THE PREVENTION OF SCALE IN STEAM BOILERS.

The formation and prevention of scale in steam boilers has been from time to time discussed pretty keenly in almost every mechanical and engineering journal. The number of specifics and nostrums, sold under all kinds of fancy names, for its prevention and removal, are legion. Complicated apparatus and constructions have also been proposed, and, to some extent, used for removing the scale by boiling and heating the feed-water under pressure previous to use. Unfortunately, however, the trouble and expense of these arrangements, added to their first cost, come to nearly the same thing as simply replacing the worn-out steam boiler, which has become injured by scale, with a new one. Learned articles with chemical signs and equivalents have been published, explaining scientifically the theory and formation of boiler scale; but to many steam users unacquainted with chemistry they are about as instructive as if they were written in a foreign language. Perhaps it may not therefore be out of place to explain, in as simple a manner as possible, the nature of boiler-scale and the cause of its formation.

What is termed boiler-scale is a mineral deposit from the feed-water whenever hard water is used as a source of supply. All lake, river, and spring water is more or less hard. The hardness is caused by the water coming in contact with certain mineral substances, which the water dissolves to a small extent when running over or through the ground. These substances are chiefly carbonates and sulphates of lime, some magnesia, and, at times, traces of iron. There are two kinds of hard water, which chemists call "temporary" and "permanent" hard water. The first kind, or temporary hardness, is caused by the carbonate of lime and magnesia which has been dissolved by the water, and it is called temporarily hard because when the water is boiled all the carbonate of lime is rendered insoluble, that is to say, it is no longer dissolved by the water, but is thrown out, and falls in a white slimy deposit of carbonate of lime. The second kind of hard water, that termed permanently hard, is caused by the sulphate of lime dissolved by the water. Simple boiling does not make it insoluble or remove it. The water therefore that contains it is permanently hard, that is to say, it cannot be softened by simple boiling, but only by boiling under a high pressure, or by heating the water up to a high temperature, which means the same thing. All water contains more or less of these two substances, carbonate and sulphate of lime, causing the temporary and permanent hardness. They are by no means always present in the same quantities or proportions; that is to say, some waters are much harder than others, and some are much more temporarily hard than permanently hard, or the reverse may be the case. It will be seen, therefore, from this simple explanation that the carbonate and sulphate of lime must both be rendered insoluble and deposited in the steam boiler, the first as soon as the water begins to boil, the second as soon as the water comes under the steam pressure of the boiler. It will also be evident that they will be deposited in the hottest place in the steam boiler, that is to say, just on the surface of the plates exposed to the fire, it being entirely the action of the heat that makes them insoluble. This is, of course, what takes place in practice. The coolest water in the boiler is constantly descending, the hot water ascending. The cold water is deprived of its lime salts just on the surface of the heated plate; the purified water passes up, leaving the sulphate and carbonate of lime sticking to the boiler plate in the form of scale. The action of this scale is that of a non-conductor—that is to say, it keeps the heat passing into the iron plate from being imparted to the water of the boiler; the consequence is a largely increased consumption of fuel, and the burning of the boiler plate by the fire, owing to its not being in contact with the water, and thus kept cool.

From the above simple description of the theory of the formation of boiler-scale, it will be evident that if the substances causing the hardness of the water, and also the boiler-scale, can be rendered insoluble *before* they come in contact with the heated boiler plate, that the formation of the boiler-scale will be impossible. This is all that is required, and not necessarily their removal previous to entering the boiler, as they settle down to the bottom, instead of adhering to the plates or the tubes, and pass away by the blow-off tap. This is, or rather should be, the object of the many boiler compounds sold as anti-crustators; but of the many different kinds offered to the public, few fulfil the necessary conditions of doing their work cheaply and effectively. A boiler compound should in the first place render all the lime salts insoluble before they are rendered insoluble by coming in contact with the heated plates of the boiler. Secondly, it should have no action whatever on the iron of which the boiler is made; and lastly, it should be cheap, readily obtained, and easy to handle.

Now, considering all these points, no substance seems better suited for the purpose than pure soda. The usual form, or what is generally understood by soda, is soda ash or soda crystals. These articles, however, are not soda properly so-called, but carbonate of soda more or less impure—that is to say, soda in combination with carbonic acid, and in this form sluggish and comparatively ineffective in rendering insoluble and removing the carbonates and sulphates of lime which form the boiler-scale. Soda properly so-called is "caustic soda," that is to say, soda uncombined with any acid, and therefore in a free state. This article is very effective in softening water, or, in other words, rendering the carbonates and sulphates of lime insoluble, and, when *pure*, has no action whatever on the boiler plates. When required for boiler purposes it should always therefore be used in a pure state, say not less than a strength of 98 per cent., therefore the total impurities not exceeding 2 per cent. Common caustic soda, as sold in drums containing large solid blocks, does not do well for boiler purposes; the usual strength of this article is only 60 per cent., and it contains sulphur salts, besides a large quantity of common salt, which act very prejudiciously on the boiler plates. The pure 98 per cent. caustic soda is prepared in a powdered form by some manufacturers; and one of them—the Greenbank Alkali Co., of St. Helen's—seems to have made a speciality of it in small air-tight 10 lb. canisters, which are very convenient for small consumers. With the powdered caustic soda there is no trouble in handling or weighing out the exact quantity required, as is the case with the large solid blocks in drums, and it also dissolves instantly in cold water. In using pure powdered caustic soda for boiler purposes, all that is necessary is to put a small quantity daily into the feed-water of the boiler. In this way the lime is all rendered insoluble, forms no scale, and passes off in the blow-off as a muddy sediment. The quantity required is quite small, as a very little really pure caustic soda goes a long way. In ordinary cases about three pounds added daily to the feed-water of a 20-horse boiler will keep it perfectly clean and free from scale. For large consumers with many boilers a more accurate estimation of the quantity required to soften the water will be necessary. It has been already mentioned that ordinary water is of varying degrees of hardness and composition, but if drawn from the same source it is generally fairly uniform. The very hardest water generally met with will be softened and the lime removed by adding one-quarter of an ounce of pure powdered 98 per cent. caustic soda to each gallon of water. In most cases one-eighth part of an ounce is sufficient, and where the water is fairly good, one-sixteenth part of an ounce to the gallon of water will prevent all scale. To ascertain the quantity necessary, add one-sixteenth part of an ounce of 98 per cent. powdered caustic soda to a gallon of the water and boil it, as this causes the lime sediment quickly to settle. Pour off the clear water, and add to it another sixteenth part of an ounce of powdered caustic soda; if the water remains clear the first addition of soda is sufficient to remove the lime salts. If it becomes muddy the second quantity added is necessary. In this way a sufficiently accurate estimation of the quantity of pure powdered caustic soda required can be made, and then added to the feed-water in the same proportion. For example, suppose one-sixteenth part of an ounce per gallon was necessary. This will be just about four pounds of powdered 98 per cent. caustic soda to the thousand gallons; and as the cost of really pure powdered soda is about twopence per pound, the cost of perfectly softening the water will be eightpence per thousand gallons—a small cost compared with the advantage obtained of having no boiler-scale.

It may just be remarked in conclusion that many manufacturers require soft water for several other purposes besides steam boilers. It can readily be obtained by the use of pure caustic soda, and in most cases, as with steam boilers, it is not necessary absolutely to remove the carbonate and sulphate of lime, only to render them insoluble. This is the case with all water required for washing or scouring purposes when soap is used. When the lime is once precipitated it has no action on the soap, even if it remains in the water. It is also unnecessary when required for most dyeing purposes, though, in addition to the lime, the caustic soda also removes all the iron. The removal of the sediment of carbonate and sulphate of lime and iron can of course be effected, if required, by settling out in tanks, or by passing the water through any simple form of filter bed.

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Of nearly equal interest to the proposed Manchester Ship Canal is a novel suggestion to facilitate the conveyance of goods between Liverpool and the principal manufacturing centres of Lancashire, by means of what the promoters term a "Plateway." Although the proposal was unopposed on Standing Orders, it was withdrawn on the 11th inst. Probably the necessary deposit on an estimate of six millions sterling was not forthcoming; but it is by no means unlikely that the entire scheme will be revived next year, either in its present form, or something closely akin to it, and we have no hesitation, therefore, in placing the facts concerning it before our readers.

In the preliminary prospectus of the company it is stated "that although railways and canals are numerous in the district, the existing traffic occasionally taxes seriously their powers, and that their charges are so heavy as to have been the subject of long-standing and general dissatisfaction."

Besides the advantage of cheaper carriage, the Plateway Company hoped to be able to convey goods in better condition, more conveniently, and, probably, throughout Lancashire, in a shorter period of time than by any of the existing means. It is stated that the charges made by the railway companies in Lancashire are higher than can be found in other parts of the world, except in peculiar instances, such as the Panama Railway, and it is believed that fifty years of railway working have increased the cost of carriage between Liverpool and Manchester. It is alleged that traders in Lancashire are so dependent upon means of transit that, although they may grumble, the exigencies of the case compel them to pay whatever charges the railway companies demand, and that the profits made by the carriers in Lancashire are used to support unremunerative undertakings in other parts of the country. These are somewhat sweeping assertions to make, and if the promoters can substantiate them before the Committees of both Houses of Parliament, they will go far to prove the necessity for some cheaper method of carriage, or else for a revision of the scale of charges now enforced by the railway companies. These charges have long been a sore point with the Liverpool people, who accuse the railway companies of wishing to divert the traffic from Liverpool to other ports, in which they have a greater personal interest in the docks, such as Fleetwood, Garston, Barrow, Hull, &c.; but, on the other hand, one cannot lose sight of the enormous sums spent by the railway companies during the past twenty years in providing both additional station accommodation and new branch lines at Liverpool, Manchester, and all the principal towns in Lancashire. Liverpool has been surrounded by two distinct systems of railways, and magnificent goods-stations erected at the new Atlantic Docks. All these works have been of the most costly character, owing both to the nature of the country and the high price of land. It is alleged that the conveyance of goods and passengers by the same railway has increased the cost of the conveying the former to a much greater extent than is generally supposed, and has also diminished the carrying power of the line by demanding a considerable interval between the trains, and has caused needless and costly speed to the heavy traffic in order to clear the line.

In order to improve the existing state of affairs a number of the leading merchants in Liverpool formed the Lancashire Plateway Company, the idea of which, we believe, originated with Mr. Alfred Holt, M. Inst. C.E., who is a large shipowner in that port. The company entrusted the preparation of the plans to Messrs. T. and C. Hawksley and Mr. Edward Woods, of Westminster, and there can be no doubt that in the hands of such eminent engineers the plans have been prepared with the greatest skill and accuracy. The object of the Plateway Company is to construct a road, railway, tramway, or plateway, for there being no precedent for such a structure, it is somewhat difficult to give it a name—and we notice that in the list of Private Bills deposited with Parliament, the Plateway Bill is classed with Tramways—which shall be adapted to receive vehicles capable of using the ordinary roads, and to convey them to the nearest point on the plateway to their ultimate destination upon some form of rails or plates. The wheels of the vehicles cannot be provided with flanges, and, therefore, we assume that the rails will consist of a broad surface, on which the wheels will run, and provided with a flange or guard rail to keep the wheels on the rails. Many contradictory reports appeared as to the manner in which it was intended to lay the rails. At first it was rumoured that they were to be laid upon the existing highways, except in the densely populated districts where land was to be purchased; but the line was to closely follow the surface of the ground. Secondly, that the plateway was to be laid on its own land throughout, but to follow the surface, and cross all roads, and even railways, on the level. Whatever the original ideas of the promoters may have been, the plans and sections, as prepared by Messrs. Hawksley and Woods, are identical in all respects with those for an ordinary railway, and some of the works are of a very expensive character. The method of conveying goods by the plateway would be as follows:—A specially constructed wagon would be taken to the ship's side or warehouse at Liverpool and loaded, then dragged by horses to the nearest terminus of the plateway, and placed upon the metals. When a train was formed, a powerful locomotive or traction-engine would be attached, capable of drawing a heavy load at a moderate rate of speed. When any vehicle arrived at the nearest point on the plateway to its ultimate destination it would be detached from the train, and conveyed by means of horses along the high road to the mill or factory where its load was required—in fact, the plateway aims to be simply an "improved high road adapted to steam traction;" and the great advantages claimed for it are, that goods can be conveyed to their destination with a greatly diminished amount of handling; that the expense and delay of carting to and from the railway stations will be avoided, and railway "terminals" saved. In the grain trade the use of sacks will be dispensed with; in the coal trade the cart delivering at the house or factory will have been loaded at the pit, and thus avoid breakage and loss of weight. Agricultural produce can also be conveyed more easily to the towns than at present. The construction of the vehicles to be used on the plateway will present many problems to their designer. The most important point in the design will be that of weight. It is well known that the dead weight of the wagons now used on railways has steadily increased in proportion to the weight carried by them. This was rendered necessary owing to the severe strains brought upon them when forming part of the long trains now made up on our railways, and it will be a question whether the great weight required for a wagon intended to form part of a train on the plateway would not render it a somewhat unwieldy vehicle to convey by horses on the high roads, and it is doubtful whether it would be economical to do so except for very short distances.

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As an example of the expensive character of the proposed works, we may mention that in Liverpool a considerable area of valuable property has been scheduled for station purposes; that both routes leave the city through tunnels, one 2370 yards, and the other 2607 yards in length, and both having a uniform gradient of 1 in 80, which is the ruling gradient of the undertaking. The connecting line already referred to also passes through a tunnel 3127 yards long, and practically on the level. In St. Helen's there is another tunnel 750 yards in length. It will be seen from these examples that the "improved high road adapted to steam traction," referred to by the promoters in their prospectus, is of an exceedingly elaborate and costly character, and if the necessary parliamentary powers should be obtained, there may be some difficulty in raising the large capital required for the execution of the undertaking.

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Looking at Mr. Stallo's work, I should say that he holds a high place with regard to the first two of the three classes of qualities just enumerated, but that he falls very far short in the third. As a destructive critic he is admirable; even where we do not agree with his criticisms, we must acknowledge their force and their acumen. To this a far stronger testimony than mine has been given in a review in *Nature*, bearing the well-known initials of Professor Tait, which simply amounted to saying, "I cannot answer the book; but I do not believe it." As Professor Tait is perhaps the ablest British exponent of the atomo-mechanical philosophy, Mr. Stallo may well plume himself upon such a testimony to his intellect. Of his courage and readiness a pamphlet since published on "Speculative Science," in which he deals with an attack from Professor Newcomb, is a more than sufficient proof. But when we come to ask what Mr. Stallo can offer us, in place of the fabric he claims to have destroyed, we find it is nothing more than an airy tenement of metaphysical concepts, which, he is at much pains to assure us, is not and cannot be a substantial building at all.

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Again, the advocates of the mechanical theory may complain of one change made by Mr. Stallo himself in the enunciation of the above principles, viz., the substitution of mass for matter. He justifies it by saying that mass is that which remains when matter is denuded of all its active properties; and that it must be thus denuded, because all action is supposed, in this theory, to be due to motion alone. But mass, as a term used by Newton and his followers, does not mean matter, but quantity of matter; it is the ratio which the matter in any given body bears to the matter in some standard body; and if we make it a primary element, we practically recur to the theory of Pythagoras, who taught that number was the first principle of all things. "Matter and Motion," not "Mass and Motion," is the title of the well-known primer of Clerk-Maxwell, perhaps the most illustrious name to be cited—though by no means without reserve—on the side of the atomo-mechanical school; and physicists have surely acquired a right to make their own terminology. This is not the only instance in which Mr. Stallo falls into the common error of not making sure of his definitions. His feud with Professor Newcomb—which occasioned the pamphlet on "Speculative Science"—to a large extent arises from a confusion between them as to the correct application of the word "Elasticity." In older writings on mechanics—as now in common speech—an elastic body was one which suffered deformation or change of shape under stress, and recovered its original shape when that stress was removed; and thus india-rubber is said in common parlance to be more elastic than steel, because its deformation is greater. But elasticity, as a term in mechanics, is properly restricted to the definition given to it by Newton; a body is elastic when, after it has been struck by another body and the two have come to relative rest, it exercises a repulsive force, or force of restitution, which gives to the striking body a velocity in the opposite direction; and it is perfectly elastic when this velocity is equal to that with which the body was struck. It is in this latter sense that Maxwell and others have said that the ultimate atoms of matter are elastic, while Professor Newcomb, using the old sense, asserts that they are non-elastic, but have a repelling power; and Mr. Stallo has failed to perceive that the two propositions are not really in contradiction with each other.

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Similarly, various *à priori* notions as to the proper conditions of a hypothesis are the main ground of Mr. Stallo's attack on two of the most widely accepted of physical theories—the kinetic theory of gases and the wave theory of light. I apprehend that both of these will survive his assault, the nature of which we can only indicate in the briefest terms. His main objection to the kinetic theory is that the properties of a gas are far fewer and simpler than those of a solid, and therefore that any attempt to represent a gas as a mere assemblage of small solid particles is not a simplification but a further complication of the ideas. Now we admit that the pressure of a gas is in itself a simpler idea than the continual impacts of a vast multitude of elastic particles; but we deny the principle that if one phenomenon is resolved into another, the latter must necessarily be simpler than the first. That is simply the *à priori* dictum of a metaphysician, to be classed with the doctrine that planets must move in circles because a circle is the simplest of curves. Again, if we are to conceive of the atoms as nothing but so many billiard balls, I agree with Mr. Stallo that we gain nothing in simplicity by making those balls exceedingly little; but if we look on them as collections of centres of force, so bound together that we may regard each as a single centre, possessing nothing but simple forces of attraction and repulsion, then a very considerable advance in simplicity has really been attained. That the kinetic theory has other difficulties I am quite ready to admit, and also that physicists have perhaps been led away by its brilliancy to regard it as more nearly certain than is really the case; but it is not the absurd figment that Mr. Stallo would have us believe. Still less is this true of the wave theory of light. That there are difficulties in that hypothesis all physicists will allow, but these are no grounds for rejecting an hypothesis if all the others that can be formed on the subject are encumbered with difficulties much greater. Now with regard to light, there are only four hypotheses that have ever been proposed, and, so far as we can see, no others are possible. The first is that light is due to an ultimate action or exertion of force, susceptible of no further resolution, and comparable to gravity; this is the theory of J. S. Mill, and apparently of Mr. Stallo himself. The second is that light is due to an emanation of some kind from the seeing eye to the object seen; this was the theory of the ancients. The third is that light is due to the

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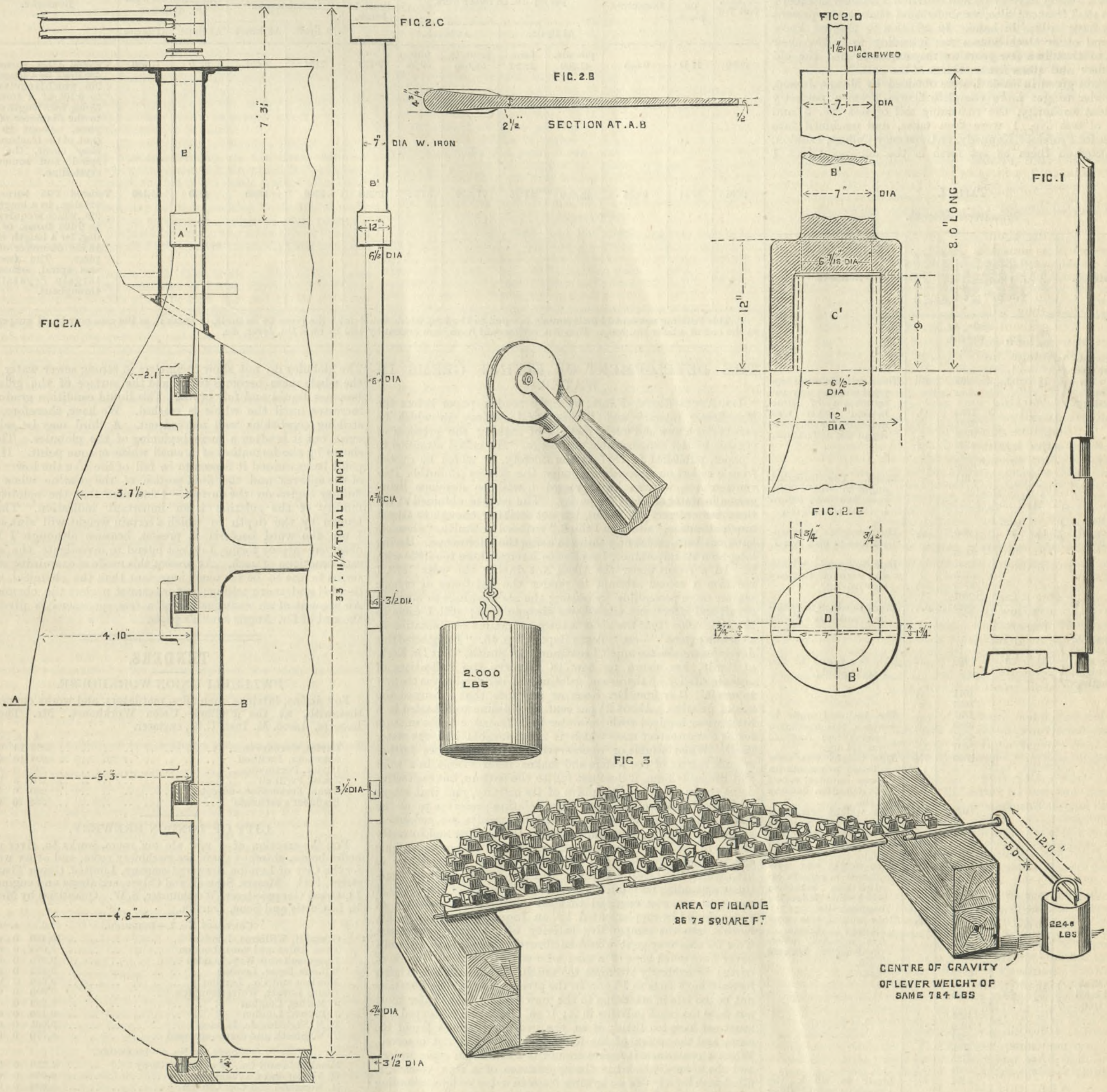
Mr. Stallo's real objection to this theory would appear to be that it recognises space and force as realities, whereas in his view they are "concepts." Everything with Mr. Stallo is a concept, and merely relative; I do not feel sure that he would not even consider number to be relative, and affirm that while the seven stars are no more than seven to us, there is no reason why they should not be eight to somebody or something else. This view is due to a singular fallacy which runs through the whole of his reasonings on this subject. It consists in assuming that because I—because men in general—cannot recognise or measure something except by relative standards and in relation to other things, therefore that thing has no absolute or independent existence at all; because we cannot measure a body's motion except with reference to some other body, supposed at rest, therefore motion in itself does not exist; because I can only describe a body's position in space by referring it to some other bodies, therefore it has no definite position in space at all, and space itself is a figment of the mind. Nothing can be more unfounded. Granting space to be a reality, it is clear that we still could not fix a body's place in it in any way except by referring it to some other thing in space, of which we could never be certain that it was fixed; and therefore the fact that we can only fix the position of bodies in that way is no evidence whatever that space is not real. For its reality, as for that of force, I simply adduce the immediate testimony of experience and observation given at almost every instant of our lives. I am as fully persuaded of their objective existence as I am of the subjective existence of any concept whatever, not only in Mr. Stallo's brain, but even in my own. Space on this view is a simple ultimate fact, which, for that very reason, can neither be explained or defined. Compare this view, not only with "that of Riemann—according to which—p. 210—space is a triply-extended multiple or aggregate, which can only be found or determined by subsuming it under that of an n-fold extended multiple—but also with Mr. Stallo's own, according to which—p. 235—space is the "abstractor concept of a form of spatial extension;" in which statement there are five words, all of them urgently needing to be defined—all of them, when defined, immeasurably less simple and clear in their meaning than space itself and two of which, at least, cannot, so far as I see, be defined at all, except by the aid of that true idea of space, the futility of which they are to assist in establishing.

The treatment of space is the best and most complete example of Mr. Stallo's method in its strength and its weakness. Nothing can be better than his refutation of J. S. Mill's views on the subject; or, again, of the extraordinary fallacies propounded by Riemann, and by the "metageometers;" but when we ask what he offers to take their place, we find nothing but an empty idealism. Similarly, while refuting the theories according to which force has no existence, Mr. Stallo regards force and mass not only as having no existence apart from each other—which is true—but as blending together to form a third thing, which is we know not what. He even lays down—p. 205—that "the measure of mass is the reciprocal of the amount of acceleration produced in a body by a given force, which force, in turn, is measured by the acceleration produced in a given mass." This is very like saying, "I know this is really a 10 lb. weight, because I have measured it to be so in my scales, and I know my scales are correct, because they measure this weight to be 10 lb." The vice of Mr. Stallo's method is, in fact, that, like other philosophers, he takes up certain *à priori* notions, spun out of his own brain, and insists that all the facts of the universe shall be made to square with them. Chief among these notions is the one already discussed, viz., that anything which can only be known in relation has therefore only a relative existence. This fallacy is the converse of the still more mischievous one which has deluded the German transcendentalists. They held that because there was absolute being, therefore there must be something which was out of all relation. He imagines that because there is nothing out of relation, therefore there is no absolute being at all. The fallacy of both lies in failing to see that a thing may at once be in relation to other things and yet independent of them; that my existence, for instance, may be altogether independent of Mr. Stallo, and so far absolute, but yet that it can only be known by him as related to himself.

Similarly, various *à priori* notions as to the proper conditions of a hypothesis are the main ground of Mr. Stallo's attack on two of the most widely accepted of physical theories—the kinetic theory of gases and the wave theory of light. I apprehend that both of these will survive his assault, the nature of which we can only indicate in the briefest terms. His main objection to the kinetic theory is that the properties of a gas are far fewer and simpler than those of a solid, and therefore that any attempt to represent a gas as a mere assemblage of small solid particles is not a simplification but a further complication of the ideas. Now we admit that the pressure of a gas is in itself a simpler idea than the continual impacts of a vast multitude of elastic particles; but we deny the principle that if one phenomenon is resolved into another, the latter must necessarily be simpler than the first. That is simply the *à priori* dictum of a metaphysician, to be classed with the doctrine that planets must move in circles because a circle is the simplest of curves. Again, if we are to conceive of the atoms as nothing but so many billiard balls, I agree with Mr. Stallo that we gain nothing in simplicity by making those balls exceedingly little; but if we look on them as collections of centres of force, so bound together that we may regard each as a single centre, possessing nothing but simple forces of attraction and repulsion, then a very considerable advance in simplicity has really been attained. That the kinetic theory has other difficulties I am quite ready to admit, and also that physicists have perhaps been led away by its brilliancy to regard it as more nearly certain than is really the case; but it is not the absurd figment that Mr. Stallo would have us believe. Still less is this true of the wave theory of light. That there are difficulties in that hypothesis all physicists will allow, but these are no grounds for rejecting an hypothesis if all the others that can be formed on the subject are encumbered with difficulties much greater. Now with regard to light, there are only four hypotheses that have ever been proposed, and, so far as we can see, no others are possible. The first is that light is due to an ultimate action or exertion of force, susceptible of no further resolution, and comparable to gravity; this is the theory of J. S. Mill, and apparently of Mr. Stallo himself. The second is that light is due to an emanation of some kind from the seeing eye to the object seen; this was the theory of the ancients. The third is that light is due to the impact of particles, which are projected from the object and strike the eye; this is the emission theory of Newton. The fourth is that light is due to a wave or vibratory movement in a medium of some kind, occupying the space between the eye and the object; this is the ordinary wave theory. Now, every physicist must admit that each of the first three theories is encumbered with difficulties immensely greater than the fourth, while it is still more inferior as to the fulness and accuracy with which it explains the facts. If this is so, we are fully justified in retaining the wave theory, not merely as a convenient hypothesis, but as a scientific doctrine of the highest probability. More especially is this the case when the difficulties are themselves found in various cases to disappear in the light of fuller knowledge. Thus the fact that the ether offers no resistance to the planets is even now cited as a difficulty by Mr. Stallo, and supposed to necessitate a belief



CRUCIBLE CAST STEEL RUDDER FOR THE SS. LA PLATA.

in its almost inconceivable tenacity; but this necessity disappeared when we were taught by William Froude that an infinite ocean having the substantial density of water would, in fact, offer no resistance whatever to the steady motion of a projectile through it. This is a signal instance of the way in which researches in one part of the domain of physics may throw a flood of light on a very distant region, and gives us a warrant to hope that the remaining difficulties of the theory will by similar means be dispersed. Meanwhile, it is to be hoped that critics of Mr. Stallo's ability will leave theories such as these, which rest on a solid basis of experiment, to develope themselves in their own way, and confine their attention to the attack on those half-metaphysical, half-materialistic, speculations which so largely encumber the advance of science.

WALTER R. BROWNE.

CRUCIBLE CAST STEEL STERN FRAMES AND RUDDERS.

IT will doubtless be remembered by many readers of this journal that the use of crucible steel in stern frames and rudders was brought prominently before the public by the recent exhibits of Messrs. Wm. Jessop and Sons, Limited, Sheffield, at the Naval and Marine Exhibitions in London and Tynemouth. The notion of producing stern frames and rudders for ships in steel castings, as far as we at present know, originated with Mr. J. F. Hall, manager to Messrs. Jessop, who several years ago conceived the idea in revising the designs of a small steam yacht, at the request of a friend, for whose private use it was eventually destined, and who wished to have as much of it in steel as possible. Shortly after this, during the winter of 1880-81, he brought the subject under the notice of a launch and boat-builder in Hull, who leased a small yard from Messrs. Bailey and Leetham, shipowners, of that place. This gentleman placed an order with Mr. Hall's firm for two small stern frames and rudders for steam pinnaces he then was about to build. The first of these was only delivered and put into the vessel when the subject was brought under the notice of Mr. Thomas Thompson, engineer to Messrs. Bailey and Leetham, who from that day, to use his own words, "made up his mind that the new feature was a correct one, and that he would adopt it on the first feasible occasion on a much larger scale." This opportunity, however, did not occur till a few months ago, when a very serious mishap, nearly resulting in the total loss of one of his employers' ships—the La Plata—through breaking her rudder, as shown in Fig. 1, during a storm in the North Sea, again brought to his mind the often-repeated solicitations of Messrs. Jessop's representative to have his rudders, as well as his stern frames and propellers, in crucible steel castings. Obtaining the consent of his employers, he placed an order with Messrs. Jessop for a crucible cast steel rudder, to replace the one made on the old lines, and which had so nearly caused the loss of the vessel herself. A few matters of detail on the subject of strengths, about which Mr. Thompson as yet was, of course, somewhat in doubt, were dispelled by the positive assurances of Mr. Hall, who guaranteed to produce a stronger rudder than had yet been put into any of the ships under his supervision. The next consideration, however, was as to how the change would be accepted by the Underwriters' Registry for Iron Vessels, with whom the ship was classed. Communication was therefore opened with the committee of that body, who at once gave their consent, and agreed to accept the solid crucible cast-steel rudder, as designed by Mr. Thompson, and shown in detail by Figs. 2, 2 A, B C, D, and E, provided it stood certain tests to be carried out under the supervision of their Hull surveyor. These tests having been accepted by Messrs. Jessop, the rudder was at once put in hand, and a few weeks later, on the 15th of September last, it was successfully cast by Mr. J. Banham, the superintendent steel melter of the firm. About the middle of the casting operation two sample test bars were taken from the metal flowing into the mould, and being carefully sealed and marked by the surveyor, were left to cool and anneal along with the rudder for future manipulations. Subsequently, when the rudder casting had been cleaned and dressed, it was subjected to the following severe tests:—First, the rudder was laid horizontally, with its ends resting on supports—and the blade at first propped up by a post, which, as the balance came on, fell away—see engraving Fig. 3. The rudder blade was loaded with an evenly distributed weight equal to a total of 12,300 lb., and balanced by a weight of 2240 lb. at the end of a lever 12ft. long, securely fastened on to the rudder head, which was 6½in. diameter. The effect of the lever itself was 3920 foot-pounds, weighing, as it did, 784 lb., with an effective length of 5ft. The rudder head therefore sustained a torsional strain of $(2240 \times 12) + (784 \times 5) = 30{,}800$ foot-pounds. The centre of loaded surface of the rudder was 2ft. 6in. from the centre of the rudder head, and the area of the blade was 86 square feet, so that the weight per square foot of rudder area, including weight of rudder was $\frac{30{,}800}{2\cdot5 \times 86} = 143$ lb. While under this torsional strain a 2000 lb. weight was dropped from a height of 4ft., striking the rudder at the centre of the area of blade, and in neither case was there any sign of a twisting movement in the rudder head. The rudder was then lifted to a height of 9ft. 3in., and dropped on to the foundry hard floor without the slightest fracture. Being again suspended and struck all over with hand hammers, it rang like a bell from end to end. The bars that had been case for testing were then placed in the machine; but they were in the rough, and had several slight flaws on the edges. Two other bars of the best forged iron were also selected to test along with them, with the results given on the next page, Table I.

These tests having considerably more than satisfied the requirements of the Liverpool Underwriters' Registry, and Mr. Thompson himself being well pleased with them, the rudder was delivered over to Messrs. Bailey and Leetham on the 30th of September last, and in less than a week was shipped into its place on the stern frame of the La Plata, which at once set sail on her voyage. The La Plata is a screw steamer 298·3ft. long, 32·1ft. beam, and 21·5ft. deep, 1778 tons gross, 1152 tons net register, with top-gallant forecastle and short poop. The cast steel rudder head or shank is not carried up to the top of the poop, but stops off about 3ft. above the counter of the ship, as shown at A[1], in Fig. 2 A. The top end of the rudder head is cast slightly taper, and has two projections or feathers cast on—see D[1] in Fig. 2 E—to which the wrought iron rudder head, B[1], with socket at bottom, is fitted, as shown by B[1], C[1], and D[1], in Fig. 2 D and E. The advantages of this arrangement are many. In the first place there is a less tendency of the rudder head to twist or warp in cooling after casting, and there is also less risk of the rudder head, through its otherwise extreme length from the point of casting, being honeycombed or unsound. But the chief advantages after all are perhaps the better facilities for shipping and unshipping the rudder in dry dock or on a slip way, where the usual drop is not more than from 4ft. to 5ft. from keel to dock bottom; whereas in a full pooped ship from 9ft. to 10ft. would be required, thus necessitating the ship being floated for shipping or unshipping the rudder. The La Plata has now had three months' good work with her steel rudder, and passed through some exceptionally rough weather, having made the following voyages:—From Hull to Cronstadt, from Cronstadt to Hull, from Hull to Cronstadt, from Cronstadt to London, from London to Shields, and at the present time she is on her way from Shields to Alexandria. The report of the captain is that the rudder works and answers admirably.

Since the completion of the La Platas rudder, we understand that Messrs. Jessop have made and delivered a number of others, as well as steel frames; also, we understand that at the present time they have orders in hand. In addition to this, we know that several other steel houses are intending to follow their example, so that in a few years we may expect to find the old iron rudders and stern frames things of the past.

The figures given in table 1 were obtained by Messrs. Jessop, and in order to get more complete figures, from a perfectly independent authority, the remaining half of test No. 3 and one half of test No. 1 were then taken, and machined into test pieces for Professor Kennedy, of University College, London, who reported on them as set forth in the annexed tables 1 and 2.

TABLE I.

Transverse Strength.

No. of test.	Material.	Size.	Length between supports.	Weight applied at centre of supports, in pounds.	Deflection, in inches.	Remarks.
		sq. in.	in.	scale, &c., weighs, lb.		
1	Crucible cast steel in the rough casting	$1\frac{1}{2}$	33	405	nil	These weights were applied without any intermission of time beyond what was necessary for the reading of the deflections.
				1693	$\frac{1}{16}$	
				2831	$\frac{3}{16}$	
				3783	$\frac{9}{32}$	
				4735	$\frac{15}{32}$	
				5687	$1\frac{3}{8}$	
				6639	$2\frac{5}{16}$	
				7311	—	Broke. The included angle to which this specimen bent before fracture was 162 deg.
2	Best forged iron	$1\frac{1}{2}$	33	405	$\frac{1}{32}$	These weights were applied as in test. No. 1.
				1693	$\frac{1}{8}$	
				2831	$\frac{7}{32}$	Included angle within any sign of fracture was 136 deg.
				3783	$\frac{3}{4}$	
				4735	$2\frac{3}{16}$	
				5687	$5\frac{3}{4}$	
				6023	$6\frac{3}{16}$	Limit to which the testing machine would allow the bar to deflect.
3	Crucible cast steel in the rough casting	$1\frac{1}{2}$	33	405	nil	This bar tested in the rough casting.
				1021	$\frac{1}{16}$	
				1693	$\frac{1}{8}$	
				2831	$\frac{7}{32}$	The included angle to which this specimen bent before fracture was 154 deg.
				3783	$\frac{9}{32}$	
				4735	$\frac{15}{32}$	
				5631	$1\frac{5}{32}$	
				6359	$1\frac{11}{16}$	This weight was now allowed to remain on seven minutes, when the deflection became $1\frac{13}{16}$in.
				6949	$2\frac{7}{32}$	This weight was now allowed to remain on five minutes, when the deflection became $2\frac{5}{16}$in.
				7509	$2\frac{3}{4}$	This weight was now allowed to remain on eighteen minutes, when the deflection became $2\frac{31}{32}$in.
				8069	$3\frac{1}{16}$	This weight was now allowed to remain on five minutes, when the deflection became $3\frac{5}{32}$in.
				8629	—	Broke.
4	Best forged iron	$1\frac{1}{2}$	33	405	nil	
				1021	$\frac{1}{16}$	
				1693	$\frac{1}{8}$	
				2831	$\frac{7}{32}$	
				3783	$\frac{5}{8}$	
				4735	$1\frac{31}{32}$	
				5631	$4\frac{1}{32}$	
				6191	$6\frac{13}{32}$	Limit to which the machine would allow the bar to deflect being an included angle of 136 deg.
5	Steel.	1	12	405	nil	This bar was the half of test No. 3, but had been planed down to 1in. sq. and polished bright.
				1021	$\frac{1}{32}$	
				1693	$\frac{1}{32}$	
				2365	$\frac{2}{32}$	
				3037	$\frac{3}{32}$	
				3709	$\frac{3}{32}$	
				4481	$\frac{3}{32}$	This weight was now allowed to remain on five minutes, but with no deflection.
				5053	$\frac{4}{32}$	
				5725	$\frac{7}{32}$	
				6397	$\frac{12}{32}$	This weight was now allowed to remain on five minutes, when the deflection became $\frac{13}{32}$in.
				7069	$\frac{19}{32}$	This weight was now allowed to remain on ten minutes, when the deflection became $\frac{20}{32}$in.*

* At this point no more weights could be placed on the machine, so it was decided to strike the centre of supports with a heavy hammer. Deflection, $\frac{30}{32}$in., with hammering; $\frac{31}{32}$in., ditto; $1\frac{4}{32}$in., ditto; $1\frac{14}{32}$in., ditto: $1\frac{24}{32}$in., ditto. Limit to which the machine would allow the bar to deflect, included angle being 145 deg. It was then placed under a large steam hammer, when it was bent to an angle of $138\frac{1}{2}$ deg., and then to 128 deg., without the slightest fracture.

TABLE II.—*Tensile Tests.*

U.C L. test No.	Marks on piece.	Dimensions.			Limit of elasticity.		Breaking load.		Ratio of limit to break.	Extension on whole length of 9in.	Reduction of area at fracture.	Remarks.
		Breadth.	Thickness.	Area.	Pounds.	Tons.	Pounds.	Tons.				
		in. dia.	in.	sq. in.	per sq. in.	pr. sq. in	per sq. in.	pr. sq.in			per cent.	
3598	H D	0·746	—	0·437	48,260	21·54	55,600	24·82	0·868	0·8in.	2·1	Crystalline fracture, with one small discoloured flaw at one edge, which accounts for low per cent. of extension and reduction of area in comparison.
3599	N H	0·747	—	0·438	40,680	18·16	68,080	30·40	0·507	4·0°/₀	5·0	Irregular and largely crystalline fracture.

TABLE III.—*Torsional Tests.*

U.C.L. test No.	Marks on piece.	Diameters.	Calculated maximum shearing stress per sq. in. in outer fibre.				Ratio of limit to break.	Actual twisting moment in inch-pounds.*		Corresponding twisting moment calculated for a bar 1in. diameter.		Remarks.
			At limit.		At break.			At limit.	At break.	At limit.	At break.	
			pounds.	tons.	pounds.	tons.						
3600	H D	0·635	42,500	18·97	88,660	39·58	0·479	2134	4451	8330	17,380	Twisted 1·498 turns, or 539 deg., in a length of 9in., which is equivalent to 0·106 of a turn, or 38 deg. for a length equal to the diameter of the piece. About 20 per cent. of the fracture was clear shear, the rest spiral, and somewhat crystalline.
3601	N H	0·635	25,000	11·16	77,330	34·52	0·323	1260	3888	4920	15,180	Twisted 1·45 turns, or 522 deg., in a length of 9in., which is equivalent to 0·103 turns, or 36·9 deg. for a length equal to the diameter of the piece. The fracture was spiral, somewhat largely crystalline throughout.

* This twisting moment in inch-pounds is equal to the load which would take the piece to its limit, or break it, as the case may be, if suspended at the end of a lever 1in. long. Thus No. 3600 would have been broken by 4451 lb. on a 1in. lever, &c.

THE DEVELOPMENT OF LIVING GERMS IN WATER.

