to five days a week, and working only eight hours a day from bank to bank. Mr. Pickard's circular further suggested that the coalowners should agree to meet the delegates of the men and consider the subject. The coalowners, who were presided over by Mr. J. D. Ellis, of the Aldwark Main and Car House Collieries, decided that the proposed restriction of the output, as stated in the circular, was detrimental to the interests of both masters and men, and should not be entertained. They expressed themselves willing, however, to meet the men, and explain the reasons which had compelled them to come to this conclusion. As the men had already appointed a deputation for this purpose, the interview will probably take place early next week. The employers, as I have previously indicated, contend that if the exigencies of trade demand supplies of coal sufficient to keep the pits going six days, it would be improper to set them down on the Saturdays. The practical effect would be, even if the project succeeded, to create an artificial stimulus, which would have the effect of raising wages for a time; but the effect on the general trade of the country would be most disastrous, even if it did favourably influence the coal industry. At present house coal is again in a depressed state, and the miners have not more than four days' employment in the week. Steam fuel, on the other hand, is fairly brisk, and the slight advance obtained before Christmas is mantained.

The file manufacturers have held another meeting to consider about reducing wages, but nothing has been definitely decided upon as yet.

At the local foundries there is a good deal of employment, several firms being exceptionally busy. Among the latter is the Thorncliffe Iron Company—Messrs. Newton, Chambers, and Co.

Mr. C. S. Wortley, M.P., attended the annual meeting of the Sheffield Chamber of Commerce on the 31st ult. Mr. F. Brittain, the president, devoted his entire speech to the question of the Spanish tariffs, pointing out that while England took one-half of the whole exports of Spanish wines, Spain treated England in a manner which would not be tolerated by any other Power in Europe. Spain professes to have two grievances against England: (1) That tobacco smuggling is carried on from the Port of Gibraltar; and (2) that our duty on Spanish wines is higher than on those of France, and operates to the disadvantage of Spanish wine growers. Mr. Brittain puts the matter very plainly. Either Spain has a grievance or she has not. If she has a grievance let it be inquired into, and remedied; if not, let her be plainly told that England will not permit the present condition of things to continue.

The Electric Lighting Committee of the Sheffield Corporation have resolved to receive applications from competent persons or firms to supply electricity for lighting purposes.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

The long expected improvement in the Cleveland iron trade has not yet set in. Consumers are buying only in very small quantities, and continue to withhold their larger orders, in the hope that makers will soon accept lower prices. On the other hand the principal producers are adhering to their previous quotations, and some of them are putting iron into stock rather than yield. The consequence is that business is almost at a standstill. At the market held at Middlesbrough on Tuesday last, the leading merchants asked 42s. 6d. per ton for No. 3 g.m.b. for early delivery, and it was reported that 42s. 3d. had been accepted for two or three small lots. Most of the makers quoted from 43s. to 43s. 6d. for No. 3, but some of the outside firms were willing to take 42s. 9d. per ton.

Warrants have been in better request during the last fortnight, but holders cannot get more than 42s. to 42s. 3d. for them.

The stock of Cleveland iron in Messrs. Connal and Co.'s Middlesbrough stores fell 1890 tons during last week. The quantity held on Monday last was 90,446 tons.

During the week ending Monday last only 6635 tons of pig iron and 5374 tons of manufactured iron and steel were shipped from the Tees. The totals for the month up to that date are: Pig iron, 52,458 tons, and manufactured iron and steel 19,714 tons.

Prices remain about the same as last week for finished iron, and a fair amount of business is being done. Ship-plates are £6 7s. 6d. to £6 12s. 6d. per ton, shipbuilding angles £5 7s. 6d., and common bars £5 12s. 6d. to £6, all f.o.t. at makers' works less $2\frac{1}{2}$ per cent. Most of the plate mills have been closed on Mondays during January, but it has been decided to work the full number of shifts in February.

The quarterly returns of the North of England manufactured iron trade, for the three months ending December 31st, 1882, were issued by Mr. E. Waterhouse, the accountant, on January 24th. They show that the average net selling price for all classes of iron was £6 8s. 6d. per ton. For all classes of iron, with the exception of rails, the price was £6 8s. 7d. per ton. These prices are the same as those for the previous quarter. The production during last quarter of iron of all kinds was 164,240 tons. In the third quarter the output was 159,855 tons. Wages are not affected by this ascertainment, as the last award of Sir J. W. Pease is in force until the last Saturday in February.

Messrs. Monkhouse, Goddard, and Co. issued on Monday last their certificate under the Durham coal trade sliding scale. The net average selling price of coal for the quarter ending December 31st was 4s. 11·34d. per ton. Under this ascertainment all classes of workmen will receive during the next three months an advance of 1¼ per cent. upon the standard of wages of November, 1879.

The Weardale Iron and Coal Company has given notice to all the men employed at the Red Vein Ironstone Mine, and the iron furnace at Stanhope Burn, to terminate their present engagement. Between 100 and 150 men will thus be thrown out of work. The notice expires on February 13th.

The Brasside Colliery, which belongs to the Earl of Durham, has been lying idle, and the ropes and winding engine are being removed. The Cocken Colliery, which also belongs to his lordship, was closed some short time since.

The Tees-side Iron and Engine Works Company, at Middlesbrough, has decided to close its puddling department for the present, as it does not find it pay to continue the manufacture of bar iron at present prices. About 150 men will be thrown idle.

The annual meeting of the Board of Arbitration for the North of England manufactured iron trade took place at Darlington on Wednesday last. The proposed new constitution was the principal subject of discussion by the delegates present.

It is announced that Messrs. Bell Brothers have decided immediately to proceed with the erection of chemical works at Port Clarence for the manufacture of soda ash. By this means they will be able to use up on the spot a portion of the large quantity of salt they are now producing from the brine pumped up from their deep boring. Messrs. Allhusen and Co. of Newcastle, have purchased a royalty near Port Clarence, and will commence boring at once. The development of the Tees-side salt trade seems likely to be very rapid, especially on the north side of the river, where only there is plenty of unoccupied land available.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

A CONSIDERABLE amount of business was done in the warrant market towards the close of last week, consisting chiefly of sales by holders, the result being that prices were still further depressed. This week the speculative department of the trade has been very inactive, there being no feature in the market to attract operators. Business therefore, such as it is, has been mainly confined to brokers. The prices of warrants have been gradually tending downwards. For makers' iron, on the other hand, there is a fair inquiry, some masters, indeed, being quite sold out, and only making iron to meet current wants. There are others, however, that are not so well circumstanced, and the prices of makers' brands generally are this week a little easier, with the exception of Glengarnock, which is 1s. dearer for No. 1, and 6d. for No. 3. The home consumption of pigs is good, although founders are rather quieter. The shipments are not very encouraging, but they do not compare unfavourably with those at the same date last year. The stock of warrants in Messrs. Connal and Co.'s stores has been reduced in the course of the week by nearly 2000 tons. The demand from the United States is quiet.

Business was done in the warrant market on Friday morning at 48s. 0½d. to 47s. 10½d. cash, and from 48s. 3d. to 48s. 1d. one month, this afternoon's quotations being 47s. 9½d. to 47s. 10d. cash. On Monday transactions were effected at 47s. 8½d., and on Tuesday from 47s. 8d. to 47s. 9d. cash. Business was done on Wednesday down to 47s. 5½d. cash. The market was very quiet this afternoon, when prices further declined to 47s. 4d. cash.

The quotations of makers' iron are as follows:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 63s. 6d.; No. 3, 54s.; Coltness, 66s. and 55s. 6d.; Langloan, do. do.; Summerlee, 62s. 6d. and 52s. 6d.; Chapelhall, 63s. and 53s.; Calder, 63s. and 51s. 6d.; Carnbroe, 56s. and 51s.; Clyde, 53s. and 50s. 0d.; Monkland, 49s. 6d. and 48s.; Quarter, 49s. and 47s. 6d.; Govan, at Broomielaw, 49s. 3d. and 47s. 9d.; Shotts, at Leith, 65s. 6d. and 56s.; Carron, at Grangemouth, 53s. (specially selected, 57s. 6d.) and 52s.; Kinneil at Bo'ness, 49s. 6d. and 48s. 6d.; Glengarnock, at Ardrossan, 56s. and 50s. 6d.; Eglinton, 50s. 6d. and 48s. 6d.; Dalmellington, 51s. and 49s.

Between 4000 and 5000 tons of iron ore from Spain were landed at Glasgow Harbour in the course of the past week.

Although complaints are heard of a lack of prospective orders, the malleable trade is at present busy. The Coats Ironworks at Coatbridge, where operations were lately stopped by Messrs. Wm. Dixon, Limited, have been taken on lease, with the object, it is presumed, of again beginning work. New tube works are to be erected at Dimdyvan and Langloan.

The iron manufactures shipped from the Clyde during the past week embraced £20,000 worth of machinery, £14,900 steel manufactures, £44,000 of various kinds of iron goods, exclusive of pig iron.

The coal trade is still fairly active in most parts of Scotland. In the west the shipping trade has now quite recovered from the effects of the recent railway strike. Cold weather has also quickened the domestic consumption, and there is a good demand for manufacturing purposes, prices for all sorts being firm. There is a want of animation in the coal trade of Fife. The f.o.b. quotations at Burntisland are 6s. 6d. to 7s. per ton, but rather smaller rates are offered for forward delivery. The miners are working full time, but coals are being stored at most of the pits. The coal exports at Firth of Forth ports are but moderate in dimensions.

The Duke of Hamilton has leased to the Bent Colliery Company upwards of 800 acres of coal lying beneath the North Haugh of Hamilton Palace grounds. Sinking operations will be at once commenced to lift the mineral, which is known to be of high quality. The new pits will be known as Hamilton Palace Colliery.

As a rule, the miners are at present very quiet, but a meeting of the men in the Baillieston district was held a few days ago, at which it was arranged to make an effort towards a fresh movement for short time and an advance of wages.

