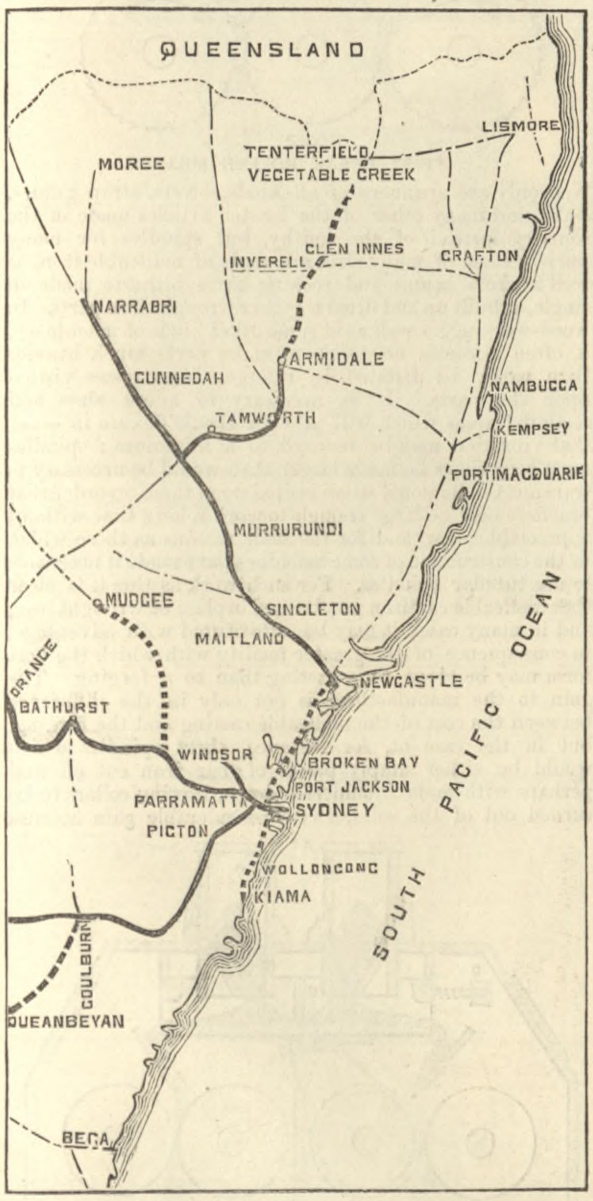
THE HAWKESBURY BRIDGE, NEW SOUTH WALES.

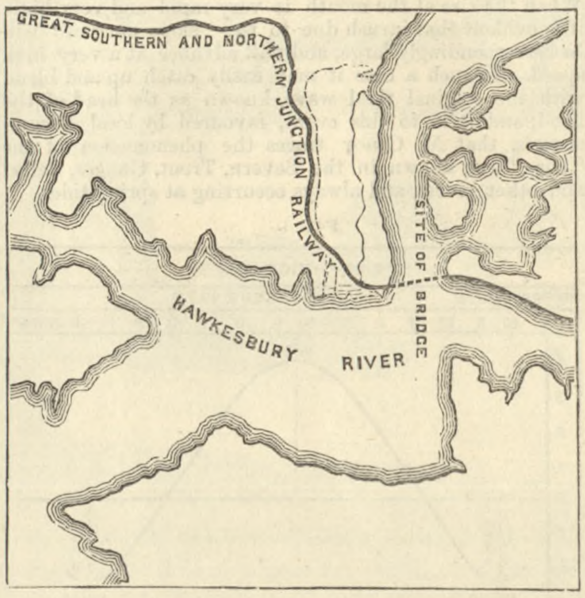
We learn from newspapers just received from Sydney that the project for the construction of a bridge over the river Hawkesbury, which has been before the Australian public for three or four years, and to which Mr. Whitton, the able and energetic chief engineer for railways, has given much attention, and for which he has, we believe, prepared complete plans, is likely now to go on. Speaking from his place in the Legislative Assembly, on September 18th, Mr. Dibbs, the Minister of Public Works, announced that it had been decided to invite competitive tenders, and that immediate steps would be taken to issue the necessary particulars in London, as well as in the Colony. As this bridge when constructed will be one of the largest in the world, and as engineers and bridge builders here may be expected to interest themselves in the scheme, we give the following description for the information of our readers. The annexed map shows the railways which have been constructed in New South Wales up to the present time; and it will be seen that while there are lines to the south and west from Sydney, there is no line directly northward. The Great Northern Railway, which will form the main communication with Queensland, and which is already completed within fifty miles of the border, starts from Newcastle; but the latter important town and coaling station is reached from Sydney, seventy-five miles distant, by sea, and the making of a railway is urgently called for. Complete surveys of this line have been made, under the direction of Mr. Whitton; but the main obstacle which has hitherto prevented the construction