DR. ANGUS SMITH, F.R.S., recently read a paper before the Manchester Literary and Philosophical Society, in which he points out a new and useful method of making the presence of organic matter demonstrable to the eye. He called attention to a paper, published in 1867 by the Society, in which he quoted from a report on proceedings under the Rivers Pollution Prevention Act, wherein he expressed a wish to develope living germs in water as a test for purity. The results obtained at the time were correct and useful, but not striking enough to attract much attention, "although I think," writes Dr. Smith, "chemists have not been sufficiently active in using the microscope. Having long seen its importance, I confess to having done too little with it. In a report under the Alkali Act during the year 1873, I mention a second attempt to render the existence of organic matter more perceptible by causing the air washings to act upon sugar, and after many trials I was disappointed; still I came to the conclusion 'that the air of a town influences fermentation to a certain extent'"—see "Tenth Report," p. 45. "I neglected this development also too much," continnes Dr. Smith, "but Dr. Koch, of Berlin, has shown us how to preserve the indications of organic vitality by the use of gelatine. I believe he was the first to use it. It is from Dr. Koch at any rate that I learned the use of gelatine. About $2\frac{1}{2}$ per cent. of gelatine well heated in a little water is mixed with the water to be tested, and the mixture forms a transparent mass which is not movable like the water itself. When soluble or unobserved matter developes further organic matter of the waters and makes itself visible in a solid and insoluble form, it does not fall to the bottom, but each active point shows around it the sphere of its activity, and that sphere is observed and remains long. The gelatine preserves to us the whole action, so far as the more striking results are concerned, and keeps a record, for a time, both of the quality and intensity of life in the liquid. I speak at present of the more striking effects which are clear and abundant, every little centre of life making itself clear—or rather turbid—to the eye, and sometimes expanding its influence to reach both sides of the tube. It seems to me now essential that all chemical examination of water should be supplemented by an inquiry, like this of Dr. Koch's, into the comparative activity of the living organisms. How far this may go it would be absurd to attempt to say, and I never have much hope of a man who writes about the future of truth; he evidently attempts too much. I am satisfied to bring forward such facts as I know in the present, so that chemists may not be too late in attending to the new ideas. The water must not have too much gelatine in it; if so, the action is stopped. It must not have too little; if so, the gelatine becomes liquid too soon, and the action of the individual centres is not observed. When a centre acts it makes around it a sphere in some waters, and the sphere, which has the appearance of a thin vescicle, is filled with liquid. These spheres form in a day or two, according to the water, and at the bottom there is a white mass containing active bacteria chiefly. The liquid filling the spheres may be taken out by a pipette and examined, as also the bacteria which lie at the bottom. I have not examined a sufficient number of waters to give general rules, but I hope to do so. It is an investigation which would properly belong to Professor Koch, and I should not have touched it had I not found that it brought into use my own inquiries as to fermentation, which were earlier, but may now be considered only a supplement to Dr. Koch's. This is by the use of sugar in addition to the gelatine. By this means a very great amount of gas is generated and retained in the gelatine. The striking amount of spheres and gas bubbles renders the examination of water by this method less dependent on the opinion of the operator, and a photograph may be taken of each specimen, and the result preserved as evidence. At the same time I know that it is necessary to examine waters of various kinds before we make or find rules, and this slight account is a mere beginning. I have as yet examined no chalk water, for example, but have been confined chiefly to the Manchester district, hill water, impure brook and pond water, Mersey, Irwell, and Medlock water, and canal water. In certain specimens of Manchester supply the spheres appear on some days very few, on other days the amount is enormous and heavy; the whole of the tube in which the experiment is made is filled with spheres. At such times the water is highly impure and complained of by the public. We have a very easy proof, therefore, of the value of this test. The photograph would be a visible report made by nature when the water has active organisms in it. The globules do not show themselves in strong sewer water, but the whole mass becomes turbid and the surface of the gelatine becomes liquid and full of life. This liquid condition gradually increases until the whole is reached. We have, therefore, two striking conditions well marked out. A third may be said to exist, but it is often a mere beginning of the globules. This is shown by the formation of a small white opaque point. If this point be examined it is seen to be full of life like the lower part of the spheres and the fluid portion of the gelatine when the fluidity begins on the surface. I find also that the solidity or fluidity of the gelatine is an important indication. This is known by the depth to which a certain weight will sink in it. I use the word bacteria at present, because although I have observed various forms, I do not intend to investigate the separate functions of each. At present this mode of examining water seems to me to be far more important than the chemical, more decided and more telling; but we cannot neglect the chemical." An account of an examination of a few specimens is given at the end of Dr. Angus Smith's paper.

TENDERS.

PWLLHELI UNION WORKHOUSE.

FOR drains, latrines, manholes, ventilators, and works connected therewith, at the Pwllheli Union Workhouse. Mr. Thomas Roberts, Assoc. M. Inst. C.E., engineer.

	£	s.	d.
Davies, Carnarvon	326	18	0
Summers, Pwllheli	294	10	0
Davies, Portmadoc	290	0	0
Jones, Pwllheli	270	8	0
Owen, Portmadoc—accepted	260	0	0
Engineer's estimate	288	0	0

CITY OF LONDON BREWERY.

FOR the erection of a new ale tun room, works to, river wall, boiler-house, chimney shaft, ice machinery room, and other works, for the City of London Brewery Company, Limited, Upper Thames-street, E.C. Messrs. Scamell and Colyer, architects and engineers, 18, Great George-street, Westminster, S.W. Quantities by Messrs. R. L. Curtis and Sons, London.

	£	s.	d.
CONTRACT No. 1.—BUILDING.			
G. and S. Williams, London	10,480	0	0
Thos. Rider and Sons, London	9,938	0	0
Langmead and Way, London	9,875	0	0
William Brass, London	9,853	0	0
Mowlem and Co., London	9,645	0	0
Henry Lovatt, Wolverhampton	9,600	0	0
J. Morter, London	9,333	0	0
J. Brown, London	9,120	0	0
B. E. Nightingale, London	9,061	0	0
T. W. Smith and Sons—accepted	8,770	0	0
CONTRACT No. 2.—IRONWORK.			
Handyside and Co., London and Derby	4,239	0	0
H. Young and Co., London	4,053	0	0
R. Moreland and Co., London	3,890	0	0
Dawson and Hunneley, Leeds	3,608	0	0
Thornewill and Warham, Burton—accepted	3,462	0	0
CONTRACT No. 3.—BOILERS.			
R. Taylor and Sons, Marsden	995	0	0
Geo. Waller and Co., London	993	0	0
Piggott and Co., Birmingham	885	0	0
Horton and Co., London	870	0	0
Thornewill and Warham, Buxton—accepted	860	0	0
CONTRACT No. 4.—MILLWRIGHT'S WORK.			
R. Moreland and Co., London	2,706	0	0
Bennett and Sons, London	2,440	0	0
Geo. Waller and Co., London	2,198	0	0
Thornewill and Warham, Burton—accepted	2,090	0	0
CONTRACT No. 5.—COOLING MACHINERY.			
Siebe, Gorman and, Co. London—accepted	1,420	0	0
CONTRACT No. 6.—BACKMAKER'S WORK.			
J. Colyer and Co., London—error in estimate	1,513	0	0
Bennett and Sons, London	1,440	0	0
Ramsden, London—accepted	1,341	0	0
CONTRACT No. 7.—SLATEMASON'S WORK.			
Braby and Co., London	790	0	0
J. and J. Sharp, London	699	0	0
Brindley and Co., London	680	0	0
Stirling and Co., London	640	0	0
Ashton and Green, London—accepted	625	0	0
CONTRACT No. 8.—PIPE CONNECTIONS.			
Bennett and Sons, London	4,720	0	0
H. Pontifex and Sons, London	4,427	0	0
Blundell and Sons, London	3,946	0	0
Pontifex and Wood, London	3,867	0	0
Bindley and Briggs, Burton—accepted	3,795	0	0

RAILWAY MATTERS.

THE official inspection of the route of the proposed railway to form the Great Southern line at Gerogery, New South Wales, towards Corowa, has been completed. The engineer finds no difficulties.

THE Lynn and Fakenham, Yarmouth and North Norfolk, and Yarmouth Union Companies are now amalgamated under the title of "The Eastern and Midlands Railway Company." The secretary's office will be, as hitherto, at the Beach Station, Great Yarmouth.

THE American *Railroad Gazette* says: "The two most gorgeous sections of railroad in the world will be on the Marretta and North Georgia and the Western North Carolina at Red Marble Gap, N.C. Both roads will run for a mile on road beds composed of variegated marble of the finest quality."

THE London and North-Western Railway Company have, as is known, to spend £330,000 upon the construction of docks at Holyhead for the convenience of ocean-going steamers. The proposal was, however, accompanied by a condition which the Government were unable to agree to. This condition is understood to be the blowing up of the Platter's Rock, which the company wished to be carried out by the Board of Trade.

THE *Cologne Gazette* mentions a regulation which is now in force on some German lines. Inconvenience is often experienced by travellers who cannot book through to certain points, owing to the difficulty of procuring a new ticket and luggage receipt in time to profit by the departure of corresponding trains from points of junction. By payment of a fee of fifty pfennings (sixpence) the necessary tickets can be ordered ahead by telegraph, and are, it is to be supposed, brought by the railway officials to the passenger at the junction where his previous ticket ceases to be valid.

IN a report on the collision that occurred on the 16th November, at the south side of Bessbrook Station, on the Great Northern Railway of Ireland, when the passenger train which is due to leave Dublin at 2 p.m. overtook and ran into a cattle train, Colonel Rich says the collision would probably not have occurred if the Great Northern Railway Company had been working their traffic under the block system, and the servants in charge of their passenger trains will be better prepared for preventing accidents of this kind when the company provide continuous brakes on all their passenger trains.

IN the middle of December the false work of the bridge across Great Dry Cañon, four miles west of Pecos River on the Sunset Road, and three-fourths of a mile from the end of the Southern Pacific track, fell in a solid mass, precipitating nineteen hands a distance of 75ft. on the rocks below. Seven men were killed outright, one more has since died, and there is little hope for recovery of three others. The false work had been erected some time, and the weight of the material brought upon it for the permanent bridge it is supposed was too great, and it gave way over the deep gorge, having almost perpendicular cliffs. The length of the bridge is 200ft. The disaster will delay the completion of the bridge perhaps sixty days.

THE 3.30 p.m. Great Western train from Paddington on Monday left Newbury at its usual time, 5.27, and when it had arrived at Benham, about midway between Newbury and Kintbury stations, it encountered a steel rail placed across the down line, which had broken the guards in front of the engine and done other damage. The rail, which was 24ft. long and weighed 5 cwt., was forced along the line for a distance of more than fifty yards, when one end of it came in contact with another steel rail lying on the embankment, the result being that it was whirled round clear of the line. But for this fortunate circumstance the engine would probably have left the metals and a disastrous accident occurred. Why should not guards be made strong enough to be of some use?

IN his report on the accident which occurred on the 4th November, at Dalnaspidal station, on the Highland Railway, when the rear bogie of a sleeping carriage ran on to the rails of the up loop line at the loop facing-points, and was followed by the two vehicles behind it, until it was pulled from under the body of the sleeping carriage and thrown off the rails, Major Marindin says. "This accident was caused by the trailing bogie of the sleeping carriage being turned on to the up line of rails at the facing-points of the loop, while the leading bogie of the same carriage and the front portion of the train ran along the proper rails on the down loop." He recommends the company to lengthen the locking bar at these points, so that it will cover the wheel base of the longest vehicle in use upon the line, as is now always required in the case of new connections or new lines.

AT the recent American Forestry Congress, held at Montreal, Professor Hough read a paper on "Tree Planting by Railway Companies." In introducing his paper he said that there being in the United States about 100,000 miles of railway, the advisability of tree planting by railway companies for construction and maintenance was an important question, 2000 to 3000 and even 3500 ties (sleepers) being used per mile. The average duration of ties is from five to eight years; consequently from 30,000,000 to 50,000,000 a year will be required for 100,000 miles of railway. Putting 500 ties as the product of an acre of woodland, from 60,000 to 100,000 acres will have to be cut every year, and as it takes thirty years for a tree to grow to the right size, the railways will require from 2,000,000 to 3,000,000 acres—or 3126 to 4687 square miles—of forest to keep up the supply. At this rate, the *Railway Review* says, there should be twenty-five acres for each mile of road, involving an investment of £100 in land per mile—a wise investment, giving the railways an independent supply of ties. He stated that wood fuel is being superseded by coal, and wooden bridges by stone or iron. In Europe wood in railway structures is very rare, and for ties mineral substances will be much dearer than wood for some time. The professor concluded his paper with some references to the necessity of planting trees to hold embankments together by their roots, and alder and willow to prevent erosion of streams, and the various kinds proper to plant for different purposes and in different localities; also the prevention of snow blocks by having trees along the railway tracks.

A DESCRIPTION has recently been given in the German technical press of a wire railway in connection with the coal-mining industry established near the Hersteigg, the products of which it brings to the main line belonging to the Southern Railway of Austria. In its alternating rise and fall during its distance of 3000 yards there is a useful excess of incline of about 142 yards, which, it is said, suffices to keep the line in self-acting working, after it has been started by means of the 12-horse power engine provided for that purpose. When there is no return load to be sent to the mine, the speed of the line can be regulated by a brake. Under these circumstances the cost of working the line is estimated at about 2¼d. per ton of coal. In its general arrangement the railway forms a straight line, and consists of two drawing ropes and the train rope. The line which is used for conveying the coal to the station is 1·10in. thick, and is composed of 19 steel wires, each ·18 of an inch in diameter. The line on which the coal vessels are returned to the mine is only ·66 of an inch thick, the 19 steel wires of which it is composed being only ·13 of an inch thick. Both ropes consist of wires about 765 yards long, coupled to each other, and for the ropes a breaking strength of 73 tons per square inch section is guaranteed. At the ends of the ropes weights of 5 and 3 tons are applied in the usual way for obtaining the proper tension. The distance between the seventeen supports varies from 60 to 400 yards. The train rope is ·6 of an inch thick, and consists of twelve soft steel wires of ·07 of an inch diameter, and runs at a speed of about 1⅝ yards per second. The vessels which convey the coal follow each other at a distance of about 83 yards; thus thirty-six are always on the way to and the same number coming from the station. Each vessel contains about 10 bushels, or about a quarter of a ton of brown coal, the total quantity carried per hour being about 17½ tons. The cost of the line was about £5000 sterling.

NOTES AND MEMORANDA.

ACCORDING to statistics given by *L'Electricité*, the two nations that have adopted the telephone to the largest extent in proportion to their population are Belgium and Switzerland, the former counting a subscriber in every 399, and the other in every 227 inhabitants. There are 4946 subscribers in England, 3640 in France, and 2142 in Germany. Paris alone has 2422 subscribers, and there are more in New York than in the whole of England, while there are 37,187 in the United States.

IN an article on the increase in the velocity of the wind with altitude, Mr. E. Douglas Archibald gives in *Nature* the following formulæ in place of Stephenson's, which, he says, is very incorrect, $\frac{V}{v} = \sqrt[4]{\frac{H}{h}}$ in which $V\ v$, $H\ h$, are the velocities and heights at the lower and upper levels respectively.

As the result of a series of experiments upon iron, steel, copper, tin, cadmium, &c., Herr Kalischer arrives at the conclusion that the crystalline state corresponds with the natural molecular structure of metals. This condition may be modified, more or less easily, by a mechanical operation; but it is generally re-established under the influence of heat. In the case of some metals drawn into wire, the heat caused by the mechanical action re-establishes the crystalline structure, and at the same time increases the electrical conductivity.

THE return of the total number of deaths reported in the United States during the census year was 756,893, or a death rate of 15·1 per thousand. But the actual number of deaths was in all probability about 100,000 more than the above number. The male death rate was placed at 15·35 per thousand, and the female at 14·81. Out of 390,644 deaths of males in which the ages were given, 96,894 were under one year of age, and 163,880 under five years. Of 363,874 deaths of females of which the ages were given, 78,372 were less than one year old, and 138,920 less than five years. No fewer than 38,398 persons are reported to have died from diphtheria, 22,905 from typhoid fever, 20,261 from malarial fever, and the large number of 91,551 of consumption.

THERE were 2808 births and 1567 deaths registered in London last week. Allowing for increase of population, the births exceeded by 22, whereas the deaths were 213 below, the average numbers in the corresponding weeks of the last ten years. The annual rate of mortality from all causes, which had been equal to 27·1, 23·0, and 20·5 per 1000 in the three preceding weeks, was 20·7. At the Royal Observatory, Greenwich, the mean reading of the barometer last week was 29·59in. The mean temperature was 38·3 deg., and 0·5 deg. above the average in the corresponding week of the twenty years ending 1868. The lowest night temperature was 30·3 deg. on Monday, and the highest day temperature in the shade 44·7 deg. on Saturday; the extreme range in the week was therefore 14·4 deg.

MR. JAMES WIMSHURST has produced another new plate-induction machine, which is remarkably simple as well as powerful. Two circular discs of ordinary window glass 14½in. in diameter are mounted about ⅛in. apart on a fixed horizontal spindle, and rapidly rotated in opposite directions by turning a winch handle below. Both plates are well varnished, and have 12 radial sector-shaped pieces of thin brass attached at equal intervals on their outer surfaces. The two sectors on the same diameter of each are twice in each revolution momentarily touched by two fine wire brushes at the ends of a curved metallic rod. The fixed conductors consist of two forks in a horizontal position, with collecting combs directed towards each other, and towards the two discs which rotate between them. To these combs are attached the terminal electrodes, which have ebonite handles, and may be shifted more or less apart. The apparatus, which can be made for a few shillings, is said to be considerably more powerful than a Voss machine of equal size and of much greater weight.

AT the present period a comparison of the blast furnaces built and at work last year, as compared with the year 1881, will doubtless be perused with interest. It would appear from the published returns that there were 963 furnaces built last year, against 968 in 1881, whilst 575 were in blast in 1882, against 555 in the previous year. The greatest increase in the number of furnaces in blast was in Scotland, when 113 out of 148 built were in blast, against 105 at work in 1881, an increase of five furnaces. Cleveland shows an increase of four on the year, 100 being at work, against 96, but there was a decrease of three furnaces built last year, as compared with 1881. East Worcestershire had also an increase of four, 50 being in blast, against 46 in 1881; but there was a decrease of five furnaces built. In Glamorganshire there was also an increase of four furnaces blowing, so that the districts named furnish the whole of the increase. The chief changes in other districts were a falling-off of four in the north-east and north-west of England. The returns of the furnaces built in some districts scarcely convey a correct idea. Some of the old furnaces, although in existence, will never be worked again, as they cannot now be worked at a profit in competition with new forms.

WHALEBONE has become the most valuable instead of the least valuable of the products of whale fishing. America has the lion's share of the whalebone industry. This product is there supplied from only seven works—four in New York and three in Boston. The *personnel* is 110 to 120. The principal application of whalebone now is that in making whips and corsets. Steel has mostly displaced whalebone in umbrellas and parasols. Some years ago umbrella ribs were made in France of an excellent imitation of whalebone (not distinguishable, indeed, until fractured); but it is no longer heard of. Genuine whalebone is often made white, and used with garments of muslin or the like, not being seen through these so easily as the dark sort. The newest application of whalebone is that to hats; it is cut into fine strips and interlaced with straw. Such hats are very dear. Another novelty is "whalebone riband." For this white whalebone is generally used, and the shaving is so thin that ordinary print can be read through it. It is often coloured blue, red, or green, and used by saddlers in making rosettes. Walking-sticks of whalebone are also in good demand. The exceptionally thick strips cut for this purpose are rounded by being drawn through holes in a steel plate.

IN their report to the President of the Local Government Board on the metropolitan water supply for December, Messrs. W. Crookes, W. Odling, and C. Meymott Tidy say:—"In our own previous monthly report we drew attention to the circumstance that, concurrently with the setting in of the winter season, there was, as there customarily is, a notable increase in the proportion of organic matter present in the water supply. In the report for the same period made to the Registrar-General—by Dr. Frankland—attention was also called to this increase; and further, the water distributed by four out of five of the companies taking their supply from the Thames, was pronounced *ex cathedrâ* to be 'unfit for drinking' by reason of its 'organic impurity.' Now we take upon ourselves to assert that the analytical results set forth in the report, which are not appreciably different from our own, do not afford ground for any such appalling statement; and that the million or more consumers of the water furnished by these stigmatised companies have not had their health in any way jeopardised by their consumption of the water supplied to them; and that they have not been placed, during the month of November, in any respect in a different position as regards injury to health, consequent on the character of their drinking water—admittedly unobjectionable in taste and appearance—from that in which they were placed during the summer months; when, owing to the different conditions of river life and change, the proportion of organic matter in the water was about one-third or one-fourth of its recent amount—the maximum of which found in any sample, as recorded in the report to the Registrar-General, was under three-quarters of a grain per gallon, or amounted to about the one-thousandth part of one per cent. of the reprobated water."

MISCELLANEA.

THE *Börsen Zeitung* announces that it has been decided to begin the construction next spring of fourteen forts at Kiel for the defence of that harbour.

MR. CHARLES R. WALKER, C.E., of Cannock and London, has been awarded the premium of £100 offered by the Town Council of Pietermaritzburg, Natal, for the best scheme of sewerage and sewage disposal suitable for that city. The decision was left with four eminent civil engineers.

THE Board of Trade have made the following rule, in pursuance of Section 5 of the Electric Lighting Act: "The time provided for by Rules 4 and 11 of the Rules made by the Board of Trade shall be the 1st day of February, instead of two months from the date of the newspaper containing the first advertisement of the application."

TENDERS are being sought for the construction of a new graving dock at the south-east end of the Routh Basin, Cardiff. It is the intention of Messrs. Morel and Co., well known for their large shipping enterprise, to have one of the largest and most complete in the Bristol Channel. It will be 600ft. in length, with a caisson in the centre—thus accommodating two long vessels at the same time. Tenders are called for in a few days.

IT is stated that the North-Eastern Marine Engineering Company, Limited, is about to erect an extensive steam winch manufactory, as well as a forge for turning out the largest crank shafts and other uses in connection with marine engines. Land for these purposes has recently been acquired by the company in close proximity to the present works, and we understand that building operations are likely to be commenced early in the ensuing spring.

THE correspondent at Rome of a German paper writes that the project of a tunnel under the sea between Calabria and Sicily is making rapid progress. The Venetian Railway Company has finished its surveys, and the plans have been submitted to the Minister. The length of the tunnel is 13½ kilometres—8½ miles—and the cost is estimated at 71,000,000 lire—£2,840,000—including the 5,500,000 lire—£220,000—for the junction between the tunnel and the Messina station.

WE are informed that the "Sun" electric lamp has just been successfully installed at Messrs. Singleton and Cole's premises, Wolverhampton. It is also being installed at Messrs. Finlay and Co.'s lace curtain works, Doune, N.B., the Bowling Ironworks, Bradford, and elsewhere. The central station of the company, 6, Riding-house-street, Portland-place, W., is now, we are told, complete, and application has been made to the vestry to light a part of London from that centre.

ON the 11th inst. a finely-modelled iron screw steamer, which had been built at the Bridge Works, Chepstow, by Edward Finch and Co. for Messrs. C. O. Young and Christies, of Cardiff, was successfully launched. The dimensions are:—Length, 240ft. between perpendiculars; beam extreme, 35ft. 2in.; and depth of hold, 18ft. 3in. She has been built under Lloyd's special survey for the highest class, 100 A 1, and will receive engines of 130 nominal horse-power, to be fitted by the builders.

THE programme for 1883 of the annual series of scientific and literary lectures, given at the Sorbonne under the auspices of the Association Scientifique de France, includes the following of special interest:—"The Physical Composition of the Sun," by M. Faye, member of the Institute, 24th February; "Recent Progress in directing the Course of Balloons," by M. Gaston Tissandier, director of the journal *La Nature*, 3rd March; "Origin and Method of Formation of the Metalliferous Ores," by M. Dieulafait, professor at the Faculty of Science, Marseilles, 17th March.

ON Tuesday a large number of gentlemen were entertained on board the steamship Paramatta by the directors of the Peninsular and Oriental Steam Navigation Company. The Paramatta is the latest addition to the company's fleet, and is a very fine vessel, 420ft. long, 43ft. beam, and 37ft. deep. Her gross tonnage is 4760, and her engines indicate over 4000-horse power. They are of the two-cylinder compound type, the cylinders being 55in. and 100in. in diameter, with a stroke of 5ft. 6in. The screw is 19ft. 6in. diameter, and 28ft. pitch, Griffith's pattern, four-bladed. Revolutions on trial trip, sixty-one; speed, 15½ knots nearly. The ship has been built and engined by Messrs. Caird and Co., of Greenock.

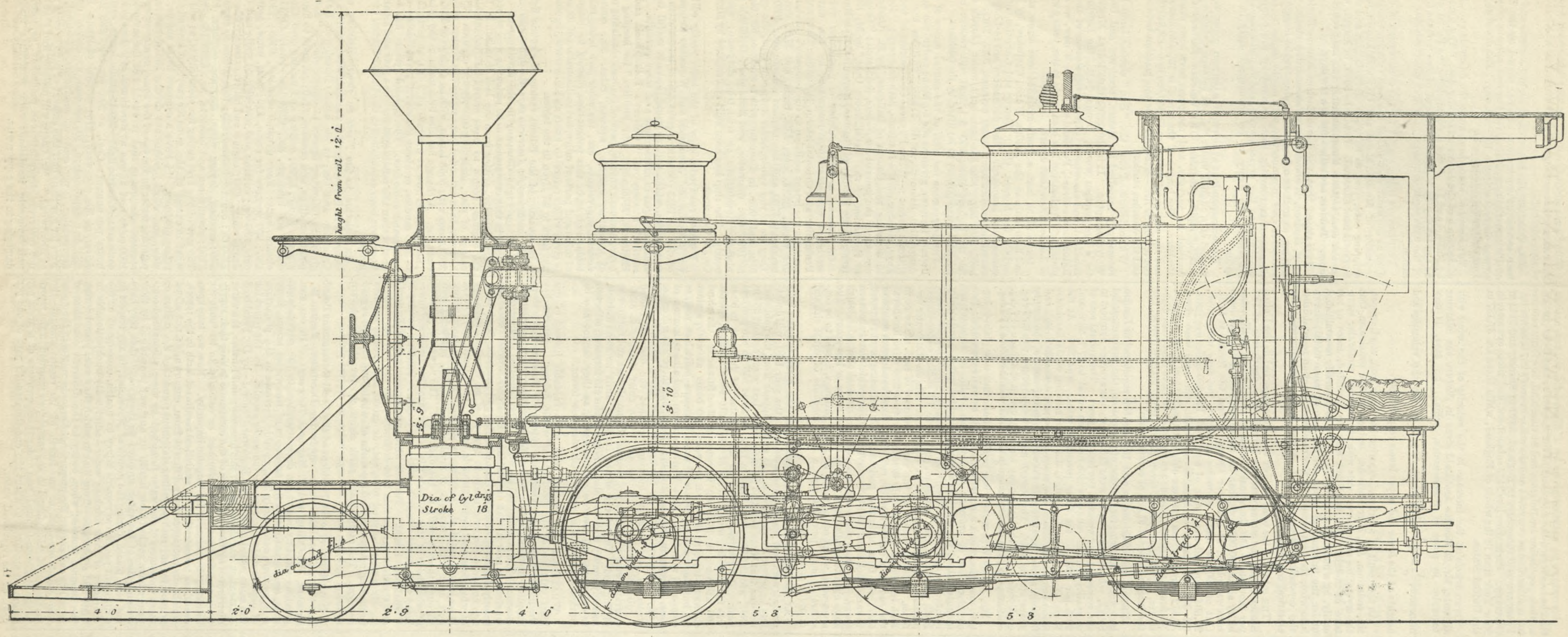
WE have received a copy of the tenth yearly edition of "Calvert's Mechanics' Almanack and Workshop Companion." This edition for 1883 contains a great deal of information in paragraphs and articles, which will, as usual, make it useful to artisans and others engaged in mechanical and other pursuits. We have also received a copy of "Calvert's Pocket-book and Annual for Engineers, Mechanics, and Builders," for keeping time, making notes, and cash entries, part of the book consisting of useful tables of measures, weights, squares, cubes, &c., conversion tables, decimal equivalents, &c., the other part being ruled paper. A table is given in this pocket-book relating to decimal equivalents of miles and parts of miles, but in illustration of its use an example is given which refers to knots and kilometres, figures for which do not seem to be given in the tables.

IN speaking of the Edison system of electric lighting in New York, the *Scientific American* says, the difficulties encountered by the Edison Light Company in the development of their public system in this city appear to be serious as well as perplexing. The main difficulty, arising from the lack of unison in the working of the engines, seems to have proved insurmountable except by a change of plan, including entirely new engines. The service has, however, been extended from eighty-five houses, with 2000 lamps to 226 houses with 5053 lamps, with an average of 3000 lamps in constant use. A change has also been made in the price of the light. The charge is now at the rate of 2 dols. an hour for a light equal to 2000 candles, or about the cost of gas at 2 dols.—about 8s. 3d.—a thousand cubic feet. The isolated system has been more successful than the public system. In a year and a-half, 154 installations have been established in the United States, employing 29,192 lamps.

IN a letter to the *Times* on electric lighting *versus* gas, Mr. Octavius E. Coope describes the installation carried out by Messrs. Crompton and Co., in his house, Berechurch Hall, Essex, and gives the following figures in comparison:—"Estimate for gas plant, buildings, and erection, £740; gas main to house, £75; laying pipes in house, £200; cutting and making good again, £50; chandeliers and brackets, &c., £268 18s.—total, £1333 18s. Cost of electric light: Four dynamo machines, £405; 220 Swan lamps, £55; 200 sockets for same, £10; cable, wires, switches, and cut-outs, £66 4s.; cutting and making good walls and floors and incidental work, £60; engine and boiler, extra fly-wheel and belting, £300 6s.; countershafting, £25; foundations to engine and flooring, £40; erection, laying wires, &c., and carriage, £90; buildings, £150; chandeliers and brackets, &c., £268 18s.—total, £1470 8s. The cost of the first outlay for electricity is, as will be seen, somewhat in excess of the same for gas;" but instead of gasworks and refuse products, "I have a compact little engine, placed out of view, and which, when not driving the dynamos, is utilised for pumping water to the top of the house, or any other purpose I may require. Assuming that it would cost the same to manufacture 1000 cubic feet of gas at Berechurch as it does at Brentwood, the costs are:—Electric light—200 18-candle lamps, each working 1150 hours per annum: Coal, at 20s. per ton, £38 10s. 1d.; engine driver, at 30s per week, £78; renewal of lamps, 153 at 5s. each, £38 5s.; depreciation, 10 per cent. on cost of machinery, £74; depreciation, 5 per cent. on conductors, £4—total, £232 15s. 1d. Now for less than half this amount of light it costs me £200 a year at Brentwood." Mr. Coope will probably find that 5 per cent. will not cover the depreciation on conductors, as, until very recently, uninflammable insulations were sometimes made of material damaging to the copper wire.

AMERICAN MOGUL LOCOMOTIVE—NEWFOUNDLAND RAILWAY.

MR. JAMES CLEMINSON, M.I.C.E., WESTMINSTER, ENGINEER.



In our impression of the 15th December last we briefly described, in an article relating to Messrs. R. and W. Hawthorn's exhibits at the recent North-East Coast Exhibition, an American Mogul locomotive, designed by Mr. James Cleminson, M.I.C.E., for the Newfoundland Railway, and illustrated by a photographic supplement of the above date. We now give further illustrations of the engine, and take the following particulars from the specification to which they were made. The cylinders are 14in. diameter and 16in. stroke, the drivers are 40in. diameter, the gauge is 3ft. 6in., the fuel, wood or soft coal; the total wheel base is 18ft., the driving wheel base is 10ft., the weight in working order about 49,000 lb.; on drivers, about 42,000 lb. The boiler is made throughout of flange plates of homogeneous steel, ⅜in. thick, rivetted with ⅝in. rivets placed 2¼in. from centre to centre; all horizontal seams and junction of waist and fire-box are double-rivetted. All the plates are planed at the edges and caulked with round-pointed caulking tools. The boiler was tested with hot water at 200 lb. pressure per square inch; the barrel is 48in. in diameter at smoke-box end, made with a wagon top and with a dome. The tubes are of steel, with steel ferules on the fire-box ends, 130 in number, 2in. diameter, and 10ft. in length. The fire-box is 72in. long, of homogeneous cast steel, all plates thoroughly annealed after flanging; the side and back sheets are $\frac{5}{16}$in. thick; the crown sheets, ⅜in. thick; the tube plate, ½in. thick. The water spaces are 2½in. at the sides and back, and 3½in. front; the stay bolts are ⅞in. diameter, and 4¼in. from centre to centre; the fire-door opening is formed by flanging and rivetting together the inner and outer sheets. The crown sheet is supported by crown bars, each made of two pieces of wrought iron 5in. by ⅝in., set 1½in. above the crown and placed 4½in. from centre to centre, and bearing on side sheets. The crown bar bolts are screwed through the crown sheet, with nuts on the underside, and rivetted over; the crown is stayed by braces to the dome and outside shell of the boiler. The frames are of best hammered iron, made in two sections; the main frames are forged solid, extra strong at front. The horn plates are protected from wear by the boxes by cast iron gibs and wedges. The bogie has a centre bearing, is two-wheeled, with a sliding radial axle. The wheels are 26in. diameter; the axles are of hammered iron, with inside journals 4in. diameter and 7in. long; the springs are tempered in oil, connected by equalising beams on Cleminson's arrangement.

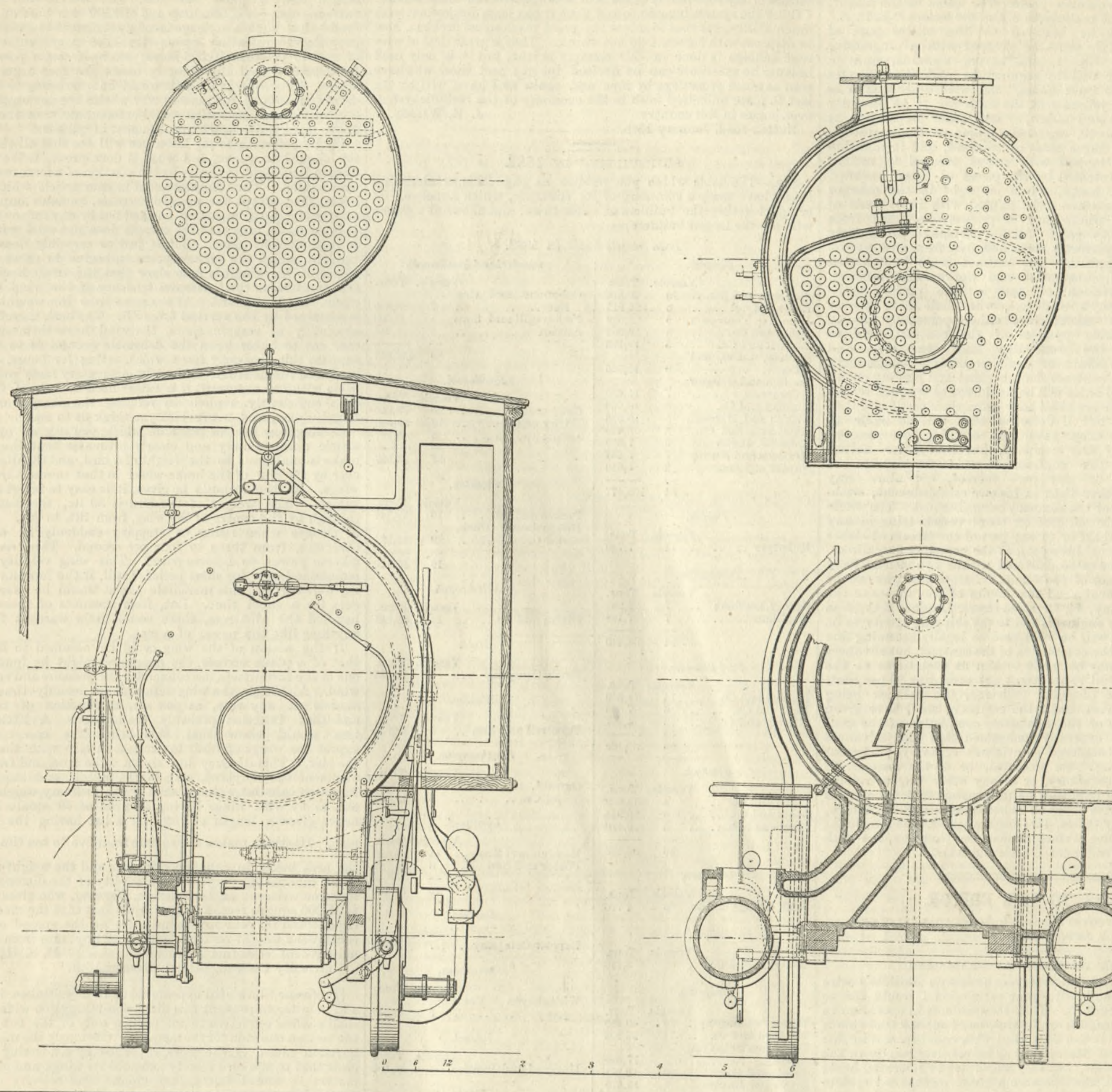
Each cylinder is cast in one piece with the half saddle placed horizontally; the right and left-hand cylinders are reversible and interchangeable. The cylinders are oiled by condensing cups on steam chests. The pistons are cast iron, fitted with two brass rings Babbitted, and with spring adjustment. The piston rods are of cold rolled iron, ground and keyed to the crossheads, and keyed and rivetted to piston. The valve motion is of the shifting link type, graduated to cut off equally at all points of stroke. The driving wheels are six in number, 40in. diameter, with centres of cast iron, and hollow spokes and rims, and turned to 35in. diameter to receive tires. The tires are of best cast steel 2½in. thick when finished; front and rear pairs flanged, 5in. wide; main pair plain, 6in. wide. The axles are wrought iron, with journals 5½in. diameter, and 8in. long. The driving boxes are cast iron. The feed-water is supplied by one No. 5 injector and one brass pump.

CONTRACTS OPEN.

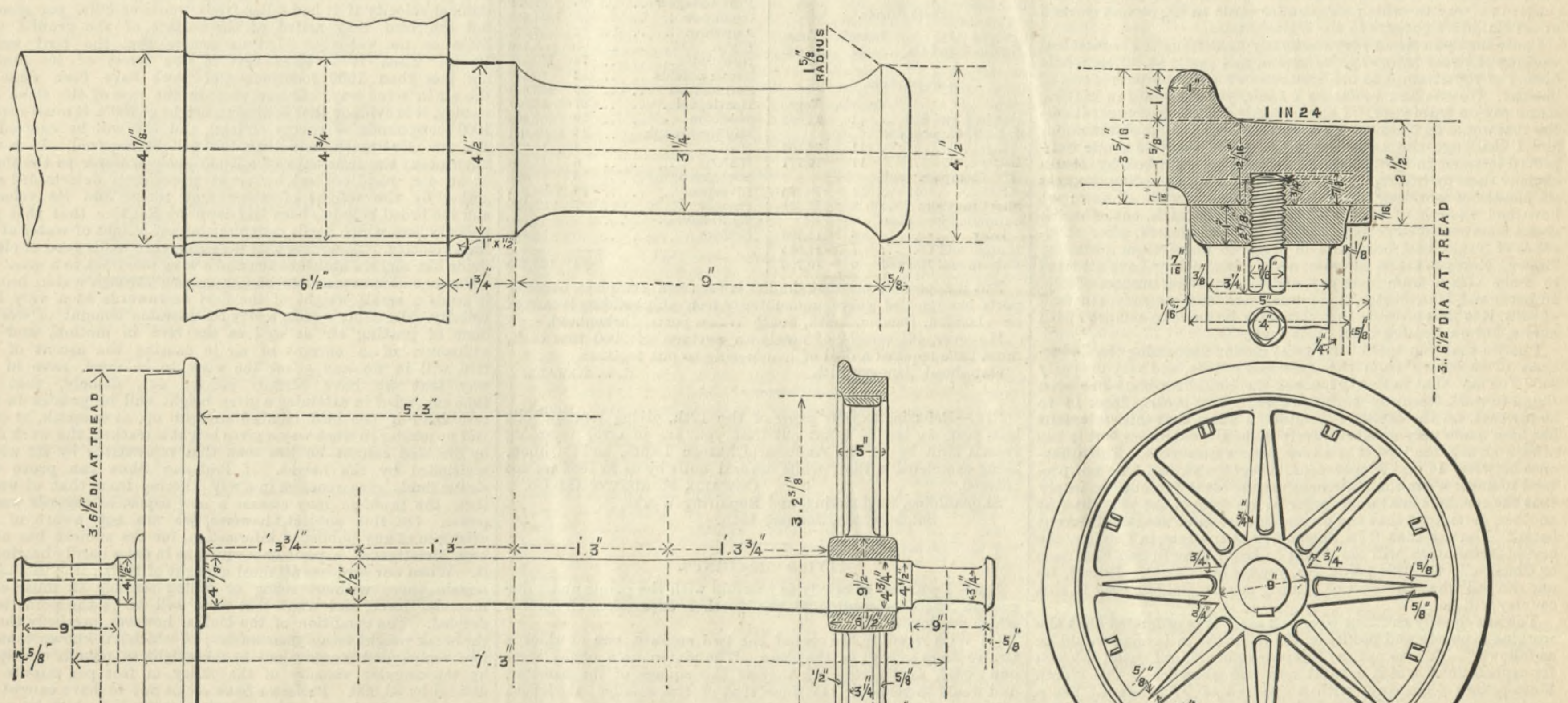
WHEELS AND AXLES, EASTERN BENGAL RAILWAY.

The Eastern Bengal Railway wants tenders for 100 sets of wheels and axles for goods wagons. There is one contract drawing accompanying and referred to in this specification, which we reproduce on page 43, and the dimensions of the various parts shown upon this drawing must be accurately worked to. The wheels are to be 3ft. 6½in. in diameter, and are intended for a railway of 5ft. 6in. gauge, each set consisting of four wheels and two axles. The contract price or prices include the manufacturing, supplying, testing, marking, painting, packing, and delivering the wheels and axles now required, and all materials, templates, gauges, measuring rods, work, operations, processes, labour and assistance connected therewith, whether referred to in this specification or that may be required by the engineers, also the payment of patent royalties, if any. The iron of which the nave spokes and rim are made must be equal in quality to the very best Staffordshire. The nave must be bored out perfectly true throughout to receive the axle, and the two faces turned. The rim is to be turned on the circumference and on the sides, great care being taken to turn the dovetail true to shape. The tires and axles are to be of first-class workmanship throughout, and to be made from such mixtures of metal as will insure the very best quality of Bessemer steel, to be approved by the engineers. The contractor is to specify in his tender which make of steel he proposes to supply, it being understood that all the tires and axles are to be of the very best quality. The tires are to be of the dimensions shown on the contract drawing, and the form must be exact to a template which will be furnished to the contractor. The tires must be secured to the rim by eight screw bolts, as shown. After the tire is shrunk on—in doing which great care is to be taken that the dovetail comes well home to its place—the holes are to be drilled and tapped, and the bolts inserted. The axles are to be turned and finished true to templates to be approved by the engineers, and are to be made of the exact forward dimensions shown on the contract drawing. The wheels are to be forced light upon the axles by hydraulic pressure—the total pressure not being less than 35 tons—and secured each by one steel key, 1in. broad and ½in. thick, fixed as shown on the contract drawing, care being taken that the key groove in the axle does not cut into the 4½in. cylindrical part outside the wheel nave. The keyway is to be cut in exactly the same position in each wheel, and each pair of wheels is to be fixed on the axle with the spoke in the same position. The turning of the tires must be done after the wheels have been fixed on their axles, and the centre holes on which the axles are turned are to be left in the ends of the axles, the tires are to be turned all over, both externally and internally and on the sides. A sample pair of wheels fixed upon their axles are to be submitted to the engineers for approval before the work is generally proceeded with, and the sample wheels and axle will be tested in any way the engineers or inspector appointed by them shall desire. The contractor is to give one week's notice in writing to the engineers previous to the sample wheels and axles being ready for inspection and testing, and as the work proceeds he is also to give the engineers similar notice prior to any of it being ready for inspection. When the tires are all rolled the engineers or inspector will select two, which will be placed under the drop, and a ton weight shall be let fall upon

AMERICAN MOGUL LOCOMOTIVE—NEWFOUNDLAND RAILWAY.