The Clyde shipbuilding trade is very busy, and the orders being secured are most encouraging. In the past week about 30,000 tons of fresh contracts are reported as secured. Among the more recent launches are the Tartar, a screw steamer of 4359 gross tonnage, with engines of 950-horse power nominal, for the Union Steamship Company's Cape line; the Procida, screw steamer of 3600 tons, for the Australian line of Messrs. Robert M. Slowmann and Co., of Hamburg; and a fine new screw steel steamer, named Moruca, for the West India trade of Messrs. David Caw and Co., Glasgow. The first-named vessel is built by Messrs. Aitken and Mansell, and will be engined by Messrs. J. and J. Thomson, both of Glasgow; the second built and engined by Messrs. Alex. Stephen and Sons, Glasgow; and the third built and engined by Messrs. J. and G. Thomson, of Clydebank.

Arrangements are thus early being made in Glasgow in view of the meeting in that city next autumn of the Sanitary Institute of Great Britain, an influential committee being appointed, and a fund for local expenses promised.

Excavations are in progress for the placing of three of the land piers of the new Tay Bridge on the Fife shore.

The sum of £10,000 has been guaranteed for the restoration of the portion of Arbroath Harbour which was destroyed by a storm in February of last year. The contract has been let to Messrs. Morrison and Sons, of Edinburgh.

A telephonic exchange is about to be opened at Aberdeen.

WALES & ADJOINING COUNTIES.

(From our own Correspondent.)

GREAT rejoicings have taken place in Cardiff this week, one of the principal events being the cutting the first sod of the Bute Extension New Docks by Lord Bute. It is about fifty years ago that his father did a similar thing, and the increase in trade since then has been prodigious. In one item, coal, I find that in 1829 the export was 83,000 tons. Compare this with the present when there are 100 steamers leaving Cardiff weekly, and an annual export taking place in coal alone of six million tons.

There are some hopes of an arrangement being brought about between the promoters and opposers of the Barry Dock and railway scheme. Mr. Reed, M.P. for Cardiff, has suggested it, and the corporation seem to follow in the same track. The promoters have not expressed an opinion yet as to the course to be taken, nor do I know that the opposers are likely to offer certain conditions. We must suspend judgment for a week or two, and see what will turn up.

Messrs. Nelson and Co., of Carlisle, who have lately had a large contract in North Wales have the new dock contract, and they are likely to show substantial progress in a short time. I shall give particulars as soon as practical operations are begun.

The staple trades continue in excellent tone. Large cargoes of iron and steel left the Welsh ports last week, amongst the more important of the cargoes being some for New Orleans, Santos, Trinidad, and one large one for East London, Cape of Good Hope. Prices remain firm, and home authorities are inclined to think that an advance is likely, seeing the fulness of the inquiry list. At present market quotations remain. Last week was one of the weeks of largest import of foreign ore on record. Taking two of the ports alone, over 40,000 tons came in, the principal of which was Spanish.

French and other consignees of pitwood are determined that we shall have no pit-prop famine in future. We have now an import varying from 7000 to 10,000 tons weekly, and prices, which have been tending high, are naturally drooping again.

I am glad to hear that there is a likelihood of the tin-plate works at Pontardulais being started again. An arrangement has been brought about which promises this very desirable result, and I hope to chronicle the re-start next week. Great destitution has prevailed all over the tin-plate district, and yet it is notorious that tin-plate workers have been earning better wages than ironworkers or colliers. Makers in the tin-plate districts say that prices are still low, and that the demand has not been so well sustained, yet they are inclined to the belief that trade is getting placed on a sounder footing, though some time may elapse before any marked improvement is shown.

The Cardiff and Monmouthshire Valleys Railway Bill will be heard on Thursday next.

I have to record an immense amount of damage to shipping. From Cardiff to the Gower coast, a track especially open to the W.S.W. winds, the storm in the early part of the week had full scope, and the coal-laden vessels from the various ports were injured greatly. One large collier, 1083 tonnage, went down with captain and crew. This was the James Gray, which sailed from Cardiff on Friday, and went down near Porthcawl. Several other vessels have been lost, many injured.

The coal trade of the week has been brisk, and prices for best steam and house show an advancing tendency. Swansea exports show an advance over the preceding week, Newport and Cardiff indicate a slight falling off, but not to an appreciable extent; patent fuel and small coal are in good demand.

The contract for Morel's new graving dock, Cardiff, has been secured by Mr. Billups. The dock is to be worked in connection with the Bute Ironworks and Treherbert Foundry, at which all of the large castings are to be made.

NEARLY 2,000,000 tons less coal was entered within the area of the city duty in 1882 than was the case in 1881.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

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

Applications for Letters Patent.

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

23rd January, 1883.

363. BOBBINS, H. Southwell, Heywood, and W. H. Dawson, Manchester.
364. MOVABLE TORPEDOES, S. Pitt.—(*C. G. Francklyn, Rome.*)
365. VELOCIPEDES, J. Hopwood, Heaton-Norris.
366. BRACELETS, A. Watson, Willesden.
367. REMOVING VEGETABLE IMPURITIES from WOOL, H. J. Haddan.—(*G. Fernau and Company, Belgium.*)
368. CONDENSERS, W. A. Miles, New York, U.S.
369. GAS-BURNER APPARATUS, G. S. Grinston, Brockley, and A. S. Bower, Saint Neots.
370. RAILWAY, &c., VEHICLES, J. Cleminson, London.
371. ELECTRIC LAMPS, A. E. Swonnikoff, London.
372. BRACES, F. Hovenden, West Dulwich.
373. INDICATING the NAMES of STATIONS in RAILWAY CARRIAGES, H. B. Palmer, London.
374. HORSESHOES, T. D. Richardson, London.
375. FORMING VACUUM, J. F. McLaren, Glasgow.
376. UTILISING REFUSE SAND from GLASS WORKS, W. D. Herman, St. Helen's.
377. PRODUCING COMBUSTIBLE GASEOUS FLUID, T. Cooper, Great Ryburgh.
378. SPRING MOTOR APPARATUS, W. R. Lake.—(*G. Stites, R. Steel, S. Austin, J. Vannote, H. G. Donnelly, and C. Mace, Philadelphia, U.S.*)
379. TREATING SUGAR CANE, W. L. Wise.—(*La Société Anonyme des anciens Etablissements Cail et M. A. Ferron, Paris.*)
380. PRINTING, &c., MACHINERY, W. R. Lake.—(*H. P. Feister and R. M. Hunter, Philadelphia, U.S.*)
381. WIRES for CRINOLINES, &c., G. Smeeton, Halifax.

24th January, 1883.

382. VEHICLES, J. Watson and G. Whalley, Keighley, and T. Weatherill, Leeds.
383. MOTIVE POWER, S. Hart, Hull.
384. FILTERING MEDIA, J. Cross & G. I. Wells, Widnes.
385. AXLE-BOXES, C. Friedrichsen, Germany.
386. FINISHING of HATS, G. Atherton.—(*G. Yule, U.S.*)
387. VENTILATING SEWERS, G. F. Harrington, Ryde.
388. GAS ENGINES, J. Howard & E. Bousfield, Bedford.
389. WINDOW STAYS, E. & J. Verity & B. Banks, Leeds.
390. FLOUR DRESSING MACHINES, M. Lyon. — (*A. Hunter, Chicago, U.S.*)
391. PAPER KNIVES, F. L. H. Aumont, Camberwell.
392. FRICTION CLUTCHES, A. M. Clark.—(*G. N. Schoenberg, Paris.*)
393. PHOTOMETER, A. J. Beer, Canterbury.
394. VELOCIPEDES, W. H. J. Grout, London.
395. RAILWAYS, P. Jensen.—(*F. H. Danchell, Paris.*)
396. PULPING COFFEE BERRIES, W. Walker.—(*Messrs. Arens Irmaos, Brazil.*)
397. ELECTRIC LIGHTING, J. Cooper, London.
398. LATHES, F. Wirth.—(*H. Voigt, Germany.*)
399. WATERPROOF COATING, L. A. Groth.—(*N. Bellefroid, Belgium.*)
400. ELECTRIC GENERATORS, &c., W. Mordey, Putney.
401. EXPRESSING JUICE from SUGAR CANE, W. L. Wise. —(*La Société Anonyme des anciens Etablissements Cail, Paris*)
402. SINGLE-LINE RAILWAYS, A. M. Clark.—(*H. Carpentier, Paris.*)

25th January, 1883.

403. BATTING GLOVES, G. Burbery, Congleton.
404. DISCHARGING, &c., MATERIALS, A. M. Clark.—(*La Compagnie Nationale de Travaux Publics, Paris.*)
405. INSULATORS, P. R. de F. d'Humy, London.
406. CARPET LINING, A. Bruckner, London.
407. OPERATING TRAMWAY POINTS, F. Beleven, London.
408. STEAM PISTONS, A. MacLaine, Belfast.
409. SEWING MACHINES, I. Nasch, London.
410. SMOKING PIPE, R. C. Christian, Dublin.
411. PERAMBULATORS, C. Thompson, Newington Butts.
412. BITS for BORING METALS, J. W. Hall, Cardiff.
413. PRINTING MACHINES, A. Coates, Rawtenstall.
414. GRINDING, &c., STONE, G. & A. Coates, Rawtenstall.
415. RAISING, &c., WEIGHTS, J. and J. T. Pickering, Stockton-on-Tees.
416. HAMMERS, F. Wirth.—(*G. Speckhart and H. Wiedmann, Germany.*)
417. SCRAPING, &c., POTATOES, T. Marshall.—(*J. B. Carter, New Jersey, U.S.*)
418. RAILWAY CHAIRS, W. Hopkins and C. Turner, Birmingham.
419. BARRELS or CASKS, F. Myers, New York, U.S.
420. LAMPS, T. Cooper, Great Ryburgh.
421. RAILWAY SIGNALS, J. H. Cureton, London.
422. UNIVERSAL PENHOLDER, T. Nordenfelt.—(*Lieut. Ferraccin, Venice.*)
423. FELT HATS, C. Vero and J. Everitt, Atherstone.
424. DITCHING MACHINES, R. Fowler.—(*H. Carter and W. Rennie, Toronto, U.S.*)
425. VALVE GEAR for ENGINES, J. H. Johnson.—(*G. W. Storer, Philadelphia, U.S.*)

26th January, 1883.