of the line has been the Hawkesbury river, which discharges into the sea at Broken Bay, and whose wide estuary extending into the interior presents considerable difficulties. We append a sketch plan of the river with a dotted line showing the site selected for the proposed crossing. At this point the channel is about 3000ft. wide, and the depth of water at high tide ranges from 30ft. to 50ft. We believe that borings have been made which show strata of mud of varying density, with sand below. As a bridge must necessarily cost much money, the question arises whether a bridge cannot for the present be dispensed with, and whether the colony considering its means, population, and the traffic to be carried, should not be content for a while with a ferry, arranged after the manner usual in America with large pontoon steamers, capable of carrying a complete train. The Minister of Works stated that this alternative would probably be adopted if the tenders for the bridge exceeded a certain amount. We hear that the preliminary estimates made by different people range from a quarter of a million to more than a million sterling, so that within these limits there is a wide field for ingenuity of design.

In a recent article we referred to the methods lately adopted in New South Wales of purchasing railway material. There is a strong feeling in the colony in favour of dealing, wherever possible, with local contractors, and doubtless in the present instance full opportunity will be given to those who are enterprising enough to undertake such a work. The bridges already constructed in the colony afford much experience in this direction; but we are not aware that any of the larger bridges were erected solely at the risk of colonial contractors. As there seems an evident anxiety to obtain the best and—taking the word in its proper sense—the cheapest structure, we would point out that the attainment of such a result will depend very much on the terms of the competition; and from the meagre reference to the subject in the newspapers that have reached us, we fear that a wrong course is already decided on. Competitive tenders are spoken of, but no mention is made of competitive designs. In the colony, as in England, public bodies are often reluctant to spend money for designs, and delude themselves with the idea that they can save such an expense by throwing it upon the contractors.

If designs are to be considered only if accompanied by trustworthy tenders, and if remuneration for skill in design depends entirely on the profit to be gained in the construction of the bridge, then the field within which good ideas may be gathered is greatly narrowed. This is the plan common in the United States, and possibly the influence of American manufacturers, who are pressing their business in the colonies, has caused it to be adopted in the present case. It should be obvious that the designing and construction of a bridge are separate functions, and it is a mere accident if the most suitable plan and the most acceptable tender come together. There are, doubtless, bridge builders in this country who are well able to compete in a case of this sort, but they will be greatly discouraged if any doubt is left as to the fate of the best offer. Often in the case of



large projects of this kind a decision is not come to at the first attempt, and the designs which are sent in are shelved, at any rate temporarily, while the matter is reconsidered, or till public opinion, restrained for a time by the high expenditure proposed, again urges the carrying out of the scheme. Then an official or other design appears, in which any good ideas which may have been obtained in the previous competition are pretty sure to find a place. With every desire to act fairly—and we do not for a moment suggest improper motives—it is almost impossible to ignore the ingenious suggestions of other engineers when once they have been made known. We trust, therefore, that when the invitation appears it will contain equitable conditions, so that the best design may have its reward, and to this end, at least three very handsome premiums should be given. The Colonial authorities would then be left free either to hold back the successful design or to utilise it, by obtaining offers for construction from the ablest contractors. If a design of the chief engineer had been adopted, tenders could have been invited on a common basis; but as this course has not been followed, we hope the method which is to be adopted will be a fair one. The problem to be solved is interesting; the various plans of constructing piers in deep water and deep foundations have to be considered, while the advantages of long spans with few piers should be weighed against the alternative of cheaper short spans with lighter but more numerous piers. We shall probably have again to refer to this subject.

ESTUARIES.