CONTRACTS OPEN.—WHEELS AND AXLES, EASTERN BENGAL RAILWAY.



each of them until they shall have deflected 2in. for every foot of internal diameter, or about 6½in. in all, and should any of the tires fail under this test the lot from which they are selected will be unconditionally rejected, and all the tires which may be damaged in this or any other manner prior to their coming into the actual possession of the company will have to be at once replaced by the contractor at his own expense. When the axles are all rolled two will be selected from the lot, and after having been placed on bearings 4ft. apart a ton weight will be let fall through 30ft. upon the centre of each of them, and the axles must stand two such blows without showing any signs of fracture; but should either of them fail, the whole of the axles will be unconditionally rejected. The materials used are to be of the very best description of their respective kinds, and perfectly free from any defects whatever. The engineers are to have power to adopt any means they may think advisable in order to satisfy themselves that the kinds of materials stipulated for are actually used throughout the contract. The workmanship is to be of first-class character throughout, and the degree of finish such as the engineers shall direct. All important parts are to be finished to standard gauges, and great attention is to be paid to the uniformity of dimensions throughout the whole number made. The name of the maker, together with the year of manufacture, also the letters "E. B. R." of the railway, must be stamped on the centre part of every axle, and each axle must be stamped with a progressive number, beginning at No. 1, and so on, upwards, and in addition the contractor will be required to mark the packages for shipment "*Vià* the Suez Canal," and with other marks as will be directed. The journals of the axles are to be carefully coated with white lead and tallow, or such other preparation as the engineers shall approve, or, at the option of the engineers, are to be painted with three coats of red lead, and in addition are to be completely lapped with canvas steeped in melted tallow, and further protected by six pieces of wood packing, banded with two iron hoops, driven on tight in the manner directed. All other parts are to be painted with three coats of oil paint, so that the whole may be properly protected from corrosion during the sea voyage. All the parts, and particularly the journals, must be perfectly clean and free from rust at the time the coating is applied. The contract is to be executed in the most approved, substantial, and workmanlike manner, according to the direction of, and to the perfect satisfaction of, the company's engineers, who shall have power to inspect the entire manufacture either personally or by deputy during the whole progress of the contract, and to reject any parts of the work they may disapprove, and their decision on any points of doubt or dispute which may arise in reference to the contract shall be final and binding on all parties. No wheels and axles will be considered as accepted by the company until the engineers shall have given their certificate that they are satisfactory, but if defective, they will be liable to rejection, even after they have been certified or received into the possession of the company, but not after actual shipment to India. The contractors must not assign or sub-let this contract or any part thereof, nor allow any portion of the work other than in his own establishment, without the express consent of the company being obtained. The whole of the work is to be delivered free on board vessels lying in any dock or alongside any wharf or in any part of the stream at either of the ports of London or Liverpool, as the company may direct. The wheels and axles are to be delivered within two months from the date of the acceptance of the tender. Before payment can be made the contractor must send four copies of the invoice to the secretary of the company, 44, Gresham-street, London, E.C., who will submit them to the engineers and to the shipping agents to be certified. No payment will be considered as legally becoming due to the contractor until the completion of the contract, but advances of money on account may be made to him at such times as the engineers may recommend to an extent not exceeding 90 per cent. of the contract value of goods delivered, the balance being retained, without interest, until the engineers shall have given their written certificate of the satisfactory completion of the contract. It is, however, expressly understood that such advances are in nowise to be considered as evidence of every particular quantity of work having been executed, or of the manner of its execution being satisfactory, or in any other way to relieve the contractor from the liabilities he may sustain under the terms of the contract. Tenders must be addressed to Mr. E. H. Smith, Eastern Bengal Railway Office, 44, Gresham-street, London, E.C., and sent in before twelve o'clock at noon on Thursday, the 25th inst., and endorsed "Tender for Wheels and Axles."

LETTERS TO THE EDITOR.

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

WIRE ROPE HAULAGE ON TRAMWAYS.

SIR,—I have read with interest your article on Hallidie's wire rope haulage system, and with your permission I would like to make a few remarks about it. That the system is in operation in San Francisco and Chicago is quite true, but I submit that this is no proof whatever that it can be worked with equal success in this country. In the United States railway locomotives run down the middle of principal streets, but they would not be tolerated here; and it cannot be argued that because a given mechanical system of working street railways will answer in one country, it will answer in another. It may work, or it may not. So far as I am aware, the streets in Chicago and San Francisco, where it is worked, are twice as wide as the streets where it is proposed to be worked here, and our streets are intersected by water and gas pipes and sewers in a way to which no parallel exists in the streets worked under Hallidie's patents in the United States.

I note that you speak very cautiously concerning the economical working of street tramways by steam, and justly so. The whole history of the attempt to use locomotives for this purpose is one of disaster. No one has, so far as I know, yet succeeded in making steam pay on tramways. I have recently endeavoured to get statistics that would be trustworthy on this subject, but I can obtain none; and I challenge the advocates of the system to cite a single well-proved instance in which tramways have been worked by steam cheaper than by horses. I will not have figures regarding the first six months of working, while the engines and cars are all new; we have had enough of that kind of thing from Paris, out of which steam tramway locomotives have at last been cleared, after thousands of francs had been lost in trying to make them a success. Brown, Merryweather, Hughes, and a dozen others have all tried to make steam tram cars pay, and all, I believe, unsuccessfully. In Leeds and Manchester, and towns where there are girders instead of rails, it is just possible that they may be made to compete with horses, but on London tram roads never.

I notice that you speak with great caution concerning the deductions to be drawn from the American results, and very properly so. You say that in San Francisco the Hallidie system has been found to work tramway traffic so cheaply that it earns from 14 to 30 per cent. on the capital expended. I know that this statement has been made very authoritatively in the United States, but it has always struck me that it is a very curious statement. The difference between 14 and 30 per cent. is very great, and I do not pretend to know what the statement means. Is it intended to imply that the earnings are much larger at one time of the year than at another, or simply that the percentages are calculated on different bases? You say that "In England, or at any rate, in London, the cost of installation will no doubt be larger than in San Francisco or Chicago." On this point, Sir, you are quite right. In fact, no one can tell what the cost of putting down a Hallidie road in this country will be.

You are equally cautious when you say "it is estimated that the working expenses and profits on the tramways in London would be as follows." You do not say it is *your* estimate, or I would ask you for explanations which I must now seek elsewhere. The North Metropolitan Company, with a dividend of 9·5 per cent., has a working expense of 73·75 of the total receipts. It is estimated that the cost of cable haulage would be 37·75 per cent. This is a reduction of very nearly, but not quite, one-half of the working expenses, while the profits are nearly doubled. On the London Street Tramway the working expenses are 82·5, the dividend 7·75. With cable haulage the cost is to be reduced to 39 per cent. of the total receipts—again nearly one-half—but the dividend is to be augmented more than fourfold. Again, if we take the London Street Tramway Company, we have working expenses 74 per cent., dividend 8·75 per cent.; but by cable haulage the working expenses are to be 41·75. Here there is a saving of much less than 50 per cent., while the dividend is not quite doubled.

Figures such as these possess no real value whatever, and when I come to examine the Hallidie system in detail as a mechanical engineering device, I see that, although excellent in its way, there is no reason to anticipate any remarkable saving. It is quite true that horses—always perishable commodities—will be got rid of, but we have a heavy rope to be kept in constant motion, and the failure of the rope in any place will disorganise the whole service. I think the system ingenious, and that it has been worked out with much ability, but that it solves the great mechanical problem, how to dispense with horses, I do not think. That a great deal of wire rope haulage is done in this country is true, but it is only used because no substitute can be devised for it; and those who have seen as much of haulage by rope and chain as I have, will be the last to place unlimited faith in the economy of the Hallidie system over horses in this country.

J. R. WILSON.

Euston-road, January 15th.

SHIPBUILDING IN 1882.

SIR,—The table which you publish at page 20 is so interesting that I have made a summary of its contents, which I enclose. It brings together the builders of each town, and shows at a glance who are the largest builders:—

Iron vessels built in 1882.

Glasgow.

	Vessels.	Tons.
Stephens and Son ..	16	29,570
Elder and Co.	6	25,915
J. and G. Thompson	5	23,513
Dobie and Co.	8	19,952
Connell and Co. ..	5	19,113
Barclay, Curle, and Co.	9	15,736
London and Glasgow Company	7	15,639
Duncan and Co. ..	6	10,660
Aitken and Mansell.	5	10,353
Henderson and Co..	3	8,450
A. and J. Inglis ..	2	7,319
Murdoch and Murray	7	6,247
Napier and Son ..	2	6,010
	81	198,477

Paisley.

	Vessels.	Tons.
McIntyre	11	7,780

Dumbarton.

	Vessels.	Tons.
Denny Brothers ..	7	21,261
McMillan	7	17,188
	14	38,449

Port Glasgow.

	Vessels.	Tons.
Russell and Co. ..	14	18,619
Reid and Co.	6	7,633
Murray and Co. ..	5	4,917
	25	31,169

Greenock.

	Vessels.	Tons.
Caird and Co.	4	14,089
Scott and Co.	6	10,924
Steele and Co.	6	9,470
	16	34,483

Aberdeen.

	Vessels.	Tons.
Hall, Russell, and Co.	3	4,776

Blyth.

	Vessels.	Tons.
Hodgkin and Co. ..	8	8,158

Newcastle.

	Vessels.	Tons.
Palmer's Company..	22	40,129
Mitchell and Co. ..	14	26,793
Tyne Iron Ship Company	9	17,049
Leslie and Co.	8	16,371
Swan and Hunter ..	9	15,675
Richardson and Co.	8	15,573
Schlesinger, Davis, and Co.	8	14,960
	78	149,550

South Shields.

	Vessels.	Tons.
Redhead and Co. ..	12	16,646

Sunderland.

	Vessels.	Tons.
Doxford and Son ..	11	22,792
J. L. Thompson and Son	11	22,502
Laing	11	19,771
R. Thompson and Son	12	19,534
Short Brothers ..	8	15,411
Sunderland Company	6	15,193
Blumer and Co. ..	7	11,865
Batram and Haswell	6	10,706

Sunderland (continued).

	Vessels.	Tons.
Osbourne and Graham..	7	9,329
Pickersgill and Sons	5	6,260
Austin	5	5,248
	89	158,611

Hartlepool.

	Vessels.	Tons.
Gray and Co.	20	38,050
Withy and Co... ..	12	20,960
Irvine and Co... ..	5	5,567
	37	64,587

Stockton.

	Vessels.	Tons.
Pearce and Co... ..	10	19,141
Richardson, Duck, and Co.	9	18,291
	19	37,432

Middlesbrough.

	Vessels.	Tons.
Dixon and Co... ..	14	25,881

Hull.

	Vessels.	Tons.
Earl's Company ..	6	11,755

Whitby.

	Vessels.	Tons.
Turnbull and Son ..	8	13,981

Southampton.

	Vessels.	Tons.
Oswald, Mordaunt, and Co.	6	13,462

Liverpool.

	Vessels.	Tons.
Royden and Son ..	11	20,475
Potter and Son ..	8	14,769
	19	35,244

Barrow.

	Vessels.	Tons.
Barrow Company ..	7	27,559

Whitehaven.

	Vessels.	Tons.
Whitehaven Company	5	6,265

Belfast.

	Vessels.	Tons.
Harland and Wolff..	6	18,590

Total.

	Vessels.	Tons.
Glasgow	81	198,477
Paisley	11	7,780
Dumbarton	14	38,449
Port Glasgow	25	31,169
Greenock	16	34,483
Aberdeen	3	4,776
Blyth	8	8,158
Newcastle	78	149,550
South Shields	12	16,646
Sunderland	89	158,611
Hartlepool..	37	64,587
Stockton	19	37,402
Middlesbrough ..	14	25,881
Hull	6	11,755
Whitby	8	13,981
Southampton	6	13,462
Liverpool	19	35,244
Barrow	7	27,559
Whitehaven	5	6,265
Belfast	6	18,590
	464	902,855

But it appears to me that the list is far from complete, as many ports are omitted where undoubtedly iron shipbuilding is carried on—London, Dundee, Leith, South Wales ports, Birkenhead.

However, 464 vessels, of nearly an average of 2000 tons each, must have required a deal of hammering to put together.

Gateshead, January 14th. R. S. NEWALL.

SIR,—Referring to your paper of the 12th, giving tonnage built last year, we beg to point out that you are in error regarding vessels built by us, the Androsa, Chateau Lafite, and Darjiling, being completed in 1881, while several built by us in 1882 are not entered.

OSWALD, MORDAUNT AND CO.

Shipbuilding, Engineering, and Repairing Works, Southampton, January 15th.

FLYING MACHINES.

SIR,—I will deal as briefly as possible with the points under discussion before proceeding to the further expression of opinion which you invite.

(1) With regard to the case of the two engines, one of which is twelve times as large as the other. The piston area of the larger one would, as you truly say, vary as the square of the diameter, and would therefore be 144 times that of the smaller; the length of the crank would be twelve times as great, and the resultant crank effort would therefore be 1728 times as before. But the strength of the shaft is also 1728 times as great, that is to say, in this particular respect, as well as in others, the proportionate strength of the large one is exactly equal to that of the smaller, and it is clear that the power and weight vary as the cube of the linear dimensions. As to the argument being taken as referring to the whole model, I beg to point out that I took the very part of the machine specially referred to in your article.

(2) I had not forgotten the existence of the whale, neither had I forgotten the purposes for which it is adapted, and, therefore, I purposely avoided citing as analogous to a ship an animal which spends so much of its time beneath the water. As a creature floating partly immersed upon its surface, the nautilus seems, however, to be strictly comparable with our rowing and sailing craft, and moreover the largest creature of the kind. Howbeit, let the case of the whale be taken and a few figures in connection with it. One of the largest whales ever caught measured 95ft. in length and weighed 249 tons. The Servia—not to take an extreme case—is 530ft. long and of 8500 tons burden. It will be found that such a tonnage is amply sufficient to enable her to be propelled by muscular power—that is to carry a sufficient number of men to produce 10,500-horse power—if steam power were not forthcoming, and this directly meets the first argument in the article. Moreover, though it would be interesting to have a clear demonstration of the reasons why whales are not bigger than they are, such a demonstration would unfortunately, in the face of the above facts, quite upset the argument in question.

(3) By referring to my letter you will see that all the diagram is set forward to prove, and what it does prove, is that a bird may sustain its weight in the air by the exertion of a force much less than that weight. Thus the statement in your article which altogether denies this, except for upward currents, remains unproved. The matter is a most important one and not by any means self-evident. It is perfectly true that the current does not exist with reference to the quiescent plane. But it just as certainly does exist when the bird, which the plane represents, begins to exert force. The object of the diagram is to show that the small horizontal force O S counteracts the horizontal tendency of the wind to move the plane, that is the bird. At the same time the weight of the bird is sustained by the vertical force P S. The bird, therefore, remains absolutely at rest in space, the wind notwithstanding. I took care not to enter upon the debatable ground as to what action supplies this necessary force which, acting for hours, can scarcely be due to momentum. What the elementary facts you quote have to do with the argument it is rather hard to see. I trust I have been sufficiently explicit in refuting the charges of oversight, forgetfulness, and error which you think fit to make.

Coming now to the point on which you ask an opinion. The article unmistakably and clearly intimates that the weight on a brake is analogous to the weight of a bird, and the distance passed over by the rim of the brake-wheel to that moved through by the wings. As the formula is given, it is easy to insert approximate values. The weight of the bird is 30 lb., the distance passed through by the centre of the wing, from 3ft. to 5ft. The number of strokes when rising or stopping suddenly is, according to observers, from three to four per second. These data give from ½-horse power to 1-horse power. This wing velocity is no doubt maintained only for short periods; still, if the formula and reasoning were correct, this incredible power would be exerted, though even for a short time. But, from accounts of those who have handled the albatross, there seems little warrant for assuming anything like the power of a man.

If the action of the wing could be assumed to be similar to that of a plane surface, the resistance might be found from any one of the formulas in use connecting the pressure and velocity of the wind. Although the wing action is not exactly thus, the resistance is at any rate, as you say, a function of the velocity, and that function probably the square. A little consideration would show that, this being the case, we should expect the wings of birds to decrease in size with the increase of the bird. This de Lucy has shown to be true, and from measurements of the ladybird, stag beetle, pigeon, and stork, Professor Thurston calculates that a man of the ordinary weight should be able to fly with wings having an area of 40 square feet. Villeneuve gives a length of 10ft. for a bat having the weight of a man. Hastings makes the surface from five to ten times $\frac{2}{3}\sqrt{W}$, the area being in square centimetres and the weight in grammes. These conclusions point to the absurdity of the dimensions allowed by some writers; as, for instance, Hartwig, who gives from 12,000 to 15,000 square feet, and also to the fact that the mode of reasoning adopted in your article to arrive at the spread of wing, and consequent weight of bone, differs at any rate from that of the most recent scientific workers.

H. S. HELE SHAW.

University College, Bristol, January 16th.

[Professor Shaw still appears to us to be mistaken in his views, and in order to prevent this discussion taking too wide a range, we shall confine ourselves to one portion only of the subject, putting the rest on one side for the moment. Obviously the most important question raised is the work expended by a hovering bird. It is clear that if the bird merely extended its wings and gave them no motion it would fall to the ground, the velocity of fall being retarded by the resistance of the air. But in falling work must b done on the air which may be measured by the difference between the actual final velocity of the bird on touching the ground and the theoretical velocity. We may take the case of a bird swooping down to the ground from, let us say, the height of 99·37ft., when its final velocity if it had fallen freely would be 80ft. per second; but the bird may arrive at the surface of the ground with little or no velocity. Let us assume that the bird weighs 10 lb. Then it is clear that in the arrest of its descent not less than 1000 foot-pounds of work have been done on the air in some way. If now we take the case of the same bird soaring, it is evident that to attain a height of 100ft. it must expend 1000 foot-pounds of energy at least, and this will be exerted on the air. But much more than this will be required. It is well known that the resistance of a liquid such as water to the thrust of an oar, paddle-wheel, or screw propeller is determined altogether by the weight of water sent astern and its velocity, and the broad rule has been laid down by Rankine that that propeller is best which sends astern the largest weight of water at the least velocity. Assuming that the same truth holds good of elastic fluids like air, we find that the bird's wing must act to a great disadvantage as compared to an oar moving through water, because it sends a small weight of the fluid downwards at a very high velocity. In other words, a very considerable amount of work is done in putting air as well as the bird in motion, and the utilisation of a current of air in causing the ascent of the bird will in no way affect the work to be done, save in the way that we have already pointed out, namely, that the time expended in attaining a given height will be greater in this case than if the bird climbed straight up, so to speak, at once. But no matter in what way a given height is reached, the work done by the bird cannot be less than that represented by its weight multiplied by the height. If Professor Shaw can prove that elastic fluids give reaction in a way differing from that of water, then the problem may assume a new aspect as regards wasted power. On this subject, however, we are not aware of the existence of any published information, for the subject has never been investigated, experiments with fans in cases hardly bearing on it. When our bird has attained a height of 100ft., if it intends to remain there without rising or falling sensibly it must exert muscular force, and what that force will be is the point to be decided. The condition of the bird is, however, precisely that of the break weight on a dynamometer; of which it is known that the power expended is equivalent to the weight in pounds multiplied by the angular velocity of the pulley in feet per minute and divided by 33,000. Professor Shaw seems not to have caught our meaning, and we can, perhaps, better convey it to him by saying that a strict parallel to the case of the bird would be supplied by a boat, which a rower, by the aid of oars, would attempt to keep stationary in still water while some one attempted to pull the boat astern by a tow line. In the case of the bird gravity takes the place of the pull on the tow line, and wings take the place of oars, and we now venture to submit the following problem for solution to our correspondent:—Let it be supposed that a Cambridge racing crew, pulling thirty strokes a minute, can impart a velocity of twelve miles an hour to their boat. Now let us suppose that a line is attached to the stem of the boat, one end of which line shall pass over a pulley, and that sufficient weight is hung on the line to impart a velocity of twelve miles an hour to the boat with her crew sitting in her but not rowing. Next let the boat be turned round and the line attached to her stern. If matters are suitably arranged the boat will then move astern at some velocity less than twelve miles an hour, depending on the shape of the boat. This difference may be neglected. Let the crew now proceed to pull as before at just such a speed as will keep the boat stationary. What proportion will the power then exerted by the crew bear to the power expended when the boat was not secured by a line? In the case of the bird the action of gravity is direct, instead of taking place through the medium of a pulley. If Professor Shaw should say that the work expended by the boat's crew will be the same in both cases, then we say that the work expended by the bird in hovering will probably be the same that it would expend in flying upwards at a velocity identical with that which it would have when, during falling with outstretched wings, the resistance of the air exactly balanced the action of gravity, and the rate of fall became constant.—ED. E.]

COMPOUND ENGINES.

SIR,—I am inclined to think that your correspondent Mr. Reuben Bramhall, in his letter in a recent impression, is not placing the saddle on the right horse in ascribing the circumstances of not being able to get within 12 lb. per square inch of the boiler pressure into his high-pressure cylinder "to the crippled area of the steam ports," for although the said cylinder had "improved double short slide valves with cut-off plates fitted with hand regulating motion of simple and efficient construction," still it would no doubt have a throttle valve to regulate the speed, and, as is evident from the diagrams Fig. 4, the engine had a comparatively light burden to overcome; with the expansion valves set to cut off at about four-tenths of the stroke, the throttle valve was wire-drawing the steam, and this alone would account for the diminished initial pressure. Had the ports been crippled in area to any great extent, I would have expected the exhaust line to have been much worse. I am assuming Fig. 4 to be the high-pressure diagram, as, in the absence of atmospheric lines in Figs. 3 and 4, they are apt to mislead.

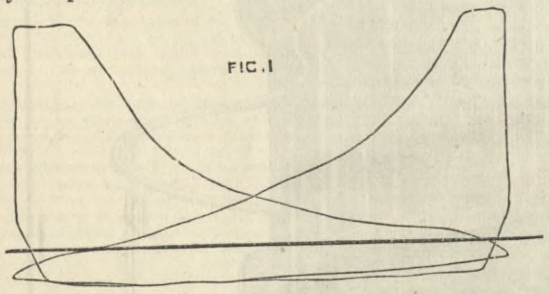
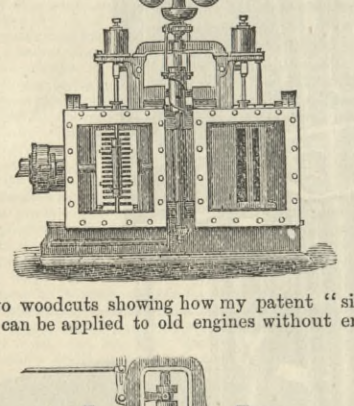


FIG. 1

I enclose a set of diagrams taken from an engine fitted with cut-off plates regulated by hand, which I think will please Mr. Bramhall. They are taken from a pumping engine which has no throttle valve nor governor, and the piston moving very slowly. They are within one pound of the boiler pressure at the commencement of the stroke.

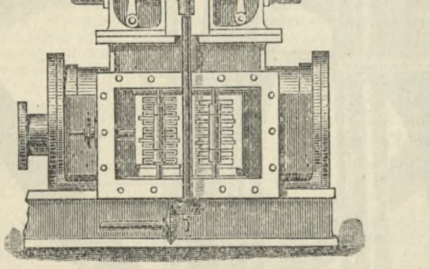
To get out of his difficulty, your correspondent referred to replaced the high-pressure cylinder with one the same diameter, but fitted with automatic cut-off gear.

Fig. 2



I enclose two woodcuts showing how my patent "simple" cut-off valve gear can be applied to old engines without entailing the

Fig 3



expense of a new cylinder. Fig. 2 shows the application for two short slide valves, and Fig. 3 for the single slide. I also

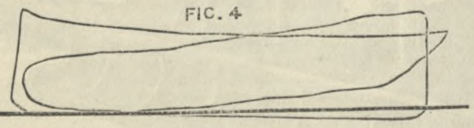


FIG. 4

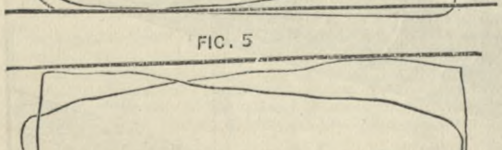


FIG. 5

enclose a set of diagrams taken from a compound engine, originally fitted with ordinary single slide valve. And a set after the same

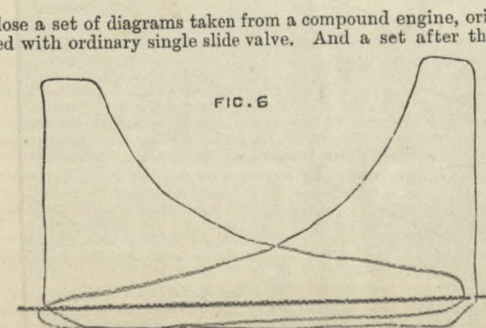


FIG. 6

engine had my patent cut-off valve gear applied. The saving from this alteration was well known, as one of the departments of the mill which had previously been driven by a separate steam engine was connected to the compound engine with even a less consumption of fuel in the steam boiler than what had formerly been the

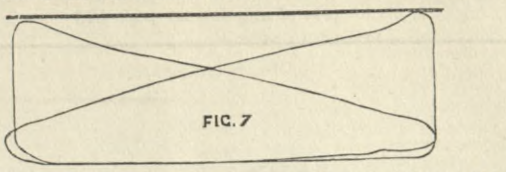


FIG. 7

case when supplying steam to the compound engine alone. I am rapidly applying this cut-off gear to all kinds of steam engines, and I had it exhibited in London two years ago, which is referred to at p. 211 of THE ENGINEER for September 27th, 1880.

184, Buchanan-street, Glasgow, JOHN TURNBULL, JUN.

THE LAWS OF PROJECTILE MOTION IN VACUO.

SIR,—I am sure a large number of your readers must have read with as much pleasure as I did Professor Lodge's masterly article in your last impression. Its lucidity is admirable, and the value of such articles to men who, like myself, have not time for much reading, cannot, I think, be overrated.

There are two points on which, if Professor Lodge would further enlighten—shall I say myself, or rather a thousand others—he would confer a great favour. First, he states that whether the projectile be discharged in a vertical or horizontal direction the result is the same; and I suppose that this is based on the assumption that the projectile fired vertically upwards would have the same angular velocity as the surface of the earth, namely, about 1000 miles per hour at the equator, or would this be true if the earth did not revolve on its axis? In other words, would this be true if the gun was placed at the north or south pole, its axis parallel to that of the earth?

Secondly, can Dr. Lodge tell us without much trouble why it is that the projectile revolves in an elliptical path instead of in a circle?

As comets approach so close to the sun, is it possible that they may have been projected from his surface? If we find one body A rotating round another body B in a track which never approaches B nearly, that is proof that A never formed part of B; but conversely, if we find A coming very close to B, or touching it, is not that evidence that it was projected from B? F. DARE.

January 15th.

AN EXTRAORDINARY BOILER EXPLOSION.

WE have on more than one occasion pointed out that although by far the greater proportion of boiler explosions are the result of strictly preventible causes, yet that explosions do now and then take place for which it is impossible to find any satisfactory explanation, save the sudden generation of a very large volume of steam and a corresponding augmentation of pressure. A remarkable instance of such an explosion is supplied by the total destruction of a locomotive engine near Dunbar Station of the North British Railway, on the 4th of September, 1882.

Major-General Hutchinson's report to the Board of Trade on this explosion has just been made public, and we reproduce in full the conclusions at which he has arrived. It will be seen that in this case all the testimony goes to show that a completely new locomotive, in excellent order, exploded with terrific violence, and without any assignable cause; for the defects spoken of by General Hutchinson could have in nowise brought about the results which the report describes. We put forward no theory on the subject, but we may point out that such events are by no means so rare as might at first sight be supposed.

The cause of this disastrous boiler explosion, says Major-General Hutchinson, is involved in much obscurity. The engine, a comparatively new one, having commenced work only in 1876, and performed a mileage of only 186,119 miles, had come out of the Cowlairs shops, after a complete overhaul, in March last, since which time, with the exception of trifling repairs, it had been running without any leakage or other important defects having been observed in the boiler or fire-box. The fire-box had been examined at the usual quarterly inspection on the 23rd June, when it was reported to be in good condition, and had been again examined on the 28th August, three days before the explosion, when a new fusible plug had been substituted for the old one—these are replaced every month—and had again been found in good order. The safety valves—two in number on the dome of the engine, each 2½in. diameter—had been adjusted to blow off at 137 lb., slightly less than the working pressure of 140 lb., on the 14th August. To increase this pressure would have required the removal of the dome cover, not an easy operation unless when the engine is in the sheds. The engine had been used by a strange driver, who had brought it back from a long trip on the morning of the explosion, and stated that the safety valves were blowing off freely at a pressure of 130 lb. Another driver had been on the foot-plate of the engine just before it started on the evening of the 1st September, and stated that the steam was easing off at the safety valves, and that the pressure gauge showed 125 lb. The fireman of a pilot engine which had joined the rear of the goods train, drawn by No. 465 engine, at Dunbar to help it up the bank to Grantshouse, had heard engine No. 465 blowing off steam just as it started; the pilot driver had not heard this. This same fireman had seen engine No. 465 taking water at Dunbar, when the driver was on the ground oiling; he heard the fireman shout twice to him to turn off the water, which he did after the second shout. He had then observed three men on the engine.

With regard to the train itself, it appears to have left Leith Walk at 8.15 p.m., ten minutes late, with thirty-seven loaded wagons, three empty ones, and a van, the maximum load for an engine being of the class of No. 465, being fifty loaded wagons to Dunbar, whence a pilot engine would assist the train up the bank to Grantshouse. The train slacked at Piers Hill, where it is probable that the third man—a wine and spirit merchant—joined the engine; did not stop at Portobello, as the driver ought to have done—as he had not a full load on—to pick up wagons, unless he received a signal to proceed from the Portobello yardsman, that there was nothing to pick up; and this signal he did not receive, as the yardsman intended him to stop, having wagons to forward. The train reached Dunbar at 9.25 p.m., not being due till 9.41 p.m.; as it started from Leith Walk ten minutes late, it must—allowing for the time which should have been occupied in stopping at Portobello—have run the distance of twenty-nine and a-half miles in a-quarter of an hour less than the allowed time, though at the same time the average speed would not even so have exceeded twenty-five miles an hour. The train moved away from Dunbar advanced signal at 9.45 p.m., and, after proceeding a short distance with the pilot engine at the back of the train, the explosion occurred at 9.47 p.m. The down goods train, which ran into some of the wreck caused by the explosion, had left Innerwick at 9.35 p.m., and, being due at Dunbar at about 9.50 p.m., must have been approaching very near the engine of the up goods train when the explosion occurred; and this tallies with the statements of the driver, fireman, and guard of the down train.

From the above it will be observed that the deceased driver of the up goods train committed two grave offences after starting from Leith Walk, first, in allowing a stranger (who turned out to have been a wine and spirit merchant, residing at Jock's Lodge, near Edinburgh) to ride upon the foot-plate of the engine (probably from Piers Hill, where the train slacked its speed); and, secondly, in not stopping his train at Portobello to pick up wagons to complete his load (which was ten wagons under the maximum), his reason for not stopping having probably been to avoid its being observed that a stranger was on the engine. He was next seen at Dunbar oiling his engine, both by his own guard and by the fireman of the pilot engine, who neither of them thought him the worse for liquor. The deceased driver was forty-one years of age, had been nineteen years in the service, and fourteen years driver. He had been reported several times for various offences, but never for drunkenness, though from the guard's evidence it would appear that he was not a strictly sober man. At Dunbar the guard of the goods train observed the stranger on the engine, and in reply to his inquiry as to what he was doing there he replied, "I am a locomotive inspector out testing coal."

The above are the principal facts connected with the train prior to the explosion, which occurred, it will be seen, shortly after the train had started—after taking in water—from Dunbar advanced signal, with by no means a heavy load, and assisted by a pilot engine up the rising gradient to Grantshouse, steam having been seen blowing off from the safety valves when the engine started, the working pressure having been nominally 140 lb., but actually, if the statement of driver Bryson—who had been on the engine before it started—is correct, not much more than 125 lb. I first saw the fragments of the exploded boiler and fire-box *in situ* before any of the principal pieces had been removed; their position, to which I have before alluded, was sufficient indication of the enormous force of the explosion, which would appear to have acted with the greatest energy to the left of the direction in which the train was running. Nearly the whole of the front barrel plate separated into two nearly equal portions, having been thrown 485 yards and 260 yards to the left and left front of the engine, the smoke-box, with the tube seating wrenched from it, having been thrown ninety-six yards to the front and slightly to the left; whereas the copper fire-box, less a portion of its right side, but with part of the outer shell and with the tubes still hanging to it, was thrown twenty-nine yards slightly to the right front, the other piece of the copper fire-box, with the whole of the outer shell, having been thrown eleven yards directly to the right. It was impossible to examine the fragments *in situ*, but after their removal to Cowlairs I made a careful examination of them on two separate occasions. The result of these examinations did not enable me to arrive at any satisfactory conclusion as to the causes of the explosion, for, so far as I could ascertain, there was no corrosion, no bad material, and no defective stays sufficient to account for it; there was slight pitting observable, and in the fractured surfaces of both barrel-plates and in the back-plate of the outside shell of the fire-box there were two places showing imperfect union between the laminæ of the plates; the worst of these was on the fire-box plate, and extended for about 4ft. horizontally and 2ft. vertically near the angle on the right-hand back side. The defective stays were very few in number, and were on the left-hand side and near the back of the fire-box. The cast iron dome — metal 1in. thick—22in. in external diameter, secured to the dome seat by twenty-one studs $\frac{7}{8}$in. in diameter, had been projected about 325 yards to the right. It had been torn off through twelve studs, and through the solid metal for the remainder of its circumference. No signs of flaw were visible in the surfaces of fracture of the cast iron. The steam pipe, 4¼in. in diameter, made of $\frac{3}{16}$in. copper, was picked up close to one of the large pieces of the barrel, 260 yards south-east of the engine; it was broken into two lengths and somewhat flattened. The pressure gauge was but little damaged; the water gauge was destroyed. The safety valves, which had been attached to the dome, had separated from it, and were picked up close to it. The fusible plug, which had been inserted in the crown of the fire-box only three days before the explosion, was found perfect, and without any incrustation on its lower side.

From the difficulty in assigning any sufficient cause for the explosion, I suggested to the locomotive superintendent of the North British Railway the desirability of testing the boiler of a sister engine—of which there are several—which had run nearly the same number of miles as No. 465, and which was as nearly as possible in the same condition, so as to endeavour to ascertain its weak points. He at once acceded to the suggestion, and the experiment was subsequently made with the boiler of an engine of about similar age and work, and which had undergone about the same repairs as No. 465. The boiler was gradually pressed hydraulically up to 500 lb. to the square inch, when, as some of the fire-box stays were beginning to give way, it was considered advisable to stop. It was then found that six fire-box stays had given way, five on the right side towards the rear, and one on the left side towards the front. There had also been a good deal of oozing from the dome-seat joint, but nowhere else. The result of the experiment did not therefore indicate that there was any specially weak point about the boiler or fire-box, the yielding of some of the fire-box stays under the high pressure of 500 lb. to the square inch being a result that might naturally have been expected. The steam pressure gauge which had been in use on the engine, and the tube of which had been very slightly damaged, I found upon trial to register correctly up to a pressure of 200 lb. After a careful consideration of all the circumstances connected with this explosion, I am unable to arrive at any other opinion than that it was caused by a sudden generation of very high-pressure steam, acting with irresistible force alike on the fire-box and barrel of the boiler, and which force neither the safety valves nor the steam pipe—which was presumably open, as the train was in motion—were able to deal with. But for the fact of there having been a new fusible plug in the crown of the copper fire-box, which must, it is conceived, have been melted had the crown of the fire-box become heated from want of water, it would have been only natural to have blamed the deceased driver for neglect of duty in having allowed the water in the boiler to get too low, especially as he had been guilty of the serious offences of allowing a stranger to be with him on the foot-plate, and of not stopping, as he ought to have done, at Portobello, to fill up his load. In addition also to the fact of the fusible plug not having been melted, there were no evident marks of scorching on the inside of the crown of the fire-box, and moreover, as the engine was moving on a rising gradient of 1 in 200, even had the water been rather low, it would have tended rather to cover the crown of the fire-box than to leave it bare.

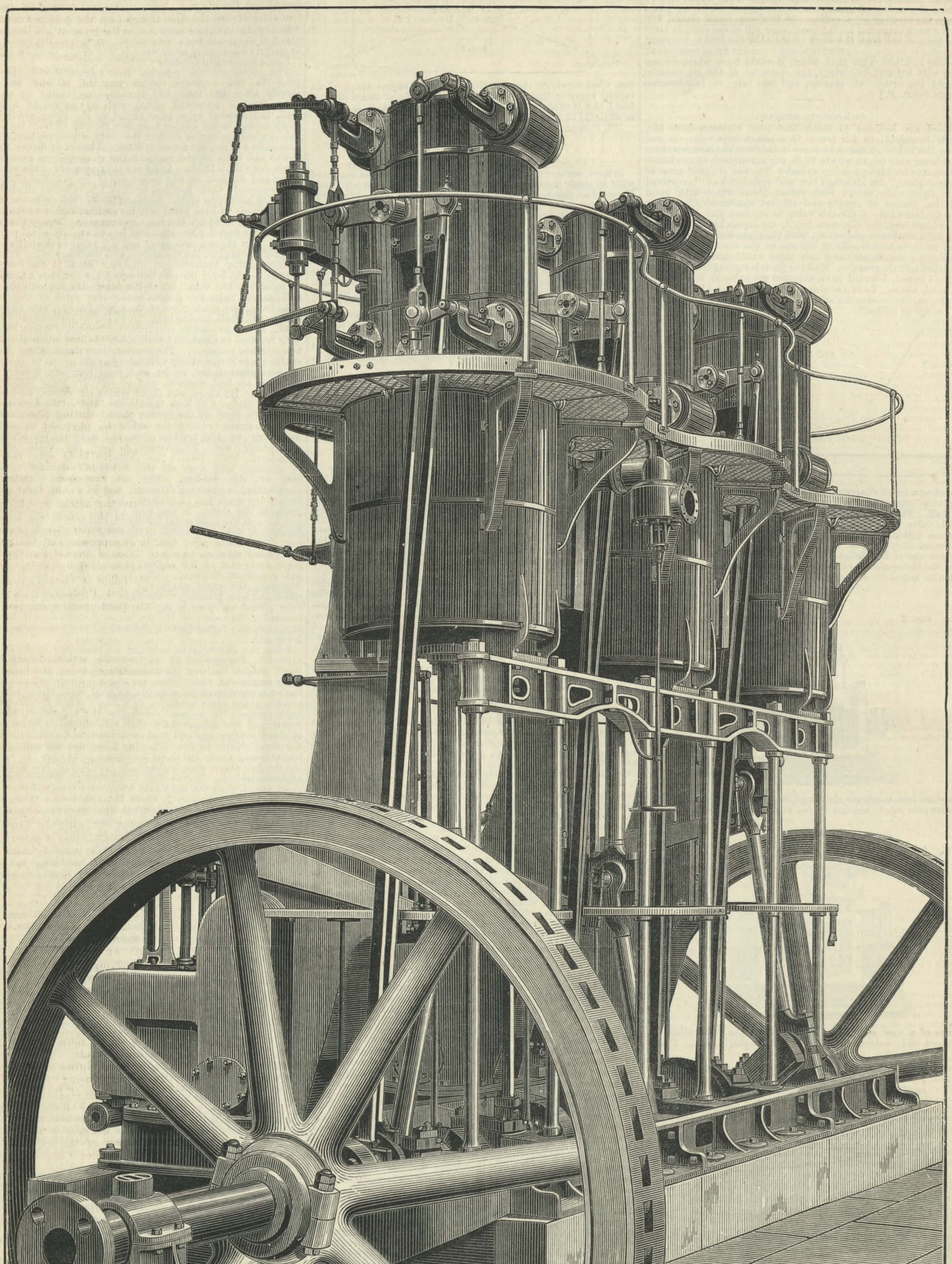
Explosions of a nature somewhat similar to the present one, and to be explained only by the fact of a sudden generation of high-pressure steam, have occurred before this, the most notable case being that of the explosion of a boiler of a Caledonian Company's engine, when running at a speed of thirty miles an hour, near Carlisle, in April, 1856.

The following statement of repairs to boiler and fire-box of No. 465 engine is appended to the report:—St. Margaret's, 12th March, 1878: All short tubes driven up, fifty-two taken out that would not drive up, pieced with copper and put in. Stays in fire-box hammered where leaking. All tube ferules renewed where bad. Plug holes retapped and plugs renewed. Smoke-box door made tight. Boiler tested with steam and safety-valves fixed at 150 lb. pressure per square inch. Damper repaired. St. Margaret's, 26th April, 1879: Tubes all driven up. Tube ferules in fire-box all renewed, and a number of stays in box hammered up. Plug holes retapped, and plugs renewed. Rivets in framing foot-plates renewed where loose. Safety-valves renewed. Boiler tested in steam, and safety-valves fixed at 150 lb. pressure per square inch. Cowlairs, 27th March, 1880: 224 tubes expanded and re-feruled. Twenty-four copper stays renewed. All wash-out and lead plugs examined. St. Margaret's, 15th May, 1880: Boiler tested with steam pressure 140 lb. per square inch. Cowlairs, 9th October, 1880: 224 tubes expanded and referuled. All wash-out and lead plugs examined. Cowlairs, 1st April, 1882: New copper half-tube plate put in; new expansion angle irons put in. Twelve expansion hangers put in. Six new longitudinal stays put in. 198 pieced brass tubes 10ft. 11in. × 1$\frac{5}{8}$in. put in. Forty water space stays put in, 1in. diameter. Smoke-box door repaired. Wash-out and lead plugs examined.