426. PRESERVING MILK, E. A. Brydges.—(*E. Scherff, Germany.*)
427. FIBROUS MATERIALS, C. Weygang, London.
428. REGULATING the SUPPLY of FUEL in BOILER FURNACES, C. J. Chubb, Clifton.
429. METALLIC PENS, H. Hewitt, Birmingham.
430. STRINGING PIANOFORTES, C. F. Southack, London.
431. INKSTANDS, F. E. Godwin, Gloucester.
432. WEFT FORKS, W. B. White, Colne.
433. AIR EXTRACTING APPARATUS, T. Rowan, London.
434. TREATING SEWAGE WATER, J. Young, Kelly, N.B.
435. VENTILATING APPARATUS, A. R. Holland, London.
436. PREVENTING DOWN DRAUGHTS in CHIMNEYS, W. Lord, Middlesbrough.
437. TUBE SCRAPERS, &c., W. S. Turner, Walworth.
438. PHOSPHATES, S. Thomas and T. Twynam, London.
439. STANDS, &c., for ALARUMS, A. M. Clark.—(*D. Roussialle, Lyons.*)
440. VELOCIPEDES, W. T. Shaw, Surbiton, and W. Sydenham, London.
441. SUBSTITUTE for INDIA-RUBBER, &c., A. M. Clark. —(*S. Barbier and C. H. Coiffier, Paris.*)

27th January, 1883.

442. COOKING APPARATUS, A. F. Link.—(*F. Desplas, France.*)
443. STEERING APPARATUS, J. Donaldson, London.
444. PACKING CASES, &c., G. H. Ellis, London.
445. FOLDING SHUTTLE, P. Born, Middlesex.
446. MOTOR MACHINE, W. Gedge.—(*M. Cavalerie, Paris.*)
447. SCREW SWAGING MACHINES, F. J. Cheesbrough.— (*S. A. Davis and R. Blake, Newark, U.S.*)
448. SCREW SWEDGING MACHINES, F. J. Cheesbrough.— (*S. A. Davis and R. Blake, Newark, U.S.*)
449. COMBINED NOTE PAPER and ENVELOPE, C. A. Drake, London.
450. ROPE TRAMWAYS, &c., G. J. Chapman, Enfield.
451. PADDLES, W. Carter, Masham.
452. BICYCLE, &c., SADDLES, F. W. Small, Walsall.
453. SIDE SADDLES, W. Winans, Brighton.
454. CIRCUITS and ELECTRIC INDICATORS, W. P. Thompson.—(*R. Hewitt, jun., and C. L. Clarke, New York.*)
455. HOLDING, &c., TICKETS, T. H. Harper, Redditch.
456. KILNS for DRYING MALT, P. R. Norton, Dublin.
457. FASTENINGS for DOORS, A. Arnott, Wandsworth.
458. MUSICAL INSTRUMENTS, H. J. Haddan.—(*C. Neumeister, Leipzig.*)
459. SELF-ACTING COUPLINGS, W. Stableford, Oldbury.
460. TELEPHONES, T. J. Handford, London.
461. PRODUCING CARBURETTED AIR for LIGHTING, H. H. Lake.—(*J. Blondel, jun., France.*)
462. BINDING SHEAVES, J. Howard and E. T. Bousfield, Bedford.
463. AXLE BOXES, F. Wirth.—(*Messrs. Dick and Kirschten, Germany.*)
464. INDICES for METERS, S Grey, London.
465. SEPARATING LIME from CRUDE PHOSPHATES, H. H. Lake.—(*E. Winkelhofer, Neusitschein.*)
466. VARNISHES, A. M. Clark.—(*E. A. Boissaye, Paris.*)
467. REFLECTORS, &c., H. H. Lake.—(*J. Oertel and Company, Ha*

29th January, 1883.

468. VELOCIPEDES, W. Jeans, Christchurch.
469. DRYING APPARATUS, E. A. Brydges.—(*D. Grove, Berlin.*)
470. GOVERNORS for STEAM ENGINES, C. J. Galloway and J. H. Beckwith, Manchester.
471. REVOLVING FLAT CARDING ENGINES, J. M. Hetherington, Manchester.
472. DISTILLATION, J. F. Lackersteen, Greenwich.
473. PORCELAIN BATHS, J. Hall, Stourbridge.
474. TUBE EXPANDERS, G. Lohf, Berlin.
475. GAS COOKING STOVES, J. Russell, Reading.
476. LOOMS for WEAVING, T. Lonsdale, Blackburn.
477. BRAKES for WAGONS, &c., R. Heaton, Blackburn.
478. ROPE DRIVING APPARATUS, M. H. Smith, Halifax.
479. MILLS for SHELLING OATS, &c., G. Perrott, Cork.
480. GAS APPARATUS, W. White, Abersychan.
481. GRAPPLING STONE, R. Stone, New York, U.S.
482. SECONDARY BATTERY, &c., A. L. Nolf, Brussels.
483. OIL PRESSING APPARATUS, F. Wirth.—(*R. Traumann, Mannheim.*)
484. STEAM BOILERS, A. Clark.—(*E. Delpech, France.*)
485. ADVERTISING TABLETS, W. E. Fisher, Birmingham.
486. RAILWAY BRAKES, E. Edwards.—(*J. B. Charlier, France.*)
487. SEWING MACHINES, R. H. Brandon. —(*Morley Sewing Machine Company, Boston, U.S.*)
488. SURFACE CONDENSERS, H. Guy, Isle of Wight.

Inventions Protected for Six Months on Deposit of Complete Specifications.

358. SHIPS' SLEEPING BERTHS, H. H. Lake, Southampton-buildings, London.—A communication from the Huston Ships' Berth Company, Incorporated, Boston, U.S.—*22nd January*, 1883.
364. MOVABLE TORPEDOES, S. Pitt, Sutton.—A communication from C. G. Francklyn, Rome.—*23rd January*, 1883.
380. PRINTING, &c., MACHINERY, W. R. Lake, Southampton-buildings, London. — (A communication from H. P. Feister and R. M. Hunter, Philadelphia, U.S.—*23rd January*, 1883.
390. FLOUR, &c., DRESSING MACHINES, M Lyon, London.—A communication from A. Hunter, Chicago, U.S.—*24th January*, 1883.
424. DITCHING MACHINES, R. Fowler, Leeds.—A communication from H. Carter and W. Rennie, Toronto. —*25th January*, 1883.

Patents on which the Stamp Duty of £50 has been paid.

309. GATHERING, &c., GRAIN CROPS, A. M. Clark, London.—*23rd January*, 1880.
292. PRODUCING COLD, J. H. Johnson, London.—*23rd January*, 1880.
235. HEATING the FEED-WATER of STEAM BOILERS, G. and J. Weir, Glasgow.—*26th January*, 1880.
331. BOOKBINDER'S CLOTH, H. Thornton and F. E. Walmsley, London.—*26th January*, 1880.
375. STOPPING STEAM ENGINES, J. Tate, Bradford.—*28th January*, 1880.
402. LOCOMOTIVE ENGINES, A. Greig and W. Beadon, Leeds.—*29th January*, 1880.
334. FASTENERS for ELASTIC BANDS, M. Innes, Manchester.—*26th January*, 1880.
361. AERATED BEVERAGES, S. C. Davidson, Belfast.—*27th January*, 1880.
362. AERATED BEVERAGE, S. C. Davidson, Belfast.—*27th January*, 1880.
364. METALLIC BEDSTEADS, J. Trobridge, Balsall Heath. —*27th January*, 1880.
374. CONDENSING STEAM, R. M. Marchant, London.—*23th January*, 1880.
376. MILLINERY BOXES, W. Dickinson, sen., Manchester.—*28th January*, 1880.
378. REFRIGERATING APPARATUS, W. R. Lake, London. —*28th January*, 1880.
409. SWITCH APPARATUS, W. R. Lake, London.—*29th January*, 1880.
434. BRAKE APPARATUS, W. P. Smith, Lostwithiel.—*31st January*, 1880.
445. DYEING COTTON WARPS, &c., BLACK, E. Posselt and R. Peters, Bradford.—*31st January*, 1880.
807. FRAMES for SWINGING COTS, A. Thompson, London.—*24th February*, 1880.
404. ELECTRIC CONNECTIONS for TELEPHONIC COMMUNICATION, G. Westinghouse, jun., London.— *29th January*, 1880.
416. DRILLING, &c., HOLES in BOILER PLATES, W. Bowker, Manchester.—*30th January*, 1880.

Patent on which the Stamp Duty of £100 has been paid.

414. PUMPS, W. Adair, Liverpool.—*2nd February*, 1876.
420. FLOOR CLOTH, F. Walton, Staines.—*2nd February*, 1876.
364. PENTAGRAPH ENGRAVING MACHINES, T. Nixon, Alexandria, N.B.—*29th January*, 1876.
323. MORTISING MACHINES, T. E. Craven, Leeds.—*26th January*, 1876.
369. POINTED, &c., AGRICULTURAL TOOLS, W. Morgans, Elm.—*29th January*, 1876.
384. CARRIAGE SPRING HEADS, J. Woodhead, Bradford. —*31st January*, 1876.
367. CONNECTING SUBMARINE TELEGRAPH CABLES with LIGHT SHIPS, F. le B. Bedwell, London.—*29th January*, 1876.

Notices of Intention to Proceed with Applications.

(*Last day for filing opposition, 16th February*, 1883.)

4476. RAILWAY CARRIAGE WHEELS, G. W. von Nawrocki, Berlin.—A communication from R. Sydow.—*26th September*, 1882.
4507. LEATHER PARING MACHINES, E. G. Brewer, London.—A com. from H. Mayer.—*21st September*, 1882.
4513. POTATO PLANTING MACHINES, H. Gardner, London.—Com. from R. Wuensche.—*21st September*, 1882.
4514. TEMPORARY PARTITIONS for CLASS-ROOMS, J. W. Cook, London.—*21st September*, 1882.
4519. VENTILATING SALOONS, &c., J. and J. K. Leather, Liverpool.—*22nd September*, 1882.
4526. PREVENTING SHOCKS to SHIPS at ANCHOR, B. C. le Moussu, London.—*22nd September*, 1882.
4528. FROSTED GLASS, W. H. Beck, London.—A communication from G. Bay.—*22nd September*, 1882.
4529. PAPER PULP, W. R. Lake, London.—A communication from E. V. J. L. Gorges.—*22nd September*, 1882.
4530. RAILWAY COUPLING APPARATUS, A. W. L. Reddie, London.—A communication from the Compagnie des Appareils Automatiques pour Accrocher et Decrocher les Wagons des Chemins de Fer.—*22nd September*, 1882.
4532. REGULATING ELECTRIC CURRENTS, W. E. Ayrton and J. Perry, London.—*23rd September*, 1882.
4539. IRON, W. Clarke, Birmingham.—*23rd September*, 1882.
4541. BREECH-LOADING FIRE-ARMS, H. and E. Hammond, Winchester.—*23rd September*, 1882.
4546. EXTRACTING MOISTURE from AIR, W. R. Lake, London.—A communication from R. S. Jennings.—*23rd September*, 1882.