By Walter R. Browne.*

Considering the importance of the results which follow from a right or wrong treatment of harbours and estuaries, and the length of time during which that treatment has been a recognised part of engineering science, it may well seem strange that any doubt should still exist on the principles which should govern it, or the limits of their application. That such is the fact, however, is abundantly proved by the single example of the Manchester Ship Canal. There a wealthy and enterprising body of projectors, having at their command all the resources of English science and skill, deliberately and without any necessity whatever—as they have themselves practically admitted—adopted a plan of operations which would demonstrably have ruined the second port in the world; and were able to support their proposal by the evidence of several well-known and influential engineers. We say "demonstrably," because there is really no more room for differences of opinion as to the effect of such works as were proposed in the Mersey than there is as to the effect of fastening down a boiler's safety valve or drilling a hole in the side of a tank. If the principles which regulate such cases are not admitted and acted upon, the only reason is that they are not recognised and understood; and it is in the hope of possibly promoting such better understanding in the future, and so preventing similar waste of time and money, that the following statement of these principles is laid before the profession. No attempt will be made to enter into theoretical investigations or to prove the physical laws involved, which are, in fact, perfectly simple and admit of no dispute; but reference will be made to such treatises as give them at length and in full detail. In all cases, where possible, practical illustrations will be adduced—not, indeed, to prove the laws, but to bring them home with full force to the mind of the reader, and furnish him with actual cases in point whenever similar works may be submitted to his judgment.

An estuary may be defined as that part of the course of a river which is invaded by the tide. It is thus distinguished on the one hand from a gulf, or arm of the sea, in which the river is practically merged and lost in the waters of the ocean; and on the other hand from a mere creek, which is an inlet occupied by the tide, but not having any river flowing into it from above.

Estuaries are divided for convenience by French writers into four sections, as follows:—(1) The mouth proper—*embouchure*—or break in the coast line, where the river opens out into the ocean; (2) the maritime section, where the estuary is still under the prevailing influence of the sea; (3) the fluvio maritime section, intermediate between No. (2) and No. (4); (4) the fluvial section, where the conditions are practically those of a river, with the difference that its downward flow is arrested twice a day by the influx of the tide.

A very important distinction with regard to the mouths of estuaries is whether or not they possess a bar. By this is meant, that at some point or other—sometimes well within the estuary, sometimes at the mouth itself, sometimes far beyond it—the bottom rises and forms a ridge extending from one side to the other, and having deeper water both inside and outside.

For engineering purposes, the most important distinction in estuaries is whether they are (1) clear or (2) turbid, *i.e.*, whether they do not or do carry any marked quantity of silt in suspension in their waters. The latter class may be again divided into (1) muddy, (2) sandy estuaries, according as the silt they contain is mainly clay or mud in a fine state of suspension or is mainly composed of grains of sand. These three classes—clear, muddy, and sandy—of estuaries require different treatment, that of the last being generally intermediate between those of the other two. Turning to muddy estuaries, as by far the most common class—at least in Europe—and also the most important, the laws which govern the motion of fine silt in water become of great practical importance. These laws are perfectly well known, and may be stated as follows:—(1) For a given velocity of current, and for a given fineness of silt, there is a certain maximum quantity of silt per unit volume of water which will be permanently held in suspension. If a larger quantity than this be present, it will sink to the bottom. (2) The rate of this sinking, when it takes place, depends on the fineness of the silt, being slower as the size of the grains is less. (3) The maximum quantity which can be so held in suspension is greater as the size of the grains is less. (4) For the same size of grains the maximum quantity is greater as the speed of the current is greater. (5) If the speed be zero, *i.e.*, if the water be still, the quantity which can be permanently held in suspension is zero, *i.e.*, if sufficient time be allowed, the whole of the silt will sink to the bottom. It is universally known, for instance, that if a phial of turbid water be allowed to stand for a time, it will gradually become quite clear. (6) Silt which has thus been deposited from a current may be afterwards "scoured" or stirred up, and again taken into suspension by another current. The velocity of this scouring current must be always considerably higher than that of the depositing current. (7) The longer the silt has lain, so as to have time to consolidate, the higher must be the velocity of a new current to scour it away. (8) The velocity of scouring here referred to is the bottom velocity of the current, and nothing else, *i.e.*, the velocity of those layers of water which are in close proximity to the silt to be scoured. The upper portion of the water, which never comes in contact with the silt, cannot possibly have any effect in increasing the scour.