COMPOUND ENGINES IN THE ROYAL MINT.

MESSRS. MAUDSLAY, SONS, AND FIELD, LAMBETH, ENGINEERS.

(*For description see page 52.*)



PUBLISHER'S NOTICE.

*** *Next week a Double Number of* THE ENGINEER *will be published containing the Index to the Fifty-fourth Volume. The Index will include a Complete Classified List of Applications for Letters Patent during the past six months, together with a list of Abstracts of Specifications published during the same period. Price of the Double Number*, 1s.

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.*

SANTANDER.—*We know nothing of the process to which you refer.*

C. AND M.—*The literature on the subject is chiefly contained in a series of reported decisions, with which your legal advisers are no doubt fully acquainted. As a text-book, you will find "Kerr on Injunctions" very useful.*

S. M. (Anerley).—*No such certificate is obtainable. If you have been educated as an engineer, and have had experience, you could probably become a member of the Institution of Mechanical Engineers, which would be, perhaps, as much a certificate as you can obtain.*

TEN YEARS' SUBSCRIBER.—*The best material for the purpose is very much a matter of opinion when proper care is taken in the treatment of the steel at the forge. We are unable to find the reference to the subject you mentioned, but may be able to do so if you can give some more definite idea of the date of the paper in which you saw the paragraph.*

C. F. C.—*A piston may be driven at any reasonable speed provided the engine is properly made. When the velocity is very high the steam must be admitted some time before the stroke is concluded, which is called giving lead, in order that the momentum of the moving parts may be arrested, and not expended, on the crank. You will find the whole subject dealt with fully in* THE ENGINEER *for March* 15*th*, 1878, *and on page* 50.

G. W. B.—*It is rather difficult to advise you. Vessels of the same tonnage differ so much in their behaviour at sea. You would get a good deal of amusement out of a twenty-tonner. Screw certainly is preferable to paddles for your purpose. Willan's little engines probably would be most convenient for you. If you have not a very clear idea of what you want, we should advise you to hire for a season or two. The experience you would thus gain, and the opportunity you would have of seeing other vessels, would save you probably disappointment in the future and mistakes which it would be too late to correct.*

STEEL CASTINGS.—*In our impression for January* 5*th, we used the words, "It will be seen that the only firms producing steel castings in the strict sense of the word are Messrs. Jessop, Spencer, and the Steel Company of Scotland; all the others manipulate the steel in some way after it has been cast." We regret that the sense of this passage has been misconstrued by several steel manufacturers, who have written to complain that we have done them an injustice, as they also make steel castings. Among those who thus write are John Brown and Co., Limited, Messrs. Hansell and Co., and Messrs. Samuel Osborn and Co. If the paragraph is read with the context it will be seen to have an entirely different meaning from that which our correspondents attribute to it. We were commenting on the efforts now being made to introduce, in marine work more especially, large steel castings to take the place of forged iron and steel, as, for example, crank shafts, rudders, stern frames, and such like; and it certainly never occurred to us that any reader could suppose that we intended to convey that no steel castings were made by firms other than those we named. Such a statement would be simply absurd, because it is a well-known fact that nearly all the steelmakers in the kingdom produce steel castings of various dimensions, from those weighing a few pounds upwards. In one sense every steelmaker has produced castings since the Bessemer and Siemens-Martin processes were introduced, namely, ingots. Crucible steel castings were made thirty years ago. More than a dozen years have elapsed since various firms undertook to produce pinions for traction engines. These were followed by spur wheels for the same class of machinery. Then came plummer blocks and saddles, and so by degrees progress has been made until very large spur wheel rims, &c., are cast. But it remains a fact that although most steelmakers produce steel castings for machinery, certain firms make this class of work a speciality. We are perfectly familiar with the circumstances, but what we had to say was not intended to apply to any but the particular class of castings in steel with which we were dealing and firms we named, and to extend the scope of our statement as our correspondents have done is a mistake, as we feel sure they will perceive upon reflection. We repeat that we wished to draw a distinction between manufacturers who produce steel in heavy masses for ship work, which castings are not subsequently hammered, and those who first cast and then hammer, squeeze, compress, or otherwise manipulate their castings, and this limitation we believe to be obvious.*

BRASS WORKING MACHINES.

(*To the Editor of The Engineer.*)

SIR,—I shall be obliged to any reader who can give particulars of the best machinery for making brass cocks and valves. BRASS.

Leeds, January 12th.

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, Jan. 23rd, at 8 p.m.: Paper to be discussed, "The Antwerp Waterworks," by Mr. William Anderson, M. Inst. C.E. Paper to be read, time permitting, "Mild Steel for the Fire-boxes of Locomotives in the United States," by Mr. John Fernie, M. Inst. C.E.

INSTITUTION OF MECHANICAL ENGINEERS.—Thursday, Jan. 25th, and Friday, Jan. 26th, the annual report of the Council will be presented to the meeting. The annual election of the President, Vice-Presidents, and Members of Council, and the ordinary election of new Members, Associates, and Graduates, will take place at the meeting. The following papers will be read and discussed:—"Report on the Hardening of Steel," by Prof. A. B. Abel, C.B., F.R.S., of Woolwich. "On the Molecular Rigidity of Tempered Steel," by Prof. D. E. Hughes, F.R.S., of London. "On the Working of Blast Furnaces, with special reference to the Analysis of the Escaping Gases," by Mr. Charles Cochrane," of Stourbridge, Vice-President. "On the St. Gothard Tunnel," by Herr E. Wendelstein, of Lucerne. "On the Strength of Shafting when Exposed both to Torsion and End Thrust," by Prof. A. G. Greenhill, of Woolwich.

SOCIETY OF ARTS.—Wednesday, Jan. 24th, at 8 p.m.: Eighth ordinary meeting, "The Suez Canal," by Lieut.-General Rundall, C.S.I., R.E. Thursday, Jan. 25th, at 8 p.m.: Applied Chemistry and Physics Section, "Technical Aspects of Lignification," by Mr. Charles F. Cross, F.C.S. Prof. H. E. Armstrong, F.R.S., will preside.

THE ENGINEER.

JANUARY 19, 1883.

MOVEMENT OF THE WATER IN A TIDAL RIVER.

THE application of measures of quantity and dimension, has done more within the past quarter of a century to replace hypotheses by theory and make sciences of subjects which were only of scientific interest, than any other work expended in the endeavour to make original speculation and observation subservient to practical wants. This is notable in geology, hydrology, metallurgy, armament, dynamics of heat, and physics. There are still many questions which remain matters of opinion, but which will be reduced to much narrower speculative ranges when the path is seen along which the figures relating to them may be marshalled so as to show their true inter-relations. The method of application of available figures has to be invented, just as much as a new machine or process is invented, and although after such invention has been made the application is seen to be simple enough, it usually requires intimate familiarity with the subject and unusually complete conception of the significance of the elements involved.

An illustration, though one which on acquaintance will perhaps be deemed of minor degree, is afforded by a paper by Professor Unwin, which we shall print at length another week, on the movement of the water in a tidal river with reference to the position of sewer outfalls. In illustration of his treatment of the subject he takes the Thames as an example. It has long been seen that there is some relation between the volumes of the upland waters and tidal entering the lower reaches of the river and the ranges of tidal oscillation, and this is affected by the relative densities of the fresh and sea-water, and by the mixture of these; and further, that in the case of the Thames, the efflux of the metropolitan sewage into a certain part of the tidal reach during a given part of the ebb tide also affects this. Float experiments in plenty have been made at different times, to show the ranges of tidal oscillation, but the differences in the results of these experiments have led, in the absence of a guiding theory, to very various opinions, and equally eminent engineers experienced in the hydraulics of rivers have in discussions at the Institution of Civil Engineers, as well as elsewhere, maintained premises leading to exactly opposite conclusions. Professor Unwin's paper is one which will throw a flood of light on these questions, while it is at the same time one which will be received in some quarters as nothing new; and in view of the inquiry now proceeding by Select Committee on the metropolitan sewage discharge, it has just now special importance.

It is, as Professor Unwin says, probably the common opinion, though not that of hydraulic engineers, that with every flood and ebb of a tidal stream the river fills and empties again—at least to so great an extent that there is a great change and exchange of the water filling the river channel. The rush of the water as the flood tide fills it, and the emptiness of its appearance at low ebb add to this impression, and the great length of the river, being unseen, lends a cover to the otherwise obvious fact, that water from, say Sheerness, could not very well under the observed circumstances pass along the fifty miles of river to London Bridge in the five or six hour period of tidal flow, and that the phenomenon of a river tide is largely one of simple displacement. With a view of arriving at some definite notions of the amount of this displacement, and to have a definite case for discussion, Professor Unwin has taken the numerical data relating to the sixty-four miles tidal compartment of the Thames from Teddington to Sheerness. The minimum and maximum discharges of the upland flow at Teddington are from about 750 cubic feet per second to probably 16,000 cubic feet, but the mean is not probably more than 1500 cubic feet. Taking, however, a flow of 2000 cubic feet, equal to 90,000,000 cubic feet each tide, and on the assumption that the direct effect of the upland water pouring into the river is to displace downstream all the water below it by a distance which at each point is equal to the length of the river-bed which the upland water would occupy, Professor Unwin shows that at Putney this quantity of water would occupy 30,000ft. of the river-bed, or the displacement would be about five and a-half miles. At Greenwich the upland water would occupy but 7500ft., or the displacement would be less than a mile and a-half, while in the wide part of the river at Sheerness it would occupy but 450ft.; and he says:—"The broad result indicated by the figures is this: Above London Bridge the displacement per tide due to the upland water is considerable, and the upland water must have a large influence in maintaining the *régime* of the river and in determining the quality of the water. Below Woolwich the displacement due to the upland water is small compared with the tidal oscillation, and the effect of the upland water in carrying material seawards must be extremely slow. The mean displacement per tide between Woolwich and Sheerness is about 1200ft. per tide. Consequently, if the travel from Woolwich to sea were *due to the upland water alone*, it would take about 130 tides, or, roughly, sixty-five days, to discharge at Sheerness material entering the river at Woolwich."

In summer the rate of seaward travel will of course be less in the proportion of about 750 to 2000, but in floods it may be eight times greater; and the upland water entering below Teddington will of course slightly affect the displacement, but this with the sewage discharge at Crossness and Barking of about 10,000,000 cubic feet per tide would increase the displacement by about 11 per cent. Taking now the volume of water in the river at low water and of tidal water above any section, it is clear that the relative tidal and upland displacement and range of horizontal oscillation due to tidal action may be obtained; and it is noticeable that curves representing the volumes in a series of tidal sections at low water, and the volume entering at each tide, cross near Greenhithe, and that "Below that point the tidal volume is less than the low water volume. Above that point the tidal volume is greater than the low water volume. The importance of this is, that for the upper parts of the river the volume in the river at high tide is greater than, and for a considerable distance three times as great as, the low water volume. Hence the water driven up the river by the tide must have a considerable influence on the condition of the water. If the tidal water is purer than the water up stream, the general effect of the tide will be to purify the river, but if, as is probable, the converse is the case, the tidal water will tend to foul the river. Thus the large proportionate volume of the tidal water neutralises to a certain extent the large influence of the upland water in the higher parts of the river."

Again, taking the above-mentioned sectional volumes, and the range of tidal oscillation deducible therefrom, namely, from ten and a-half miles at Sheerness to only five miles at Putney, the conclusion seems inevitable that the tidal action alone affects *directly* no change in the "material" water in the river, but merely an oscillation of less than eight miles in neap tides. For example, the oscillation in spring tides at Woolwich is about ten miles, less a small amount due to the displacement caused during tidal flow by the upland water. At the end of the next ebb it will have travelled back ten miles, plus the displacement due to the upland water. It will therefore be found 2400ft. downstream of its position at the previous ebb.

These are the leading points in Professor Unwin's theory, though his pamphlet is devoted to a consideration of the mixing action which produces the actual condition of the river, and which leads him to the conclusion that the exchange of river-water and sea-water takes place much more slowly than is commonly supposed, and to the transfer of material up stream. This of course is an important part of the paper, and touches on the question of transfer of sewage. We need not follow it further, however, as it will be already gathered that Professor Unwin has furnished a new key to an important question in river hydraulics.

STEAM BOILER FURNACE ECONOMY.

SINCE the appearance of our annual article, "1883," we have received several communications from inventors of smoke consuming apparatus, who each and all claim to have effectually solved a problem which we have stated to be nearly unsolvable. In the days of James Watt steam boiler furnaces smoked, and James Watt himself explained how furnaces should be fired in order to prevent smoke. This he did nearly 100 years ago. During a century the subject has been incessantly discussed and written about; many thousands of experiments have been made, and hundreds of thousands of pounds have been spent in the attempt to get rid of smoke, and it is more than doubtful if any material advance has been made in the last fifty years. The patents which have been taken out with the same object are countless; they are so numerous that it is now impossible to invent a smoke consuming apparatus which will differ from what has gone before in anything save small matters of detail; and yet the subject is so attractive that it is handled and turned and thrashed out over and over again. Its interest is perennial. If it dies out for a time it starts into life again; and it is impossible to find any invention which holds out higher hopes to the inventor, or more often entirely deludes him, by conferring on him fancied success. An extended experience with inventors of smoke consuming apparatus has convinced us that the number of those who thoroughly understand this subject in all its bearings is very small; and we write now in the hope of enlightening men who, if guided by adequate information, might yet be able to achieve something useful.

The nature of the problem to be solved must be fully understood before any progress can be made. What are needed are the means of preventing the evolution of smoke from steam boiler furnaces, without introducing complication or causing an increased consumption of fuel. We may say at once that it is extremely easy to prevent the evolution of anything save a very light coloured cloud of smoke from a boiler chimney; but it is not easy to do this without impairing the steaming power of the boiler, or increasing the consumption of fuel. We find it impossible to convince the majority of inventors of smoke-consuming apparatus of this. They say, "Before our apparatus was applied you were sending unburned fuel up the chimney; since it was applied you burn all your fuel. Therefore there *must* be a saving." We have here a very plausible argument based on a fallacy; and this same argument has perhaps misled more inventors and capitalists than any other thing ever assumed in the mechanical world. In the first place, it does not necessarily happen that because a large quantity of black smoke is going up a chimney there is a great waste of fuel going on; and in the second place, it is not clear that even if such a waste did take place, the fuel so lost could be burned to advantage. The facts connected with the combustion of coal have often been set forth, yet we make no apology for briefly stating a few of them once more. For simplicity sake we shall regard coal as a pure carbon, neglecting the hydrogen and oxygen which many varieties of it contain in considerable quantities. When carbon is completely burned, each pound of it combines with $2\frac{2}{3}$ lb. of oxygen contained in 12 lb. of air, and it developes 14,500 heat units—that is to say as much heat as would raise 14,500 lb. of water 1 deg. Fah., or 1450 lb. of water, or 145 gallons, 100 deg. One pound of coal thus burned would convert 15 lb. of water into steam at atmospheric pressure. If, now, the coal be imperfectly burned, each atom of carbon instead of getting two atoms of oxygen get but one, and carbonic oxide instead of carbonic acid—to use the old and more familiar terminology—is formed. Each pound of coal then takes $1\frac{1}{3}$ of oxygen supplied by 6 lb. of air, and the heat developed is only 4400 units, which would evaporate only 4·55 lb. of water at 212 deg. Carbonic oxide is a colourless gas, burning with a yellowish blue flame, and it is the escape of this gas unburned from a furnace that causes waste. The weight of carbon passing away as soot is almost infinitesimal; a few pounds will suffice to leave a track a mile long behind a steamer. Now, it is very commonly assumed that carbonic oxide has a great affinity for oxygen and can be readily burned, but this is really not true. The carbonic oxide and the oxygen will only combine at a high temperature, and when intimately mixed; carbon and oxygen have a very much greater affinity for each other, and for this reason the carbon will rob carbonic acid of its oxygen, converting it again into carbonic oxide if it gets the chance. For this reason many smoke burners have entirely failed in practice. The smoke from one grate is compelled to pass through a bed of burning coke. The evolution of black smoke is prevented, because the coke acts as a sieve and strains out the flying particles of soot and burns them; but the heated coke seizes the oxygen from the carbonic acid evolved from the first fire and produces with it more carbonic oxide, and the result is that a large quantity of unconsumed gaseous fuel goes up the chimney. This matter is so important, and we have heard the accuracy of the statement which we have just made so often disputed, that we make no apology for quoting here the following passage from Rankine on "The Steam-Engine and other Prime Movers," second edition, p. 270:—"The burning of carbon is always complete at first; that is to say, 1 lb. of carbon combines with $2\frac{2}{3}$ lb. of oxygen, and makes $3\frac{2}{3}$ lb. of carbonic acid; and although the carbon is solid immediately before the combustion, it passes during the combustion into the gaseous state, and the carbonic acid is gaseous. This terminates the process when the layer of carbon is not so thick, and the supply of air not so small but that oxygen in sufficient quantity can get direct access to all the solid carbon. The quantity of heat produced is 14,500 thermal units, as already stated. But in other cases part of the solid carbon is not supplied directly with oxygen, but is first heated and then dissolved into the gaseous state by the hot carbonic acid from other parts of the furnace. The $3\frac{2}{3}$ lb. of carbonic acid from 1 lb. of carbon are capable of dissolving an additional pound of carbon, making $4\frac{2}{3}$ lb. of carbonic oxide gas, and the volume of this gas is double of that which produced it. In this case the heat produced instead of being that due to the complete combustion of the 1 lb. of carbon or 14,500 deg., falls to the amount due to the imperfect combustion of 2 lb. of carbon, or 2×4400, showing a loss of heat of 5700 deg., which disappears in volatilising the second pound of carbon." Those smoke consumers in which the products of combustion from one fire pass *through* another fully comply with the conditions here laid down. Yet they are, as a rule, smokeless, and we have here an admirable instance of the fallaciousness of the theory that because smoke is prevented fuel must be saved.

The favourite expedient for the prevention of smoke is the introduction of air above the grate bars. This operates generally by igniting the hydrogen and olefiant gas given out by coal and the carbonic oxide. Flame is produced, and the soot particles are burned. But here again we must bear in mind that hydrogen, and olefiant, and marsh gas, all have more affinity for oxygen than has carbonic oxide; and in a mixture of these gases the carbonic oxide may escape without its equivalent of oxygen, while the other gas gets it, so that even the presence of a good flame in the flues of a boiler is no proof that carbonic oxide is not being wasted. It will be seen that the carbon atoms have already obtained one equivalent of oxygen, and, to speak popularly, they are half satisfied, and by no means so eager for more, as the hydrogen and carbon, which are perfectly ravenous for oxygen by comparison. To effect complete combustion in the full sense of the term the gases must be thoroughly mixed with air, and they must be kept at a very high temperature; but the admission of air over the fire at once cools them down, and the cooling is further promoted by contact with the comparatively cold boiler plates. It ensues then that while smoke may be prevented by the admission of air, the production of carbonic oxide may be promoted instead of being checked, with great waste of fuel. Here, then, we have another example of the fallacy of the assumption that because smoke is prevented fuel must be saved.

Now, let us suppose that we have a furnace with a grate one square foot in area, on which is burned in every hour 20 lb. of coal; let us neglect the hydrogen, and deal with the coal as though it were carbon; let us suppose that the combustion is so badly managed that 5 lb. of coal are converted into carbonic oxide and 15 lb. into carbonic acid, the total result will then be $15 \times 14,500 = 217,500$ and $5 \times 4400 = 22,000$ and $217,500 + 22,000 = 219,500$ units instead of 290,000 units. We shall assume that under these conditions but 360 lb. of air, or 18 lb. per pound of coal passes through the grate per hour. This air we may assume enters at 60 deg. and leaves the boiler flues at 460 deg., which will be a very favourable result indeed. Thus, the fuel has not only to evaporate water in the boiler, but to heat 360 lb. of air 400 deg. The specific heat of air may be taken for our present purpose at ·23, and the calculation stands $360 \times 400 \times {\cdot}23 = 33,120$ units carried away in the air and lost, leaving us net $219,500 - 33,120 = 186,380$ units. Let now the admission of air be augmented to 24 lb. per pound of coal, or 480 lb.; then we have $480 \times 400 \times {\cdot}23 = 44,160$ units carried off in the air and lost; but, on the other hand, if we take it for granted that perfect combustion has been secured, we have net $290,000 - 44,160 = 245,840$, or a distinct gain of $245,840 - 186,380 = 59,460$ units. But it will be seen that the extra air admitted represents no less than 11,040 units, or as much as would suffice to convert about 10 lb. of water into steam, or $\frac{1}{2}$ lb. per pound of our 20 lb. of coal; so that while if it had been possible to get complete combustion with 18 lb. of air per pound of coal the evaporation would have been, say, 11 lb. of water per pound of coal, with 24 lb. of air the evaporation must fall of necessity to 10·5 lb. Indeed, whether there will be any gain secured under the circumstances depends altogether on the extent to which combustion is rendered more complete by the extra air admitted; and it is not difficult to see that the conditions might be such that extra air would so far cool down the gas that while smoke was prevented there would be no diminution in the quantity of carbonic oxide evolved, and so no saving would be effected.

Are we then to assume that smoke prevention is economically impossible? By no means. In the first place, the process of making steam is a complex operation, and many things have to be taken into consideration. The prevention of smoke would be sometimes worth the money even if it were expensive, because, as we have already pointed out, the heating surfaces could be kept clean and free from soot, and the heat passing more readily into the water, the temperature of the products of combustion leaving the boiler would be reduced below the point possible of attainment when soot is deposited thickly on them. But apart from this, we know that it is possible to prevent smoke economically, because it is done daily in locomotives. In them, and in them almost alone, has the problem been solved, and from locomotive practice smoke preventers can learn a great deal. The secret of success is that by the use of an intensely heated brick arch the gases are prevented from getting at the cold boiler-plates until they are in the act of combination; by the use of dampers to the ashpan the whole quantity of air admitted to the fire is kept much the same as though the fire door were not open; and, thirdly, the use of a scoop in the fire-door throws the entering current of air into the fire in such a way that mixture of the air and gases can hardly fail to take place. With most smoke-combustion contrivances which depend for success on the admission of air through the perforated fire-doors and suchlike, it will be found that no attempt is made to prevent the entrance of air through the fire-bars as well; but, as we have said, in the case of the locomotive, long runs are made with the ash-pan dampers nearly shut, almost all the air getting in through the fire-door. Such a system of working is, in skilful hands, perfectly successful; but we do not quite see how it is to be applied to a Lancashire boiler.

THE FLOODS AT VIENNA.

THE danger of being inundated, from which Vienna has just escaped, has been of a very prosaic character. There have been no hair-breadth escapes to record, nor heroic attempts at rescue. But the practical experiences that have been gained, from a careful observance of cause and effect, are more than compensation for the last excitement of personal danger, and prove that the large sums of money expended some years ago in regulating the Danube in the immediate vicinity of the city, and in endeavouring to check the inflow of water into the Danube Canal, have not been spent in vain.

The forms of flood to which the Danube is subject are of two kinds. The first and most frequent form is caused by the increase of water from the melting of the snow in the higher regions simultaneously with the breaking up and packing of ice in the river at the mouths of confluent streams, or at places where the force of the current, expending itself over a wider area, is unable to carry with it the accumulated masses with sufficient rapidity. The last great flood arising from this cause occurred in February, 1876, at the sudden break up of a long and severe frost, before the river embankment on the left shore was completely finished. The water, finding its way into one of the old arms, was no longer able to concentrate its force in the main channel, and a block was formed midway in the new regulation to such an extent that the pent-up current was forced down the Danube Canal and flooded a great portion of the lower part of the town. This cause has happily been removed by the completion of the embankment, but so long as the regulation is not continued to a place far below the point of confluence of the main Danube with the Danube Canal—where it now ends—a similar, although perhaps a lesser, danger must always be apprehended. The great danger arising from this class of flood is the impossibility of calculating its course; whereas in an ordinary flood, *i.e.*, one caused by an increase of water, the rise of the water can almost invariably be calculated at any point down stream from observations remitted from above. In the case of a flood caused by the packing of the ice, although some idea may be formed from previous observations, and from the local conditions of different parts of the stream, no one can foresee the eventualities of an apparently insignificant character that may at any point cause an obstruction, and utterly destroy one district, while the adjoining one is scarcely affected.

The second form of high water is caused either by a sudden thaw in the mountains or by heavy rains in the Valley of the Danube itself, or of some, or of all, of its tributaries. The late flood arose from a simultaneous combination of all the above causes, and was of unusual duration. As far back as the 29th December the river at Nussdorf, a village at the inflow of the Danube Canal, had reached a height of 10ft., and on the afternoon of the 4th January attained its maximum of 14ft. 11in.; at the same hour, at three different points almost equidistant in the main stream, the heights were respectively 15ft. 8in., 15ft. $7\frac{3}{4}$in., and 16ft. $7\frac{1}{2}$in. The first two are situated in the new bed of the river, where all obstructions to the current have been removed. The last is overgrown with brushwood, and slight as the obstruction appears, the inference to be drawn from it is that no regulation of a river can be perfect unless its channel be divested of every, even the slightest, obstruction, and that the course for the water must be made as smooth and equal as possible. The execution of the Danube Regulation Works is of too recent a date for any comparison to be fair between the height of flood recorded now and those which previously occurred.

The nearest point to Vienna at which a standard of comparison can be made is Stein, about twenty miles up stream, where an old bridge exists, on which the floods of the previous century are recorded. One occurred on the 18th July, 1736, when the water reached the height of 17ft. 10in.; the second on the 4th February, 1862, with a height of 19ft. 4in.; and the last, on the 4th inst., was 17ft. $9\frac{1}{4}$in., or nearly the same as the flood of 1736. In 1862, that is, before the regulation of the river was commenced, the width of the river during the flood at Kaiser Ebersdorf, just below Vienna, was nearly four and a-half miles; but, in spite of the large area offered to the stream, its current was so much obstructed that all the low-lying districts of the city were inundated to a considerable depth. At the present flood, since the bed of the river has been reduced to a width of about 800 yards, the vast stream of water has passed without injury to the surrounding districts or the buildings on its banks. Baron Engerth's pontoon, or Sperrschiff, at the mouth of the Danube Canal, where it leaves the main stream, has greatly contributed to the avoidance of flood in the Leopoldstadt and Landstrasse, as, by sinking it in the entrance of the canal to a sufficient depth, the water in the canal has been depressed to an extent of 3ft. $8\frac{1}{2}$in. below the level of the water in the Danube river.

When we consider that the whole of the Leopoldstadt was flooded in 1862 to such a depth that boats were required in the streets, and that the flood this year was only 0·47 metre less than in the above-named year, and that with a height in the Danube Canal of 13ft. 3in. at the Ferdinand Bridge, the water begins to flow through the sewer gratings into the streets, it is quite evident that, although the depression at the entrance to the canal exerted by the Sperrschiff would naturally, from the increased velocity, be somewhat greater than at a point further down after the stream has assumed its natural speed, the pontoon assisted in averting the calamity that would otherwise have been inevitable. As it was, the canal attained within $4\frac{1}{4}$in. the height at which the overflow begins; and although we have no wish to detract from the services rendered by the costly obstruction at the entrance to the canal, we cannot help thinking that a providential change in the weather occurred at a most fortunate moment, both for the verification of the calculations on which the effectiveness of the Sperrschiff is based, and for the unfortunate inhabitants of the Leopoldstadt, who have more often been drowned out by the backwater of their own drains and sewers, which empty themselves into the canal, than by the swollen torrent of the Danube itself.

THE PROPOSED CANAL FROM THE TYNE TO THE SOLWAY.

WE announced last week that a movement had been set on foot for constructing a ship canal from the Tyne to the Solway Firth, and as the interests of several large and important manufacturing districts are thereby affected, we now propose to draw attention to some of the chief features of the scheme in so far as they have yet been made public. Projects for considerably increasing the navigable length of the River Tyne, and even for making a canal between that river and the Eden, have for a very long time engaged the attention of commercial men in the North of England. Early in the eighteenth century, during the reign of Queen Anne, it was proposed to render the Tyne navigable as far as Hexham, while towards the end of last and during the commencement of the present century numerous schemes, having pretty much the same object in view, were brought forward, some for the construction of a canal between the Tyne and the West Coast, and others for the canalisation of the river as far as Hexham, Haydon Bridge, or Haltwhistle. Since 1838, however, when the Newcastle and Carlisle Railway was opened, little has been heard of these projects, until the question was re-opened in a new and vastly increased form by Mr. Andrew Leslie, an eminent iron shipbuilder at Hebburn-on-Tyne, at a meeting held at the close of the recent Exhibition of Marine Engineering at Tynemouth. Mr. Leslie here suggested the formation of a canal from the Tyne to the Solway Firth of such magnitude that the largest vessels could pass between the two coasts. More recently, at a meeting of the North of England Foreman Engineers' and Draughtsmen's Association, Mr. T. P. Barkas, a gentleman well acquainted with the trade requirements of the district, delivered a lecture on the scheme advocated by Mr. Leslie, much of which was of an exceedingly interesting character. Mr. Barkas commenced by referring to the present and prospective canal enterprises in various parts of the world, and pointed out that those already carried out in this country were all lucrative concerns, paying good dividends. Attention was drawn to the fact that the Clyde, which comparatively a few years ago was a rivulet, is now practically a canal from the ocean to Glasgow; while the revenue had risen from £68,875 in 1851, to £248,061 in 1881, and the tonnage of vessels entering had increased in the same period from 1,446,606 to 3,067,533. The Tyne for the last twelve miles of its course is also a canal. Thanks to the energetic and far-sighted policy of the River Tyne Commissioners, the Tyne from its mouth to Elswick can now be nagivated by large steam vessels, while the bar which at one time reduced the available low-water depth at the entrance to 4ft., has now practically no existence. From 1861 to 1881 the revenue of the Tyne Commissioners has increased from £74,985 to £261,186, and the tonnage of vessels entering the river has risen from 3,196,781 to 5,908,886. The lecturer then drew attention to the proposed ocean highway from the Tyne to the Solway Firth, which would open out a more direct communication with America, and convert Mid-Britain into an important centre for trade and commerce. The line proposed to be followed passes from Ryton-on-Tyne through Stocksfield, Riding Mill, Corbridge, Hexham, Haltwhistle, Greenhead, and Brampton to Carlisle. The geological formation throughout is palæozoic, consisting of millstone grit, carboniferous limestone, and old and new red sandstone. The highest elevation is at Greenhead, which is some 400ft. above the level of the sea at Tynemouth, and the hardest cutting would also occur in this neighbourhood through the basalt dyke, which, however, is here only some 40ft. wide. Generally, the cuttings would pass through comparatively soft material. It is proposed to make the canal wide and deep enough to accommodate the largest vessels, and to provide numerous dock basins and passing places in suitble localities. Probably four or five locks would supply all the lifting power required, and an abundance of water for working them can be obtained from the South Tyne. By diverting the surplus waters of the North and South Tyne they might be made available for driving dynamo machines for electrically lighting the banks of the canal and rendering it available by night as well as by day, and for transmitting power for utilisation in factories. Several alterations to existing railways would be entailed, the more important being the introduction of swing bridges in two or three instances. Looking at the commercial aspect of the scheme, it is said that the entire Baltic trade with Ireland and North America would probably pass through the canal, and much of the goods now delivered at Liverpool, Glasgow, and other Western ports, and forwarded by rail to London, Newcastle, and elsewhere, to be re-shipped abroad, would be forwarded directly through it without the trouble, cost, and delay now attending their transit. The canal would afford the means of loading coal at small cost for land carriage from collieries along its route, and would more freely open out the mineral resources of the country through which it passes.

From an engineering point of view there is, probably, no doubt that the construction of such a canal is possible; but whether the cost of acquiring the necessary land and of carrying out the works will be such as to make it likely that the revenue to be derived in the immediate future will be sufficient to make the concern satisfactory and profitable to the shareholders, is a question which cannot be entered into at the present time. No doubt such an undertaking as is proposed would to a large extent stimulate trade, and cause the investment of capital in industries in the districts affected by it; but, as far as increase on this head is concerned, we venture to think the actual result would be dependent on the value of the coal and other mineral deposits opened out, and unless this is found to be very considerable, we fear that those promoters who have already drawn fanciful pictures of large and flourishing factories, with chimneys smoking, along the line of route, are destined to be sadly disappointed.

AWARDS TO WORKMEN FOR INVENTIONS.

IN August, 1880, Messrs. Denny and Bros., shipbuilders, Dumbarton, wishing to recognise the advantages accruing to their business from the skill and ingenuity of their *employés*, instituted a scheme of reward for all subsequent inventions or improvements introduced by their workmen, and which should commend themselves to a committee of adjudicators appointed by the firm. The rules by which all claims made by the workmen were to be adjudicated upon, were that any workman in the employ might lay claim to an award on the following grounds:—"That he has either invented or introduced a new machine or hand-tool into the yard. That he has improved any existing machine or hand-tool. That he has applied any existing machine or hand-tool to a new class of work. That he has discovered or introduced any new method of carrying on or arranging work. Or, generally, that he has made any change by which the work of the yard is rendered either superior in quality or more economical in cost." The rules also said that "on the establishment of a claim under the conditions specified, the committee are to make an award which is not to fall below £2 nor to exceed £10. Between these limits the award will be fixed by the committee, according to the opinion they may form of the value of the improvement or invention for which claim has been made." During the first five months the scheme was in operation as many as twelve claims were laid before the committee. Seven of these were found valid, three were rejected, and two were still under consideration when the report was made. Several of the successful claims were for improvements on existing machines and methods of work which were considered highly important, and the committee were enabled to say that the scheme so far had given results which were encouraging both to the firm and to the workmen. To this, their first report, the committee appended a lengthy note, directing attention anew to the objects and advantages of the scheme, and tendered suggestions for the guidance of workmen desirous of availing themselves of its benefits. These suggestions were, amongst other encouraging things, that "as many a workman gifted with high inventive ability, but having little or no knowledge of science, often spends much time and labour in attempting to do that which is impossible, or trying to find out that which is already known, the committee, in order to save the waste of effort in such a case, have willingly agreed to give the benefit of their knowledge to anyone who may apply for it." In addition to this, offers were made of the use of tools and appliances to any inventor finding that such were indispensable in perfecting his ideas. As the results of a further year's operations, the committee's report showed that thirty-two claims had been made, twenty-two of which were granted awards, the sum represented being £62. Further inducements were held out by a modification in the clause relating to the range of awards, which stated that "in the case of an invention or improvement being considered by the committee worthy of a greater award than £10, they shall submit a report on the same to the firm, who may sanction either (1) the granting of such greater award than £10; or (2) should the invention be considered worthy of being protected by patent, an award of £10, together with the taking out at the firm's expense of provisional protection at the Patent-office on behalf of the inventor, all with a view to enable him either to dispose of his invention during the period of protection, or to make arrangements for completing the patent at his own or his friend's expense, provided always that the firm shall have for all time coming the use of any such invention so provisionally protected at their expense, free from the payment of any royalty or patent rights that may be chargeable on the same, should the patent be completed." The committee have just made their third annual report, from which it is seen that the success attending the scheme has been greater even than formerly. Not only are the claims for awards more numerous, but some of the inventions are of a highly important character, and in two cases the maximum award of £10 has been given. The number of new claims during the year was twenty-seven, and four postponed claims had also been considered by the committee. Of these twenty-one had been found worthy of award, seven had been rejected, and three are held over for further consideration. When compared with the previous year, there is a slight decrease in the number of claims lodged; but, on the other hand, the awards made are all but equal, whilst some of the inventions are of even greater merit and value than any previously brought forward. The committee also state that the total sum paid in grants is about one-half more than last year, owing to the greater value of some of the claims and the more liberal scale of payment adopted by the committee. Of the various departments in the ship-yard which share in the awards for claims found valid, the joiners are this year, as formerly, in the first place. About one-half of the awards go to that department alone, the remaining half being shared by carpenters, blacksmiths, and other sections of the ship-yard artizans. Since the scheme was set on foot, in 1880, seventy-one claims have been received, viz., twelve in 1880, thirty-two in 1881, and twenty-seven in 1882. Awards were granted for fifty of these—seven in 1880, twenty-two in 1881, and twenty-one in 1882. The total amount paid to claimants reaches £171, viz., £18 in 1880, £62 in 1881, and £91 in 1882.

THE SODA MANUFACTURE.

IN a paper by Mr. W. Weldon an attempt is made to estimate the extent of the soda manufacture of the world. The soda production is divided into two classes—that made by the Leblanc process, and that by the ammonia process. The production of Leblanc soda is estimated as 545,500 tons, of which Great Britain makes 380,000 tons; and the "ammonia soda" 163,225 tons, of which Great Britain produces 52,000 tons. Taking the chief producing countries it is stated that Great Britain makes 12 per cent. of her soda by the ammonia process; France, 44·9 per cent.; Germany, 43·8 per cent.; Austria, 2·5 per cent.; and the slight production of Belgium and the United States is entirely by the ammonia process. The latter process has grown very rapidly, especially on the continent, the first works where the class of soda was made on a commercial, if small, scale being those of M. Solvay, near Charleroi, commenced about sixteen years ago. The enlarged production by this process has brought about a serious competition, and forced down the price of soda to an extent that has, it is said, made it unprofitable for the makers by the old process. At the same time it has made possible many economies. Mr. Weldon quotes some facts in relation to one of the chief works in the United Kingdom, where, ten years ago, 336 tons of coals were used for every 100 tons of product, and where now 216 tons only are used; and the reduction in the sums paid for wages are even more in proportion now to what they were a decade ago. Still, the fall in the price has in that period been very remarkable, and it is certain that many of the works where the Leblanc process is in use find it impossible to make profit on the soda produced and sold at rates anything like those current. The question of a further utilisation of the waste products is, therefore, forcing itself upon the minds of the manufacturers—and with these, with the use of cheaper fuel, and possibly with a rise in the selling price of one of the products of the mode of manufacture which is not yielded in the ammonia process, it is hoped that there may be some change for the better in one of our ancient industries. Nearly one-half of the alkali works existing on the banks of the Tyne a few years ago have been closed, and though many of these were small, yet the reduction of production must have been considerable; but until the end of last year there had been only a very slight recovery in prices. Whether as the result of the increased competition in the trade, and of its unprofitable state, others may be closed also, cannot be guessed; but it is certain that the sooner that those economies that are possible in the manufacture are made general the better it will be for the manufacturers and for the soda industry as a whole.

THE RAILWAY HALF YEAR.

THE conclusion of the half year shows how the receipts of the railways have been maintained, and how capital continues to appreciate their securities. So far as the first is considered the returns are satisfactory. The six great railways show very large additions to their income on the corresponding period of last year—additions that vary from a few thousands to £123,000, the latter being the large addition to the income of the North-Eastern Railway. There are one or two exceptions to the rule—the London and Brighton line recording a decrease of some moment—but, generally speaking, the rule is an increase with both small and large companies, and the four largest take considerably augmented incomes. It is true that the capital requirements have caused the amount to be paid for interest to be larger, and there is naturally an increased cost in working the additional traffic; but on the whole the current revenue statements will turn out well, more especially as the companies in many instances carried large balances forward from the preceding half year. But when the value of the stocks and shares of the companies is looked at for the past half year, it must be seen that there has been a falling off. This is mainly due to the change in the value of money, but there is possibly a slight feeling that has had some effect—a feeling that the latter months of the half year have not been so productive as the earlier, and that the cost of working is rising. Hence the market prices of most of the stocks of the companies have fallen, but it seems probable that the full effect has been felt, and that there will be some recovery speedily. Usually stocks show a slight tendency to fall before the close of the year, when accounts of speculators are as much as possible closed, and there is with the commencement of a new year a rising influence. On the whole then the half year has been one of comparative prosperity to the railways, and this the more when it is remembered that last year showed large additions to revenue and value, and that the present—over its whole course—has at least continued these additions.

LEAD MINING IN WEARDALE.

THE announcement that lead mining in Weardale is to be abandoned by the Beaumonts will come not so much as a surprise as unpleasant news to many. For generations that family and its predecessor had been connected with lead mining in the counties of Durham and Northumberland, and they had raised the production of lead, at what have been for years called the "W.B. mines," to the highest rank in the county. Down to about ten years ago, that production continued to be enlarged, despite the pressure of occasional times of dulness in the industry. In that year there was a memorable strike amongst the lead miners of Durham, partly for higher pay and partly against the old patriarchal plan of treatment of the mines. The demand for labour at that date enabled the miners to obtain their object, but with the exception of a very few years when the wages were higher, there has been since a growing dissatisfaction in the district, a lessening production of lead, and coupled with the increased importation and the low prices that have prevailed, there has been a working of mines without profit. The end of it has been a prolonged agitation, protracted negociations for reductions of the royalties, and finally the closing of the mines and the surrender of the lease that the Beaumonts have long held from first the Bishops of Durham and then the Ecclesiastical Commissioners. If others are to open out the mines, they will find that the vales of Durham are rich in lead and iron still, but that they will need to be worked in a commercial spirit, and possibly they will have to endeavour to obtain lower royalty rates. Weardale is no longer our sole dependency for lead; the treasures of the world are before us, and if the grand old mines are to be again worked, it will have to be in a changed manner under commercial auspices, and with a view to profit.

"NARROW ESCAPE OF AN EXPRESS TRAIN."

AN exciting paragraph has gone the round of the papers describing the "narrow escape" of an express train, which ran past Spalding station, on the Great Eastern Railway, on the 11th instant, and which was attributed to the Westinghouse brake failing to act. It now turns out that it was never attempted to apply this brake at all, for although both engine and train were fitted with the Westinghouse brake, it was not, and had not been in use on this occasion, owing to some repairs being wanted by the engine which was attached to the train at March. The only failure was that of the hand-brake upon the tender, which was found to be of no use upon trying to apply it, owing to the loss of a bolt out of the hand-brake gear.