4547. Dynamo-electric Machines, R. Barker, Seacombe.—23rd *September*, 1882.
4558. Dividing Dough into Loaves, R. Abercromby, Glasgow.—25th *September*, 1882.
4562. Producing Relievos with Equally Deepened Excavations, L. H. Philippi, Hamburg.—25th *September*, 1882.
4575. Propellers, R. Gibb, Liverpool.—26th *September*, 1882.
4576. Camp Stools, J. C. Mewburn, London.—A communication from W. Walcker.—26th *September*, 1882.
4589. Corset Busks, C. A. Snow, Washington.—A communication from C. A. Adams.—26th *September*, 1882.
4592. Ventilating Soil Pipes, H. Blair, Glasgow.—27th *September*, 1882.
4608. Obtaining Artificial Light, J. Mayer, London.—28th *September*, 1882.
4621. Locomotive Slide Valves, W. R. Lake, London.—A com. from N. Bonnefond.—28th *September*, 1882.
4624. Rolling Mills, W. R. Lake, London.—A communication from G. Erkenzweig.—28th *September*, 1882.
4632. Furnaces, J. W. Couchman, London.—29th *September*, 1882.
4664. Churns, J. Llewellin, Haverfordwest.—30th *September*, 1882.
4668. Velocipedes, S. Miller, London.—30th *September*, 1882.
4680. Dynamo-electric Machines, J. S. Beeman, W. Taylor, and F. King, London.—2nd *October*, 1882.
4692. Bicarbonate of Soda, A. W. L. Reddie, London.—A com from B. T. Babbitt.—13th *October*, 1882.
4720. Spinning Cotton, T. Coulthard, Preston.—4th *October*, 1882.
4874. Producing a Fertile Yeast from Saccharine Juices of Grain, &c., A. M. Clark, London.—A com. from G. Claudon and C. Vigreux.—13th *October*, 1882.
5151. Iron and Steel, E. F. Göransson, Stockholm.—30th *October*, 1882.
5685. Walls, &c., F. Smith, London.—29th *November*, 1882.
5697. Moulds for Casting Pipes, J. and F. Chambers, Stanton Ironworks.—30th *November*, 1882.
5835. Utilising Slags, C. Pieper, Berlin.—A communication from C. Scheibler.—7th *December*, 1882.
5848. Indurating Artificial Stone, J. W. Butler, Blackheath.—7th *December*, 1882
5953. Purifying Coal Gas, J. F. Kromschröder, London.—13th *December*, 1882.
6109. Gas Ovens, W. A. Crommelin, J. Lees, H. Spain, and W. H. Thompson, London.—21st *December*, 1882.
247. Treadle Mechanism for Sewing Machines, A. M. Clark, London.—A communication from G. B. Ward.—16th *January*, 1883.
307. Alarm Guns, W. Burgess, Malvern Wells.—18th *January*, 1883.

(*Last day for filing opposition*, 20th *February*, 1883.)

4549. Metal Hurdles, &c., S. Bayliss and W. Bailey, Wolverhampton.—25th *September*, 1882.
4550. Indicating Presence of Water in Cisterns, J. Shaw & F. Milan, Lockwood.—25th *September*, 1882.
4560. Machines for Composing Type, E. G. Brewer, London.—A communication from I. Delcambre and V. Riesz.—25th *September*, 1882.
4568. Heating Water, A. J. Billing, London.—26th *September*, 1882.
4583. Rotary Pumps, M. Benson, London.—A communication from F. M. Roots.—27th *September*, 1882.
4584. Buckles for Belts, &c., J. B. Brooks and F. R. Baker, Birmingham.—27th *September*, 1882.
4588. Water-gauge Taps, T. Allison, Milnsbridge.—27th *September*, 1882.
4597. Bicycles, &c., T. Warwick, Aston.—27th *September*, 1882.
4606. Compound Vacuum Pump, J. H. Johnson, London.—A com. from W. Richter.—28th *September*, 1882.
4607. Obtaining the Soluble Portion from Tanning Materials, J. Hutchings, Warrington.—28th *September*, 1882.
4645. Electric Meters, S. D. Mott, London.—29th *September*, 1882.
4646. Electric Meters, S. D. Mott, London.—29th *September*, 1882.
4650. Musical Instruments, T. Machell, Glasgow.—30th *September*, 1882.
4701. Appliance to Assist in Swimming, J. Imray, London.—A communication from La Société P. Garcet et Nisius.—3rd *October*, 1882.
4704. Metallic Frames for Bedsteads, &c., B. J. la Mothe, New York.—3rd *October*, 1882.
4714. Alkalies, E. W. Parnell, Widnes, and J. Simpson, Liverpool.—4th *October*, 1882.
4723. Petroleum Furnaces, J. Findlay, Glasgow.—4th *October*, 1882.
4926. Range Finders, F. H. Poore, Portsmouth.—16th *October*, 1882.
5300. Electro-plating with Nickel and Cobalt, A. J. Boult, London.—A communication from J. Vandermersch.—6th *November*, 1882.
5436. Putty, G. A. Biddis, Newbury.—14th *November*, 1882.
5466. Making Soap, W. P. Thompson, London.—A communication from W. West.—16th *November*, 1882.
5543. Air Compressors, C. Pilkington and J. Forrest, Haydock.—22nd *November*, 1882.
5549. Handles for Saucepans, E. Baldwin, Worcester.—22nd *November*, 1882.
5740. Rope Attachments, C. M. E. Kortüm, Wolverhampton.—1st *December*, 1882.
6142. Burning Gas, J. W. Plunkett, London.—23rd *December*, 1882.
6146. Dynamo-electric Machines, &c., R. Matthews, Hyde.—23rd *December*, 1882.
6208. Substitutes for Barm, A. Esilman, Manchester, and H. Esilman, Glasgow.—29th *December*, 1882.
1. Dynamo electric Machines, F. J. Cheesbrough, Liverpool.—A communication from E. R. Knowles.—1st *January*, 1883.
2. Storage Batteries, F. J. Cheesbrough, Liverpool.—A com. from E. R. Knowles.—1st *January*, 1883.
3. Applying Electricity to Houses, F. J. Cheesbrough, Liverpool.—A communication from E. R. Knowles.—1st *January*, 1883.
4. Electric Arc Lamps, F. J. Cheesbrough, Liverpool.—A com. from E. R. Knowles.—1st *January*, 1883.
5. Electric Arc Lamps, F. J. Cheesbrough, Liverpool.—A com. from E. R. Knowles.—1st *January*, 1883.
6. Incandescent Electric Lamps, F. J. Cheesbrough, Liverpool.—A communication from J. R. Knowles.—1st *January*, 1883.
13. Cleaning the Fibres of Tow, &c., F. C. Glaser, Berlin.—A communication from T. Calow and Co.—1st *January*, 1883.
34. Electric Lamps, W. R. Lake, London.—A com. from O. Hussey and A. Dodd.—2nd *January*, 1883.
46. Incandescent Electric Lamps, J. R. H. Williamson and E. Böhm, London.—3rd *January*, 1883.
108. Voltaic Batteries, G. G. André, Dorking.—8th *January*, 1883.
204. Classifying Colours, B. J. B. Mills, London.—13th *January*, 1883.
261. Electro-telegraphic Systems, P. M. Justice, London.—A communication from T. M. Foote and H. C. Goodspeed.—16th *January*, 1883.
364. Movable Torpedoes, S. Pitt, Sutton.—A communication from C. G. Francklyn.—23rd *January*, 1883.
390. Flour Dressing Machines, M. Lyons, London.—24th *January*, 1883.

Patents Sealed.

(*List of Letters Patent which passed the Great Seal on the* 26th *January*, 1883.)