This last law is so obvious that it may read like a truism, not worth setting down; but as a matter of fact it is continually forgotten in making or discussing designs for estuary work. It is continually assumed that the velocity at the surface, which can be seen and measured without difficulty, determines the amount of scour going on at the bottom; whereas it clearly tells us nothing whatever on the subject, unless the relation which the bottom velocity bears to the surface velocity is known. The laws of this relation have not been fully investigated, but for the general purposes of this treatise their accurate determination is not necessary. Roughly they may be stated as follows:—(1) The bottom velocity is always less than the surface velocity. (2) The fraction expressing the ratio of the bottom to the surface velocity is less as the depth is greater. For currents in an established and steady condition, such as those of an ordinary river, the ratio may be taken at 0·61 for 6½ft. depth, 0·59 for 8½ft. depth, and 0·55 for 10ft. depth. In very many large rivers the ratio is higher, and may be taken at 0·70 for 60ft. depth.* (3) In the particular case of an ebb current in a tidal estuary, there is evidence to show that the bottom velocity is actually *nil* for some time after the surface current has begun and has attained a considerable speed. It is said that in other places this has not been found to hold, but the details of these latter experiments have not been published.

Without insisting for the present on the last of these laws, we see that the bottom velocity in a tidal estuary is always much lower than the surface velocity, and that the difference is greater as the depth is greater. From this, and from law 4 of silt in suspension, it follows that when such

* This is, we believe, the last technical article written by the late Mr. W. R. Browne before his death. Although complete in itself, Mr. Browne in no way regarded it as his final utterance on the subject.—Ed. E.

* Browne on Tidal Scour, "Proceedings" Inst. C.E., Vol. lxvi., p. 12. At one time the observations on the Mississippi and Irrawaddy seemed to prove that in such rivers the bottom velocity was almost equal to the surface velocity. Mr. Robert Gordon has since proved—Notes on Works in the Irrawaddy Circle—that this was due to the defect of the system of measurement employed—by double floats—and that the true ratio is at least as low as that given above.

silt begins to sink its rate of sinking will increase as it approaches the bottom, and therefore the turbidity near the bottom need not be much greater than near the top, as would otherwise be the case.

We have now to consider the effect upon an estuary of the rise of water which takes place at its mouth due to the flow of the tidal wave and the ocean outside. We must begin by stating briefly the laws of two distinct forms of waves which may exist on the surface of a liquid, viz., waves of translation and waves of oscillation.

Waves of translation.—These are formed by a disturbance of the nature of thrust produced in the upper layers of water—such a disturbance, for instance, as is produced by the advance of a boat. The effect is to heap up, as it were, a ridge of water on the surface of the channel, standing entirely above this surface and sweeping rapidly along it. It occupies the whole width of the channel, decreasing in height but increasing in length if the channel widens, and increasing in height and decreasing in width if the channel narrows. Its velocity varies with the depth, being greater as the depth is greater. The motion extends to the whole depth of the water. Any individual particle advances horizontally for a certain small distance, and then stops, never returning to its original position. It has also, of course, a vertical movement accompanying the rise and fall of the water level. The velocity of propagation of a wave of translation within a current is given by the following formula:—

$$V = \sqrt{g\,(H + h)} \mp U$$

where H is the depth of the channel, h the height of the wave, and U the velocity of the current existing in the channel. Waves of translation die away by degrees in consequence of friction, but very slowly; thus a wave 6in. in height was observed by Scott Russell to have lost 1in. only after a course of 700ft.

Waves of oscillation.—These may be produced by various causes, but in general are due to a vertical force—such as that of a stone falling into a pond—which causes a momentary depression of part of the surface of the liquid. The water thus displaced necessarily rises all round the depression in the form of an annular ridge, which is immediately propagated in all directions as a circular wave; at the same time reaction causes the hollow originally formed to be filled, and more than filled, by water rushing in from all round. A protuberance is thus formed on the surface, which sinks again immediately and produces a second wave, following the first, and so on successively until the effect of the disturbance gradually dies away. Instead of the original source of the action being a depression in the water, the effects will be similar if it is a lifting or protuberance of the water. This is the case with the tidal waves of the ocean, which are due to a drawing together or lifting of the water under the attraction of the moon or sun. In this case the same cause recurs at any given place at regular intervals—about every twelve hours—and the rise and fall of the wave of course recurs also. This class of waves, in which the cause operates at regular periods, are called periodic waves.