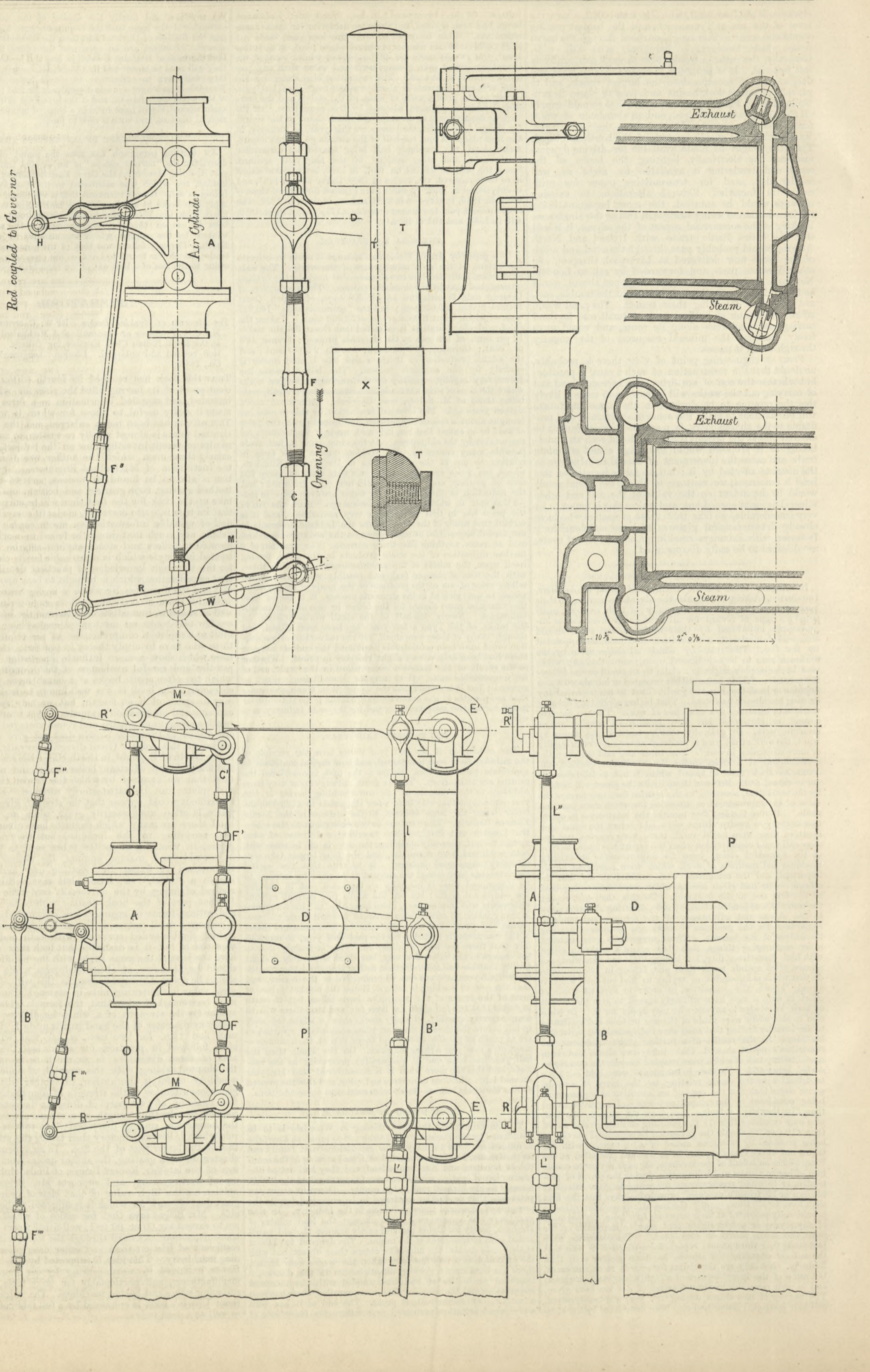
LITERATURE.

The Elements of Machine Design. BY W. CAWTHORNE UNWIN, M.I.C.E., Professor of Hydraulic and Mechanical Engineering at the Royal Indian Civil Engineering College. Fourth edition, revised and enlarged. London: Longmans, Green, and Co., 1882.

THAT this book has reached its fourth edition is a sufficient proof of its having filled the place for which it was intended, and supplied information in a form which has made it really useful to those for whom it was written. This edition has been much enlarged, and the chapter on rivetted joints is almost wholly re-written, so as to give the results of recent investigations on the subject, and particularly those upon which the author wrote a report for the Institution of Mechanical Engineers. New information is also to be found in various parts of the book on toothed gearing, rope gearing, and belting, and many who take up the book for the first time will be surprised to find that its title is, quite correctly, made to comprise a great deal of valuable information on steam engine and boiler details, and much that cannot be found in works specially devoted to boilers and steam engines may be here found treated in a style which is remarkable for its clearness and for the thorough knowledge of practical detail and practical consideration which is brought to bear upon it. The text and the drawings by which it is illustrated are such as to give those actively engaged in engineering work, as well as students, immediate confidence in the book. There are few text-books on mechanical engineering which exhibit so complete a comprehension of the requirements of those who have to apply theory in practice; and there are none which show a more intimate knowledge of modern practice and careful avoidance of that slurring of detail which too often spoils books of a much more pretentious character. The book is too well known to make it necessary to speak of it at length, but we may remark that experimental information is apparently yet wanting on the relative strength of square and round unstayed plates, flat and dished, as Professor Unwin does not give new information on this point. Great diversity prevails, especially in the North of England, in the thickness assigned to dished and flat plate tops of steam boiler domes, and no formulæ exist that we know of by which the proper thickness of such plates can be satisfactorily assigned. From those available it would appear that the strength given to these plates is often unnecessarily great, while on the other hand there are many which ought to have given way long ago, according to the formulæ, but they have not. Again, in speaking of boiler tubes such as those used in portable and marine engines, the author describes the method of fixing by rivetting over and by driving in a "steel," *sic*, ferule, but says nothing of the method of fixing by the universally-used tube expander. In that part of the book dealing with bolts, nuts, keys, and cottars, forms of spanners are shown, and though it is perhaps a small matter, it is worth mentioning that in making double-ended spanners with both ends for the same size of nut it is desirable that both ends should not have the jaws at the same angle with the handle, but one should be, as shown, at about 30 degrees, while the other should be about 15 degrees less, as this will often be of great value in tightening nuts in cramped situations. It may be remarked also that the formula given by the author for the strength of a winch handle, by which the necessary diameter of the hand part is made $1\frac{1}{16}$in. for one man and $1\frac{1}{2}$in. for two men, is one that will not be often followed in practice, for about half the sectional area of those diameters is as much as is usual. In the chapter dealing with the strength of boiler flues, it would be useful if the author, in another edition, could give some attention to the strength of comparatively short flues made up of two parts of different diameters. It is common to take the strength as a mean between that of the longer and smaller diameters; but that is a thumb rule which is less satisfactory than taking the strength as that of the larger part of the flue. In an appendix to the chapter on tooth gearing, the author quotes from the writings of the late Mr. Robert Briggs, of Philadelphia, on the use of worm gearing, and supports Mr. Briggs in his opinion on the high value of that class of gearing for a great deal of work for which it is supposed to be inapplicable. Mr. Briggs says that for ratios of wheel to worm not to exceed say 60 or 80 to 1, well-fitted worm gear will transmit motion backward through the worm with a lower coefficient of friction than any other description of running machinery. This idea is supported by the increasing favour extended to worm gearing by our machine tool manufacturers, and particularly for large tools, such as surfacing lathes and boring machines. The value of Professor Unwin's book is enhanced by a full table of contents as well as a good index.

COMPOUND ENGINES FOR THE ROYAL MINT.—DETAILS OF VALVE GEAR.

(For description see page 52.)



OSCILLATION *v.* ROTATION.

By PROFESSOR OSBORNE REYNOLDS, F.R.S.

No. II.

(5) THE object of the present article is the consideration of certain dynamical problems presented by the oscillating pieces of machines. In former articles under the head "Limits to Speed," it has been shown that the resistance called forth by the inertia of the revolving and oscillating parts of machines must, as the speed increases, reach a point beyond which the strength of material will not allow them to go. In this respect there is but little difference between revolving and oscillating pieces. But, as regards friction, or the work necessary to overcome friction, it will appear that oscillating pieces stand in a very different position to rotary pieces.

In applying the principles of mechanics to machines it is customary to treat separately the kinematical, or purely geometrical considerations, leaving all forces out of account. In this respect, *i.e.*, as regards the geometry of their motion, mechanisms, such as the crank and piston, which involve oscillating pieces, have received their due share of attention. But considerations relating to the forces in such mechanism have not received very systematic treatment. These considerations belong to two different classes, those which do not and those which do depend on the inertia of the moving parts. The first of these, although applied to moving bodies, are strictly statical, relating solely to the resolution and balance of forces; and it is this class which has received most attention. The considerations relating to the inertia of the parts have been much neglected. They constitute what, a few years ago, would have been called the dynamics of machinery, but what is now better expressed as the kinetics of machinery. In some few instances, as in the case of the fly-wheel of the steam engine, inertia is necessary to the action of the machine; but with the majority of moving pieces the inertia only plays an incidental part in the action of the machine, or, in other words, the machine would get on better if these parts could be made of matter without inertia, and hence it has been very much the custom to leave inertia out of consideration.

This omission to consider the effect of inertia has been one of the main causes of the much complained of discrepancy between theory and practice, and it is to such considerations that we must look for explanations of the practical selection of one form of mechanism from amongst several, which, so far as kinematics show, appear to be equally applicable, as for instance, the reciprocating piston as against all forms of rotary engines. For some purposes the requisite motion is so slow that the inertia and energy of motion of the moving parts and quantities depending on these are so small, as to be of no account, and then kinetic considerations are of no importance in determining the fitness of the mechanism; but whenever it is a question of attaining the highest possible speed, such considerations assume the first importance.

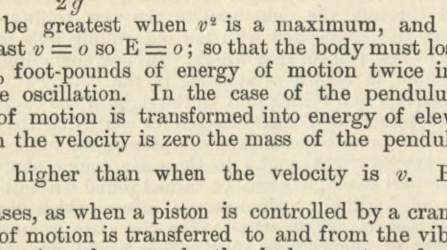
(6) *The kinetics of oscillating pieces.*—If treated completely by integrating the equations of motion this would be a very difficult, if at all a possible, subject; only one case, that in which the motion is harmonic, has received much, if any, attention. And this case may be dealt with by the aid of elementary mathematics. By the laws of work and energy, however, the kinetics of oscillation are tractable, and the results so obtained are sufficient for the present purpose. When a heavy body is subject to reciprocating motion its velocity will vary from some maximum value, v* to zero, so that the E, the energy of motion is given by

$$E = \frac{Wv^2}{2g} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (1)$$

E will be greatest when v^2 is a maximum, and when at its least $v = o$ so $E = o$; so that the body must lose and gain E_0 foot-pounds of energy of motion twice in each complete oscillation. In the case of the pendulum the energy of motion is transformed into energy of elevation, or when the velocity is zero the mass of the pendulum is $\frac{v^2}{2g}$ feet higher than when the velocity is v. But in other cases, as when a piston is controlled by a crank, the energy of motion is transferred to and from the vibrating body, or, in other words, the body must perform and receive work to the extent of $\frac{Wv^2_0}{2g}$ on each reversal of its motion.

(7) It will be well to express this graphically. Let A O B be the path of the oscillating body, and suppose it to move from A to B, and to have its greatest energy of motion E_0 at O. Then, since it starts from rest at A, before reaching O, it must have been subject to the action of forces which will do E_0 foot-pounds of work. These forces might, if their magnitude were known at each point P of the path, be represented as in the diagram of the steam indicator by distances P M perpendicular to A B. If so represented, the ends M of these distances would lie on some line A M O, which, with A O, would form the diagram of inertia, or of the force to balance inertia from A to O. The area of this diagram would represent the work done on the body, and would therefore represent E_0, the energy of motion at O. In the same way, since the body comes to rest at B, the body must have encountered resistance or opposing force against which it does E_0 foot-pounds of work in moving from O to B. This is represented by a diagram O N B, the area of which represents E_0 foot-pounds of work, and is therefore equal to the area O N A. Since the resistance from O to B is in the opposite direction to the force from A to O, N will be on the opposite side of A B to M. When the motion takes place from A to B the area A M O represents work done on the moving body to cause energy of motion, and the area O N B represents work done by the moving body to get rid of its energy of motion. Therefore, O N B would be negative work done on the body. When the motion is from B to A the area B N O represents work done on the body, and O H A is negative. Taking v_0 for the velocity at O and v for the velocity at any other point P, and supposing P M to represent force at p lb. to a foot. Then,

FIG. I.



$$p \times AMO = p \times ONB = \frac{Wv^2_0}{2g} \quad . \; . \; . \quad (2)$$

and $p \times$ area O P M represents the work from O to P or P to O. Then, by the equation of the conservation of energy we have—

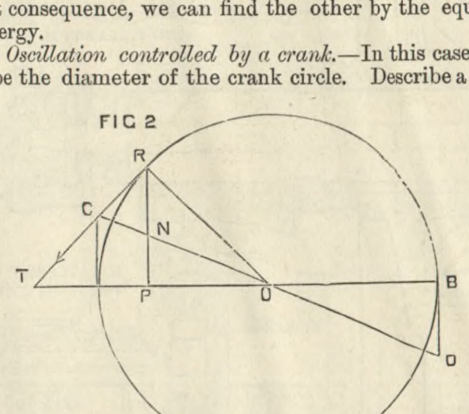
$$\frac{Wv^2}{2g} = p \times AMP \quad . \; . \; . \; . \quad (3)$$

$$\frac{Wv^2_0}{2g} = p\,OPM + \frac{Wv^2}{2g} \quad . \; . \; . \quad (4)$$

In cases of reciprocation it is not easy to find either the force p P M, or the velocity v at every point of the path, but one or other of these is always a direct circumstance of the motion. Thus, if the body move under the action of a spring, the stiffness of the spring determines the force p P M, which is thus independent of every other condition. Or if the body be moved by a crank and connecting rod, as in the steam engine, the velocity at each point is a kinematical consequence of the velocity of the crank. In every case, therefore, p P M or v is a direct consequence of the circumstance of motion. Now, whichever of these may be the direct consequence, the other is a consequence of the equation of energy, or if we know the one as a direct consequence, we can find the other by the equation of energy.

(8) *Oscillation controlled by a crank.*—In this case A B will be the diameter of the crank circle. Describe a circle

FIG 2



with A B as diameter; then, neglecting the effect of the obliquity of the connecting rod, the position R of the crank on its circle corresponding to the position P of the piston, is given by producing P M to meet the circle in R. Let R T be the tangent to the circle at R, then if u is the velocity of the crank pin at R, the velocity of P is

$$u\frac{TP}{TR} = u\frac{PR}{OR} \quad . \; . \; . \; . \; . \quad (5)$$

whatever may be the position of P. If u is constant all round, when P is at O we have from (2)

$$v_0 = u, \quad . \; . \; . \; . \; . \; . \quad (6)$$

and for every other point

$$v = u\frac{PR}{OR}. \quad . \; . \; . \; . \quad (7)$$

Substituting in the equation of energy (4)

$$\frac{W}{2g}u^2 = p.\,OPM + \frac{W}{2g}\left(\frac{PR}{OR}\right)^2.u^2$$

or,

$$OPM = \frac{W}{2gp}u^2\frac{OR^2 - PR^2}{OR^2}$$

$$= \frac{W}{2gp}u^2\frac{OP^2}{OR^2} \quad . \; . \; . \; . \; . \quad (8)$$

take

$$PM^1 = \frac{W}{gp}.\frac{u^2\,OP}{OR^2} \quad . \; . \; . \quad (9)$$

then

$$\frac{PM^1 \times OP}{2} = OPM \quad . \; . \; . \quad (10)$$

Join O M¹ and produce it to meet perpendiculars through A and B in C and D. Then M¹ must lie on the line C D for all positions of P, since by (9) P M¹ is proportional to O P. Therefore by (10) the area O P M is equal to the area of the triangle O P M¹ Therefore M coincides with M¹ on C D, and the force p P N is completely expressed. Put O Q = a, and by (6)

$$e = \frac{W}{gp}\frac{u^2}{a^2} \quad . \; . \; . \; . \; . \; . \quad (11)$$

then by (6)

$$PM = eOP \quad . \; . \; . \; . \quad (12)$$

So that W, u, a, being known, we have e and P M for each value of O P.

(9) *Oscillation controlled by a spring.*—The spring gives the force p P M; take the usual case in which this force p P M is proportioned to o P; let

$$p\,PM = pe\,OP \quad . \; . \; . \; . \quad (13)$$

Then as before M is on the line C D. And it is obvious that, the diagram of forces being the same as before, the relation between the force and velocity will be the same; but as in the case already considered, the force is controlled by the motion, and in this case the motion is controlled by the force. It is well to make the two proofs independent.

Let R be a point moving on the circle so as always to be opposite to P, then, as before, we have—

$$u\frac{PQ}{OQ} = v \quad . \; . \; . \; . \; . \quad (14)$$

And from the equation of energy (4)

$$\frac{W}{2g}\left(v_0^2 - u^2\left(\frac{PR}{OR}\right)^2\right) = p\frac{OP\,PM}{2}\Big)$$

$$= ep\frac{OP^2}{2} \quad . \quad (15)$$

When P is at A,

$$\frac{W}{2g}v_0^2 = ep\frac{OR^2}{2}$$

Therefore,

$$\frac{W}{2g}u^2\frac{PR^2}{OR^2} = ep\left(\frac{OR^2 - OP^2}{2}\right)$$

$$= ep\frac{PR^2}{2}$$

$$u^2 = \frac{epg}{W}a^2 = v_0^2 \quad . \; . \; . \; . \quad (16)$$

Equation (16) shows that u is constant all round the circle, so that in the case of a spring controlled weight the motion is such that P is always opposite a point R revolving uniformly with a velocity V_0. Thus the motion of P is completely defined.

The two cases which have been completely considered are cases of harmonic motion which may and have been dealt with by other methods. The method just given, as a matter of course, leads in these cases to the same results as other methods, but it has the advantage of being applicable to obtain certain results when neither the law of motion or the law of force are completely defined, and, what is its chief advantage as regards the theory of machines, is that the kinetic forces are represented by a diagram, which may be at once combined with the diagram such as that of steam pressure, representing the forces acting on the oscillating pieces; and hence a complete diagram of transmitted forces obtained. The advantages of this will appear in the sequel; but first there are some other general points to be dealt with.

(10) *Vibration and reciprocation.*—The two classes of oscillating motion typifyed by the two cases considered—namely, that controlled by the crank and that controlled by the spring, are, as regards the circumstances on which they depend, essentially different; and although custom is not uniform in the matter, it is well to distinguish them by different names. The class represented by the crank may be well called a motion of reciprocation, as the body is constrained to move backwards and forwards exactly along the same path and through the same distance, whatever may be the speed. Whereas in the case of a vibrating body, although it moves backwards and forwards along the same path, the distance depends on the speed. In the former case, that of reciprocation, the only effect of increasing the speed of motion is to increase the rate of oscillation, whereas the effect of increasing the speed of motion in the case of vibration is primarily to increase the length of the path, the effect on the rate of oscillation depending on the law of stiffness of the spring, which in the case of a normal spring is such that the rate of oscillation is constant.

If a weight of 1lb. be held by a spring which requires 1·2 lb. to deflect it 1ft., it would vibrate in a period of one second, and through a distance depending on the initial disturbance. A weight of 1 lb. controlled by a uniformly revolving crank would vibrate in the period of revolution of the crank and through a distance of twice the length of the crank. If the crank revolve in a period of one second, and the spring be disturbed to move through twice the length of the crank, the two motions become identical, and the energy of motion is the same in both cases.

The next question is, What becomes of this energy of motion? and this will form the subject of the next article.

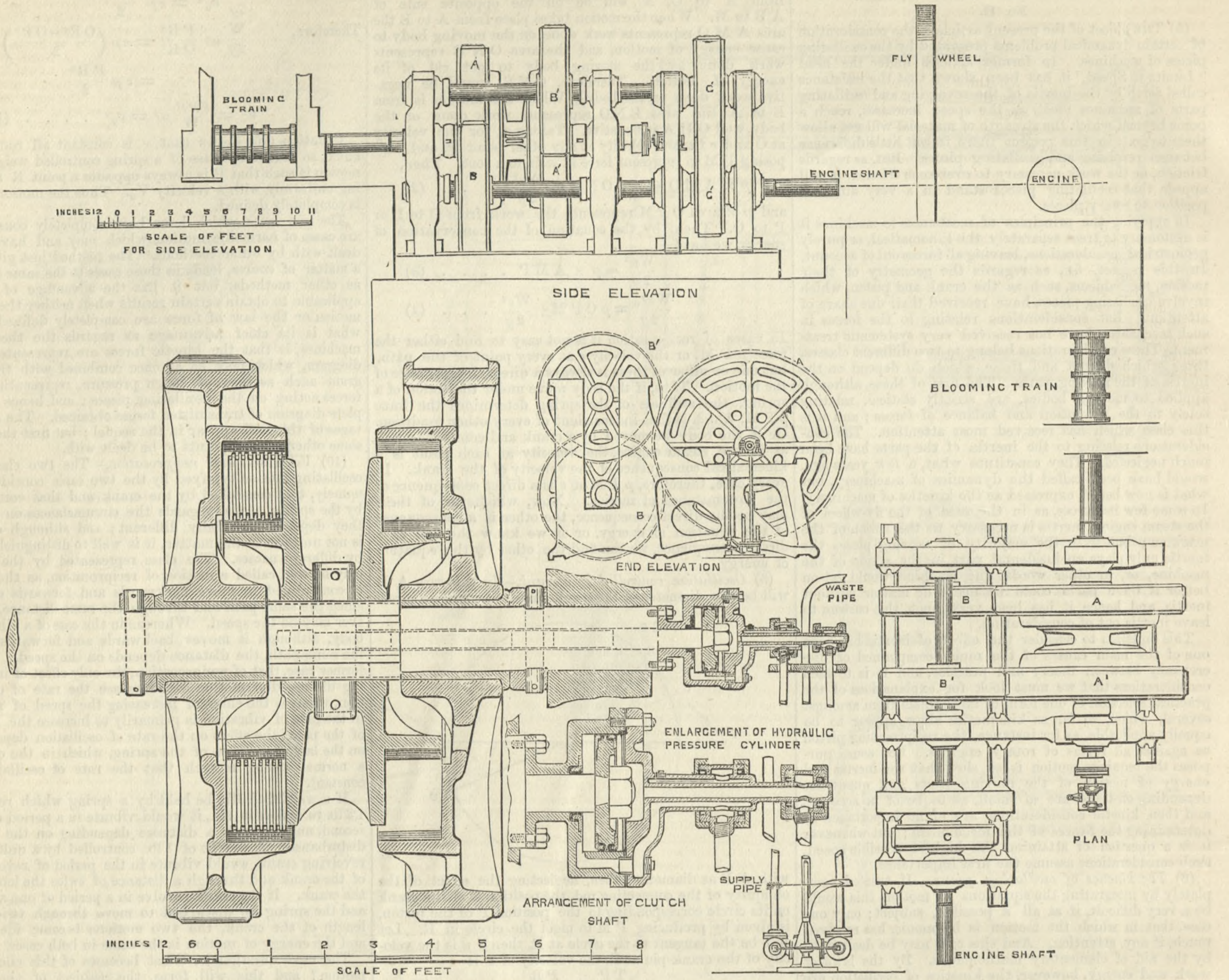
* The following notation will be used unless otherwise stated:—v is velocity in feet per second; W weight in pounds; E energy in foot-pounds; g = 32, acceleration of gravity.

NAVAL ENGINEER STUDENTS.

THE Lords of the Admiralty have issued a new code of regulations for the entry of engineer students in her Majesty's dockyards, with a view to their being trained for service afloat as engineer officers of the Navy. The vacancies for appointments as students in the dockyards will in future be filled principally by means of competitive examinations, open to all sons of British subjects being of the prescribed age and of good moral character, but the Admiralty reserve to themselves the right to nominate a few candidates at the entry, who will be appointed on passing a test examination. The candidates to be nominated will be selected by the Board of Admiralty from sons of officers of the Navy, Army, or Royal Marines, who have been killed in action, or who have been lost at sea on active service, or killed on duty, or who have died of wounds received in action, or injuries received in duty within six months from the date of such action or injury; or sons of officers of the Navy or Royal Marines who have performed any meritorious service. The number to be so nominated will not exceed one-fifth of the total number of engineer students to be entered. Except as regards exemption from competitive examination, these candidates will be subject in all respects to the ordinary regulations. The number of appointments to be made in each year, and the dockyard at which engineer students are to be entered, will be fixed by their Lordships. The list of candidates for these appointments by open competition will as heretofore be kept at the office of the Civil Service Commissioners, and the list of nominated candidates will be kept at the Admiralty. Applications for nominations must be made before the 1st of February each year, and should be addressed to the Secretary of the Admiralty if the candidate is the son of an officer of the Navy or Marines; to the Military Secretary, Horse Guards, if the candidate is the son of an officer of the Army; and to the Military Secretary, India-office, if the candidate is the son of an officer of the Indian Army. The following will be the subjects of the competitive examinations, from which it will be seen that there is a material alteration from the original regulation:—Arithmetic, 300 marks; handwriting, 40; accuracy and intelligence in writing from dictation, 60; composition, 100; grammer, 150; translation into English of French or German or Italian, 150 marks; translation of Latin into English, 150; geography, 100; algebra, up to and including quadratic equations, 300; Euclid's Elements (Books 1 to 4, and Book 6, and the definitions of Book 5), 300; mechanical drawing (elementary), 100; total 1750. The parent and guardian of each engineer student entered in the future will be required to make four annual payments during the first four years of the student's training, namely, £30 each year for the first two years, and £20 each year for the two subsequent years. It will, however, be in the discretion of the Admiralty to reduce these annual payments in the case of sons of officers killed or drowned on service. In other respects the regulations are similar to those now in force.

SOUTH KENSINGTON MUSEUM.—Visitors during the week ending Jan. 13th, 1883:—On Monday, Tuesday, and Saturday, free, from 10 a.m. to 10 p.m., Museum, 14,092; mercantile marine, Indian section, and other collections, 4499. On Wednesday, Thursday, and Friday, admission 6d., from 10 a.m. to 4 p.m., Museum, 1946; mercantile marine, Indian section, and other collections, 405. Total, 20,942. Average of corresponding week in former years, 16,621. Total from the opening of the Museum, 21,628,314.

WESTON'S FRICTIONAL REVERSING CLUTCH FOR ROLLING MILLS.



We illustrate above a frictional reversing clutch, constructed according to the plans and patents of Mr. T. A. Weston by the Yale Lock Manufacturing Company, engineers and ironfounders, Stamford, Connecticut, U.S., for a rolling mill at Chicago, Illinois. The staff and clutch wheels weigh some 40,000 lb. It is in some respects analogous to the reversing gear we illustrated in THE ENGINEER, Aug. 29, 1879, p. 379, but with new and improved details. One hydraulic pressure cylinder, a double-acting one, is attached to the shaft, and revolves with it. The Weston frictional discs are 6ft. 6in. in diameter; the spur wheels 10ft. 6in. diameter, and 6in. pitch. The discs, twelve pairs in each clutch, are kept oiled, the low coefficient of friction due to lubrication still affording ample driving power, owing to the large area of the discs, viz., 500 square feet of effective friction surface in each clutch, the total area of the whole 48 discs in both clutches being over 2000 square feet. We hope hereafter to illustrate still later forms of frictional driving mechanism of various kinds, for the construction of which the inventor has entered into arrangements with Messrs. James Watt and Co., of Soho and London, and with Messrs. J. Bagshaw and Sons, Batley, Yorkshire.

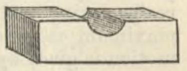
NEW MACHINERY IN THE MINT.

The machinery of the Mint had become so old and untrustworthy, and had fallen so far behind the requirements of the present time, that it became necessary to provide a new set of plant; and, as the Select Committee of the House of Commons decided against the removal of the Mint to a new site, arrangements were made by which the reconstruction of the operative departments, in accordance with the recommendation of that committee, could proceed during the time that the new plant was in course of construction and erection. This involved the suspension of coinage for about nine months, and the expenditure of about £30,000 for new machinery, and £9000 for alteration and extension of buildings. The new buildings, the arrangements of which were made under the officers of the Mint, including the Deputy-Master, the Hon. C. W. Fremantle, the Superintendent of the Operative Department, Mr. R. A. Hill, and the Chemist of the Mint, Mr. W. Chandlers-Roberts, F.R.S., were commenced in the early part of this year, with the exception of a new mechanics' workshop 60ft. by 45ft., which was completed towards the end of 1881. Those who knew the Mint previous to the alterations will feel as though in an entirely new building, and will miss many venerable machines and apparatus, including the big old crown wheel, and the ring of presses. The new mechanics' shop above mentioned is built next to the smiths' forge and the die-turning shop, and in close proximity to the rest of the die department, so that the whole establishment of artificers will for the future be centralised. The silver melting house remains unaltered, but the gold melting house, with office and stronghold, has been much enlarged. The old grinding-room has been included in this house, and a new grinding-room has been placed on the site of the former engine-house. The rolling-room is retained without material alteration, but the circular room, containing the antiquated and cumbrous cutting machinery, has been removed, giving place to an enlarged cutting and marking-room and new engine-house. A second rolling-room, with an area of 3361 square feet, has been arranged on the space formerly occupied by the cutting and marking-room, and by two dwelling-houses in the courtyard. The coining press-room has been enlarged by the removal of a partition wall, and has been heightened, and is to be lighted by electricity.

Of the new machinery, all of which is much more powerful or more rapid than that which it has replaced, the engines which give motion to the whole, stand first. Of these, which are built by Messrs. Maudslay, Sons, and Field, we give a full page illustration on page 46, and details on page 50. The engine, collectively, consists of three separate compound tandem engines, with inverted cylinders. They may be worked singly or coupled together, and the middle engine will be used only in case of one of the other engines being stopped, its crank shaft being, at other times, replaced by an intermediate straight coupling shaft. The high-pressure cylinder of each engine is 22in. in diameter; the low-pressure cylinder 40in. in diameter, with a stroke of 3ft. 6in.; at fifty revolutions per minute each engine is capable of indicating 250-horse power, with a vacuum of 22in. to 23in. of mercury. The cylinders are fitted with separate working barrels, the casing forming a steam jacket. The steam and exhaust valves—see sections on page 50—of the high-pressure cylinders are of the Corliss type, constructed in accordance with the patent of Messrs. Musgrave and Sons, of Bolton. The steam valves are entirely controlled by the governor, of the Porter type, the cut-off being instantaneous. The form and action of the Musgrave-Corliss gear can be best explained with reference to the detail engravings on page 50.

The two lower views on that page show the side and front elevations of the gear, while the upper part of the page give enlarged views of parts of this gear and sections of the upper and lower parts of the high-pressure cylinder and the top part of the low-pressure cylinder. In these engravings P is the high-pressure cylinder, B^1 the excentric rod connected to the rocking arm D by which the steam admission gear is worked, the exhaust valves being worked by the excentric rod L. Motion is given to the steam valves in the cases M M^1 by the other end of the rocking arm D, working the rods C C^1 adjustable by the screws F and F^1, the rods C being cut away so as to catch alternately on the trip piece T^1 on the pin X, T, shown to an enlarged scale at the top of the page. This pin is controlled by the levers R R^1 attached to the rod B from the governor, adjustable by nuts F^{11} and F^{111}, and the movement of the valve is effected through the medium of the levers W against the resistance of springs in the air cylinder A, and consequently the higher the rods R R^1 are held by the governor, the sooner will the edge of the short rods C C^1 pass the trip piece T^1 in the central part T of the pin operated by the governor levers R R^1.

The low pressure cylinders have double ported slide valves—see page 50—and a separate eccentric. The air pumps are single acting, and are worked from the crosshead, and are placed at the rear of the cast iron standards, which form the condensers. At the front the three low-pressure cylinders are fixed on one long girder, which is supported from the crank frame by wrought iron columns. The gland between the cylinders is fitted with metallic packing, set up with springs, the door being accessible from the top platform. The metallic packing consists simply of two pieces, thus placed in the space shown at page 50, between the cylinder.



The fly-wheels, each of which is 14ft. diameter, and 10 tons weight, are situated beyond the crank frames, on the first length of shafting, which is then continued through the right wall to the new rolling mill; on the left the connection with the old rolling mill is made by means of two pairs of spur wheels. In our engraving, page 46, the engine is shown as standing in the builder's works. In addition to a new rolling mill, on the right of the engine there is a set of wheels and shaft attached for conveying the power to the coining press room, cutting out presses, and other machines, which are at right angles to the main engine shafting. The engines and machinery can be turned round without steam by means of hydraulic cylinders and claws, which lay hold of notches cast in each fly-wheel. The claws are so made that in the event of the engines starting they would slip out of gear. The large tank on the top of the building supplies the necessary hydraulic pressure.

For supplying the engine power and steam-hammer there are four cylindrical boilers, fixed about 80ft. to the left of the engine-house. They are each 7ft. 3in. diameter, and 23ft. long, having two furnaces and flues, 2ft. 10in. diameter, fitted with eight Galloway tubes. The furnaces are of Messrs. Vicars' patent self-feeding grates, with travelling fire-bars, by which means common slack coal can be used without making smoke. During a recent visit we noticed that very common slack was being burned. The boilers are constructed for working at 90 lb. per square inch, and were pressed with water to 180 lb., the usual working pressure being about 80 lb. The feed-water is drawn from the hot wells while the engines are working, and is pumped into the boilers by donkey engines. The cost of injection water, when taken from the main, is so great that it was found more economical, financially, to increase slightly the consumption of the coal, which is only slack, and to materially reduce the water required for a vacuum only 4in. or 5in. better than that above mentioned. This was also partly compensated for by increasing the working pressure in the boilers. There is, of course, something gained by the increased temperature of the feed-water from the hot well.

The work of rolling precious metals is exceedingly variable, owing to the shortness of the bars, and it sometimes happens that bars may be put into nearly all the rolls at the same time, but scarcely any variation is perceptible in the speed of the engines, so perfect is the control by the instantaneous cut-off.

In the new rolling mill, the machinery of which has also been constructed by Messrs. Maudslay, Sons, and Field, several novelties have been introduced, and the speed of rolling has been considerably increased, being one-third greater than in the old mill. There are in all six pairs of rolls in this new mill. The first two pairs of rolls, 14in. diameter, which are used for breaking down the bars, and the third, 12in. diameter, and fourth, 10in. diameter, are set apart by means of screws and worm wheels. The two finishing rolls, 8in. and 6in. diameter respectively, are capable of the finest adjustment by means of wedges controlled by screws. In the four smaller mills one roll is driven direct from the main-shaft, while the idle roll receives its motion by means of a pair of steel pinions fixed upon the gudgeons of the driven rolls. In order that the mills shall be of the most trustworthy character, the housings of all of them are solid forgings of the best wrought iron. In the same mill there is also a pair of powerful shears. It is somewhat indicative of the decrepid state of much of the machinery in the rolling and cutting departments that, with few exceptions, the most novel machinery is the drawing table for finishing the strips after they have left the finishing rolls, which was made by Henry Maudslay, and bears date 1816. This machine is exceedingly well made, and is still used for pulling the strips between a pair of very hard perfectly true steel rollers, which take the place of the ordinary draw plates. To some of the other machinery of the Mint, including the new Uhlhorn presses, by Messrs. Ralph Heaton and Sons, and the interesting process involved in coinage, we may refer on another occasion.

THE INSTITUTION OF CIVIL ENGINEERS.

PRESIDENT'S ADDRESS.

AT the ordinary meeting on Tuesday, the 9th of January, Mr. James Brunlees, F.R.S.E., delivered an inaugural address as president. He stated that it was thirty years since he had been elected a member of the Institution. When he joined it in 1852 there were 745 members of all classes; the number now was 4210. Then only one volume of minutes was issued annually, now there were four. Then there was no Benevolent Fund in connection with the Institution, nor had the Student Class been established. The former was founded in 1864, and had been a great boon to many who had been laid low by sickness or who had been overtaken by adverse circumstances. The Student Class was established in 1867, and now numbered 759. He would remind his younger hearers that they were entering a field in which competition became yearly more keen; and that they could not afford to despise the acquisition of knowledge, the immediate use of which, in their professional career, might perhaps not be self-evident. A change had been made of late years in the scope of the papers brought before the Institution. Formerly they were restricted chiefly to descriptions of executed works; latterly they had embraced a wider range of subjects, affording more matter for useful discussion. The address of his immediate predecessor in the chair, Sir William Armstrong, mainly bore on the relations of engineering science to the arts of war; and the soundness of his observations had since been strikingly exemplified by the rapid and decisive events of the recent campaign in Egypt. Some part of that rapidity was due to the labours of the civil engineer, especially as regarded the celerity and freshness with which the troops were enabled to take the field, and the ease with which material was moved forward by ship and railway, to say nothing of the service performed in the early stage of the land operations by the movements of the armoured train. In considering the more important engineering works which had been lately finished, or were in process of execution, he was reminded of the small progress in the arts of construction until a recent period. In nearly all that concerned work executed in stone, wood, or earth, the constructions of the ancient engineers might be put in comparison with some of the best modern examples, and in those materials probably their work would never be surpassed. The Panama Canal, when completed, would be as important a link in water communication as the Suez Canal. But canals of great magnitude were amongst the earliest engineering works on record. History mentioned two at least of importance; the canal for uniting the Red Sea with the Nile, and a canal across the Isthmus of Athos, vestiges of which remained. In regard to tunnelling, the ancients had not yet been outstripped. To carry off the superfluous waters of Lake Fucinus, the Emperor Claudius constructed a tunnel 38ft. high, 28ft. wide, and three miles long, chiefly through solid rock. With the exception of explosives and machine drilling, it was apparently executed much as work of that kind would be now; but those exceptions showed that it must have required vastly more labour and time. He then referred to the manner in which a passage had been opened beneath the river Euphrates, from one bank to the other, a distance of more than 130 yards. The course of the river was diverted, and a tunnel was constructed of brick, cemented inside and out with asphaltum. The walls, which were twenty bricks thick, were 12ft. high to the springings of the arch, and the width of the tunnel was 15ft. It was on the Island of Pharos, opposite Alexandria, that the first lighthouse was erected by Ptolemy, nearly three centuries before the Christian era. Winstanley's lighthouse at the Eddystone, the predecessor of the works of Smeaton and of Douglass, was probably not more efficient than the Roman pharos on the heights of Dover. Even the problems regarding the disposal of sewage were attempted to be solved by ancient Rome, and dealt with by her engineers, much in the same way as in the present day. A great "low-level" sewer, 30ft. high by 15ft. wide, received the drainage of a network of sewers coming from the city on the hills, and delivered the accumulation into the Tiber. It was the main artery of a system of sewerage and drainage which there had been no attempt to rival until, in modern times, the London main drainage system had been carried out. Recently, some of the most formidable barriers to communication were being surmounted by the introduction of steel.

The bridge to be erected across the Forth, at Queensferry, was the largest ever undertaken. It would consist of two spans of 1700ft., two of 675ft., fourteen of 168ft., and six of 50ft., with a clear headway for navigation of 150ft. above high water of spring tides. The two large spans were composed of two cantilevers, each 675ft. long, with a central girder 350ft. long, the depth of the cantilevers being 350ft. at the piers and 50ft. in the centre. To hold aloft and to maintain the immense weight of steel of which the cantilevers and girder were composed, piers would be required of corresponding magnitude. The central pier, on the island of Inchgarvie, would consist of four cylindrical masses of concrete and masonry, 45ft. in diameter at the top and 70ft. at the bottom. They would be founded on rock at a depth below high-water varying from 24ft. to 70ft., and would be carried up to 18ft. above high-water. The length of the bridge would be more than a mile, and of the viaduct approaches 2754ft. The contract had been let for £1,600,000. A less remarkable work, but still one of great importance, was the new Tay Bridge. This was to be erected on new foundations on the up-stream side, and as near as practicable to the site of the previous bridge. It would be 10,780ft. long, divided into eighty-five spans, of which eighty-one would be crossed with iron girders, and the remaining four would be brickwork and masonry. Of the thirteen spans over the navigable waterway two would be 227ft., and eleven of 245ft. each, and the height from high-water to the bottom of the girders would be 77ft. The piers would be of wrought iron, plated all over, and supported on iron cylinders of suitable dimensions, sunk 20ft. into the bed of the river, and filled with concrete and brickwork. The parliamentry estimate for the work was £654,000, but the contract had been let for less than that sum. Another bridge of a similar character was that over the river Ganges at Benares. It consisted of seven large spans, each 356ft. from centre to centre of the piers, and nine smaller spans. The depth of the river when at the ordinary level was about 20ft. to 30ft. but floods had been known to rise 50ft. higher, thus making the whole depth of water fron 70ft. to 80ft. The scour in the river bed, which was of sand, was very great; therefore the foundations had to be sunk to a depth of 120ft. The girders were of steel, 25ft. apart, with a 5ft. pathway on each side.

A work of a different type was the Kinzua Viaduct, across a long narrow valley, with lofty precipitous sides, on the Bradford branch of the New York, Lake Erie, and Western Railroad. Its height was 302ft. from the bed of the stream to the rails. Its length between the abutments was 2051ft., divided into twenty spans of 61ft. each, and one span of 62ft. The girders were carried by wrought iron towers or piers having a uniform width at the top of 10ft. and a span of 38½ft. The upper half of the piers was composed of four, and the lower of six wrought iron columns, 1ft. in diameter, braced together, and having a batter laterally of 2in. per foot, so that the highest pier had a base of about 100ft. As an additional stay against the wind, the iron shoes at the bottom of the columns were bolted through the piers, and the columns were braced together throughout their length. The East River Bridge, between New York and Brooklyn, was on the suspension principle. The total length was 5989ft., which was divided into three spans, the land spans being 930ft. each, the river span 1595ft. 6in., and its height above high-water 135ft. The width of the bridge was 85ft., and it was intended to accommodate foot-passengers, railway trains, and ordinary street traffic. The cables were four in number, each having a diameter of 15¾in., and were calculated to stand a strain of 12,200 tons each. There were two suspension towers, each 278ft. in height above high water, and 159ft. above the roadway. Its cost would be, in round figures, about £2,800,000, independent of the cost of land.