3359. Artificial Cream, J. V. den Bergh, London.—15th *July*, 1882.
3498. Metallising Cloth, A. J. Boult, London.—22nd *July*, 1882.
3557. Telephonic Apparatus, J. Munro and B. Warwick, London.—27th *July*, 1882.
3569. Finishing Textile Fabrics, W. W. Blackett, Leeds.—27th *July*, 1882.
3578. Impregnating Wood, W. P. Thompson, London.—27th *July*, 1882.
3606. Rolling Steel, W. T. Beesley, Sheffield.—29th *July*, 1882.
3608. Obtaining Sulphur from Sulphide of Hydrogen, C. F. Claus, London.—29th *July*, 1882.
3611. Regulating Supply of Gas, A. Haley and A. C. Savage, London.—31st *July*, 1882.
3626. Treating Textile Fabrics, W. J. S. Grawitz, Fontenay-sous-Bois.—31st *July*, 1882.
3633. Tachygraphical Apparatus, H. H. Lake, London.—31st *July*, 1882.
3647. Packing for Stuffing-boxes, J. Brown, London.—1st *August*, 1882.
3661. Telephonic Circuits, J. W. Fletcher, Stockport.—2nd *August*, 1882.
3679. Permanent Way of Railways, L. A. Groth, London.—2nd *August*, 1882.
3703. Making Ice, T. Watts, Newport, and W. A. Gorman, London.—3rd *August*, 1882.
3731. Recovering Tin from Scrap Tin-plate, A. T. Becks, Aston.—5th *August*, 1882.
3736. Heating Fluids, W. and G. Lawrence, London.—5th *August*, 1882.
3737. Ceramic Composition, B. J. B. Mills, London.—5th *August*, 1882.
3741. Bricks, &c., A. Bouquié, Paris.—5th *August*, 1882.
3751. Electrical Signalling Apparatus, W. R. Lake, London.—5th *August*, 1882.
3753. Holder and Switch for Electric Lamps, C. E. Sibley, London.—5th *August*, 1882.
3754. Furnaces, W. R. Lake, London.—5th *August*, 1882.
3761. Preserving Wood, F. C. Glaser, Berlin.—8th *August*, 1882.
3765. Spools, E. Hunt, Glasgow.—8th *August*, 1882.
3812. Secondary Batteries, J. S. Beeman, W. Taylor, and F. King, London.—10th *August*, 1882.
3813. Regulating Electric Currents, J. S. Beeman, W. Taylor, and F. King, London.—10th *August*, 1882.
3865. Stays, &c., J. Ingleby, Manchester.—14th *August*, 1882.
3874. Bending Metal, &c., C. Scriven, Leeds.—14th *August*, 1882.
3891. Basic Fire-proof Materials, H. Ulsmann, Königshütte.—15th *August*, 1882.
3918. Book Holders, H. J. Allison, London.—16th *August*, 1882.
3972. Utilising Heat for Calcining, &c., G. H. Blenkinsop, Swansea.—19th *August*, 1882.
4183. Railway Vehicles, W. L. Wise, London.—2nd *September*, 1882.
4184. Metal Fencing, W. Bailey, Wolverhampton.—2nd *September*, 1882.
4594. Lamps, &c., W. L. Wise, London.—26th *September*, 1882.
4834. Utilising Burned Shale, T. L. Paterson and T. I. Scott, Glasgow.—11th *October*, 1882.
4846. Explosives for Fire-arms, &c., R. Hannan, Glasgow.—12th *October*, 1882.
4876. Gun Carriages, J. Vavasseur, Southwark.—13th *October*, 1882.
5009. Destroying Solid Impurities of Textile Fabrics, O. Imray, London.—21st *October*, 1882.
5021. Aërated, &c., Drinks, J. Prosser, London.—21st *October*, 1882.
5084. Obtaining Ammonia, &c., from Coal, W. Young, Peebles, & G. Beilby, Midcalder.—25th *October*, 1882.
5131. Coloured Photographs, H. H. Lake, London.—27th *October*, 1882.
5136. Watchmen's Time Detectors, J. Wetter, New Wandsworth.—28th *October*, 1882.
5180. Shaping, &c., Labels, C. Anderson and T. Cormie, London.—31st *October*, 1882.
5252. Distillation of Coal, &c., G. R. Hislop, Paisley.—3rd *November*, 1882.
5398. Hydraulic Lifts, J. S. Stevens, C. G. Major, and T. W. Barber, London.—13th *November*, 1882.
5449. Rolling Mills, F. Asthöwer and T. Bicheroux, Annen, Germany.—15th *November*, 1882.
5468. Carriage Wheels, W. J. Fraser, London.—17th *November*, 1882.
5484. Preservative Compound for Ships' Bottoms, J. and T. Kirkaldy, London.—18th *November*, 1882.
5520. Affixing Tubing to Couplings, J. Hunt and T. E. Mitton, Birmingham.—21st *November*, 1882.
5537. Drying Grain, &c., W. R. Lake, London.—21st *November*, 1882.
5564. Wheels and Axles, A. M. Clark, London.—22nd *November*, 1882.
5569. Ribbed Pile Fabrics, J. R. Hutchinson, Bury.—23rd *November*, 1882.
5570. Chains, &c., for Dredgers, W. R. Kinipple, Greenock.—23rd *November*, 1882.
5572. Antiseptics, &c., C. T. Kingzett and M. Zingler, London.—23rd *November*, 1882.
5604. Benzol, Nitro-benzol, S. Mellor, Patricroft.—25th *November*, 1882.
5618. Fermenting Liquids, N. Lubbock, London.—25th *November*, 1882.
5622. Tubular Steam Generators, C. D. Abel, London.—27th *November*, 1882.
5673. Electric Cables, A. J. Boult, London.—29th *November*, 1882.
5688. Screens for Cleaning Grain, H. S. Coleman and A. G. E. Morton, Chelmsford, and T. F. Stidolph, Woodbridge.—29th *November*, 1882.
5694. Combined Furnace and Steam Engine, V. W. Blanchard, New York.—30th *November*, 1882.
5695. Generating Electricity, V. W. Blanchard, New York.—30th *November*, 1882.
5850. Electro-magnets, V. W. Blanchard, New York.—8th *December*, 1882.

(*List of Letters Patent which passed the Great Seal on the* 30th *January*, 1883.)

3621. Uniting Pieces of Amber, W. Morgan-Brown, London.—31st *July*, 1882.
3631. Amber Varnish, W. Morgan-Brown, London.—31st *July*, 1882.
3645. Anti-friction Bearings, W. P. Thompson, London.—1st *August*, 1882.
3649. Screw Propellers, H. Hardy, Edinburgh.—1st *August*, 1882.
3652. Driving Belt Fasteners, W. H. Chase, London.—1st *August*, 1882.
3656. Cigarette Machines, W. R. Lake, London.—1st *August*, 1882.
3657. Embroidering Machines, W. R. Lake, London.—1st *August*, 1882.
3662. Tube Expanders, G. Sonnenthal, London.—2nd *August*, 1882.
3671. Railway Switches and Signals, &c., P. Prince, Derby.—2nd *August*, 1882.
3675. Cleaning Wool, W. P. Thompson, London.—2nd *August*, 1882.
3688. Door Knobs, W. Thomson, Crompton Fold.—2nd *August*, 1882.
3691. Channels for Electric Wires, G. M. Edwards, London.—2nd *August*, 1882.
3692. Tension Winding, Y. Duxbury, Over Darwen.—2nd *August*, 1882.
3693. Evaporating Liquids, H. Gardner, London.—3rd *August*, 1882.
3699. Bells for Bicycles, J. Harrison, Birmingham.—3rd *August*, 1882.
3700. Secondary Batteries, E. G. Brewer, London.—3rd *August*, 1882.
3701. Preventing Down Draught in Chimneys, C. E. Hanewald, London.—3rd *August*, 1882.
3706. Combining Harmoniums with Pianos, L. Kiitsner, Hamburg.—4th *August*, 1882.
3708. Cleaning Wool, H. J. Haddan, London.—4th *August*, 1882.
3711. Bridges of Furnaces, C. Hill, Blaydon-on-Tyne.—4th *August*, 1882.
3726. Fac-simile Copies of Writings, &c., T. H. Taylor, Manchester.—4th *August*, 1882.
3733. Propellers for Ships, G. C. Parini, Lombardy.—5th *August*, 1882.
3749. Fabric for Wall Hangings, A. M. Clark, London.—5th *August*, 1882.
3760. Turbines, &c., J. McConnell, Ballymena.—7th *August*, 1882.
3763. Telephones, J. J. Barrier and F. T. de Lavernède, Paris.—8th *August*, 1882.
3803. Steam Boilers, G. Sinclair, Leith.—10th *August*, 1882.
3824. Electric Meters, A. M. Clark, London.—10th *August*, 1882.
3844. Reed Fabrics, E. A. Brydges, London.—12th *August*, 1882.
3862. Steam, &c., Valves, D. Hancock, Stratford.—12th *August*, 1882.
3906. Electric Lamps, W. R. Lake, London.—15th *August*, 1882.
3932. Fire-proof Paint, W. Astrop and R. Ridgway, Homerton.—17th *August*, 1882.
3953. Dredging Machinery, H. C. Löbnitz, Renfrew.—18th *August*, 1882.
3997. Solid Cumidine, &c., C. D. Abel, London.—21st *August*, 1882.
4144. Caustic Potash, W. L. Wise, London.—30th *August*, 1882.
4157. Tricycles, W. J. Lloyd, Harborne.—31st *August*, 1882.
4488. Hair-pins, F. Kingston, St. John's.—20th *September*, 1882.
4678. Regenerating Sulphur from Alkali Waste, W. Weldon, Burstow.—2nd *October*, 1882.
4907. Hosiery Stitching Machines, &c., H. Clarke, Leicester.—16th *October*, 1882.
4948. Gas Engines, D. Clerk, Glasgow.—18th *October*, 1882.
4962. Valves, &c., J. N. Sperryn, Brixton Hill.—18th *October*, 1882.
5020. Mechanical Musical Instrument Motors, G. D. Garvie & G. Wood, New York.—21st *October*, 1882.
5360. Cutting Cloth, W. Lee, Manchester.—10th *November*, 1882.
5464. Spinning Machines, J. B. and T. H. Dewhurst and R. Cornthwaite, Skipton.—16th *November*, 1882.
5495. Electric Arc Lamps, W. B. F. Elphinstone, Musselburgh, and C. W. Vincent and J. Cottrell, London.—18th *November*, 1882.
5567. Harvesting Machinery, A. C. Bamlett, Thirsk.—22nd *November*, 1882.
5587. Railway Switches, E. N. Molesworth-Hepworth, Manchester.—24th *November*, 1882.
5605. Nails, &c., S. Watkins, Wolverhampton.—24th *November*, 1882.
5690. Tramways, H. H. M. Smith, London.—29th *November*, 1882.
5836. Leather, J. Imray, London.—7th *December*, 1882.

List of Specifications published during the week ending January 27th, 1883.

5644, 6d.; 1955, 2d.; 2558, 1s.; 2678, 6d.; 2701, 6d.; 2761, 8d.; 2783, 6d.; 2788, 6d.; 2792, 6d.; 2797, 6d.; 2799, 6d.; 2803, 6d.; 2806, 6d.; 2808, 6d.; 2810, 6d.; 2816, 6d.; 2826, 6d.; 2827, 6d.; 2828, 6d.; 2829, 6d.; 2832, 6d.; 2837, 6d.; 2838, 6d.; 2839, 6d.; 2850, 4d.; 2867, 6d.; 2871, 6d.; 2874, 4d.; 2875, 6d.; 2876, 6d.; 2877, 2d.; 2884, 2d.; 2903, 2d.; 2905, 2d.; 2909, 2d.; 2910, 2d.; 2911, 2d.; 2922, 2d.; 2923, 2d.; 2924, 6d.; 2929, 2d.; 2932, 4d.; 2933, 2d.; 2935, 2d.; 2940, 2d.; 2943, 4d.; 2946, 4d.; 2947, 8d.; 2951, 2d.; 2952, 2d.; 2954, 2d.; 2957, 2d.; 2963, 6d.; 2966, 6d.; 3024, 2d.; 3044, 4d.; 3090, 6d.; 4407, 2d.; 4633, 6d.; 4795, 6d.; 4835, 6d.