Waves of oscillation differ from waves of translation specially in this, that their action rapidly diminishes as it descends from the surface, and soon becomes inappreciable. The heaviest storm waves do not disturb loose stones at depths of from 25ft. to 50ft., sand at depths of 50ft. to 150ft., and fine silt at depths of 300ft. to 500ft. In consequence, waves of oscillation must be divided into two classes, according as they exist in shallow water, where their effect reaches to the bottom, or in deep water, where their effect disappears before the bottom is reached. The tidal waves which enter an estuary usually belong to the former class.

The motion of any individual drop of water in a wave of oscillation is mainly that of rise and fall, but there must also be a certain amount of horizontal motion, since the depth at a section can be momentarily increased—as it is in the passage of a wave—only by an influx of water from neighbouring sections. Such a drop describes, in fact, an oval curve, returning to its original position at last; and this in waves of small height and great weight, such as tidal waves, is represented by an alternate current, first in the direction of propagation, and then in the opposite direction.

The velocity of propagation in waves of oscillation in deep water depends solely on the length L of the wave—*i.e.*, the distance between two crests—and is given by the formula—

$$V = \sqrt{\frac{g}{2\pi}\,L}$$

In shallow water the depth exerts the preponderating influence; and when the duration of the wave is long—as is the case with tidal waves—it is sufficiently represented by the formula—

$$V = \sqrt{g\,H}$$

where H is the original depth of the water.

The velocity of propagation here, as in all cases of wave motion, must be carefully distinguished from the velocity of the water affected by the wave. The former may be called the velocity of the tide; the latter the velocity of the stream. The former is always large, and always in one direction; the latter is always very much smaller, and in opposite directions alternately. And this latter current must again be carefully distinguished from the currents of an ordinary river, due simply to water running down from a higher to a lower level; in other words, to the slope of the surface. Such a current may therefore be termed a "slope current."

We are now in a position to state what takes place in an estuary during the rise and fall of the tide in the ocean outside its mouth.

Let us begin at the time of low tide. Here there is in general a period of slack water, during which the level alters very little, falling slightly and then rising, but the whole remaining nearly stationary. After this, as the tidal wave sweeps in from the ocean, the level rises with great rapidity. This is shown graphically by constituting the "local curve" of the tide at any point of a coast—that is, a curve in which the abscissæ represent times, while the ordinates represent the heights of the tide at each successive interval. Only one such example need here be given, viz., Fig. 1, which represents the "local curve" of the spring tide of 19th September, 1876, at the port of Brest. Here it will be seen that in two hours, from 9.30 to 11.30 p.m., the tide fell 0·43 m., and rose again by the same amount, while in the succeeding two hours, from 11.30 p.m. to 1.30 a.m., it rose 3 m.

This rapid rise of tide at the mouth of the estuary is of the character of a disturbance, and projects a wave of oscillation up the river. That this wave is of the character of an undulation is shown by the fact that its forward edge—or the head of the flood—is found to travel several times as fast as the current of flow at any particular point. This wave, being in comparatively shallow water, acts on the whole depth of the water, and has a velocity varying with the square root of the depth.

Hence as it passes higher up the river, where the depth is less, its velocity decreases, until it gradually dies away at the upper end of the estuary. Meanwhile the tide continues to rise at the mouth, and projects a succession of similar waves, each higher, and therefore more rapid, than its predecessor. But this is not all. The rise in the water level at the mouth above that further up the estuary occasions a "slope current," or actual inrush of salt water into the channel, tending to fill it. The combination of these two—the waves of undulation projected from the disturbance at the mouth, and the inrush of water due to the higher level in the ocean outside—forms the "estuary tidal wave." The amount of the effort due to each of these causes differs according to circumstances. When the rise at the mouth is very rapid and very high, it is evident that inrush due to the "slope current" will be correspondingly large, and will advance at a very high speed. In such a case it may easily catch up and blend with the original tidal wave, known as the head of the flood; and it is to this event, favoured by local circumstances, that M. Canoy traces the phenomenon of the "bore" well known in the Severn, Trent, Ganges, Seine, and other rivers, and always occurring at spring tides.