From the consideration of bridges, Mr. Brunlees passed to the subject of tunnels. The longest tunnel yet constructed was the St. Gothard, having a length of 14,912 metres. It was opened for traffic on the first day of 1882. The northern end was 3638ft., and the southern end 3756ft. above sea level. The sudden rise from the level of the railway proper to the mouths of the tunnel was surmounted by spiral tunnels of approach, which ran above one another on a radius of 15 chains and a gradient of 1 in 43·5. There were three of these spiral tunnels at the north, and four at the south end of the great tunnel. The Severn Tunnel was the largest work of the kind in this country. It passed under the estuary about half a mile below the ferry which connected the Great Western Railway with the railways of South Wales. The total length of the tunnel was 7942 yards, of which 2¼ miles were under the tideway. The greatest depth of water over the tunnel at high water was 96ft., and at low water 60ft. The tunnel passed through beds of shale and Pennant sandstone of the coal measures, and through the nearly horizontal beds of Keuper marls, which overlay these measures. Water had been met with in all the strata, sometimes in large quantities. One spring in the Millstone Grit, on the land approach to the tunnel, discharged over 5000 gallons a minute, and its sudden inroad caused a temporary stoppage of the works. The tunnel was 26ft. wide at 7ft. above rail-level. It was lined with vitrified bricks, set in Portland cement, the lining being from 1ft. 10½in. to 3ft. thick. The total cost of the tunnel would be about £1,500,000. The work of tunnelling beneath the river Hudson, between New York and Jersey City, was remarkable chiefly on account of the difficult nature of the material. There were two single-line tunnels, 30ft. apart, and parallel to each other, and they were intended to bring the railway traffic of the south-west and south into the city of New York, from which the traffic was at present cut off by the Hudson. The width of the river at the point being tunnelled was one mile; its greatest depth at mean low water was 62ft. The tunnels were being driven by the pneumatic process. The Mersey Railway was intended to effect direct communication between the Lancashire and Cheshire railway systems, and included a tunnel 3820 yards in length, between Liverpool and Birkenhead, 1300 yards of which were under the river Mersey. The tunnel and drainage headings below it were being driven through the red sandstone formation. These headings commenced from shafts one mile apart, sunk on each side to a depth of 180ft.; they were carried on an ascending gradient to the centre of the river, where they would meet the main tunnel, which was constructed on a descending gradient to the same point. Powerful pumping machinery had been erected at each side, and at Liverpool 4500 gallons of water per minute had been raised. At Birkenhead the water had never exceeded 300 gallons per minute. The main tunnel was being driven from two independent shafts, and was carried forward from these landwards and riverwards simultaneously. It is being lined with brickwork set in cement. The length of the railway was three miles, and its cost would be about £1,000,000.

After alluding to the proposed Channel tunnel, Mr. Brunlees referred to the Panama Canal. The project to unite the Atlantic and Pacific oceans by a canal across the narrow neck of land which joined the two American continents was a very old one. During the last century and a-half many surveys had been made in different parts of the isthmus to demonstrate the practicability of the project. Several schemes resulting from independent local investigations were before the public, when Count de Lesseps succeeded in obtaining a meeting of an International Congress in Paris in May, 1879, to select the project which might be entrusted to a public company. This Congress adopted the general features of the scheme now being carried out. It was proposed to be a canal without locks from the Atlantic to the Pacific, 73,000 metres long, 8½ metres deep, and having a minimum width at the water line of 22 metres. The canal commenced on the Atlantic coast, at the Bay of Limon, with a depth of 8½ metres, and went through the marshes of Mindi, in the direction of the river Chagres, which it joined in the vicinity of Gatun. It was then kept up near to the river, which it cut several times, and by a series of curves and straight lines reached Matachin, where it separated from the river Chagres, and continued in a south-east direction along the valley of the Obispo, a tributary of the Chagres. It then entered the valley at the Rio Grande, and in a series of straight lines and curves reached the Gulf of Panama, near the islands of Naos and Flameneo, with a depth of 7½ metres below the lowest tides. It was provided with passing places at suitable distances. The estimated cost of the canal was £31,200,000. The canal would abridge the voyage between Europe and the western coast of America at the equator some 2500 marine leagues, and considerably shorten the voyage to the eastern parts of Australia, to New Zealand, and to China and Japan.

Among works of interest for the shelter and accommodation of shipping, Mr. Brunlees drew attention to the Alexandra Dock works at Hull, and the new harbour of Port Elizabeth. The former were situated on the left foreshore of the river Humber, some distance below the town, in great part seaward of the high-water line. The sea embankments, upwards of 6000ft. in length, had been completed, together with the cofferdam for the entrance lock, and the tidal water had been excluded from the site of the dock and quays. For the first time in carrying out works of this class the excavations and masonry were executed, in great part, by hydraulic machinery, worked by the permanent engines of 300-horse power. The water space of the dock would be 2300ft. in length and 1000ft. in width. The total length of wharfage afforded by the walls and jetties would be 9450 lineal feet. The harbour for Port Elizabeth, in Algoa Bay, was of a different type. It solved the problem of affording shelter for shipping from the heavy seas constantly rolling in upon the beach in that region, without obstructing the natural movement of the sand, which would speedily render any ordinary protection useless. This movement was confined to the comparatively shallow water near the shore, and was caused by heavy south-easterly seas. As a first step towards the execution of the general design, a retaining bank had been constructed along the shore at the southern end of the town, which had had the desired effect of clearing away a large quantity of the sand accumulations. From the northern end of this bank a viaduct was to run out in a north-easterly direction 3000ft., into six fathoms of water at low tide. It was to be formed of wrought iron piles placed in bays 30ft. apart, securely braced together, and supporting a deck of wrought iron girders, with a plated floor carrying the road surface, on which the rails would be laid in the usual manner and connected with the system of existing railways. The viaduct would present no obstruction to the sand-travel, and therefore cause no diminution of the depth of water. At the outer end a breakwater was to be constructed of large concrete blocks, founded on a substratum of rubble, carried down to a sufficient depth to prevent disturbance by wave action. The cost of the work would be about £950,000.

The works for an improved supply of water for Liverpool were making rapid progress. The water was to be impounded from the watershed of the river Vyrnwy, in North Wales, a distance of 67½ miles from the Prescot reservoirs, to which it was to be brought partly by aqueduct and partly in tunnels and pipes. The area of the watershed was 17,513 acres. The upper waters of the Vyrnwy were to be impounded in the valley of the river by a dam, which would collect the waters of the river into a reservoir having an area of 1115 acres. Manchester recently obtained powers for an additional supply of water from Thirlmere. All were agreed that a supply of pure water was one of the most important means of maintaining the health of large towns, and it had also come to be admitted that it had an important influence on their moral condition. It would be well, therefore, if London would seek to emulate the northern cities in supplying its population with pure water. The old Eddystone Lighthouse, completed in 1759, had always been an object of peculiar interest to the nation. It was with a feeling akin to personal regret that the public learned for the first time in 1877 that Smeaton's work was doomed; but it was a source of satisfaction and consolation that nothing in the design or construction of the tower itself conduced to the necessity for replacing it; but the rock upon which it was reared had not been so enduring. The new tower was 130ft. high above high water, or 58ft. higher than the old tower, and nearly five times the quantity of stone was used in its construction. Smeaton's tower contained only four rooms; that of Sir James Douglass nine, of larger and loftier proportions. It had cost £78,000, and had been completed in three and a-half years. Since the application of electric light at the South Foreland Lighthouse, in December, 1858, considerable progress had been made with all the luminaries applied to lighthouses. At the above date, the standard intensity of the first-order oil light was 230 candle-units, and the intensity of the most powerful electric light was about 670 candle-units. Recently at the Eddystone Lighthouse two oil lamps, each of 720 candle-units, had been adopted. This intensity would shortly be considerably exceeded. With electric light, a focal intensity of about 10,000 candle-units was applied at the Lizard, and arrangements were being made by the Trinity House for practically testing the merits of an electric light of 60,000 candle-units intensity. With coal-gas light great progress had been made since 1865 by Mr. John Wigham, of Dublin. In the latest development of his system four burners were employed, each of 1250 candle-units intensity.

Mr. Brunlees then briefly referred to the want of railway communication in many productive countries. The immense population of China would derive great advantages from the construction of railways. It had been said that the objection of the Chinese proceeded chiefly from the fear of introducing foreigners in any considerable number. Chinese statesmen, even those most liberal and enlightened, at one time believed that railways were not adapted to the circumstances of China. They had recently formed a different opinion. An official memorial had been drawn up by one important Government officer, and favourably reported on to the Government by another high official, suggesting and recommending the construction of four important trunk lines, and no doubt if these were once executed many more would follow. In India somewhat more than 900 miles of railway were in course of construction, including three bridges of more than ordinary importance. When the works now in progress were completed, India would have nearly 12,000 miles of railway open for traffic. In New Zealand the length of railway in various stages of progress during the year ended 31st March last was 234 miles, and 1333 miles were then open for traffic, and an additional expenditure of £1,650,000 had been ordered. In Queensland only a few miles appeared to be under construction; but an extensive system of railways was under the consideration of the Government. In South Australia considerable progress had been made in railway building, and this might also be said of Victoria and New South Wales, where there were 342 miles under construction. He regretted that the Australian colonies had not adopted the same gauge for their lines. With the disadvantages which had arisen in England, in India, and in America, from a break of gauge, and from the great advantages which Western and Central Europe had derived from a uniform gauge, it might have been thought prudent on the part of the Australian Colonies to have accepted the experience of older communities. In Canada, 2910 miles of railway were under construction; and in the United States some 11,000 miles had been constructed during the last year. In the United States and in Canada the tendency was towards a uniformity of gauge.

The undue neglect of the inland navigation of this country was a subject which deserved the attention of the engineer. For coarse goods a slower conveyance than the goods train might be endured in consideration of its greater cheapness. But to be more extensively useful it must be something between the present speed of the canal-boat and the goods train, with the punctuality of the latter.

Mr. Brunlees then drew attention to the fact that the trained engineer was a comparatively modern creation. Until little more than a hundred years ago Great Britain contained hardly a canal or a passable high road; and two centuries ago it was necessary to send to Holland for an engineer to build a sea-wall. A Rivers Conservancy and Flood Prevention Act was greatly needed. Private interests of the most insignificant character were suffered to interfere with or prevent the execution of plans which would be of manifest advantage to large populations. To carry out any local or general public improvement, private persons must be organised into public bodies, and appeal must be made to the cumbrous and costly machinery of parliamentary legislation in every individual case. There were signs that this ancient system, suitable enough for the rate of progress of public works half a century ago, but unsuited to the rapid march of improvement in our time, would before long be modified and improved. During recent times of depression fear had been expressed that the profession was too full, that the work of engineers had been completed. But these fears were vain. So long as capital accumulated in this country, it must be expended in some productive way at home or abroad. Judiciously planned public works were always productive, and the men who found the means would appoint the agents for carrying out the works. Not only were public works, including many new or larger harbours and docks, required at home; not only were new countries of vast extent and enormous resources being gradually laid open to the operations of the engineer, but a greater diversity of employment was offered to him. It was impossible to say to what uses the comparatively new power of electricity might be put, but it must play an important part in the social industrial economy of the age.

It was announced that the Council had recently transferred H. Groves and R. T. Hall to the class of members; and had admitted H. S. Bassett, M. S. Bell, C. F. Bengough, G. C. Borton, A. H. Broun, J. H. Burton, F. E. Cairnes, F. A. Campion, J. Collie, W. R. Crabtree, R. F. Dalziel, W. Dawson, C. R. B. de la Salle, J. A. Despeissis, E. I. Evans, R. Findlay, S. S. Grimley, C. H. Hall, J. Hardisty, A. E. Hezlet, G. W. Holmes, H. G. Horne, S. Ingram, jun., C. H. Lawson, E. E. Light, J. S. L. Long, G. E. J. McMurtrie, F. Y. Marrian, A. W. Metcalf, C. F. Minchin, the Hon. E. H. S. Napier, H. E. Nichol, W. B. Norton, C. Roberts, A. J. Salter, W. C. E. Smith, H. F. Snow, E. F. Sollom, F. H. Stone, C. F. Sykes, A. M. Thompson, E. S. Tiddeman, A. E. Wackrill, J. D. Watson, S. W. Price Williams, and W. Wood, as Students of the Institution. At the monthly ballot W. Belk, J. Chambers, and W. H. Le Mesurier were elected Members; T. Adams, Stud. Inst. C.E.; W. Barrington, jun., Stud. Inst. C.E.; R. H. Brookhouse, Stud. Inst. C.E.; J. Clare, H.

B. Cox, J. P. Curtis, G. J. A. Danford, H. N. Harvey, Stud. Inst. C.E.; T. H. Houghton, Stud. Inst. C.E.; C. L. Morgan, G. T. St. A. Nixon, H. A. Purdon, Stud. Inst. C.E.; E. R. Saunders, Stud. Inst. C.E.; C. B. B. Sherman, F. C. Sheppard, W. Spinks, Stud. Inst. C.E.; A. Summerscale, Stud. Inst. C.E.; and R. Wilson, Associate Members; and Fung Yee, G. B. Godfrey, and J. W. Theobald, Associates.

VARIETIES OF THE RAILWAY PASSENGER DUTY.—Very various are the results of the different modes of calculating the duty since the decision in the Court of Exchequer. They range from an increase in the duty of 78 per cent. on some railways, down to a diminution of duty amounting to 22 per cent. on other railways, according to the difference in the nature of the passenger traffic. Out of eighty-two railways in Great Britain, the whole amount of tax, except about £21,660, is paid by twenty-two railways, so that the remaining sixty might be exempted without much loss to the revenue.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty: Charles P. Turner, inspector of machinery, to the Alexandra; James C. Oare, William T. Allen, and George Sparks, engineers, to the Alexandra; Charles J. Cock, engineer, additional, to the Indus, vice Alexander; George Mackney, engineer, to the Coquette; Alfred Lawton, engineer, additional, to the Defence, vice Mackney; James Shirwell, engineer, to the Hibernia, additional, vice Alton; Harry W. Wilkins, engineer, additional, to the Asia, vice Shirwell; Samuel H. Berry, acting engineer, to the Alexandra; John A. H. Hicks, assistant engineer, to the Téméraire, vice Sharp; Edwin C. Carnt, acting engineer, to the Warrior, vice Hicks; George W. Fowler and George W. Hudson, acting engineers, to the Alexandra; George G. Smith, engineer, to the Cygnet; and John Fawcett, engineer, to the Espoir; James H. Gilbert, engineer, to the Alexandra.

THE THROSTLE NEST WEIR.—The new automatic tilting weir on the river Irwell at Throstle Nest, designed by Mr. F. Wiswell, the engineer to the Bridgewater Navigation Company, and which has been already fully described in our pages, is now practically completed. The weir, which consists of fourteen tilted sluice gates, has been built in two sections, the first consisting of six of the sluices, which were completed about six months back. The remaining eight sluices have now been put in, and with the exception that the centre gate, owing to the flood of water recently, has not yet been connected, the weir is practically finished. Some difficulty has at times been experienced in dealing with the water during the construction of the weir when the river has been exceptionally high, but any actual flooding has been avoided. There has not yet been a sufficient weight of water to really test the automatic action of the gates, but still, there has been sufficient back pressure from the water to materially assist in lifting the gates when required.

THE RIVERS POLLUTION ACT.—Mr. Lonsdale, the Judge of the Maidstone County Court, made on Monday an order under the Rivers Pollution Prevention Act, calling upon the West Malling Rural Sanitary Authority to cease polluting the Leybourne stream, which runs through the Kentish estate of Sir Henry Hawley. The action was brought by Sir Henry on the ground that the defendants, after ineffectively treating their sewage in certain filtering beds, discharged what was really liquid sewage into this stream, and had thereby destroyed the fish. The defendants, at the first hearing of the case, last month, suggested that they were using the best practical means to render the sewage harmless; but on Monday they submitted to the order, and asked that its operation might be suspended six months to enable them to carry out necessary works. This was conceded, on the understanding that a gentleman selected by Sir Henry Hawley should have power to make suggestions for temporary arrangements, so that in the six months the stream shall not be unnecessarily polluted. The defendants were ordered to pay the costs of the action.

THE FUTURE OF TRAMWAYS.—What are the advantages, mechanical or otherwise, which the tramway is calculated to offer? By the correct appreciation of these we shall be able to form a sounder judgment as to the probable development of the system than seems to be common just now. The mechanical advantage obtained by the use of tramways consists solely in the diminution of the running friction—or, in other words, of the draught—as compared with that of such a vehicle as an omnibus on the common road. On a perfectly level line the draught of the tram-car is just half that of a carriage of equal weight on a road in good order. But perfectly level roads are rare, and as soon as a hill, however slight, intervenes, the advantage derivable from the use of tramplates becomes proportionately less. On an incline of one in a hundred, which is hardly to be detected by the eye, the gain is reduced to one-third; and on a rise of one in thirty, which is considered moderate for a main road, the gain is reduced to little more than one-eighth. These mechanical facts limit the saving to be effected by the use of tramways, and explain how it is that the financial outcome of the system does not compare more favourably with that of the ordinary omnibus. There may be said to be three classes of persons, representing different and, to some respect, conflicting interests, who are mainly affected by the introduction of the tramway—namely, passengers, neighbours, and investors. It cannot be denied that to the passengers a tramway offers a gain in comfort, almost amounting to luxury. The contrast between a trip in a thoroughly well-appointed tramway car (such as those which ply over forty-two miles of line in Manchester) and the London omnibus is almost as great as that between a brougham and a tax-cart. There is more room, more ease of motion, and far greater quiet. These are very great advantages; but though it may be said that they are enough, they are all that the passenger obtains. There is no gain in economy, no gain in speed, and perhaps loss rather than gain in convenience of access to the carriage. We have, therefore, to place on the credit side of the account the increased comfort of about 430,000 passengers. We arrive at that number by allowing two journeys, for 300 days in the year, to each of the 257,600,000 passengers returned for the year ending June, 30, 1882. It is true that this is rather more than one-third of the number of railway passengers in a year; but then it must be remembered that the distances traversed by the latter are at least five times as much as those covered by the tramway passengers, the mean receipts on the tramways being 1·8d. per trip against 9·5d. per trip on the railways. Against the gain in comfort, then, of less than half a million of passengers have to be set the cost, inconvenience, and even danger, which are caused to the owners and users of all kind of vehicles, as well as of all horsemen, that use the roads on which the tramways are laid. To this item has to be added the great increase in noise occasioned by the tram-plate. As far as the tram-cars themselves are concerned, indeed, the noise of their wheels is much less to the neighbouring residents, as well as to the passengers, than is that of the wheels of the omnibus. But the vehicles using the tramway form but a small number in proportion to those using the road. And the addition to the noise made by these other vehicles, especially at corners or crossings, is deafening. Balancing gain and loss, then, it may appear that more annoyance is caused to a much larger number of people by the tramways than is saved to the 430,000 persons who use them for conveyance. And as to national gain, while the average return for 1881-82 did not allow a nominal net income of 5 per cent. (with no allowance for sinking-fund) on tramway capital, the losses incurred in depreciation of house property, in extra wear and tear of carriages and horses, and in compensation due for accidents, have to be considered. On these grounds it appears probable that the 444 miles of tramway open in England will not witness an increase at all corresponding to that which has taken place with our railway system. The main advantage offered by the railway—gain of time—is absent in the case of the tramways. And when all is said and done, nothing tells on passenger traffic like gain in time.—*St. James's Gazette.*

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

(*From our own Correspondent.*)

THE tone of the markets, alike in Wolverhampton yesterday and in Birmingham this afternoon, was such as we are not unaccustomed to on the week succeeding the quarterly meetings. Business wore a tame appearance, and prices were not strong. Merchants and consumers were reported to be standing off, in the hope that this policy would influence the markets in their favour; but men of experience declined to give way in price to much extent.

Galvanising and common sheets are in less demand than usual at this time, and the result of the excessive production is now apparent in falling prices. Although £9 is quoted for doubles, it is no secret that they are being sold at £8 15s. to £8 10s. Lattens are about £9 10s. to £9 15s. The galvanisers quoted this afternoon £14 for corrugated sheets delivered at outports, but the sales were few. For best brands £14 10s. is being obtained on indented orders.

The best thin sheet makers and the tin-plate makers announced a continuance of the tolerable activity at the works which has for some time past marked these branches of trade. The quotations of £11 for sheets, singles, to merchants, and £12 to consumers are little more than nominal.

Messrs. Knight, of the Cookley Ironworks, quote £10 for their K.B.C. "singles," £11 10s. for doubles, and £13 for trebles. These sheets are for best "working-up purposes." Their stamping qualities, they price at £3 per ton more. Tin-plates the firm quote at: Cookley K, charcoals 25s. to 26s. per box, and Cookley coke plates 21s. to 22s. per box according to specifications. These tin-plates the firm claim are the best in the world.

To the Staffordshire and Worcestershire tin-plate makers, who were present at the quarterly meeting of the Welsh tin-plate makers in Birmingham last week, it was not unpleasant news that the estimate of the association concerning the reduced make which was likely to result from the stoppage of the Welsh mills through the recent failures was between a million and a million and a quarter boxes per annum.

Orders for merchant sections of finished iron, such as bars, hoops, strips, and nail rods, were this afternoon much sought after. Makers were not, however, generally successful in booking large lots. Marked bars remained at £8 12s. 6d. for the Earl of Dudley's make, and £8 to £7 10s. for the make of the other "list" houses. Yet an excellent bar might have been had at £7, and common sorts ranged down to as low as £6. Hoops were abundant at £6 15s. easy, though some firms still quote £7. Strip for gas tube manufacture was a minimum of about £6 12s. 6d.

Advices from Melbourne report galvanised corrugated sheets were moving off quietly, favourite brands being offered at from £21 10s. to £22 5s., while ordinary brands were quoted at £20 10s. Sheet iron in the black was firm, No. 8 to 18 being disposed of at £10 10s., and Nos. 20 to 26 at £13. Plates were quiet, with quotations ruling at £10 to £10 10s. Hoop iron was saleable at £10.

Pig iron was quoted in the Melbourne market up to £4 per ton for quantities and £4 4s. for smaller parcels. About 600 tons to arrive had at date of despatch been taken up at these rates, and another line of the same quantity had been placed at an advance.

This afternoon in Birmingham pig iron was not active, but vendors of Derbyshire and Northampton sorts reported here and there sales during the week of lots varying from 3000 to 1000 tons or above. The quotation for such pigs was 48s. 9d. to 50s., though the last price could but rarely be got. The "Westbury" brand was quoted at 50s., and Lincolnshire pigs at 50s. 8d. delivered at stations. The Kirkless Hall—Wigan—pigs were quoted at 48s. 6d. for grey forge qualities. Hematites and native all-mine pigs were slightly easier than at quarter-day, the price of both being 65s., although 67s. 6d. was quoted. The "Capponfield" brand of native pigs were quoted at 55s. for best, and 42s. 6d. for common sorts. Other cinder pigs were to be had at a minimum of 40s.

The Wrought Iron Tube Makers' Association have declared a reduction in prices equal to an increase in discounts of 2½ per cent. The new discounts are, gas tubes, 72½ per cent.; steam and galvanised gas tubes, 57½ per cent. On fittings the new discount is, gas tubes 77½ per cent., and steam and galvanised gas tubes 62½ per cent.

The Star Nut and Bolt Works, formerly owned by Messrs. Brookes Bros., Smethwick, have just been purchased by the Midland Bolt and Nut Company.

Two new directors have just been appointed on the board of the Midland Railway Carriage and Wagon Company, Limited. They are Mr. S. T. Williams, of Malvern and Birmingham, and Mr. T. Campbell Evans (late of the Indian State Railways). Mr. Evans will also act as consulting engineer to the company.

This week the Birmingham Corporation have applied for the loan of a quarter of million of money to enable them to extend their gas undertaking, and erect new offices at a cost of £75,000. The capital expenses of the undertaking up to the year 1890 will be met by the loan.

The proposed Walsall, Birmingham, and Cannock Chase Railway has been abandoned, the promoters having decided not to proceed with the Bill. This decision has caused much disappointment in the districts affected, especially to the colliery owners on Cannock Chase, who had regarded the railway as an important new outlet for their produce.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—The condition of the iron trade in this district has remained without much material change during the past week. There is still a margin between the views of buyers and sellers as to prices, which stands in the way of any weight of business being done, and apparently the issue will have to be decided as necessities compel makers or consumers to come first into the market. Makers of both pig and manufactured iron are still in most cases being kept going with old orders, and fairly large deliveries from the Lancashire blast furnaces continue to be made against contracts, but these are rapidly coming to an end, and some of the finished iron makers are already short of work. There are, however, known to be buyers in the market who will have to place out orders before long, and makers are not disposed to force sales at low prices.

The Manchester market on Tuesday was a repetition of the comparatively lifeless meetings which have prevailed since the commencement of the year. Lancashire makers of pig iron were still asking 47s. 6d. per ton less 2½ for forge and foundry qualities delivered equal to Manchester, and business to a considerable extent has been declined at about 1s. 6d. per ton under this figure. Local makers, however, are open to some concession, and although no orders are coming forward at their quoted rates, offers for a moderate quantity of iron have been made during the week which may lead to some business being done. In district brands of pig iron a few sales have been made since the quarterly meetings at the minimum rates, and in some cases makers do not appear anxious to book further except they can get slightly better prices. At 46s. 10d. to 47s. 10d. less 2½ for forge and foundry qualities delivered equal to Manchester, Lincolnshire makers may be said to be firm, but there are odd lots in second hands to be bought at 6d. per ton under these figures, and merchants seem disposed to undersell. For Derbyshire iron the average price is about 48s. 6d. for forge up to 50s. for foundry less 2½ delivered here, but in this brand there are also low-priced parcels to be bought. Middlesbrough iron continues practically out of this market, but I hear of a few special sales of best foundry brands on the basis of 52s. net cash delivered equal to Manchester.

For finished iron inquiries both on home accounts and for shipment have been very limited, buyers all round holding back for lower prices. Nominally makers are holding on to £6 10s. as the list price for bars delivered at Manchester, and they show very little disposition to give way where quotations are asked for forward delivery. Where actual specifications, however, are offered £6 10s. per ton is being readily taken, and in some cases these are selling as low as £6 5s. per ton. Hoop iron makers are easier, and I have heard quotations as low as £6 15s., but this is the minimum.

In the ironfoundry trade orders have still to be sought at very low prices, and one large founder in the district in conversation told me that he had come to the conclusion that any material increase of profit on contracts was not to be looked for from an increase of price or from a decrease of wages, but must be sought in improved and more economical methods of production.

For brass foundry work the demand is only moderate, and there is a falling off in inquiries both for engineers' and marine fittings. Prices have to be kept very low to secure business, and any attempt to raise quotations invariably results in orders going elsewhere.

The small class of motors, such as hot air engines, are only in moderate demand, and the inquiries put forward some time back for driving purposes in connection with electric lighting have not yet resulted in any development of the demand for engines of the above type.

The official returns sent in for the last month from the various Lancashire districts connected with the Amalgamated Society of Engineers do not, owing to the holidays, afford any very reliable basis as the present actual state of employment. With, however, the exception of the machine trade the close of the holidays appears to have been followed by a general return to employment. The locomotive building, tool making, and engine trades throughout the district are all finding full work for the men, and where any members have remained on the books of the society after the stoppages for the holidays it is almost entirely confined to the cotton-machine making trade. In this brand there has been a falling off in orders, which has caused some of the large firms in the district to be slack, and a considerable number of men stopped during the holidays have not yet been again taken on.

Some of the cotton machinists are, however, kept busy, and notwithstanding the depression in the cotton trade, new mills continue to be floated. At Shaw, near Oldham, where a few days ago a company, with a capital of £100,000, was floated without giving the villagers an opportunity of becoming shareholders, it has been decided to float another company, open to the public, also with a capital of £100,000, and to erect a mill with 80,000 spindles. The mill is to be of fireproof construction, and the estimated cost is about a guinea per spindle.

Mr. Thos. Ashbury, C.E., in the course of his inaugural address as president of the Manchester Association of Employers, Foremen, and Draughtsmen, delivered to the members on Friday last, after reviewing the influence of the engineer on the rapid development of the world's civilisation and power, pointed to the extraordinary ingenuity which of late years had been displayed by the engineer in the designing and making of tools and machinery required to keep pace with his own demands. To this end his best talents and most enthusiastic labours had been, and still were being, devoted. In the production of labour-saving tools and machines Manchester had ever, and he hoped would still, take the lead, and the products of its workshops were to be found all over the world wherever motive power was required. The immense strides made of late years to meet the demands of shipbuilders, rolling mills, &c., had caused tools to be designed of a size that a few years back would have been thought incredible. Lathes, planing machines, slotting machines, &c., were now made weighing 100 to 150 tons each, whilst the fertile brain of the engineer was constantly designing machines to supersede manual labours, producing much better work in larger quantities and at much less cost. No matter how extravagant the demand made upon him, the engineering tool maker fearlessly faced every difficulty, the word "impossible" was not found in his vocabulary, and again and again his intelligent and indefatigable labours were worthily crowned with success, and the work of his hands seemed almost to have imparted to it the guiding and controlling power of its maker's mind. As an association of employers, foremen, and draughtsmen of the mechanical trades of Great Britain, they had it in their power, and, in fact, it became their duty not only to maintain, but to enhance the mechanical renown of that district. With the splendid educational facilities in Manchester and the adjoining towns for scientific and technical education, and the immense advantage of such an institution as the Victoria University, enriched in its engineering and mechanical branches by the legacies of departed and the gifts of living engineers of the district—and he might perhaps be pardoned for mentioning that a valuable scholarship in engineering had been founded in memory of his late uncle, John Ashbury, of Manchester, by Mr. James Ashbury—the rising young men had within their reach glorious opportunities of leading the way in the future in every form of engineering and mechanical progress, and they hoped that the mantles of their Roberts, Fairbairns, Whitworths, and others of their distinguished Manchester engineers might fall upon them. We may add that the past year in connection with the association has been a very successful one. The papers brought forward for discussion have been of a higher class, and the attendance at the meetings has been larger than during previous years. There has been a full average increase of members, who now number 186, whilst there has been excess of income over expenditure of £100, the funds to the credit of the association at the close of the year amounting to £2383.

The literature and correspondence with regard to the Manchester Ship Canal project increases in bulk week by week. The published literature has hitherto been practically one-sided, and to a large extent has emanated from the promoters of the scheme. During the past week, however, a counterblast has appeared in the shape of a pamphlet by Mr. A. Provand, which is an adverse mercantile criticism of the project, in which he urges a number of reasons against the scheme. The pamphlet is a somewhat bulky affair, full of figures and calculations, which cannot be dealt with here, and is naturally bringing out strong refutations from the promoters of the canal.

The abandonment of the Lancashire Plateway scheme, considering the influential names by which it was supported, has created some surprise.

The coal trade of the district continues quiet for the time of the year, with abundant supplies in the market, and pits in some cases going on to short time. There is a good deal of low selling to secure orders, but it is only in exceptional cases that actual reductions are made in the quoted list rates, although colliery proprietors are finding these difficult to maintain. At the pit mouth the average prices are about 10s. to 10s. 6d. for best coals, 8s. to 8s. 6d. for seconds, 6s. 6d. to 7s. for common house coals, 6s. to 6s. 6d. for steam and forge coals, 4s. 9d. to 5s. for burgy, 3s. 6d. to 4s. for good slack, with common sorts to be bought as low as 3s. and 3s. 3d. per ton.

Shipping is generally quiet, with low prices quoted to secure orders, steam coal being offered at the high level, Liverpool, at 7s. 6d., whilst at Garston Docks not more than about 7s. 9d. to 8s. per ton is being obtained as a rule.

Barrow.—There is a rather better feeling in the hematite iron trade, but the business which has been done during the past few days shows no improvement. There is, nevertheless, some chance of a good trade in a few weeks, as unmistakeable evidence have presented themselves that a large weight of iron will be required shortly both of home and foreign users. This is all the more certain owing to the fact that a larger trade is being done in steel goods, and a consequent increased consumption of Bessemer iron is the result. The output of iron is full and strong, and only a comparatively small number of furnaces are out of blast. The appointment of gentlemen of the highest standing in the iron and steel trades to the management of the various departments of the Barrow Iron and Steel Company's works is an evidence of the determination of west-coast capitalists to keep well to the front in the future development of this industry. The output of metal this year has been larger than in any previous year, and the arrangements which are being made will result in an increase in the production to an extent which may, so far as the next year is concerned, show an increase of from 10 to 20 per cent., according to the trade which is done.

THE SHEFFIELD DISTRICT.

(*From Our Own Correspondent.*)

NEXT to the house coal trade with London, the export of fuel to Hull is most interesting. Indeed, as house coal is only one-fifth of the entire output, the Hull business is most important, as it deals almost exclusively with the various kinds used in manufactures, &c. The quantity sent by about ninety colliery companies in South Yorkshire to Hull last year was 1,327,723 tons against 1,266,790 tons in 1881, an increase of nearly 61,000 tons. The exports show that of this weight 658,083 tons went to foreign countries, as compared with 616,155 tons in 1881. Thrybergh Hall sent 51,564 tons; Houghton Main, 47,458 tons, against 15,618 tons in 1881; Elsecar, 58,900 tons, against 41,942 in 1881; Carlton Main, 29,483 tons; Hemsworth, 5604, last year only 648; Swarthe Main, 14,136 tons; Roundwood, 22,100 tons; Thornecliffe, Silkstone, 37,948 tons, against 6580 in 1881. Several collieries show a decided decrease. Manvers Main, which is usually about the head, supplied 43,800 tons in 1882 against 52,161 tons in 1881.

The weather keeps so mild that the local coalowners find house-coal a drug in the market. On Tuesday there was another drop in prices at London, owing to the quantity on sale being far in excess of the supply. Coalowners say that the 10 per cent. recently given to the men should be withdrawn, and that it ought never to have been given; but there is no likelihood of the present wages arrangement being disturbed before the summer.

At the Church-lane Colliery, Dodworth, near Barnsley, the men complain that, owing to certain grievances in working, they cannot make 2s. 6d. per day. Mr. Parrott, of the Yorkshire Miners' Association, dissuaded them from striking, promising to have their complaints considered by the Executive. The men declare that out of 100 men who were working at the pit a week ago 30 have already left because they cannot make good wages. The owners are advertising for men.

At a general meeting of the Chesterfield and Derbyshire Institute of Mining, Civil, and Mechanical Engineers, held last Saturday, Mr. A. Barnes, M.P., made an interesting presentation. Some months ago there was an explosion at Baddesley Colliery, and great bravery was shown by a number of officials and men in rescuing the imperilled miners. The facts were brought under the notice of Sir William Harcourt, with the result that the Albert medal has been awarded for the gallant efforts then made. The recipients are:—First-class Albert medals: Messrs. Reuben Smallman, mining engineer, Nuneaton; Arthur Henry Stokes, inspector of mines, Derby; Charles Day and Charles Chetwynd, colliers, Atherstone. Second-class medals: Messrs. Samuel Spruce, mining engineer, Tamworth; Frederick Samuel Marsh, colliery manager, Hallen End, Tamworth; Thomas Harry Mottram, colliery manager, Tamworth; and William Pickering and Joseph Chetwynd, colliers, Atherstone.

The Manchester, Sheffield, and Lincolnshire Railway Company has come to an arrangement with its signalmen. The request for an advance of 2s. a week in wages is declined; but at several signal-boxes the hours are reduced from twelve hours to eight. The lodging allowance of signalmen sent to a distance is increased from 10s. 6d. to 14s. 6d., and six days' leave of absence—four without stoppage of pay—are granted in the year. The men seem to have laid special stress on being supplied with cloth trousers instead of cord, and the request has also been granted. The concessions have been favourably received by the men. At present, signalmen of the first, second, and third classes make 28s., 25s. 8d., and 23s. 4d. respectively per week, while in addition there is a a bonus of 1s. a week for freedom from fines, and the clothes are supplied by the company.

It has been decided to abandon the project for constructing a line of railway between Derby and Ashbourne, in consequence of the lack of support given to the scheme by the landowners of the district.

The Sheffield Chamber of Commerce had before them on Thursday the question of the proposed bridge across the Humber at Hessle, for the Hull and Lincoln Railway. Mr. Fowler, C.E., in his report, stated that the bridge would have a span of 600ft. over the water-way, and allow a clear headway of 90ft. above high-water at ordinary spring tides. The consideration of this matter was adjourned until after the annual meeting of the Chamber, on account of its great importance.

Ivory cutters tell me that stocks are at present very low, and there will be a strong inclination to buy at the forthcoming sales in Liverpool and London. This, of course, will cause still higher prices to rule. It was thought that recent heavy advances would have caused ivory to be less used, but so far from this being the case, cutters generally have had large sales during the year. Ann Smith, an ivory cutter and dealer, trading as Smith Brothers, has filed her petition this week with liabilities stated at £5000.

It is stated that the concesssion for the construction of the railway from Ekaterinburg to Tumen will be given by the Russian Government to the English syndicate, with which Sir J. Taylor, the engineer, is connected, and represented by Baron Steinbock in Russia. It will be a condition of the contract, however, that the rails, locomotives, and wagons shall be taken from the stock of the Government. The Russian Government have on hand some 120,000 tons of steel rails, 300 locomotives, and 5000 goods wagons, prepared and constructed by various firms in Russia, in order to prevent the different works from being closed. This enormous amount of *matériel* is lying idle and useless, and a "paternal" Government must devise some means of putting it to a practical purpose.

Good progress is being made with the new steel works in course of erection for Messrs. Charles Cammell and Co., at Workington. The two new chimney-stacks are completed, and smoke has been issuing from them by way of drying. The workshops are up to roof height, and form a very large building. The roof will be of iron, and will be removed from Dronfield. All this is sorrowful reading for Dronfield, which looks with dismay on 400 empty houses, and the exodus of over 2000 from a population of 4500, and a debt of £23,000 to be cleared off on a rateable value of £18,000, which will be still further reduced by several thousand pounds when the works are closed and workmen's houses tenantless.

The Caledonian Railway Company has just placed a heavy order for wagons, &c., with the Birmingham Wagon Company, and Messrs. Browne, Marshall, and Co., also of Birmingham. A goodly share of the work in wheels, axles, &c., will doubtless come to Sheffield.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

SCARCELY any change has taken place in the Cleveland iron trade since the last report. Inquiries are somewhat more numerous than they were, and makers and merchants have done a certain amount of business during the week, but consumers still withhold large orders. There is an impression that this state of things cannot last much longer. Stocks at Middlesbrough and at Glasgow are decreasing rapidly, and shipments are improving; it is not likely, therefore, that prices will reach a much lower figure. At the Cleveland iron market held on Tuesday last, merchants asked 42s. 7½d. to 42s. 9d. for No. 3 g.m.b. for early delivery. Makers in the combination would not quote less than 43s. 6d. per ton for No. 3, and were able to book a few orders at that figure. The other producers quoted 43s. per ton.

There is little or no demand for warrants, and holders seem to have come to the conclusion that they will do better if they hold until the spring shipping season commences.

The stock of Cleveland iron in Messrs. Connal's store at Middlesbrough continues to decrease. On Monday night the quantity was 94,781 tons, being 1746 tons less than a week ago.

The shipments from the Tees continue to be fairly satisfactory. The quantities for the month up to Monday night were—pig iron 30,578 tons, and manufactured iron and steel 11,152 tons.

Returns have been issued which show that the total value of the exports from the Tees in 1882 amounted to £2,047,811. This is an increase over 1881 of £700,756.

In the manufactured iron trade inquiry is a little more brisk, and it is expected that the news from America will gradually help to strengthen the market. At present, however, prices remain the same as quoted last week, viz.:—Ship plates, £6 7s. 6d. to £6 12s. 6d. per ton; angles and bars, £5 10s.; all f.o.t. at makers' works, cash 10th, less 2½ per cent.

Messrs. Bolckow, Vaughan and Co., Limited, have contradicted the rumour which was circulated as to the removal of the Witton Park Ironworks to Eston. They have sufficient work in hand to keep the Witton Park works fully employed for the present, and have no intention of making any change whatever.

A portion of the Skerne Ironworks at Darlington was set to work again on Wednesday, the 17th inst. It will be remembered that these works were closed some weeks since owing to the scarcity of orders and difficulty of obtaining specifications.

Nothing definite has been settled between the Bishop Auckland Iron and Steel Company and the Local Board with respect to the cinder heap question. The company, through their secretary, have, however, intimated their willingness to adopt the proposal made by the board for the abatement of the nuisance by pumping water upon the heap. The board are not taking any further steps with regard to the smoke emitted from the furnace stacks. There is, therefore, some prospect of an arrangement being come to, and work may yet be resumed before long.

The Ferryhill Ironworks have been sold by the liquidators of the Rosedale and Ferryhill Iron Company to Mr. John Rogerson, of the Weardale Iron and Coal Company. The property consists of eight blast furnaces, with machinery and plant, and upwards of seventy acres of leasehold land. It is said that £11,500 is the amount which has to be paid for the property. Mr. Rogerson will take possession next month, and will no doubt take steps to put the furnaces into working order as soon as possible.

Messrs. Black, Hawthorn, and Co., of Gateshead-upon-Tyne, have received a large order for locomotives to be sent out to South America.

The North-Eastern Marine Engineering Company, of Sunderland, is about to erect works on the Tyne for the manufacture of steam winches on a large scale. It also intends to put down a forge, which will enable it to turn out very large forgings.

Mr. John McIntyre, sen., and Mr. J. McIntyre, jun., who have been for some time in responsible position with Messrs. Palmer's and Co., of Yarrow, are about to start a new shipbuilding yard on the banks of the Tyne. They have bought about twenty acres of land on the south side of the river.

Messrs. Bell Bros. have now completed the electric lighting arrangements at their Page Bank Colliery. The whole of the lamps, numbering 102 in all, were put to work on Saturday last, and give the greatest satisfaction. The two dynamo machines are worked at about 900 revolutions per minute, and are driven by a pair of horizontal engines running at 105 revolutions. A spare engine has also been erected, which can be put to work at any time, in case anything should happen to the other engines.

The South Hetton Coal Company has had electric lights placed at the screens and the pit heap at their Elemore Colliery. The system adopted is Brockie's, and so far it seems to be attended with success.

Another large sale of angle iron for delivery over next year has been reported. The price is said to be about £5 6s. 3d. cash, less 2½ per cent., free in trucks at the makers' works, and the quantity 4000 tons.

Several shunting locomotive engines, mauufactured by Barclay and Co., of Kilmarnock, are finding their way into the Cleveland district. So far they are giving great satisfaction, and they are much cheaper than similar engines by Newcastle or Leeds makers. It is difficult to understand why the latter should allow their domains to be thus encroached upon without an effort to recover their position.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

VERY extensive transactions of a speculative nature have taken place in the Glasgow warrant market within the past ten days. These have consisted mainly of sales by holders, who had become tired of waiting for an upward turn in prices, and the natural consequence of throwing so many warrants upon the market was to depress the quotations. Expectations founded upon the proposed changes in the American import duties helped to inspire the market with a more cheerful feeling in the early part of the present week, when the value of warrants assumed a slight upward turn, and there were considerable purchases made on behalf of operators, who were of opinion that it might be of advantage to invest in pig iron at the present low figures. Otherwise the condition of the trade is unchanged. Three furnaces are being put out for repairs, so that the production is rather diminishing than increasing. The decrease of stocks in Messrs. Connal and Co.'s stores continues at the rate of from 1000 to 1500 tons a week.