, Specifications will be forwarded by post from the Patent-office on receipt of the amount of price and postage. Sums exceeding 1s. must be remitted by Post-office order, made payable at the Post-office, 5, High Holborn, to Mr. H. Reader Lack, her Majesty's Patent-office, Southampton-buildings, Chancery-lane, London.

ABSTRACTS OF SPECIFICATIONS.

Prepared by ourselves expressly for The Engineer *at the office of Her Majesty's Commissioners of Patents.*

1955. Umbrellas, Parasols, and Sunshades, *F. Wolf, Copenhagen.*—25th *April*, 1882.—(*A communication from A. Malmros, Sweden.*—(*Not proceeded with.*) 2d.

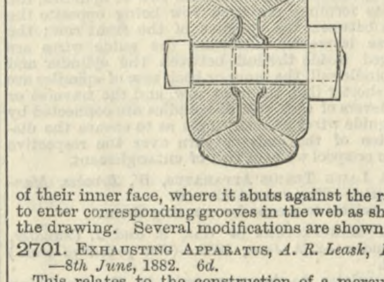
This relates to means for allowing an additional folding up of the umbrella when it is not used or is shut up.

2558. Improvements in the Generation, Storage, Distribution, &c., of Electricity, *J. S. Williams, Riverton, New Jersey, U.S.*—30th *May*, 1882. 1s.

This relates, First, to the employment of metal or metallic alloys placed in suitable chambers constructed of transparent materials, which will give out light when heated to such a degree as to be liquefied by the electric current. The chamber is exhausted of air. It also relates to apparatus for the distribution, regulation, and storage of electric currents and power. There are twenty-two claims.

2678. Railway Rails, Fish-joints, &c., *F. C. Winby, Westminster.*—7th *June*, 1882. 6d.

This consists partly in the construction of fish-plates with longitudinal projections along the top and bottom



of their inner face, where it abuts against the rail web to enter corresponding grooves in the web as shown in the drawing. Several modifications are shown.

2701. Exhausting Apparatus, *A. R. Leask, London.*—8th *June*, 1882. 6d.

This relates to the construction of a mercurial air pump, specially applicable to exhausting the bulbs of incandescent electric lamps.

2761. Paper Bag Machines, *M. and L. Campe, Berlin.*—12th *June*, 1882. 8d.

This relates to improvements in the general construction of the machine for manufacturing either three-cornered or four-cornered paper bags.

2783. Machinery for Cutting and Dressing Stone, *H. J. Haddan, Kensington.*—13th *June*, 1882.—(*A communication from A. McDonald, Massachusetts.*) 6d.

This relates to mechanism for adjusting each rotary disc to its proper vertical position and dip or inclination to the stone to be cut by it.

2788. Wheeled Vehicles for Facilitating the Unloading of Timber, &c., *E. Rayner, Liverpool.*—14th *June*, 1882. 6d.

This consists in constructing or fitting the body of the vehicle with two or more rollers placed transversely at distances from each other in an inclined plane from rear to front of the said vehicle. The rollers, or one or more of these, is or are so arranged that immediately before and during the time of unloading, the timber or other articles are carried by the said rollers, which rollers are free to rotate on their axes.

2792. Centre Seconds Watches, *J. H. Godsell, Coventry.*—14th *June*, 1882. 6d.

This consists in the construction and arrangement of parts for causing the centre seconds hand of the watch, driven from the fourth wheel carrying the ordinary seconds hand, to describe five revolutions per minute, or other number of revolutions per minute more than one, so as to fit the watch for the measurement of shorter intervals of time than can be measured by ordinary centre seconds watches.

2797. Abdominal Belt, *W. A. Barlow, London.*—14th *June*, 1882.—(*A communication from W. Teufel, Stuttgart.*) 6d.

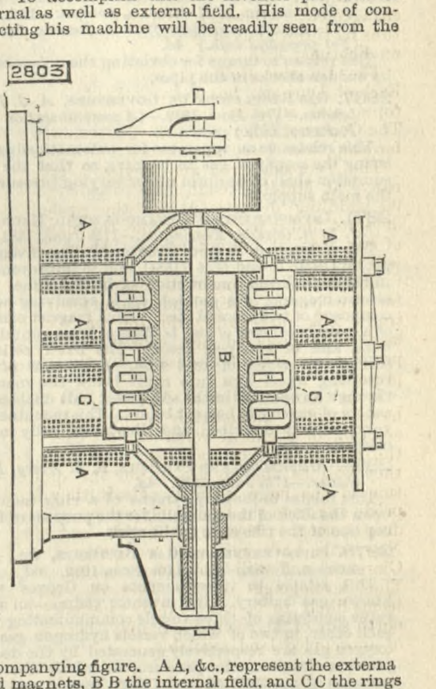
This consists in the employment of a lock girth in combination with a pad attached inside, and spring fastened to the outside of the pad attached to the belt proper.

2799. Machinery for Spinning Fibres, *S. Tweedale, Accrington.*—14th *June*, 1882. 6d.

This relates to the employment of a movable or tilting carrier and pin, combined with the spindle and wharle.

2803. Improvements in Dynamo-electric Machines, *F. L. Willard, Hoxton.*—14th *June*, 1882. 6d.

The object of this invention is to so surround the armature by the inducing magnets that it shall receive nearly all inductive effect they are capable of giving off. To accomplish this the inventor provides an internal as well as external field. His mode of constructing his machine will be readily seen from the



accompanying figure. A A, &c., represent the externa field magnets, B B the internal field, and C C the rings of the armature in section. The latter is composed of a series of rings of cast iron or wrought iron, bolted together and supported by check plates.

2806. Securing Sheets of Glass, Metal, &c., for Roofing or other Purposes, *S. Deards, Harlow.*—14th *June*, 1882. 6d.

This relates to the construction of clips.

2808. Fluting of Metal Rollers, *J. A. A. Buchholz, Vauxhall.*—14th *June*, 1882. 6d.

The inventor claims, First, the fluting of metal rollers by the use of multiple pointed grooving tools; Secondly, the manufacture of the multiple pointed grooving tools, by means of rotary cutters or milling tools.

2810. Ratchet Braces, *T. W. Cheesebrough, London.*—14th *June*, 1882. 6d.

This consists of a ball ratchet, the teeth whereof are cut or formed obliquely or skew-wise on the ball, the ratchet being propelled by not less than two pawls, which may be placed in the usual handle.

2816. Filter Press, *J. Simpson and E. W. Parnell, Liverpool.*—15th *June*, 1882. 6d

This consists, First, in a chamber provided with suitable inlet and outlet ways, and with a movable bottom carrying the filter bed; Secondly, the employment in the chamber of a scraper or stirrer; Thirdly, employment of a hydraulic screw or other suitable means for raising and lowering the movable bottom; Fourthly, gear for removing the filtered residue from the bottom after each operation.

2826. Manufacture of Lead in the Form of Thread-like Fibre, *F. J. Cheesbrough, Liverpool.*—15th *June*, 1882.—(*A communication from A. K. Eaton, Brooklyn, U.S.*) 6d.

This consists in manufacturing lead in the form of fine hair or thread-like fibre by forcing it through fine perforations.

2827. Wire Ropes, *F. C. Guilleaume, Cologne.*—15th *June*, 1882. 6d.

This consists chiefly in making the wire ropes of a hollow or tubular construction.

2828. Attaching Door Knobs to Spindles, &c., *H. E. Baxter, Birmingham.*—15th *June*, 1882. 6d.

One handle is fixed to the spindle and the other in fastened by means of a disc passing through a slit is the handle, and engaging with one of a series of slots in the face of the spindle.

2829. Water Supply and Regulating Apparatus for Flushing Drains, *R. R. McKee, Kirkcaldy.*—15th *June*, 1882. 6d.

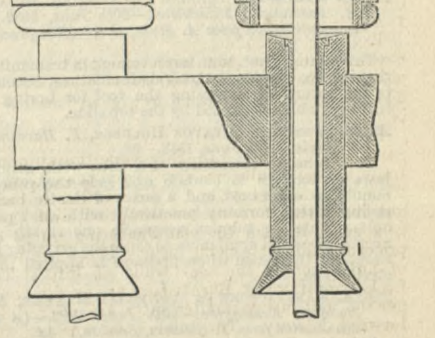
This relates to means for flushing drains with water periodically and automatically.

2832. Flap Valves, *E. Edwards, London.*—15th *June*, 1882.—(*A communication from E. Roche, Marseilles.*) 6d.

The inventor claims the combination of the valve seat with or without a projection, a flap valve, a hook, guides, cross bar, and screwed rod actuated by a nut or its equivalent.

2838. Ring Spinning Machinery, *G. Perkins, G. Wimpenny, and J. H. Evans, Manchester.*—16th *June*, 1882. 6d.

This consists, First, in the traveller G in connection with an internally grooved ring; Secondly, a traveller made of wire bent so as to produce yarn guides, hooks or eyes, and having bent or curved ends or parts



which run in an internal groove turned or formed in a ring; Thirdly, a traveller having yarn guides or eyes suitably formed to be sprung into position within a ring to be formed with an internal groove in which the two ends run; and, Fourthly, the groove I in the lower end of the bolster in connection with a suitably formed whirl running close to the bolster end.

2837. Water Taps or Valves, *G. Chisholm, sen. and jun., Stirling.—16th June*, 1882. 6*d*.

This consists, First, in the construction of taps or valves through which the passage of water is regulated by a ball of india-rubber or other equivalent material operated by an excentric acting upon a spindle; Secondly, the construction of taps or valves through which the passage of water is regulated by a ball of stone, glass, porcelain, or other equivalent material in combination with a valve seat of india-rubber or other equivalent material.

2839. Apparatus for Retaining Heat in Infants' Feed Bottles, *C. P. D. Chittenden, Lee.—16th June*, 1882. 6*d*.

This relates to the employment of two boxes one within the other, the space between them containing a non-conducting substance. The bottle is placed in the inner box.

2850. Supplying and Distributing Water to and in Houses, &c., *J. H. Johnson, London.—16th June*, 1882.—(*A communication from A. Dumas, Paris.*)—(*Not proceeded with.*) 4*d*.

This relates to means for obviating the noises caused by sudden shocks in the pipes.

2867. Gas Regulators or Governors, *A. J. Boult, London.—17th June*, 1882.—(*A communication from P. Parsy, Lille.*) 6*d*.

This relates to an apparatus for automatically regulating the supply of gas to burners, so that the consumption shall be uniform under varying pressures in the main supply.