Business was done in the warrant market on Friday forenoon at 48s. to 47s. 11d. and 48s. 2½d. cash, and 48s. 2½d. to 48s. 3d. one month, the afternoon quotations being 48s. 2½d. to 48s. cash and 48s. 5d. to 48s. 3d. one month. On Monday morning business was done at 48s. to 48s. 3d. cash and 48s. 6d. one month, and the same afternoon the market was quiet with transactions at from 48s. 4d. to 48s. 2½d. cash and 48s. 6d. to 48s. 7d. and back to 48s. 6d. one month. Tuesday morning's market was rather more cheerful in tone, with business at 48s. 4d. to 48s. 4½d. cash and 48s. 7d. one month; but the market was easier in the afternoon at 48s. 3½d. to 48s. 2d. cash. Wednesday's market was quiet, with business between 48s. 2d. and 48s. 1d. cash, and at 48s. 4d. one month. Business was done to-day—Thursday—at 48s. 1d. cash, and 48s. 4d. one month.

There is a fair demand for makers' iron, but the quotations are a shade easier as follow:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 63s. 6d.; No. 3, 54s.; Coltness, 63s. and 56s.; Langloan, 67s. and 56s.; Summerlee, 62s. 6d. and 52s. 6d.; Chapelhall, 63s. and 53s.; Calder, 63s. and 52s. 3d.; Carnbroe, 55s. 6d. and 51s.; Clyde, 53s. and 50s. 6d.; Monkland, 50s. and 48s. 6d.; Quarter, 49s. 6d. and 48s.; Govan, at Broomielaw, 49s. 6d. and 48s.; 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, 55s. 6d. and 50s.; Eglinton, 51s. and 49s.; Dalmellington, 51s. and 49s. 6d. The shipments of pig iron to date amount to 25,571 tons, against 18,765 in the corresponding period of last year.

Exclusive of pig iron the values of the iron and steel manufactures exported from the Clyde in the course of the past week amount to between £80,000 and £90,000.

The different branches of the manufactured iron trade are busy, with fair prospects in almost every case.

The coal trade of Scotland is, on the whole, quite brisk, and there are indications of a good spring trade coming forward. Steam coals have been more in demand at an advance of about 3d. per ton. The past week's shipments have not been quite so good as those of the same week in 1882, and this week the trade has been very seriously impeded by a strike of workmen in the employment of the Caledonian Railway Company. This strike, which assumed large proportions, resulted from a refusal of the general manager of the company to answer a memorial which the men had sent him, demanding shorter hours, payment of overtime, and double pay on Sundays. The directors and Mr. Thomson declined to hold any communication with the agent of the workmen's union. They are decidedly opposed to the introduction of trade union regulations, which they deemed quite impracticable in the working of their railway. But they intimated, some time ago, that they were quite willing to hear complaints, and redress any grievances under which the men might labour, provided they came directly with their statement to the general manager, who, however, would not listen to them through the medium of an outsider, or union agent. This is the real difference which caused the strike, and paralysed the entire mineral traffic of the company.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

THE old "battle of the gauges" promises to be rivalled in this direction by the battle of the docks and the railways. It is very clear that a severe struggle is pending. The Barry Docks is literally an effort on the part of the Ocean Colliery proprietary and other influential freighters to have a line distinct from the Taff, and full dock accommodation apart from that afforded by the Bute Docks. Two impelling motives are evident—the high dividends paid by the Taff Vale Railway, and the prosperous character of the Bute Docks; and perhaps there never was a time when the antagonistic element opposed to the Bute Docks was in better position for a bold fight. Those who expect that the Barry Bill will be thrown out at an early stage evidently are unaware of the resources and ability of the promoters. The only hope of this being done at an early stage will be in technical opposition on the grounds of levels and gradients. Later on I think that the Taff and Bute Docks will be able to show that ample arrangements now—or will shortly—exist to meet all needs, and that the schemes, without having the merit of great public service, will be hostile to well-earned rights.

I am glad to hear that the Swansea Bay and Rhondda Railway scheme has been taken up well; but surely it will not take, as some fear, three years in carrying it out.

The staple trades are in a good healthy condition, and though in the matter of coal prices remain, as a rule, for best qualities under 10s. 4d., still there is a sound tone about business, and the demand is maintained at a high pressure.

New sinkings are projected, old works are in course of being re-opened, and amongst these the Abercarn, the scene of a disastrous explosion a few years ago, is to be re-worked under an influential limited liability company. It is intended to sink a new shaft, and avoid the scene of the explosion, where the dead yet remains, and by utilising the old shaft get an output of 3000 tons per diem.

Large outputs are the order of the dey. At Penrhiwceiber, a fine colliery in the Aberdare Valley, the output last week averaged over 1000 tons daily of excellent coal.

The Ocean collieries and Ferndale collieries have a sliding scale of their own distinct from that of the Coalowners' Association. This time the examination of books has just been declared by the auditors not to justify any change of wages under either of the scales.

The total export of coals last week from all Wales amounted to the extraordinary quantity of 227,494 tons; of iron 4600 tons were sent, the principal part of which was from Cardiff.

The Welsh ironmasters are doing a brisk trade with the colonies, Australia, Victoria, New Zealand in particular; in fact, the colonies are our backbone at present, and, thanks to them, there is ample employment, though prices are rather low, and at present there is not much prospect of an advance in the market rates. Much is hoped for from America, where the West is sturdily opposed to the North, and bent on doing away with, or materially lessening, the tariff. At present perhaps the bitterest opponent to Wales is Germany, but the secret of the successful winning of various contracts is now thoroughly understood here. Home railways in Germany have to pay losses incurred on foreign contracts.

There has not been much done of late in the tin-plate trade generally, though a few workers in the Swansea and Abercarn district are busy. Prices are rather stagnant.

I must not omit to add that Mr. Forester, of Swansea, has met with a good deal of sympathy in his failure, and a re-start is fully expected.

AT Wednesbury, on Tuesday, a coroner's inquest was opened touching the deaths of the three men who were killed by the breaking of a wire rope at the Willingsworth Colliery, on the 6th inst. The main facts elicited were that the rope, which was 1¼in. in diameter, was known to be faulty before the men were raised, and that the gin might have been used instead of the men being brought up on the top of the tank. The inquiry stands adjourned.

PROTECTING SAND EMBANKMENTS.—The following is an extract from a paper read before the Engineers' Club of Philadelphia, by Mr. C. d'Invilliers, on the building of the Philadelphia and Long Branch Road through the sand of the New Jersey sea shore: "A cross section of the beach would show first a gradual upward slope from the sea towards the bay, for from 100ft. to 300ft., until an elevation of from 15ft. to 25ft. is reached: this elevation being the summit of what are known as sand dunes. The slope is then downwards, at first abrupt, and then gradual, to the bay. The sand dunes are broken quite frequently, leaving the gaps called glades, through which the sea passes at storm tide, and even in some cases at ordinary high water. The crest of these glades is generally 8ft. or 9ft. above tide. Over this the water comes perhaps from 1in. to 3in. at ordinary high water and 3in. to 8in. at storm tide, and having downward course towards the bay, the volume rapidly accumulates at each succeeding wave, so that before reaching the railroad it becomes a running stream 18in. or 2ft. deep. It was at first proposed to build pile bridges over all these glades, but, as this was expensive and the glades numerous, the following much simpler plan was adopted, and has worked quite successfully, preventing the water from coming through the glades at all. On the crest of the glade a row of old railroad ties was planted on end, being placed 3ft. or 4ft. in the sand or down to water, and an inch apart in the clear; then a quantity of brush placed before and behind the ties, at first parallel and then at right angles to the sea, and sand thrown up outside of this to a height sufficient to prevent ordinary storm tides from passing over it. The dike thus formed is 8ft. wide on top and 15ft. or 20ft. at the bottom, and in this state is only, I might say, commenced. We rely on nature to finish it, as it has done already in several places, for every time the tide comes to the dike it leaves more sand on the ocean side, and every time the west wind blows it carries sand to the other side; the result in a year or two is a sand dune more solid than its neighbours. None of this work was done until the road was finished, and where the embankments were made across the glades, wooden boxes were placed under them for temporary drainage. It was the intention to have all the diking done before the winter storms began, but as this was not accomplished the necessity of having them, and the utter uselessness of box drains was shown by the banks being cut entirely away in several places, and the boxes carried a quarter of a mile into the bay. About 7000ft. of dike have so far been built, and probably 600ft. or 700ft. remain to be done. The average cost is 10 cents per lineal foot. So the saving in not building bridges has been considerable, as they would have cost about 7 dols. per foot. I forgot to mention that the reason for placing the ties a small distance apart was to give free passage for the sand to collect among the brush. The accumulative power of sand, where there is anything to form a nucleus, is astonishing. I have seen places where a few sticks and pieces of grass have collected in two years sufficient sand to make a hill 4ft. or 5ft. high."

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.

9th January, 1883.

110. Refrigerators, H. Allison.—(*R. Messervey, U.S.*)

111. Numbering Cheques, &c., J. Maynes, London.

112. Valves and Taps, A. Bateman, East Greenwich.

113. Railway Signalling, F. Venables, Hadley Green.

114. Bicycle Saddles, J. B. Brooks, Birmingham

115. Self-coupling Railway Trucks, G. F. Belling, Little Ilford.

116. Two-wheeled Vehicles, H. E. Newton.—(*E. Storm, Poughkeepsie, U.S.*)

117. Sharpening Drills, J. H. Johnson.—(*J. S. Bancroft and W. H. Thorne, Philadelphia, U.S.*)

118. Surface Condensing Engines, J. Chapman, Leith, N.B.

119. Portable Railways, E. de Pass.—(*G. A. Bélaird, Paris.*)

120. Magneto-electric Machines, H. Joel, Dalston.

121. Pickers for Looms, H. Ingham, Thornton.

122. Joints of Sanitary Pipes, &c., A. B. Wren, Lenwood, near Bideford.

123. Spark Arresters, A. J. Boult.—(*J. A. Sterling, New York.*)

124. Communicating between Passengers and the Guards and Drivers, W. Rathbone, New Southgate.

125. Electrical Fire-arms and Ordnance, &c., E. A. Monfort, New York.

126. Velocipedes, J. White and J. Ashbury, Coventry.

127. Looms, W. E. Gedge.—(*H. L. Morel and J. B. Poncet, Lyons.*)

128. Signalling Apparatus, R. Chidley, Wood Green.

129. Cable Traction Railways and Tramways, J. Imray.—(*S. H. Terry, Guthrie, U.S.*)

130. Gas Motor Engines, F. J. Odling, Derby.

131. Step-by-step Rotary Motion, C. D. Abel.—(*A. Kaiser, Berlin.*)

132. Gas Engines, W. Lake.—(*H. Maxim, Brooklyn.*)

133. Gas Cooking Stoves, Burners, &c., J. Allen, Crouch Hill.

134. Rivetting and Eyletting Machines, W. R. Lake.—(*C. M. Platt, Waterbury, U.S.*)

10th January, 1883.

135. Calcining Limestone, &c., J. Brocklehurst, Stockport.

136. Engine Governors, J. N. Paxman, Colchester.

137. Clasps or Snaps for Bracelets, &c., T. Burgess, Birmingham.

138. Killing Fish, &c., C. A. Barber, London.

139. Producing Aniline, F. Wirth.—(*P. Greiff, Frankfort-on-the-Maine.*)

140. Boilers, M. H. Smith, Halifax.

141. Manufacture of Woollen Fabrics, B. Josephy, Leeds.

142. Sewing Machines, W. Walker, Dunstable.

143. Matches, &c., L. Groth.—(*H. Hosemann, Berlin.*)

144. Washing Clay, L. A. Groth.—(*L. Ramberg, Helsingborg, Sweden.*)

145. Breech-loading Small-arms, J. F. Swinburn, Birmingham.

146. Wheels and Pulleys, R. R. Gubbins, New Cross.

147. Manufacturing Woven Fabrics, J. Crabtree, Heckmondwike.

148. Manufacturing Woven Fabrics, J. Crabtree, Heckmondwike.

149. Manufacturing Screw Bolts, Rivets, &c., W. Barwell and T. Johnstone, Birmingham.

150. Spooling Machines, W. R. Lake.—(*N. A. Baldwin, Milford, U.S.*)

151. Harvesting Machines, W. P. Thompson.—(*C. H. McCormick, Chicago, U.S.*)

152. Hydraulic Cements, &c., W. P. Thompson.—(*M. M. R. Dosse and P. R. Freise, Brunswick.*)

153. Separating Volatile from Non-volatile Substances, W. Thompson.—(*J. Mathieu, Detroit, U.S.*)

154. Cars, Omnibuses, &c., S. Andrews, Cardiff.

155. Pens for Fountain Penholders, G. S. Rayson, Balham.

156. Apparatus for Controlling, &c., Electric Current, W. M. Mordey, Putney.

157. Recovering Ammonia from Gases, F. Wirth.—(*F. Philipp, Romanshorn, Switzerland.*)

158. Apparatus for Cutting Marble, &c., E. Edwards.—(*A. Jeansaume, Paris.*)

11th January, 1883.

159. Making Silicia Bricks, A. Dunnachie, Glasgow.

160. Looms for Weaving, G. A. Shiers and A. Wright, Oldham.

161. Crimping, &c., Cartridge Cases, H. A. A. Thorn, London.

162. Indicating the Presence or Absence of Water, J. Shaw and F. Milan, Lockwood.

163. Varnishing, Gumming, and Sizing Paper, G. Newsum, Leeds, W. H. Ibbetson, Bradford.

164. Brake Apparatus for Perambulators, C. Coleman, London.

165. Apparatus for Kneading and Airing Dough, L. Dathis, Paris.

166. Movable Oven, L. Dathis, Paris.

167. Middlings Purifiers, H. J. Haddan.—(*J. D. Hurst, Oregon, U.S.*)

168. Tools for Shearing, &c., T. Perkins, Hitchin, and S. Gilbert, jun., Wansford.

169. Pavement, W. Berry and P. Stuart, Edinburgh.

170. Colouring Matters, J. H. Loder, Brussels.

171. Apparatus for Artificially Hatching Eggs, W. Muir, Thornliebank.

172. Cutting or Reaping Sugar Cane, &c., J. Burns, R. Barr, and A. D. Hunter, London.

173. Hygienic Pillows and Bedding, H. T. Baeschlin, Montpellier, France.

174. Candle Moulding Machine and Candles, H. A. Biertumpfel, London.

175. Knitting Machines, W. Morgan-Brown.—(*H. Martini, Chemnitz, Germany.*)

176. Lubricating Steam Cylinders, W. P. Thompson.—(*C. H. Parshall, Detroit, U.S.*)

177. Sewing Machines, E. W. Lee, Wigston Magna.

178. Hoeing between Rows of Plants, E. Edwards.—(*L. Viet, Paris.*)

179. Telephonic Transmitters, H. Alabaster, South Croydon, and T. E. Gatehouse, Camberwell.

180. Electric Lamps, T. E. Gatehouse, Camberwell, and H. Alabaster, South Croydon.

181. Electrically Controlling the Speed of Engines, J. Richardson, Lincoln.

182. Coverings for Preventing the Radiation of Heat, C. Toope, Stepney.

183. Electric Arc Lamps, J. Lorrain, Westminster.

184. Dynamo and Magneto-electric Machines, H. H. Lake.—(*C. L. R. E. Menges, Hague, Holland.*

12th January, 1883.

185. Releasing Fallen Horses from their Harness, G. Craddock, London.

186. Preventing the Entry of Water into Air and Water-tight Compartments, A. Williams, Peckham.

187. Producing Electric Light, J. A. Briggs, Westminster.

188. Valves and Valve Gear, J. Aimers and J. Tinline, Galashiels.

189. Sheaves for Pulley Blocks, W. Alexander, Govan.

190. Furnaces, J. Williams, Cardiff.

191. Sleeve-links, &c., W. J. Jordan, London.

192. Doubling and Twisting Machines, P. Smith, jun., and S. Ambler, Keighley.

193. Centrifugal Machines, J. Meyer, Copenhagen.

194. Boots and Shoes, E. Quick, Bristol.

195. Tobacco, W. E. Gedge.—(*F. C. Glaser, Berlin.*)

196. Pulverising Stones, &c., S. Mason, Leicester.

197. Knit Stockings, W. P. Thompson.—(*F. Lasher and W. H. Bradford, Bennington, U.S.*)

198. Etching on Rollers, C. J. Appleton, Salford, and D. Appleton, Manchester.

199. Work Baskets, &c., J. Johnson and E. Renaudin, London.

200. Steel, R. Hadfield, Sheffield.

13th January, 1883.

201. Compound Steam Engines, J. Wells, New York.

202. Forming the Heads of Bolts, &c., J. Bilsland, Glasgow.

203. Iron Hand-rail Stanchions, W. Rockliffe, Sunderland.

204. Classifying Colours, B. J. B. Mills.—(*J. Pittiot, Lyons, France.*)

205. Posts for Supporting Wires, &c., C. E. J. May, Charlton.

206. Locomotive Engines, R. Fairlie, Westminster.

207. Drawing Corks from Bottles, F. H. F. Engel.—(*E. Berlien, Altona, Prussia.*)

208. Colour Boxes, T. Foxall, London.

209. Steam Generators, H. Lane, London.

210. Key for Securing Rails, H. B. Moreton, Cardiff.

211. Harvest Saving Appliances, E. O. Greening and E. D. Barker, London.

212. Letting Down Carriage Windows, G. T. Cheetham, Bradford.

213. Sash and Casement Fastenings, E. A. Showell, jun., and C. Turner, Birmingham.

214. Hot-air Engines, H. H. Lake.—(*J. Schreiber and M. Fellner, Vienna.*)

215. Breech-loading Cannon, R. H. Brandon.—(*B. B. Hotchkiss, Paris.*)

216. Rotary Pumps and Engines, E. B. Donkin, Bermondsey.

217. Working and Regulating Secondary Batteries, J. S. Sellon, London.

218. Red Colouring Matters, F. Wirth.—(*Kalle and Co., Biebrich, Germany.*)

219. Self-filling Grapples, &c., G. Fuller, Millwall.

15th January, 1883.

220. Chimney Cowls and Ventilators, G. Davis, Aberystwith, W. Jones, Llannon, and R. Girdwood, Edinburgh.

221. Bearings, &c., J. Nicoll, Dundee.

222. Grinding Corn, &c., W. L. Wise.—(*A. Mariotte, A. Mariotte, and E. Boffy, Paris.*)

223. Double-lock Universal Joint, R. Watkinson, Salford.

224. Delivering Consecutively Numbered Tickets, M. Bebro, Kilburn.

225. Belting, H. J. Haddan.—(*E. M. Cross, Syracuse.*)

226. Producing Homogeneous Metal Castings, G. W. von Nawrocki.—(*W. G. Otto, Darmstadt.*)

227. Preserving Milk, H. W. von Roden, Hamburg.

228. Kettles, R. F. Farquharson, London.

229. Repeating Mechanism, &c., for Fire-arms, G. E. Vaughan.—(*J. Werndl, Steyr, Austria.*)

230. Damp-proof Socks, &c., R. J. Baggaley, Nottingham.

231. Stamping, Endorsing, &c., N. Wilson, and T. Hinds, London.

232. Carbonate of Strontia, D. Urquhart, Westminster.

233. Diffusing Powerful Lights, A. Trotter, London.

234. Holding and Releasing Roller Blinds, J. Hudson, Bolton.

235. Bowls or Rollers, &c., C. L. Jackson, Bolton.

236. Gas Retort Furnaces, J. Dempster, Elland, and J. A. Drake, Halifax.

237. Screw Taps, H. H. Lake.—(*C. R. C. French and F. Bullivant, Providence, U.S.*)

238. Water-closets, H. Lake.—(*J. Bennor, U.S.*)

239. Pens, W. Brierley.—(*A. Scholz, Transylvania.*)

240. Artificial Stone, R. Stone, London.

241. Reducing Metallic Ores, S. Emmens, London.

242. Substitute for Gutta-percha, &c., M. Zingler, London.

243. Galvanic Batteries, H. H. Lake.—(*A. Skene, Vienna, and F. Kühmaier, Pressburg.*)

Invention Protected for Six Months on Deposit of Complete Specifications.

86. Sewing Machines, J. Imray, Southampton-buildings, London.—A communication from R. Leavitt, Boston, Massachusetts, and E. Flather, Bridgeport, Connecticut.—*6th January*, 1883.

127. Looms for the Manufacture of Velvet, W. E. Gedge, Wellington-street, London.—A communication from H. L. Morel and J.-B. Poncet, Lyons, London.—*9th January*, 1883.

129. Cable Traction Railways or Tramways, J. Imray, Southampton-buildings, London.—A communication from S. H. Terry, Guthrie, Missouri, U.S.—*9th January*, 1883.

134. Rivetting and Eyeletting Machines, W. R. Lake, Southampton-buildings, London.—A communication from C. M. Platt, Waterbury, Connecticut, U.S.—*9th January*, 1883.

150. Spooling Machines, W. R. Lake, Southampton-buildings, London.—A communication from N. A. Baldwin, Milford, Connecticut, U.S.—*10th January*, 1883.

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

85. Brackets or Stays, G. Lee, Watford.—*8th January*, 1880.

86. Generating Heat, &c., H. J. Haddan, Westminster.—*8th January*, 1880.

102. Brick-making Machinery, T. C. Fawcett, Leeds.—*9th January*, 1880.

101. Cutting Bars or Tubes of Metal, J. W. Newall, Salford.—*9th January*, 1880.

117. Gas Motor Engines, H. Robinson, Manchester.—*10th January*, 1880.

176. Heating and Purifying Water, W. P. Thompson, London.—*15th January*, 1880.

217. Ironing Hats, E. de Pass, London.—*17th January*, 1880.

138. Hydraulic Lifts, C. W. Baldwin, London.—*13th January*, 1880.

266. Circular Slide and Sluice Valves, W. Church, Brixton.—*21st January*, 1880.

143. Pianofortes, R. Howson, Middlesbrough-on-Tees.—*13th January*, 1880.

147. Tannic Acid, F. A. Zimmermann, London.—*13th January*, 1880.

168. Steam Engines and Boilers, L. Perkins and W. Harris, London.—*14th January*, 1880.

205. Shade Holders for Lamps, G. Atkins, Birmingham.—*16th January*, 1880.

245. Lamps for Burning Kerosene, &c., W. R. Lake, London.—*20th January*, 1880.

303. Telephone Signal Apparatus, W. Morgan-Brown, London.—*23rd January*, 1880.

394. Sewing Machines, E. T. Hughes, London.—*29th January*, 1880.

863. Stereotyping, G. Pearce and E. Hughes, London.—*27th February*, 1880.

182. Pulverising Bark, Bone, &c., G. Burman and W. H. Firth, Dewsbury.—*15th January*, 1880.

183. Looms for Weaving, G. Keighley, Burnley.—*15th January*, 1880.

212. Fastening Elastic Bands, C. H. Eden, Manchester.—*17th January*, 1880.

239. Preparing Materials for Paper Making, J. Collins, Bowling.—*20th January*, 1880.

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

121. Steam and Water Taps, G. Marchant, Huddersfield.—*11th January*, 1876.

399. Railway Wheels, W. H. Kitson, Leeds.—*1st February*, 1876.

139. Sewing Machines, J. H. Johnson, London.—*13th January*, 1876.

198. Cleansing and Disinfecting Fluids, W. Little, Sleaford.—*18th January*, 1876.

274. Antiseptics and Disinfectants, C. T. Kingzett and M. Zingler, London.—*24th January*, 1876.

141. Combined Ventilating Gulley and Trap, H. Wilson, Halifax.—*13th January*, 1876.

Notices of Intention to Proceed with Applications.

(*Last day for filing opposition, 2nd February*, 1883.)

4242. Strainers, &c., G. Tidcombe, jun., Watford.—*6th September*, 1882.

4245. Rotary Engines, W. R. Lake, London.—A communication from I. Lojda.—*6th September*, 1882.

4251. Obtaining Electric Currents, T. Slater, London.—*6th September*, 1882.

4253. Steel Frames as used in Pianofortes, E. Parr and J. R. Gibson, London.—*7th September*, 1882.

4260. Electric Governors for Steam Engines, &c., A. Blechynden, Newcastle-upon-Tyne.—*7th September*, 1882.

4266. Storing Electric Energy, T. Slater, London.—*7th September*, 1882.

4285. Cutting, &c., Glass, W. R. Lake, London.—Com. from H. Thivollet.—*8th September*, 1882.

4286. Electric Bell, &c., Apparatus, T. R. Brailsford, London.—*8th September*, 1882.

4289. Needle Instruments for Speaking Telegraphs, E. J. Houghton, Peckham.—*8th September*, 1882.

4297. Joining Lead, &c., Pipes, C. Hinksman, London.—*9th September*, 1882.

4298. Keyboard Instruments, A. W. L. Reddie, London.—A communication from C. T. Virot.—*9th September*, 1882.

4299. Accumulators, &c., W. A. Barlow, London.—A communication from Messrs. L. Encausse and Canésie.—*9th September*, 1882.

4307. Saving Waste Heat of Sugar Refineries, W. R. Lake, London.—A communication from S. M. Lille.—*9th September*, 1882.

4316. Secondary or Storage Batteries, F. J. Cheesbrough, Liverpool.—A communication from A. K. Eaton.—*11th September*, 1882.

4317. Secondary or Storage Batteries, F. J. Cheesbrough, Liverpool.—A communication from A. K. Eaton.—*11th September*, 1882.

4336. Governor for Steam, &c., Engines, A. Beverley, Stanley, & A. Sykes, Wakefield.—*12th September*, 1882.

4337. Thread-winding Machines, J. W. Shepherd and W. Ayrton, Longsight, and S. Hallam, Manchester.—*12th September*, 1882.

4367. Electric Lighting, W. Morgan-Brown, London.—Com. from F. Schmidt.—*14th September*, 1882.

4389. Stoppering Bottles, &c., J. J. Rawley, London.—*15th September*, 1882.

4404. Electric Lamps, H. H. Lake, London.—Com. from S. F. V. Choate.—*15th September*, 1882.

4450. Porcelain, &c., Insulators, W. E. Langdon, Derby, and J. C. and G. Fuller, Bow.—*19th September*, 1882.

4485. Shields for Protecting Buttons, &c., W. P. Thompson, London.—A communication from Messrs. D. Sauget and N. A. Aubertin and Madame V. Grangier.—*20th September*, 1882.

4533. Constructing Ships' Anchors, J. Scott, Helensburg.—*23rd September*, 1882.

4605. Making Paper, J. H. Johnson, London.—Com. from E. Musil.—*28th September*, 1882.

4618. Firegrates or Stoves, E. Whillier, London.—*28th September*, 1882.

4644. Purifying Coal Gas, C. F. Claus, London.—*29th September*, 1882.

4686. Expressing Oil from Seed, W. Bushell and W. T. Haydon, Dover.—*2nd October*, 1882.

4854. Transmitting Heat to Fluids, W. L. Wise, London.—Com. from B. Röber.—*12th October*, 1882.

5264. Coal Gas, H. E. Newton, London.—A communication from A. Klönne.—*4th November*, 1882.

5309. Making Envelopes, W. R. Lake, London.—A communication from A. C. Fletcher.—*7th November*, 1882.

5363. Treating Compressed Air, &c., T. A. English J. Sturgeon, London.—A communication from C. J. T. Hanssen.—*10th November*, 1882.

5492. Electric Light Switches, C. Maynard, London.—*18th November*, 1882.

5837. Bending Metallic Plates, C. Scriven, Leeds.—*7th December*, 1882.

5847. Indicating, &c., Time, C. H. and C. W. Thompson, London.—*7th December*, 1882.

5986. Explosives for Blasting, R. Hannan, Glasgow.—*15th December*, 1882.

6015. Explosive Compound or Blasting Powder, J. Polkinghorne, Cornwall.—*16th December*, 1882.

6019. Dynamo-electric Machines, W. S. Horry, London.—*16th December*, 1882.

6154. Bedsteads, G. Gentle, London.—*23rd December*, 1882.

6158. Making Carpets, F. B. Fawcett, Kidderminster.—*23rd December*, 1882.

(*Last day for filing opposition, 6th February*, 1883.)

4319. Rollers for Grinding, &c., Cards, J. Sykes, Lindley.—*11th September*, 1882.

4320. Rollers for Pointing, &c., Cards, J. Sykes, Lindley.—*11th September*, 1882.

4323. Vegetable Parchment, H. Hymans, London.—*12th September*, 1882.

4329. Starting, &c., Steam Engines, W. H. Allen, R. Wright, and W. L. Williams, London.—*12th September*, 1882.

4330. Looms for Weaving, T. Blezard, Padiham, and W. Nelson, Darwen.—*12th September*, 1882.

4331. Producing Stamped Fabrics, J. Coates, London.—*12th September*, 1882.

4339. Wire Card Points, T. Morgan, London.—A communication from F. Gillet.—*12th September*, 1882.

4347. Stoppering, &c., Bottles, A. J. T. Wild, Peckham.—*12th September*, 1882.

4352. Electrodes, W. Sinnock, London.—*13th September*, 1882.

4353. Opening, &c., Fanlights, &c., H. Pearce, London.—*13th September*, 1882.

4363. Gas Engines, A. M. Clark, London.—A communication from J. Schweizer.—*13th September*, 1882.

4365. Feed Motions for Turning Lathes, T. Shanks, jun., Johnstone, N.B.—*14th September*, 1882.

4384. Preparing, &c., Cotton, Silk, &c., T. Berry, Rochdale.—*14th September*, 1882.

4385. Nails and Screws, T. J. Sloan, Paris.—*14th September*, 1882.

4392. Umbrella Frames, H. J. Haddan, London.—Com. from C. Neumeister.—*15th September*, 1882.

4414. Tricycles, E. Marshall, Birmingham.—*16th September*, 1882.

4415. Automatic Regulator, E. Wilson, Exeter.—*16th September*, 1882.

4422. Telephonic Telegraphy, C. A. McEvoy and J. Mathieson, London.—*16th September*, 1882.

4503. Governing Electric Currents, J. S. Beeman, W. Taylor, & F. King, London.—*21st September*, 1882.

4504. Measuring Electric Force, &c., J. S. Beeman, W. Taylor, & F. King, London.—*21st September*, 1882.

4522. Spring Mattresses, J. Lokie, Glasgow.—*22nd September*, 1882.

4536. Stop-watches, H. J. Haddan, London.—A communication from O. Domon.—*23rd September*, 1882.

4537. Folding Cases, H. J. Haddan, London.—A communication from A. Collin.—*23rd September*, 1882.

4552. Paints for Coating Ships, A. B. Rodyk, London.—Com. from N. B. Dennys.—*25th September*, 1882.

4579. Ice-making Machinery, W. H. Beck, London.—Com. from G. Dubern.—*26th September*, 1882.

4585. Apparatus for Aerial and Marine Navigation, B. W. Maughan and S. D. Waddy, London.—*27th September*, 1882.

4779. Obtaining Synchronous Movements, F. Wolff, Copenhagen.—A communication from P. la Cour.—*7th October*, 1882.

4995. Warming and Heating Rooms, &c., T. Kay, Stockport.—*20th October*, 1882.

5702. Telephonic Receivers, T. Torrey, London.—*30th November*, 1882.

5705. Moderator Lamps, G. E. Ménage, London.—*30th November*, 1882.

5764. Furnaces, &c., J. C. Brentnall, Timperley.—*4th December*, 1882.

5813. Machine for Drying Corn in Rick, &c., J. E. Fox, Gloucester.—*6th December*, 1882.

5820. Playing Pianofortes, A. Capra, London.—*6th December*, 1882.

5834. Pipe Couplings for Air or Vacuum Brake Apparatus, D. Drummond, Lenzie.—*7th December*, 1882.

5978. Actuating Railway Points, H. Johnson, Eccles.—*14th December*, 1882.

6016. Inserting Pressing Boards between Folds of Cloth, J. C. Mewburn, London.—A communication from C. H. Weisbach.—*16th December*, 1882.

6048. Machines for Sewing Straw Plaits into Hats, &c., J. H. Johnson, London.—A communication from C. H. Willcox.—*19th December*, 1882.

6129. Inserting Movable Type in Stereotype Plates, J. E. Taylor, P. Allen, W. Evans, and C. P. Scott, Manchester.—*22nd December*, 1882.

6134. Preserving Animal, &c., Matter, J. Townsend, Glasgow.—*23rd December*, 1882.

6157. Fastenings for Gloves, &c., G. Capewell, Birmingham.—*23rd December*, 1882.

6188. Printing Machines, &c., J. H. Johnson, London—Com. from E. Anthony.—*28th December*, 1882.

6220. Looms for Weaving, W. Smith, Heywood.—*29th December*, 1882.

86. Sewing Machines, J. Imray, London.—Com. from R. Leavitt and E. Flather.—*6th January*, 1883.

129. Apparatus for Cable Traction Railways, J. Imray, London.—A communication from S. H. Terry.—*9th January*, 1883.

134. Rivetting, &c., Machines, W. R. Lake, London.—Com. from C. M. Platt.—*9th January*, 1883.

150. Spooling Machines, W. R. Lake, London.—Com. from N. A. Baldwin.—*10th January*, 1883.

Patents Sealed.

(*List of Letters Patent which passed the Great Seal on the 12th January*, 1883.)

3308. Dyeing Cotton, G. W. von Nawrocki, Berlin.—*12th July*, 1882.

3314. Table or Stand, T. Hansell, St. Alban's.—*12th July*, 1882.

3325. Folding Bedsteads, A. C. Henderson, London.—*13th July*, 1882.

3337. Temples used in Weaving, J. Holding, Manchester.—*14th July*, 1882.

3345. Attaching the Bolsters and Handles of Cutlery, J. E. Beal, Sheffield.—*14th July*, 1882.

3364. Artificial Hips, &c., for Stands, A. W. Child and G. B. Childs, London.—*15th July*, 1882.

3370. Indicating the Presence of Fire by Electricity, E. Edwards, London.—*15th July*, 1882.

3373. Sawing Metals, J. H. Johnson, London.—*15th July*, 1882.

3374. Wire Netting, D. Peres, London.—*15th July*, 1882.

3375. Obtaining Motive Power, H. Robinson, Manchester.—*15th July*, 1882.

3380. Electrical Haulage System, W. E. Ayrton and J. Perry, London.—*17th July*, 1882.

3385. Electric Arc Lamp, L. A. Groth, London.—*17th July*, 1882.

3387. Filing Belt or other Saw Blades, L. A. Groth, London.—*17th July*, 1882.

3394. Coverings for Pipes, &c., E. K. Leadbetter, Upton Park, Essex.—*17th July*, 1882.

3396. Printing in Colours, J. Davies, Hatcham, T. A. Middleton, Staines, and W. G. White, Deptford.—*17th July*, 1882.

3402. Drawing, &c., Fibrous Substances, F. W. Fox, Burley-in-Wharfedale, and T. Coulthard, Preston.—*18th July*, 1882.

3405. Eyeleted Healds, W. R. Harris and J. G. Cooper, Manchester.—*18th July*, 1882.

3409. Plates for Secondary Batteries, W. Taylor, Tottenham, & F. King, New Cross.—*18th July*, 1882.

3415. Separating one Kind of Grain from Another, P. V. Gelder, Sowerby Bridge.—*18th July*, 1882.

3447. Valves of Hydraulic Rams, J. Blake, Accrington.—*20th July*, 1882.

3455. Dynamo and Magneto-electric Machinery, J. S. Beeman, London.—*20th July*, 1882.

3478. Actuating the Valves of Steam, &c., Engines, P. R. Allen, London.—*21st July*, 1882.

3496. Suspension for Carriages, &c., E. M. Desprez, Paris.—*22nd July*, 1882.

3508. Electric Lamps, A. M. Clark, London.—*24th July*, 1882.

3552. Separating Grain, &c., W. R. Lake, London.—*26th July*, 1882.

3559. Closing or Locking Device, H. J. Haddan, London.—*27th July*, 1882.

3595. Electric Telegraphy, J. H. Johnson, London.—*29th July*, 1882.

3624. Sleeping Berths, E. Lawson, Birmingham, and E. W. de Russett, Anerley.—*31st July*, 1882.

3654. Saw-filing Apparatus, A. M. Clark, London.—*1st August*, 1882.

3667. Indicating the Position of Railway Switches, H. J. Haddan, London.—*2nd August*, 1882.

3684. Fire-arms, W. R. Lake, London.—*2nd August*, 1882.

3796. Fixing Swing Looking-glasses, &c., W. J. Hinde, London.—*9th August*, 1882.

3820. Magneto-electrical Apparatus, J. H. Johnson, London.—*10th August*, 1882.

3892. Substitute for Butter, &c., H. J. Haddan, London.—*15th August*, 1882.

3937. Constructing Meters for Water, &c., J. T. Dann, London.—*17th August*, 1882.

4314. Making Shot, T. Spence, Gateshead-on-Tyne.—*11th September*, 1882.

4362. Distributing Electricity, L. Gaulard and J. D. Gibbs, London.—*13th September*, 1882.

4509. Drain Pipes, F. H. Noott, London.—*21st September*, 1882.

4553. Injectors, H. J. Haddan, London.—*25th September*, 1882.

4771. Producing Electric Light, O. G. Pritchard, Penge.—*7th October*, 1882.

4798. Tousing or Opening Horse-hair, M. G. Daughters, London.—*9th October*, 1882.

4850. Apparatus for Ventilating, W. Teague, Illogan.—*12th October*, 1882.

4996. Compound Armour-plates, T. D. Clare, Handsworth.—*20th October*, 1882.

5128. Crushing Stone, &c., G. Dalton, Leeds.—*27th October*, 1882.

5320. Reeling or Winding Silk, &c., W. R. Lake, London.—*7th November*, 1882.

5332. Producing Light and Heat, E. P. Chaimsonovitz, Leytonstone.—*8th November*, 1882.

5407. Filters, J. Wetter, New Wandsworth.—*13th November*, 1882.

5486. Compound to be used in Rendering Animal, &c., Fibres Repellent, &c., C. B. Warner, London.—*18th November*, 1882.

(*List of Letters Patent which passed the Great Seal on the 16th January*, 1883.)

3391. Making Wire, T. Morgan, London.—*17th July*, 1882.

3400. Perambulators, J. Aylward, Birmingham.—*18th July*, 1882.

3408. Looms for Weaving, R. L. Hattersley and J. Hill, Keighley.—*18th July*, 1882.

3417. Water Bottles, J. C. Cook, London.—*18th July*, 1882.

3427. Rotary Steam Engine, J. Pinchbeck, London.—*19th July*, 1882.

3432. Screw Propellers, E. G. Brewer, London.—*19th July*, 1882.

3451. Life-saving, &c., Apparatus, A. I. Rath, Manchester.—*20th July*, 1882.

3454. FORMING COVERS and BACKS of ACCOUNT BOOKS, J. H. Linsey, London.—*20th July*, 1882.
3458. TELEPHONIC APPARATUS, J. E. Chaster, Manchester.—*20th July*, 1882.
3459. CHECKING CORDS of BLINDS, &c., A. and T. H. Dix, Rock Ferry.—*20th July*, 1882.
3461. DOMESTIC APPARATUS for the SUPPLY of WATER, J. Shanks, Barrhead.—*21st July*, 1882.
3484. EJECTOR NOZZLES, J. L. Norton, London.—*21st July*, 1882.
3520. ARC ELECTRIC LAMPS, A. L. Lineff, London.—*25th July*, 1882.
3563. REGENERATIVE FURNACES, A. Beard, Swansea.—*27th July*, 1882.
3567. POCKET CASES, P. Everitt, London.—*27th July*, 1882.
3570. ELECTRIC ARC LAMPS, F. M. Newton, Taunton.—*27th July*, 1882.
3579. LOCOMOTIVE ENGINES, J. B. Fell, Ulverston.—*28th July*, 1882.
3585. FACILITATING REFERENCE to DICTIONARIES, A. Gerken, London.—*28th July*, 1882.
3646. OBTAINING PRODUCTS of DRY DESTRUCTIVE DISTILLATION from SOLID MATTERS, G. F. Redfern, London.—*1st August*, 1882.
3648. FASTENING for LACES for BOOTS, &c., G. F. Redfern, London.—*1st August*, 1882.
3653. PERMANENT WAY of RAILWAYS, A. Vogt and A. Figge, London.—*1st August*, 1882.
3663. STEAM TRAPS, H. Lancaster, Pendleton.—*2nd August*, 1882.
3816. STOVES or FURNACES, H. J. Haddan, London.—*10th August*, 1882.
3876. CLEARING TRAMWAY RAILS of DIRT, S. Shields, Liverpool.—*14th August*, 1882.
3985. GRINDING MILLS, W. Wingfield-Bonnyn, London.—*19th August*, 1882.
4717. DISC DYNAMO, &c., MACHINES, J. Gordon and J. Gray, London.—*4th October*, 1882.
5143. TAKING UP the BRASSES of LOCOMOTIVE ENGINES, W. L. Hunt, London.—*30th October*, 1882.
5221. PURIFIERS for COAL GAS, C. C. Walker, Lilleshall, and W. T. Walker, Highgate.—*1st November*, 1882.
5246. METALLIC WAGONS, R. Hudson, Gildersome.—*3rd November*, 1882.
5315. INSULATING ELECTRIC CONDUCTING WIRES, J. Wetter, New Wandsworth.—*7th November*, 1882.
5344. REGENERATIVE GAS FURNACES, W. Hackney, Swansea, and J. W. Wailes, Wednesbury.—*9th November*, 1882.
5412. BISULPHATE of SODA, E. Carey and F. Hurter, Widnes.—*13th November*, 1882.
5419. MARKING or SCORING in CARD PLAYING, G. F. Redfern, London.—*14th November*, 1882.
5426. LAMPS, J. Thomas, London.—*14th November*, 1882.
5494. INDICATING AMOUNTS of MONIES RECEIVED or PAID in SHOPS, &c., S. H. and J. C. Boswell, Norwich.—*18th November*, 1882.

List of Specifications published during the week ending January 13th, 1883.