2871. Improvements in Dynamo-electric Machines, *J. E. H. Gordon, Kensington.—17th June*, 1882. 6*d*.

This relates to improvements in the inventor's patents Nos. 78 and 5536 (1881), and to improvements in the mechanical construction of his machine. The electro-magnets are carried on a revolving wheel composed of two discs of steel. Each magnet consists of a cylindrical core of two bobbins of brass containing wire, and of two pole pieces. The fixed coils are carried by rings of cast iron. A portion of the revolving wheel dips into a pit below the machine through an opening in the sole plate; this enables the centre of gravity to be kept below. This machine was very recently described and illustrated fully in our columns.

2874. Umbrellas and Parasols, *R. B. Avery, Manchester.—17th June*, 1882. 4*d*.

This relates to the employment of a ring mounted upon the stick of the umbrella for the purpose of holding tips of the ribs close to the stick.

2875. Improvements in Gas Batteries, &c., *R. J. Gülcher, Notting-hill.—17th June*, 1882. 6*d*.

This relates to improvements on Groves' well-known gas battery. The inventor claims—an apparatus consisting of three vessels communicating with each other, in two of which vessels hydrogen gas and oxygen gas are respectively generated by the decomposition of water under pressure, caused by the compression of air confined in the third vessel; and also, apparatus in combination with the above, by means of which the gases may be utilised to produce lime-light.

2876. Manufacture of Carbonate of Soda, *H. Gaskell, jun., and F. Hurter, Widnes.—17th June*, 1882. 6*d*.

This consists in the production or manufacture of bicarbonate of soda by subjecting anhydrous carbonate of soda to the action of water or aqueous vapour, and of carbonic acid gas.

2877. Improvements in Electrical Apparatus for Ascertaining the Depth of Water, &c., *W. R. Lake, London.—17th June*, 1882.—(*A communication from L. G. Coffinières de Nordeck, Paris.*)—(*Not proceeded with.*) 2*d*.

This relates to a sounding line combined with suitable apparatus, which registers the depth immediately the lead touches the bottom.

2884. Preparing Colours with Mordants, *B. Grénié, London.—19th June*, 1882.—(*Not proceeded with.*) 2*d*.

This relates to the preparation of colours and mordants so as to render such colours indelible, and to fasten them permanently in any material upon which they are used. This result is effected by the emulsion of gumlac under proper conditions by means of borate of sodium.

2903. Cloth Plaiting and Measuring Machines, *C. and A. Edmeston, Manchester.—20th June*, 1882.—(*Not proceeded with.*) 2*d*.

The invention consists in arranging the gripper plates or bars to rise and fall, and in actuating them by cams or excentrics, and connected mechanism from the crank shaft to lift, and allow the plaiting knife or edge to pass under, and then descend upon, and hold the plait of the cloth when the knife or edge retires.

2905. A New Telephone Receiver, *W. H. Snell, Tiverton.—20th June*, 1882.—(*Not proceeded with.*) 2*d*.

The receiver is composed of a steel diaphragm, which is magnetised and acted on by a flat helix of wire parallel to it, in which the current travels.

2909. Lighting Purposes, *J. H. Johnson, London.—20th June*, 1882.—(*A communication from A. Jeansaume, Paris.*)—(*Not proceeded with.*) 2*d*.

A candle or lamp is attached to spectacles or otherwise conveniently secured to the head of the person using the light.

2910. Improvements in Machinery or Apparatus for Generating or Utilising Electricity, *C. E. Kelway, London.—20th June*, 1882.—(*Not proceeded with.*) 2*d*.

This relates to a method of constructing dynamo machines, in which both armature and field magnets are made to revolve in opposite directions to one another.

2911. Improvements in Means for Carrying Electric Wires through Streets, *J. Kincaid, Westminster.—20th June*, 1882.—(*Not proceeded with.*) 2*d*.

This relates to hollow blocks of iron, stoneware, &c., to be laid as kerbs to footpaths, &c., and at the same time to carry the wires inside them.

2922. Fastenings for Brooches and Scarf Pins, *E. P. Wells, London.—20th June*, 1882.—(*Not proceeded with.*) 2*d*.

As applied to brooches the fastening is made of a hooked form, that is, two hooks actings as springs are arranged in a vertical plane one within the other and turned in opposite directions.

2923. Lathes for Turning and Cutting Metal, *J. A. Farnworth, Manchester.—20th June*, 1882.—(*A communication from A. Muir, U.S.*—(*Not proceeded with.*) 2*d*.

This relates, First, to an improvement in transmitting the variable speed to the back shaft of lathes; Secondly, to the means of traversing the tool for boring and turning, which is carried by the top slide.

2924. Pencil or Crayon Holders, *F. Hardtmuth, Budweis.—20th June*, 1882. 6*d*.

This consists essentially of a tube with gripping jaws or tongues to contain and grip the pencil, a handle, or outer case, and a series of elastic bars, or spring levers, forming practically with said pencil holder, tube, or tubular receptacle one rigidly connected piece and appliances to cause the gripping jaws to release the pencil when pressure is applied to the elastic bars.

2932. Manufacture of Artificial Manure, *H. J. Haddan, Kensington.—20th June*, 1882.—(*A communication from T. Richters, Breslau.*) 4*d*.

The inventor claims in the process of producing nitrogenous manure from nitrogenous material, the moderate dry heating of waste material impregnated with sulphuric acid in two stages, and with the access of air in such a manner that the sulphuric acid is first concentrated and the waste material partly dried by heating the said material up to 100 deg. C., and that the said waste material is further dried and its structure destroyed by a subsequent heating up to 250 deg. maximum, and so as to prevent the burning of the material by keeping the temperature low.

2929. Metallic Printing, &c., *H. Panowski and K. M. Ross, London.—20th June*, 1882.—(*Not proceeded with.*) 2*d*.

This consists in printing in the usual way with an ink containing in itself the metallic substance.

2933. Fire-escapes, *H. J. Haddan, Kensington.—20th June*, 1882.—(*A communication from C. H. Hohmann, Cassel, Germany.*)—(*Not proceeded with.*) 2*d*.

The object is to lower persons or goods from burning houses by means of a band or rope and without loss of time, also to enable persons to lift themselves up to the windows or other parts of buildings by winding up the rope or band from which they are suspended.

2935. Fire-proof Screen or Shutter for Separating the Stage from the Auditorium of Theatres, &c., *A. Clark, London.—20th June*, 1882.—(*Not proceeded with.*) 2*d*.

The screen is constructed of iron or steel plates, and is made double with a space between the two skins, which may be filled with water or a non-conductor of heat. Suitable means are provided for raising and lowering the screen.

2940. Apparatus for Supplying Disinfectants to Water-closets, Urinals, Drains, &c., *T. Beddoe, London.—21st June*, 1882.—(*Not proceeded with.*) 2*d*.

This relates to an apparatus for distributing disinfectant through a pipe by means of a force of air.

2943. Improvements in Primary and Secondary Galvanic Batteries, &c., *Dr. H. Aron, Berlin.—21st June*, 1882. 4*d*.

This relates to the application of a material formed by the combination of gun-cotton and collodium with metallic oxides or salts to the production of electric currents. The inventor calls the material metallodion. It is produced, according to one method, by mixing salts soluble in alcohol with collodium, allowing the mixture to be sucked up by plates of textile material, and placing these plates in a solution of a metallic salt, whereby the metal forms, with the salt of the collodium, the metallodion. For use in batteries, a plate of conducting material is covered with a fresh emulsion and allowed to dry, after which it is ready for use.

2946. Producing Azo Colours on Cotton Fibre, &c., *C. Holliday, Huddersfield.—21st June*, 1882. 4*d*.

The inventor claims the production of azo-colours on cotton or other vegetable fibre by neutralising the bath of diazo or diazo-azo compounds employed.

2947. Bicycles, Tricycles, &c., *J. Edge, jun., and F. W. Ticehurst, Birmingham.—21st June*, 1882. 8*d*.

This relates, First, to improvements in connecting the fork to the back-bone; Secondly, to the construction of the pedals; Thirdly, to the construction of lamps; Fourthly, to the mode of attaching the lamps.

2951. Machines for Sharpening Pencils, *H. F. Hambruch, Hamburg.—21st June*, 1882.—(*Not proceeded with.*) 2*d*.

This relates, First, to the material for covering the rotating sharpening roller with; Secondly, to clamping devices for holding the pencil; Thirdly, to mechanism for pressing the pencil to the sharpening roller.

2952. Machines for Cleaning Knives, *H. F. Hambruch, Hamburg.—21st June*, 1882.—(*Not proceeded with.*) 2*d*.

This relates to mechanism in which the blades pass between rotating rollers, and the objects are, First, to apply a device for automatically pushing the blades to and fro; Secondly, to provide a fastening mechanism for holding the knives while cleaned; Thirdly, to facilitate the adjusting of the knives in the proper position for passing the blades between the cleaning rollers; and, Fourthly, to furnish a transportable feeder for cleaning powder.

2954. Improvements in the Means or Apparatus for Measuring Electric Currents, *C. A. Carus-Wilson, Grenville-place, Middlesex.—21st June*, 1882.—(*Not proceeded with.*) 2*d*.

The inventor employs two vessels separated by a porous partition and filled with a suitable liquid in which electrodes are plunged, and with these vessels he combines apparatus for registering the amount of liquid, which, under the action of endosmose produced by the passage of an electric current, flows from one vessel to the other.

2957. Impregnating and Preserving Soft Wood and Timber, *G. J. Cross, New Cross.—21st June*, 1882. 2*d*.

This consists in the employment of fine powdered asbestos in combination with silicate of soda or silica in powder, or cyanite and a liquid forming a paint or liquid bath for application to soft wood and other material, to render it uninflammable and for preserving it from climatic decay and from the ravages of white ants.

2963. Mules for Spinning Fibres, *J. S. Cooke and A. Hardwick, Liversedge.—22nd June*, 1882. 6*d*.

The mules comprise a double row of spindles, the spindles forming the back row being opposite the spaces between the spindles of the front row; the traverse levers for actuating the guide wires are arranged inside the rail between the cylinder and the spindle rail, the inner or back row of spindles are made shorter than the front row, and the traverse or faller levers of each pair of spindles are connected by cross guide wires at such angle as to ensure the distribution of the ends or yarn over the respective bobbin or spool without risk of entanglement.

2966. Lawn Tennis Apparatus, *W. Brookes, Manchester.—22nd June*, 1882. 6*d*.

This relates to means for securing the net.

3024. Manufacture of Gas, *S. and J. Chandler, London.—27th June*, 1882.—(*Not proceeded with.*) 2*d*.

This relates to improvements in the scrubbing device.

3044. Production of Certain Derivatives of Alpho-oxyhydro-chinoline and of Beta Oxyhydro-chinoline, *J. Erskine, Glasgow.—28th June*, 1882.—(*A communication from M. Lucius and Brüning, Hoechst-on-Main.*) 4*d*.

The inventor claims the preparation of alpha oxyhydro-methyl chinoline and alpha oxyhydro-ethyl chinoline and of beta oxyhydro-methyl chinoline and of beta oxyhydro-ethyl chinoline from alpha and from beta oxyhydro chinoline.

3090. Self-acting Mules, *C. A. Barlow, London.—30th June*, 1882.—(*A communication from V. Lenoir, Paris.*) 6*d*.

This consists in making the driving or drum shaft in two pieces, and connecting them by bands or gearing in order to reverse the motion of the spindles.

4407. Improvements in Galvanic Elements, *J. H. Johnson, Lincoln's-inn-fields.—16th September*, 1882.—(*A communication from Dr. A. Bernstein, Berlin.*) 2*d*.

This relates to the employment of an amalgamated alkali metal—for instance, potassium or sodium—as an electrode. The electrode thus composed is introduced into a small bag consisting of any cloth not affected by the exciting fluid employed. This bag is then impregnated with a solution of caustic soda or potash, containing in 100 parts from 30 to 50 parts by weight of the alkali.

4785. Treating Linseed for Obtaining Flour or Seed of Flax, *G. G. B. Casero, France.—7th October*, 1882.—(*Complete.*) 2*d*.

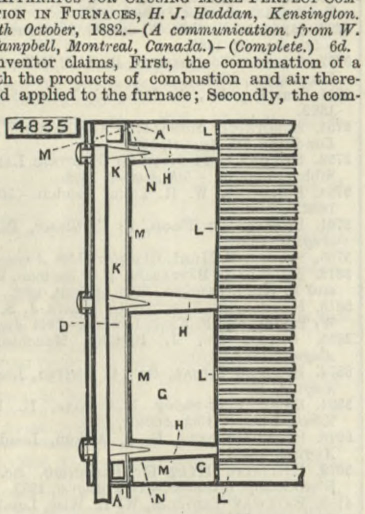
This relates to the production of tablets suitable for the toilet, for medical applications, and for finishing or dressing woven fabrics from linseed by reducing the same to powder and eliminating the oil by means of liquids which dissolve it, and which are afterwards expelled by distillation. The powder is spread out in thin layers and subjected to a current of dry air. The powder may be pressed into moulds.

4795. Machinery for Preparing Fibrous Substances for Spinning, *H. J. Haddan, Kensington.—9th October*, 1882.—(*A communication from J. F. Gebhart, New Albany, U.S.*)—(*Complete.*) 6*d*.

The object is to obtain a perfect and reliable mechanism for feeding second breaker and condenser carding engines, and to obtain a continuous uniformity of the prepared sliver or roving during the process of laying it in parallel serpentine rows upon an endless feed table.

4835. Apparatus for Causing More Perfect Combustion in Furnaces, *H. J. Haddan, Kensington.—11th October*, 1882.—(*A communication from W. A. Campbell, Montreal, Canada.*)—(*Complete.*) 6*d*.

The inventor claims, First, the combination of a blast with the products of combustion and air therewith, and applied to the furnace; Secondly, the com-



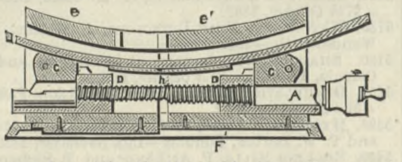
bination of the chamber D, passages H, openings A1, M, and L, and nozzle K, provided with a blast; Thirdly, the combination of the perforated chambers, chamber D, passages H, openings M L, damper or valve N, and nozzles K, provided with a blast.

SELECTED AMERICAN PATENTS.

From the United States' Patent Office Official Gazette.

269,901. Tire Upsetter, *Frederic E. and Frank O. Wells, Greenfield, Mass.—Filed July 24th*, 1882.

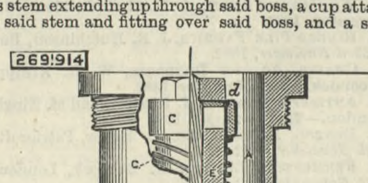
Claim.—(1) The combination of the shoe H and pieces E E1, cams C C, nuts D D, and shaft A for the



purpose of upsetting the tire and incidentally preventing it from bending, substantially as described. (2) The combination of the shaft A, cams C C, nuts D D, pieces E E1, bed piece F, plates J J1, and shoe H, substantially as described.

269,914. Air Pump Valve, *George B. Brayton, Boston, Mass.—Filed April 10th*, 1882.

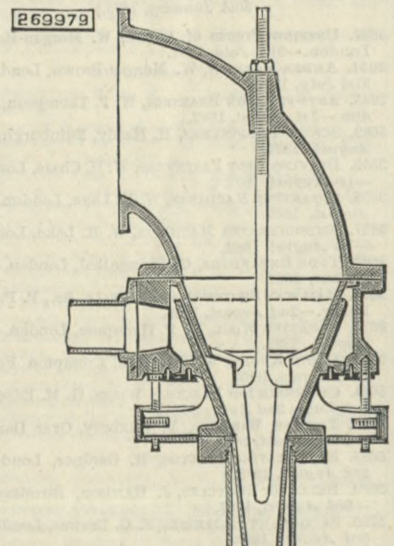
Claim.—(1) In combination with valve-box A, having tubular boss E attached thereto, the valve B having its stem extending up through said boss, a cup attached to said stem and fitting over said boss, and a spring



which tends to force said cup away from said boss, substantially as set forth. (2) The cup C, having an aperture *d*, for the purpose set forth, in combination with boss E, spring *c*, and valve B, substantially as set forth.

269,979. Injector Condenser, *Jerome Wheelock, Worcester, Mass.—Filed September 6th*, 1882.

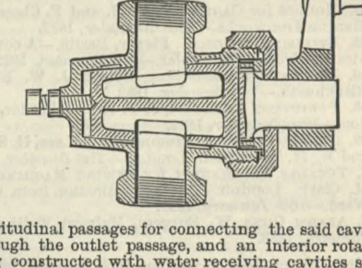
Claim.—(1) In an injector condenser, the combination, substantially as hereinbefore described, of the exhaust pipe, the conical steam nozzle, the discharge nozzle, and an annular water passage having one wall



which is adjustable with reference to the other. (2) In an injector condenser, the combination of a conical steam nozzle, a water chamber containing the steam nozzle and a fixed outer wall and a movable conical inner wall surrounding the steam nozzle, substantially as described, whereby the annular space between said inner wall and the conical steam nozzle may be graduated for the passage of water. (3) In an injector condenser, a water chamber having an outer and an inner wall separately constructed and united by a flexible ring, substantially as described. (4) In an injector condenser, the combination of the central steam nozzle, the surrounding annular water passage, the contracted tapering ejection nozzle below the water passage, and the central nozzle plug located within the steam nozzle and also within the ejection nozzle, substantially as described, whereby the descending column of steam is deflected radially against the surrounding annular column of water, and the steam and water then concentrated into an annular column in their passage through the ejector nozzle, as set forth. (5) In an injector condenser, the combination of the central steam nozzle, the surrounding water passage, the ejector nozzle, the central plug within the steam nozzle and within the ejection nozzle, and means for longitudinally adjusting said plug, substantially as described, whereby the radial deflection of steam may be varied at the steam nozzle and the descending column of steam and water more or less annularly concentrated at the ejector nozzle, as set forth. (6) The injector condenser, substantially as described, embodying in combination, substantially as described, the steam nozzle, the ejection nozzle, the solid central nozzle plug, and the adjustable annular water passage. (7) The combination, in an injector condenser having a water chamber and steam nozzle, of the movable inner wall of said water chamber surrounding said steam nozzle, the gear nuts and bolts by which said inner wall is supported, and the internal gear by which said gear nuts are simultaneously rotated, substantially as described, for adjusting the postion of said inner wall with relation to the steam nozzle, and thereby regulating the water supply, as set forth.

269,993. Boiler Feeder, *Benjamin T. Babbitt, New York, N.Y.—Filed October 28th*, 1882.

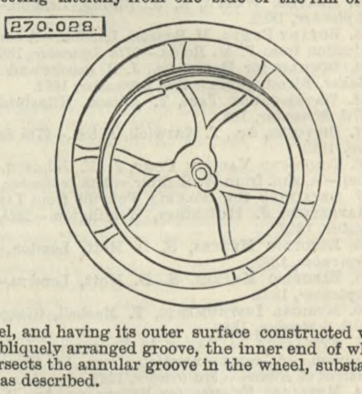
Claim.—A device for feeding water to boilers, combining in its structure a shell or casing having an inlet and an outlet passage, interior balancing cavities and



longitudinal passages for connecting the said cavities through the outlet passage, and an interior rotating plug constructed with water receiving cavities separated by a partition, said shell or casing having means for connecting it with the steam space of a boiler, substantially as and for the purpose described.

270,028. Self Belting Pulley, *John E. Donovan, Cincinnati, Ohio.—Filed July 6th*, 1882.

Claim.—A band wheel constructed with an annular band receiving groove in its periphery, and a flange projecting laterally from one side of the rim of the



wheel, and having its outer surface constructed with an obliquely arranged groove, the inner end of which intersects the annular groove in the wheel, substantially as described.

CONTENTS.

South Kensington Museum.—Visitors during the week ending Jan. 27th, 1883 :—On Monday, Tuesday, and Saturday, free, from 10 a.m. to 10 p.m., Museum, 11,204; mercantile marine, Indian section, and other collections, 3307. On Wednesday, Thursday, and Friday, admission 6d., from 10 a.m. to 4 p.m., Museum, 1570; mercantile marine, Indian section, and other collections, 179. Total, 16,260. Average of corresponding week in former years, 13,475. Total from the opening of the Museum, 21,663,067.