5369*, 4d.; 2000, 2d.; 2054, 10d.; 2099, 6d.; 2187, 4d.; 2265, 8d.; 2340, 10d.; 2359, 4d.; 2455, 6d.; 2510, 6d.; 2517, 2d.; 2578, 6d.; 2584, 6d.; 2585, 6d.; 2592, 8d.; 2598, 6d.; 2600, 6d.; 2613, 6d.; 2620, 4d.; 2636, 8d.; 2637, 6d.; 2638, 6d.; 2639, 6d.; 2641, 6d.; 5650, 6d.; 2653, 2d.; 2654, 6d.; 2656, 6d.; 2650, 2d.; 2661, 6d.; 2668, 6d.; 2672, 8d.; 2676, 4d.; 2679, 6d.; 2685, 6d.; 2689, 6d.; 2693, 6d.; 2695, 2d.; 2697, 6d.; 2699, 10d.; 2702, 6d.; 2703, 2d.; 2705, 2d.; 2707, 6d.; 2709, 4d.; 2711, 6d.; 2714, 2d.; 2715, 4d.; 2722, 2d.; 2724, 2d.; 2725, 4d.; 2729, 2d.; 2730, 4d.; 2733, 2d.; 2735, 6d.; 2737, 6d.; 2738, 2d.; 2740, 2d.; 2741, 4d.; 2751, 2d.; 2754, 2d.; 2758, 4d.; 2760, 2d.; 2762, 2d.; 2763, 2d.; 2772, 2d.; 2774, 2d.; 2780, 4d.; 2782, 2d.; 2784, 2d.; 2785, 2d.; 2787, 2d.; 2790, 2d.; 2791, 2d.; 2793, 2d.; 2818, 4d.; 2821, 2d.; 2822, 2d.; 2825, 2d.; 2844, 6d.; 2872, 2d.; 2873, 4d.; 4785, 2d.; 4804, 10d.

*** 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.

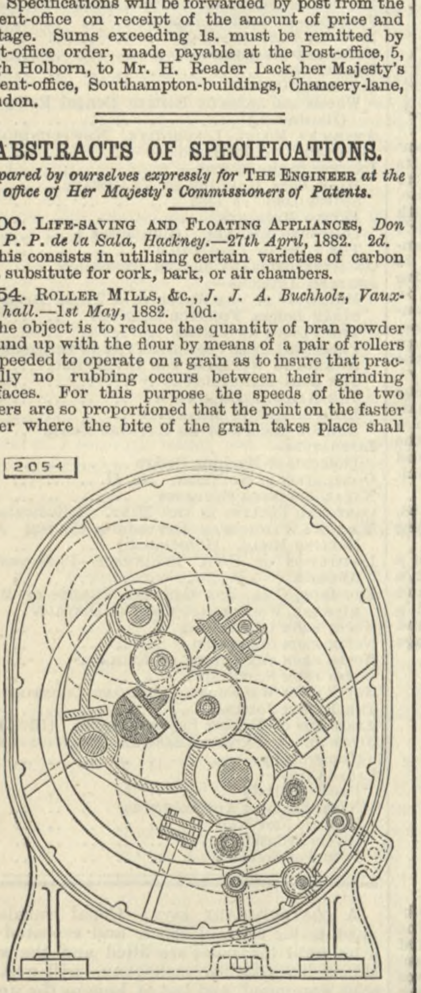
Prepared by ourselves expressly for THE ENGINEER at the office of Her Majesty's Commissioners of Patents.

2000. LIFE-SAVING AND FLOATING APPLIANCES, *Don P. P. de la Sala, Hackney.—27th April*, 1882. 2d.

This consists in utilising certain varieties of carbon as a substitute for cork, bark, or air chambers.

2054. ROLLER MILLS, &c., *J. J. A. Buchholz, Vauxhall.—1st May*, 1882. 10d.

The object is to reduce the quantity of bran powder ground up with the flour by means of a pair of rollers so speeded to operate on a grain as to insure that practically no rubbing occurs between their grinding surfaces. For this purpose the speeds of the two rollers are so proportioned that the point on the faster roller where the bite of the grain takes place shall



reach the plane of the axes of the rollers by the time that the rolled out bran carried by the slower roller enters that plane. The drawing shows the method of mounting the roller axes on antifriction bearings. A testing apparatus is also described, for determining the diameters and relative speeds of the rollers.

2099. COMBINED SOFA OR CHAIR, WITH BED, *C. Klemetsen, Christiania.—4th May*, 1882. 6d.

This consists in making the seat of the chair of three cushions enclosed by frames being hinged to the back or sides of the chair, and while the second frame rests on the front legs as well as on the movable part of the back legs, which legs run on rollers, and can be drawn forward for converting the chair into a bed.

2187. LIFT, *A. Gain, London.—10th May*, 1882.—(*Not proceeded with.*) 4d.

This relates to the employment of articulated levers for the raising of a platform.

2265. LAMPS FOR BURNING VOLATILE OILS, *J. Hinks, Birmingham.—13th May*, 1882. 8d.

The object is to facilitate the trimming of the wicks and the lighting of the lamps, and the filling of the reservoirs.

2340. IMPROVEMENTS IN THE CONSTRUCTION OF DYNAMO-ELECTRIC MACHINES, *C. W. Vincent, Holloway.—18th May*, 1882.—(*Partly a communication from Baron Elphinstone, at present in Canada.*) 10d.

This relates to a mode of facilitating the manufacture of the coil of armatures, constructed according to the inventor's patent, No. 332, 27th January, 1879. Hitherto it has been customary to wind the coils or hanks of the armature *in situ*. The form of the coils used in the inventor's machine is that of a broad link composed of one or more wires, and they propose to wind each coil on a "former," making it of suitable length to fit the armature drum as before. This machine was illustrated and described by us in a recent issue.

2359. SELF-ACTING TIP VAN OR WAGON, *W. Mead, London.—19th May*, 1882.—(*Provisional protection not allowed.*) 4d.

This relates to the employment of levers and springs for tipping purposes.

2455. APPARATUS FOR RAISING AND LOWERING RAILWAY CARRIAGE AND OTHER WINDOWS, *R. J. Iron, Dover.—24th May*, 1882. 6d.

This relates to apparatus for raising and lowering windows in which the weight of the window is counterbalanced by a barrel or spiral spring, conveniently placed beneath it, so that a very slight upward or downward pressure upon the window will carry it to and leave it at any desired point of suspension.

2510. FRAMES FOR MANUFACTURING STAY LACES, BRAID, &c., *A. W. L. Reddie, London.—26th May*, 1882.—(*A communication from La Société Industrielle des Tresses et Lacets de St. Chamond, Paris.*) 6d.

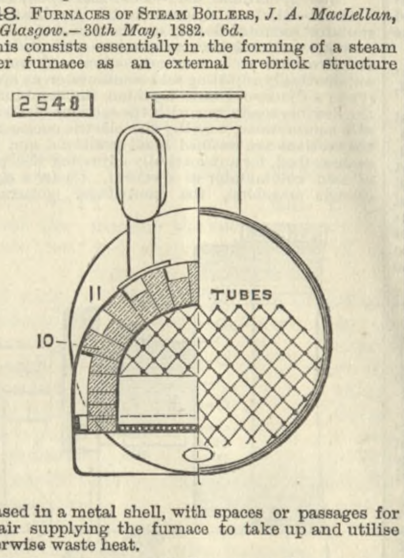
This relates to the mode of effecting the circulation of the "puppets" in braiding frames or machines, without shock or rubbing, the said mode consisting essentially in the transfer of the "puppets" from one "spindle" to another by means of claws or gripping arms, which are caused to alternately grasp or release the stems of the puppets at the proper moment.

2517. TREATMENT OF FOUSEL OIL, *J. K. Field, Battersea Park.—26th May*, 1882.—(*Partly a communication from H. Ujhely, Vienna.*) 2d.

This consists in the method of defecating fousel oil and separating watery constituents therefrom by admixture therewith of petroleum spirit, and after separation from the water and other impurities by decantation, subjecting the mixture of fousel oil and petroleum spirit to fractional distillation.

2548. FURNACES OF STEAM BOILERS, *J. A. MacLellan, Glasgow.—30th May*, 1882. 6d.

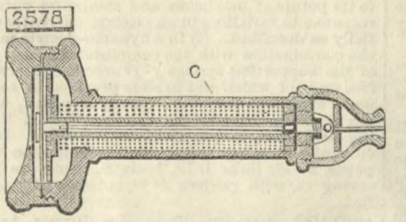
This consists essentially in the forming of a steam boiler furnace as an external firebrick structure



encased in a metal shell, with spaces or passages for the air supplying the furnace to take up and utilise otherwise waste heat.

2578. IMPROVEMENTS IN TELEPHONIC INSTRUMENTS, *S. P. Thompson, Bristol.—31st May*, 1882. 6d.

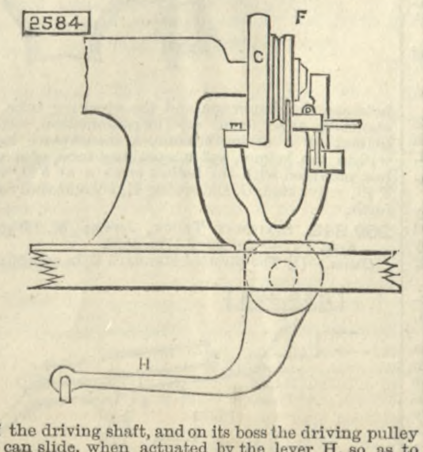
This invention relates to improvements in the receiver of Phillip Reis. One form of the inventor's improvements is shown in the accompanying figure. The action of the instrument illustrated is as follows:—If the current received in the coils C through the line from the transmitter increases in strength it will change the molecular condition of the central rod or wire, causing it to elongate slightly if of iron, steel



or cobalt, and if it be nickel, to contract slightly. A decrease in the strength of the current will be followed by a partial demagnetisation of the central rod, producing an inverse movement. Hence, as one end of the rod is tightly screwed up to the case of the instrument, and the other affixed to the tympanum, the varying or fluctuating currents entering the same will cause corresponding vibrations of the tympanum. Other improvements are also described and illustrated.

2584. STARTING, DRIVING, AND STOPPING SEWING MACHINES, *A. D. Pentz, New Jersey, U.S.—1st June*, 1882. 6d.

The improvements are applicable to machines driven by mechanical power, so as to instantly start or stop the same while the driving pulley is being continuously rotated. A hollow disc C is mounted on the end



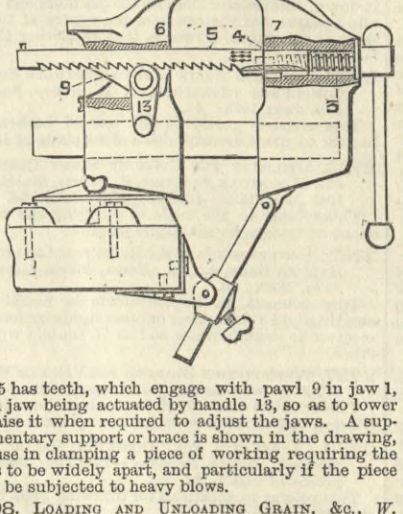
of the driving shaft, and on its boss the driving pulley F can slide, when actuated by the lever H, so as to bring its inner end in contact with a disc of millboard, secured to the disc C, and the friction is sufficient to cause the disc C to rotate, and so drive the machine.

2585. SEPARATING SOLUBLE MATTERS FROM GASES, *G. T. Beilby, Mid-Calder.—1st June*, 1882. 6d.

The processes to be used instead of the ordinary washing or scrubbing operations are effected by injecting into the gas to be treated the solvent liquid or substance in the form of a very fine spray, so that the gas and the solvent may be brought into very intimate contact.

2592. PARALLEL, SCREW, OR BENCH VICES, *P. Lawrence, Farringdon-street.—1st June*, 1882. 8d.

So as to rapidly adjust the jaws to suit varying sizes the screw 3 is made short, and works in nut 4 formed in the end of sliding rod 5 connecting the jaws, and which slides in bearing 6 in jaw 1, while the nut at its other end slides in bearing 7 of jaw 2. One side of the



rod 5 has teeth, which engage with pawl 9 in jaw 1, such jaw being actuated by handle 13, so as to lower or raise it when required to adjust the jaws. A supplementary support or brace is shown in the drawing, for use in clamping a piece of working requiring the jaws to be widely apart, and particularly if the piece is to be subjected to heavy blows.

2598. LOADING AND UNLOADING GRAIN, &c., *W. Cooper and J. Holdsworth, Hull.—2nd June*, 1882. 6d.

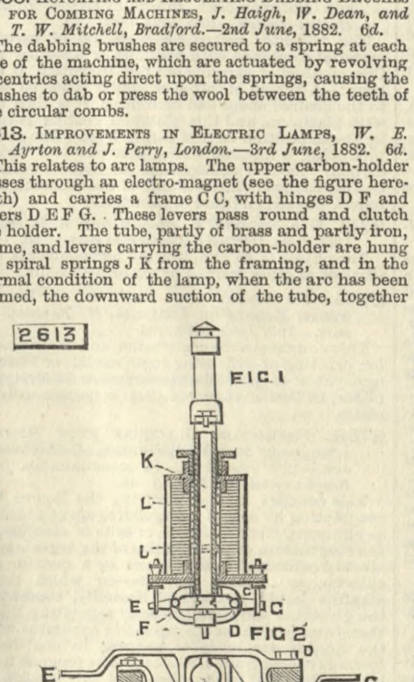
This relates to the method of opening, closing, lifting, and lowering vessels, buckets, or scoops of lifting, depositing, or excavating apparatus, by means of an opening chain or chains and a closing chain or chains connected with the said vessel, bucket, or scoop, and one continuous operating rope or chain, passing over a pulley block adapted to retard or stop when required the motion of one of the chains connected with the vessel, scoop, or bucket.

2600. ACTUATING AND REGULATING DABBING BRUSHES FOR COMBING MACHINES, *J. Haigh, W. Dean, and T. W. Mitchell, Bradford.—2nd June*, 1882. 6d.

The dabbing brushes are secured to a spring at each side of the machine, which are actuated by revolving excentrics acting direct upon the springs, causing the brushes to dab or press the wool between the teeth of the circular combs.

2613. IMPROVEMENTS IN ELECTRIC LAMPS, *W. E. Ayrton and J. Perry, London.—3rd June*, 1882. 6d.

This relates to arc lamps. The upper carbon-holder passes through an electro-magnet (see the figure herewith) and carries a frame C C, with hinges D F and levers D E F G. These levers pass round and clutch the holder. The tube, partly of brass and partly iron, frame, and levers carrying the carbon-holder are hung by spiral springs J K from the framing, and in the normal condition of the lamp, when the arc has been formed, the downward suction of the tube, together



with the weight of the movable parts, just balance the upward pulls of the springs. The electro-magnet is wound with a coil of considerable resistance, which acts as a shunt to the arc. When the latter gets too long and its resistance increases, more current passes through the magnet and the carbon falls, thus shortening the arc. It cannot fall far before the two levers come in contact with stops at E and G; this diminishes their grip and lets the carbon slide independently of the tube and frame C. This is the feeding arrangement. Fig. 2 gives a more detailed view of the gripping levers.

2620. MACHINERY FOR PARING THE CURLS OF HAT BRIMS, *J. T. Grimshaw, Stockport.—3rd June*, 1882. 4d.

This relates partly to the use of an oscillating shape, by which the edge of the brim of the hat forms the guide for paring the curls.

2636. IMPROVEMENTS IN DYNAMO-ELECTRIC, &c., MACHINES, *A. L. Fyfe, London, and J. Main, Brixton.—5th June*, 1882. 8d.

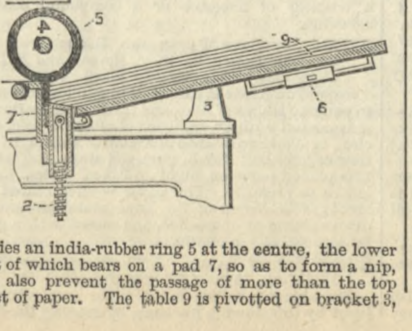
This relates to the construction of dynamo machines in which that part of the armature which usually remains idle is cut out of circuit at a certain point by means of the brushes with which it is connected being caused to bear against a separate part of the commutator, so that the current is not allowed to pass through the inactive portion of the armature and thereby increase its resistance. Other improvements are also described and claimed.

2637. SHOES FOR HORSES, &c., *T. H. Heard, Sheffield.—5th June*, 1882. 6d.

This relates to the construction of the shoe and to the employment of clips for securing the shoe.

2638. PAPER DAMPING AND PRINTING MACHINES, *J. J. Allen, Halifax.—5th June*, 1882. 6d.

This relates to apparatus for feeding the paper sheet by sheet to the damping machine or to the printing machine. Shaft 4 is supported in brackets, and



carries an india-rubber ring 5 at the centre, the lower part of which bears on a pad 7, so as to form a nip, and also prevent the passage of more than the top sheet of paper. The table 9 is pivotted on bracket 3, and is moved upwards by means of the weight 6 and springs 2.

2639. FOLDING CHAIRS, &c., *J. Hayes, Kingsland.—5th June*, 1882. 6d.

This relates to the employment of ratchets and links for facilitating the folding.

2641. IMPROVED SYSTEM AND ARRANGEMENT OF TELEPHONIC COMMUNICATORS FOR USE AS FIRE ALARMS, &c., *A. W. Rose, Farringdon-road.—5th June*, 1882. 6d.

This relates to a combination of telephone' batteries, and alarm bells, by means of which several stations can communicate with a head station on an alarm of fire.

2650. UMBRELLAS, *J. Wetter, New Wandsworth.—6th June*, 1882.—(*A communication from H. Papke, Berlin.*) 6d.

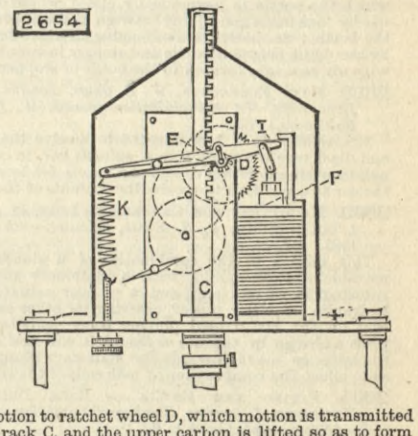
This consists in a mode of folding up the umbrella so that it occupies a small space.

2653. TROUSERS' HOLDERS, *W. G. Stone, Bath.—6th June*, 1882. 2d.

This relates to the employment of clamps.

2654. AN IMPROVED ELECTRIC LAMP, *R. J. Hatton, Stratford, and A. L. Paul, Kensington.—6th June*, 1882. 6d.

The action of the inventor's lamp will be understood on reference to the accompanying illustration. When the current is switched on, plunger F is drawn into the solenoids, drawing down one end of lever E, and causing spring pawl I to engage with and give



motion to ratchet wheel D, which motion is transmitted to rack C, and the upper carbon is lifted so as to form the arc. When the arc becomes too long the action of the solenoid is weakened and spring K overcomes it, disengages I, and the carbon descends until the arc is adjusted to the proper length.

2656. MEANS FOR HOLDING UP CARRIAGE AND OTHER WINDOWS, *J. Harris, Kentish Town.—6th June*, 1882. 6d.

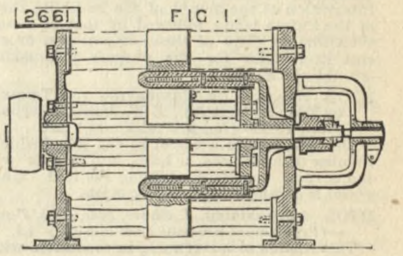
This relates to the employment of a roller or rollers kept in forced contact with the window by a spring or springs.

2659. IMPROVEMENTS IN PRIMARY AND SECONDARY BATTERIES, &c., *W. Brain, Cinderford, Gloucestershire.—6th June*, 1882.—(*Void.*) 2d.

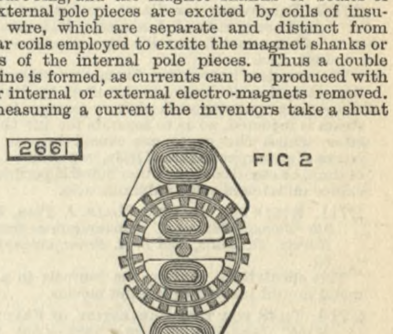
This relates to improvements on the inventor's patent of 30th March, 1882, and consists mainly in subjecting the electrodes and secondary batteries therein described to considerable pressure before or after charging.

2661. IMPROVEMENTS IN APPARATUS FOR PRODUCING ELECTRIC CURRENTS AND IN APPARATUS FOR MEASURING SUCH CURRENTS, *Professor J. Blyth, Glasgow, and D. B. Peebles, Bonnington, Edinburgh.—7th June*, 1882. 6d.

For the production of currents the inventors employ the machine illustrated in Figs. 1 and 2, which are longitudinal and transverse vertical sections respectively. The machine has a rotating armature consisting of a cylindrical ring of soft iron, having upon it a number of separate coils of insulated wires.



Between the coils are iron links, by means of which the armature ring is fixed to one end or edges of a cylinder of iron, which has at its other end a disc or spider connecting it to a boss fast on the driving shaft. The coils of wire are connected to a commutator. Separate electro-magnetic pole pieces are arranged to act upon the outer and inner sides of the armature ring, and the magnet shanks or bodies of the external pole pieces are excited by coils of insulated wire, which are separate and distinct from similar coils employed to excite the magnet shanks or bodies of the internal pole pieces. Thus a double machine is formed, as currents can be produced with either internal or external electro-magnets removed. For measuring a current the inventors take a shunt



of comparatively great and known resistance from the main circuit by means of two wires which are led to separate electrodes immersed in water in a closed vessel. The shunt current causes electrolysis of the water, and the oxygen or hydrogen, or the two combined, are led through a meter such as is used for measuring illuminating gas. As the production of the gases has a known and definite relation to the current passing through the main circuit, the meter measurement serves as a data for calculating the quantities of the main current.

2668. PORTABLE CHAFF ENGINES, *R. Maynard, near Cambridge.—7th June*, 1882. 6d.

This consists partly in the fitting a portable chaff engine with automatic machinery for preparing the straw or other material to be cut by straightening or yealuring it before it passes to the knives.

2672. LOOPED FABRICS, *W. R. Lake, London.—7th June*, 1882.—(*A communication from C. Young, Chicago.*) 8d.

This relates to machinery for knitting or crocheting looped fabrics, and consists in several improved devices and combinations of devices.

2679. ATTACHING HANDLES TO CUTLERY, &c., AND FERRULES TO HANDLES, *T. and J. Brooke, Sheffield.—7th June*, 1882. 6d.

This relates to the method of attaching the handles of steel and plated cutlery by means of ferrules which are compressed and contracted upon cone-shaped pieces formed on either the handle or the bolster, or on both of them.

2676. An Improved Process of Forming or Preparing Electrodes for Secondary Batteries, *A. M. Clark, of A. M. and W. Clark, Chancery-lane.—7th June, 1882.—(A communication from J. M. A. Gérard-Lescuyer, Paris.)* 4d.

The inventor utilises a salt, of which the radicle is an oxide acting as an acid, as an oxidising agent for the rapid formation of secondary battery plates. He proceeds as follows:—In an electro-chemical bath, containing one or more such salts, he substitutes for the soluble anode the secondary pair to be formed. The two plates of this pair are connected together and attached to the positive pole of the generator which is to decompose the bath, and to the negative pole he connects a plate, say of carbon. Under the action of the current the cathode becomes metallised, whilst the pair of lead plates forming the anode becomes rapidly oxidised. The inventor generally uses sodic or potassic plumbite prepared by dissolving massicot or litharge in a boiling alkaline lye at 32 deg. to 35 deg. Beaumé, in the proportion of 15 to 20 grammes of massicot per litre (= about 1000 to 1400 grains per gallon).

2685. Feeding Bottles, *G. Falconnier, Switzerland.—8th June, 1882.* 6d.

This relates, First, to the stoppers and bottles by which the bottle is hermetically closed when out of use by making a good joint between the stopper and the bottle; Secondly, to a self-acting air valve formed by the joint between bottle and stopper in connection with air passages formed in the bottle or stopper.

2689. Mail Elevators, *W. E. Gedge, London.—8th June, 1882.—(A communication from J. W. Paine, Baltimore.)* 6d.

This relates to a box adapted to receive the mail and discharge the same into a suitable car, in combination with a hoisting device and means for lowering the car to a position to receive the contents of the box.

2693. Machinery for Compressing Lime, &c., into a Solid Form, *C. S. Smith, Leicester.—8th June, 1882.* 6d.

This relates to the combination of a yielding or movable die or mould with a stationary plunger entering it at one end, and a plunger actuated by hydraulic or other power entering its other end, so that on the last-named plunger being made to compress a charge in the die or mould, it will also cause the latter to move towards the stationary plunger so as to effect the compression at both ends of the charge.

2695. Fixing the Drills of Rock Drilling Machines, *J. Swaine, Handsworth.—8th June, 1882.—(Not proceeded with.)* 2d.

A rod is screw-threaded U at each end and bent into a U shape. The two branches of this U-shaped staple are passed through the holes in the holder, and screw nuts on their screwed ends are made to hold the cap and fix the drill.

2697. Propelling Velocipedes, Road Carriages, and Tram-cars, &c., *C. H. Brooks, Glenelg, South Australia.—8th June, 1882.—(Partly a communication from W. Chew, Norwood, North Australia.)* 6d.

This consists in an arrangement of levers and gearing for driving velocipedes, &c., whereby the use of driving cranks is avoided.

2699. Harrows, *J. Howard and E. T. Bousfield, Bedford.—8th June, 1882.* 10d.

The inventors claim, First, the improvements relating to the employment of a tine fitted into a mortice or hole in the transverse bar, and secured therein by being held or gripped tightly between the side of the mortice and the longitudinal bar; Secondly, the improvements relating to the employment of a block or clip, in combination with the bars of the frame and the tine, with or without provision for the angular adjustment of the latter.

2702. Apparatus for Levelling Molehills, &c., *T. Morgan, London.—8th June, 1882.—(A communication from A. Royer, Paris.)* 6d.

This relates to the employment of an angular bar of metal and a double row of knives, arranged quincunxially, in order to obtain a more thorough disintegration of the mould of the molehills, the action of the knives being followed by that of a curved or semicircular plate of sheet or cast iron or a jointed cast iron roller for the purpose of crushing and crumbling the clods.

2703. Heating or Preserving the Temperature of Tea, Coffee, &c., *J. W. Morris, Liverpool.—8th June, 1882.—(Not proceeded with.)* 2d.

This consists of a vessel in the lid of which are a number of apertures or holes into or over which fit the several vessels containing the food. Under the vessel is arranged a series of gas jets.

2705. Advertising, *J. Sinico, Soho.—9th June, 1882.—(Provisional protection not allowed.)* 2d.

This relates to advertising in connection with cigar and cigarette boxes, &c.

2707. Spinning and Doubling Cotton, Worsted, Silk, &c., *R. Scaife, Colne.—9th June, 1882.* 6d.

This relates to throstle spinning or doubling, with a dead or stationary spindle, and consists in the use of a long collar fitting upon the said spindle, and in a guard for preventing broken threads from interfering with the other threads.

2709. Treatment of Gases containing Ammonia for Production of Artificial Manures, &c., *F. J. Bolton and J. A. Wanklyn, London.—9th June, 1882.* 4d.

This consists in treating furnace or other gases for the extraction of ammonia therefrom by first causing the gases to pass through pipes or passages into which steam is injected, so as to separate the tar therefrom, after which the gases are caused to pass through layers of superphosphate of lime, or powdered sulphate of lime, or small coke, or other suitable permeable substance moistened with sulphuric acid.

2711. Rolls for Rolling Mills, *J. Tinn, Bristol.—9th June, 1882.—(A communication from W. E. Harris, St. Louis, and E. B. Evans, Covington, U.S.)* 6d.

This consists in casting the journals in a chill or metal mould instead of in sand moulds.

2714. Tills for the Prevention of Fraud, *B. W. Webb, London.—9th June, 1882.—(Not proceeded with.)* 2d.

This relates to a till in which the last money paid is visible until another payment paid and deposited in the till.

2715. Treatment of Regulus or Matte for the Extraction of Metals, *E. A. Parnell, Swansea.—9th June, 1882.* 4d.

This consists in the treatment of regulus or matte with hydrochloric acid for the separation from the valuable metals, of iron as ferrous chloride, and of sulphur as sulphuretted hydrogen.

2722. Improvements in Secondary Batteries, *A. P. Price, Lincoln's-inn-fields.—9th June, 1882.* 2d.

This relates to improvements on patent No. 1587, granted to A. Tribe, and dated 1st April, 1882, and consists in enveloping one or both plates of the battery in spongy india-rubber.

2724. Sewing Machines, *W. A. Barlow, London.—9th June, 1882.—(A communication from L. Gühring and W. Köhrer, Stuttgart.)—(Not proceeded with.)* 2d.

This consists in mechanically turning the presser foot so as to turn automatically when the machine is at work for the purpose of doing circular or oval sewing in boot and shoe making of every kind.

2725. Granulating Glucose or Grape Sugar, &c., *J. M. Cameron and H. J. Anderson, London.—9th June, 1882.* 4d.

This consists in the process of first mixing with glucose and other substances of similar constituency a dehydrating substance, such as starch or corn-flour, then crushing the mixture and passing it through granulating seives; and, lastly, separating the said dehydrating substance in great part from the granules by sifting or by blowing currents of air through the same.

2729. Steel Ingots for Rolling into Plates, &c., *J. Beardmore, Glasgow.—10th June, 1882.—(Void.)* 2d.

The ingots are cast of an oval or elliptical section in moulds specially constructed. As the oval or elliptical ingot passes through the rolls, the rolls act first on the central or highest portion thereof, and in flattening it down, compress or close up the gas holes and gradually squeeze out the gas from the centre of the surfaces of the ingot outwards, thus rendering the surfaces solid.

2730. Treating Waste Lime to Separate Sulphur Compounds therefrom, *G. R. Hislop, Paisley.—10th June, 1882.* 4d.

This consists partly in the use of carbonaceous matter to effect decomposition of sulphate of lime.

2733. Utilising the Cases of Spent Cartridges for Miniature Practice, *R. Morris, Blackheath.—10th June, 1882.—(Not proceeded with.)* 2d.

This relates to the mode of charging the cases of spent cartridges for miniature practice.

2735. Compressed Air Machines for Aerating and Raising Beer, &c., *S. Mason, Birmingham.—10th June, 1882.* 6d.

This consists in improvements in machines for aerating and raising beer or other fluids by forming a receiver to contain water and air in contact with each other.

2737. Antifriction Bearings for Vehicle Wheels, *W. J. Brewer, London.—15th June, 1882.* 6d.

This consists of a wheel in combination with antifriction ball or roller bearings, as at present known.

2738. Apparatus for Throwing Balls, *F. W. Wruuck, Auclam, Germany.—10th June, 1882.—(Not proceeded with.)* 2d.

This relates to apparatus for throwing glass balls for shooting practice.

2740. Improvements in Electric Lamps, &c., *G. Zanni, Hatton-garden.—10th June, 1882.—(Not proceeded with.)* 2d.

This relates to improvements in lamps in which light is produced by the incandescence of a carbon point which is pressed by weight against a block of carbon. Two or more carbon rods are proposed to be substituted for the one hitherto employed, in order to avoid the extinguishing of the light owing to flaws in the single carbon.

2741. Improvements in Illuminating Conductors for Incandescent Electric Lamps, *G. Zanni, Hatton-garden.—10th June, 1882.* 4d.

The inventor makes his filaments of carbonised material combined with platinum or a similar metal. One method of carrying out this invention is as follows:—A thread of cotton or similar material is bent to the desired shape and carbonised, it is then coated with platinum, and this platinum coating is covered by the deposition on it of carbon from some gas, thus producing a metallic lining between two bodies of carbon. By this arrangement the inventor claims to be able to lower the resistance of the filament, and so reduce the expenditure of electricity.

2751. Gas Engines, *P. Braham and R. H. Seaton.—12th June, 1882.—(Not proceeded with.)* 2d.

The object is to simplify the arrangements of the parts of engines worked by gas or petroleum.

2754. Machinery for Printing or Embossing Sugar Medals or Lozenges, *H. Faulder, Stockport.—12th June, 1882.* 2d.

This consists in the combination and use in machines for printing or embossing sugar medals or lozenges of removable or portable stereotype or electrotype die plates, in lieu of engraved dies or permanently fixed plates.

2758. Extracting Glycerine from Residuary Liquors of Soap Manufacture, *A. M. Clark, London.—12th June, 1882.—(A communication from E. Brochan and Co., Milan.)* 4d.

This consists in first purifying the liquors by the coagulation by acid of a coagulating agent added, such as albumen, blood, gelatine, or salts of alumina, or by the coagulation or precipitation of the organic matters already contained in the liquors by a metallic acid—chloride or soluble sulphate—on which the still alkaline liquid reacts; and Secondly, concentrating the glycerine and simultaneously separating the salts therefrom in a series of evaporative apparatus wherein the liquids are made to progress in one direction towards concentration, while the salts progress towards impoverishment in the other—and this whatever may be the mode of evaporating employed.

2760. Posts or Supports for Telegraph Wires, &c., *H. H. Lake, London.—12th June, 1882.—(A communication from J. G. Richard, Paris.)—(Not proceeded with.)* 2d.

This relates to the means of preservation; and it consists in isolating the foot or base of the post from the ground and destructive elements by enclosing the part of the said post which is susceptible of being attacked by the humidity of the earth in an impermeable box, cylinder, base, or block.

2762. Improvements in Voltaic Batteries, *D. G. FitzGerald, Brixton.—12th June, 1882.—(Not proceeded with.)* 2d.

This relates to the employment of peroxide of lead in a strongly compressed condition as the depolarising agent in primary batteries. The positive element may be tin or other metal in a more or less porous condition, and the negative element carbon.

2763. Manufacture of Peroxide of Lead, &c., *D. G. FitzGerald, Brixton.—12th June, 1882.—(Not proceeded with.)* 2d.

According to one portion of the invention the inventor treats certain salts and insoluble compounds of lead in admixture with an electrolyte, which may be a salt of a metal other than lead, by subjecting them to electrolysis in a tank or in a series of tanks containing suitable electrodes.

2772. Slabs of Plaster or Composition for Ceilings, &c., *R. W. Hitchins, Stoke Newington.—13th June, 1882.—(Not proceeded with.)* 2d.

This relates to the manufacture of slabs in long lengths by machinery, instead of by hand

2774. Velocipedes, *W. Dixon, Brighton.—13th June, 1882.—(Not proceeded with.)* 2d.

This relates to the use of handles connected with the driving cranks, so that the rider can use both hands and feet to propel the velocipede when desired.

2777. Fusees or Vesuvians, *W. T. Evans, Manchester.—13th June, 1882.* 2d.

This consists in constructing matches formed by fusee or vesuvian composition with the stick or wood handle protected before the composition is applied by a coating of asbestos or a compound containing asbestos.

2780. Sensitive Paper and Blocks for Photographic Purposes, *W. T. Morgan and R. L. Kidd, Greenwich.—(Not proceeded with.)* 4d.

Superfine paper is passed through an acid solution to remove traces of lime, and then rinsed; after which it is coated with an emulsion of asbestos, talc, chinese clay, or other substance of a similar nature, in a solution of gelatine, starch, gum, and alum, and when dry it is placed between highly-polished plates, and subjected to pressure. The paper is then coated with a stronger emulsion of the same materials, and when dry is glazed or enamelled, and coated with a gelatine bromide of silver emulsion.

2782. Safety Lamps, *W. Smethurst, near Wigan.—13th June, 1882.—(Not proceeded with.)* 2d.

The object is to prevent a miner from obtaining a light by unscrewing his lamp, by causing the flame to be extinguished when the bottom of the lamp is unscrewed.

2784. Rag Engines Used for the Manufacture of Paper, *H. J. Haddan, Kensington.—13th June, 1882.—(A communication from J. P. Horschilgen, Germany.)—(Not proceeded with.)* 2d.

This consists in surrounding the cylinder of the rag engine with knives along a large portion of its circumference.

2785. Candles and Candle Holders, *G. W. von Nawrocki, Berlin.—13th June, 1882.—(A communication from A. Mann and R. Jacobi, Germany.)—(Not proceeded with.)* 2d.

This relates to the formation of a central channel in the candle, so as to supply air to the centre of the flame, and also in forming holes in the candle holder, and providing a slide to regulate the supply of air to the central channel in the candle.

2787. Transmitting Motive Power, *A. Lafargue, Kensington.—14th June, 1882.—(Not proceeded with.)* 2d.

This consists in connecting the piston rod of an engine to the shaft to be driven by means of a cross head fitted with studs and friction rollers working in spiral grooves formed in the shaft.

2790. Albums for Holding Photographs, *A. Aron, Newgate-street.—14th June, 1882.—(Not proceeded with.)* 2d.

The object is to prevent the tearing of the album when inserting or removing the photographs, and it consists in the use of slides to receive the photographs and slide in the apertures left to receive the latter.

2793. Generating Heat, Economising Fuel, and Consuming Smoke, *J. Teer, Salford.—14th June, 1882.—(Not proceeded with.)* 2d.

This consists of tubes placed in front of the furnace for the purpose of converting the fuel into gas. The fuel passes through the tubes and falls on to a lower fire bed, and is brought to the front of the oven, and may be taken up to re-feed the supply to the tube fire, and being replenished with fresh fuel, will heat the tubes and again gasify the charges in them.

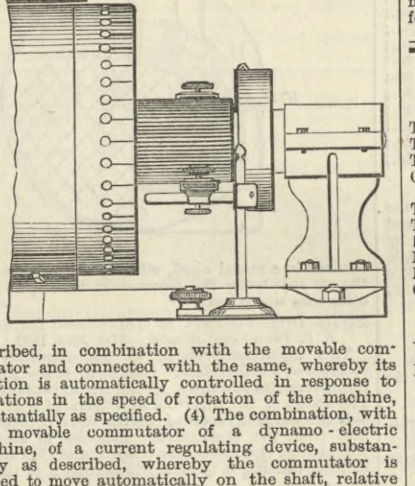
SELECTED AMERICAN PATENTS.

From the United States' Patent Office Official Gazette.

268,956. Dynamo-electric Machine, *Elmer A. Sperry, Cortland, N.Y.—Filed 28th April, 1881.*

Claim.—(1) In a dynamo-electric machine, a commutator mounted loosely on the armature shaft, its sections retaining their connections with their respective armature coils, in combination with means for automatically adjusting said commutator, as specified. (2) In a dynamo-electric machine, the combination of the flexible conductors with the sections of an adjustable commutator, whereby the electric connections of the sections are retained in all positions, and means, as described, for automatically adjusting the position of said commutator as specified. (3) In a dynamo-electric machine, the centrifugal governor, as

268.956

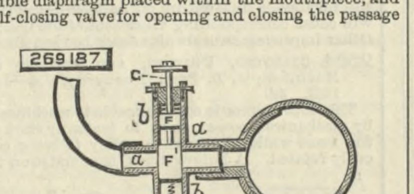


described, in combination with the movable commutator and connected with the same, whereby its position is automatically controlled in response to variations in the speed of rotation of the machine, substantially as specified. (4) The combination, with the movable commutator of a dynamo-electric machine, of a current regulating device, substantially as described, whereby the commutator is caused to move automatically on the shaft, relative to its points of maximum and minimum current, in response to variations in an electric current, substantially as described. (5) In a dynamo-electric machine, the combination with the commutator brush clamps of the supporting springs f^2 f^3 attached thereto, the free ends of which rest in slots provided in rods $f f^1$, upon which the clamps are loosely mounted, whereby the pressure of the brushes can be adjusted by rotating said rods, substantially as described. (6) In a current-regulating device, the combination of the pawls k^1 k^2, links L L^1, lever K, armature M, and spring m, with ratchets k^3 k^4, substantially as specified.

269,187. Speaking Tube for Diving Armours, *William R. Darling and John S. Bundick, New York.—Filed June 15th, 1882.*

Claim.—(1) The combination, with the helmet of a diving armour, of a mouth-piece within the helmet, a speaking tube connected with the mouthpiece, and extending above the surface of the water, and a flexible diaphragm placed within the mouthpiece, and a self-closing valve for opening and closing the passage

269187

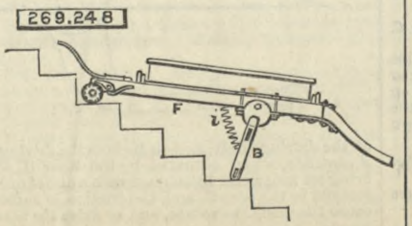


between the diaphragm and the speaking tube, substantially as set forth. (2) The combination, with the helmet of a diving armour, a mouthpiece located within the helmet, and a speaking tube, of a valve-box provided with the hollow arms a a^1 b b^1, valves F F^1, valve stem G, and spring H, substantially as set forth.

269,248. Stairway Truck, *Jerome W. Wetmore, Erie, Pa.—Filed April 17th, 1882.*

Claim.—(1) The pivotted standard B, in combination

269.248

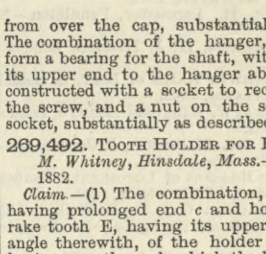


with the spring i, substantially as described. (2) The spring i, detached from the frame F and attached to it behind B, for the purposes specified, substantially as described. (3) The hinged or movable arms v and the hinged handles F on the truck, substantially as described, for the purpose specified. (4) The stairway truck, when constructed with the standard, spring, ratchet wheel, and pawl combined, substantially as described.

269,263. Shaft Hanger, *Ernest V. Clemens, Ansonia, Conn.—Filed November 4th, 1882.*

Claim.—(1) The combination of the hanger, box, and cap, which form a bearing for the shaft, with a screw hinged by its upper end to the hanger above the cap, and a nut on the screw to bear upon the cap or to release the cap, so that the screw may be turned away

269.263



from over the cap, substantially as described. (2) The combination of the hanger, box, and cap, which form a bearing for the shaft, with a screw hinged by its upper end to the hanger above the cap, the cap constructed with a socket to receive the lower end of the screw, and a nut on the screw to bear on said socket, substantially as described.

269,492. Tooth Holder for Horse Hay Rakes, *Eli M. Whitney, Hinsdale, Mass.—Filed September 19th, 1882.*

Claim.—(1) The combination, with a coiled spring having prolonged end c and hooked end h, and the rake tooth E, having its upper end bent at a right angle therewith, of the holder A, cast with ears C, having eyes through which the bent end of the tooth passes to be encircled by the spring and grasped by the hooked end thereof, and formed with groove d

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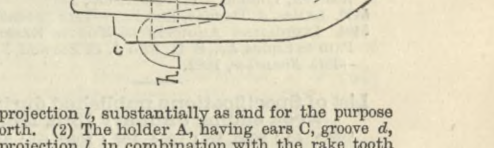

and projection l, substantially as and for the purpose set forth. (2) The holder A, having ears C, groove d, and projection l, in combination with the rake tooth E, having its upper end bent at a right angle therewith, and the coiled spring D, formed with hooked end h and prolonged end c, the latter resting in the groove d and held therein by the bolt a, which connects the holder to the rake head, substantially as and for the purposes specified.

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A contemporary says:—Copal varnish applied to the soles of shoes, and repeated as it dries until the pores are filled and the surface shines like polished mahogany, will make the soles waterproof, and last as long as the uppers.