FIG. 1

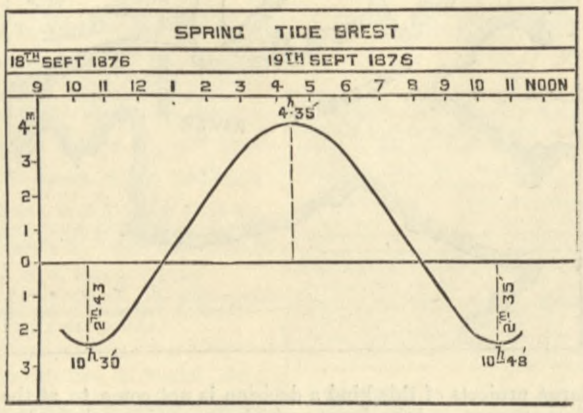


FIG. 2
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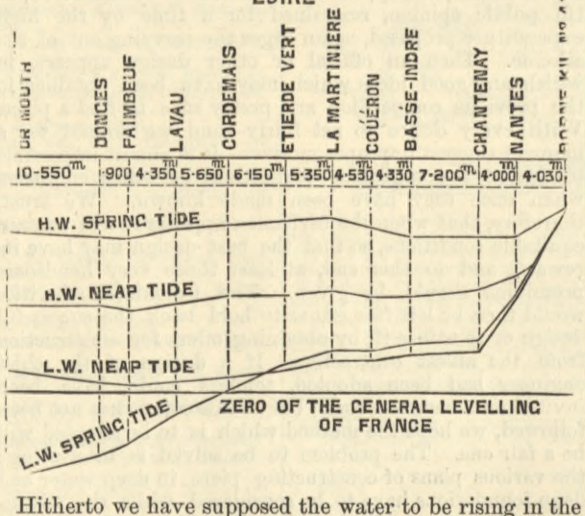


Hitherto we have supposed the water to be rising in the ocean outside. Let us now suppose the "top of the tide" to be reached, and that the level begins to fall. By this time the "head of the flood" will have penetrated many miles inland, but whether to the actual limit of the estuary or not will depend upon the length of the latter. If not, the wave will still continue to travel forwards till it dies away, in virtue of the thrust due to the mass of waters behind it; but this is not a point of much significance. In any case, the distance from the head of the flood to the crest, or highest level, of the tidal wave, will by this time be very short, owing to the fact that the later waves are in deeper water, and travel faster, so as to be always catching up those in front. This is shown by Fig. 2, which represents, to a highly exaggerated scale, the actual outlines of the tidal waves in the estuary of the Loire, as taken every successive hour during the spring-tide of September 19th, 1876. From this crest of the wave to the mouth the estuary is filled with salt water to a level which practically coincides throughout with the highest level at the mouth. As soon as this latter level falls, a downward slope is established in the river, which causes the impounded waters to flow down again towards the sea. The commencement of this downward current is called the "turn of the stream," and corresponds nearly, though not exactly, at each point of the estuary with the "turn of the tide," when the level itself becomes stationary, and then begins to descend. This downward current has, however, none of the characteristics of an undulation; it is simply a slope current, due to the fall of tide at the mouth. It is probable that for some time it does not extend to the bottom of the estuary, where the water still remains quiescent. At any rate, the velocity here is only a fraction of what it is at the surface. This downward flow or ebb rapidly extends to the head of the estuary, and for the last few hours of the ebb tide the whole estuary is in the condition of an ordinary river of rapid fall, which is emptying itself into a lake or a tideless sea.

VISITS IN THE PROVINCES.

MESSRS. ROBINSON AND SON'S WORKS, ROCHDALE.

The wood-working machinery of Messrs. Robinson and Son is well known wherever wood conversion is effected on any scale, and their productions in the new branch of mechanical engineering which they have taken up, namely, roller milling machinery, is likely to gain an equally wide reputation. The appliances of the old system of milling are in all directions being torn up by the roots and the new adopted in their stead, and seeing the probable wide field for this, Messrs. Robinson have taken it in hand with energy. In looking at some of this machinery lately, we passed through their works at Rochdale, which include one of the finest foundries in Lancashire. The extensive use of machine frames or bodies of the hollow pattern cast in one piece, necessitates considerable foundry facilities, and a recent extensive substitution of malleable iron for wrought iron forgings has added to the work of the foundry, while it has equally reduced the smithy requirements. It was somewhat of a surprise, for instance, to find that room for a fine stores, chiefly for malleable iron castings, had been obtained by taking what had been a part of the smiths' shop and altering it for this use. But an examination of the stock, as well as of parts in the fitting and machine shops, showed what an extensive reduction in the work of the smithy had been made.

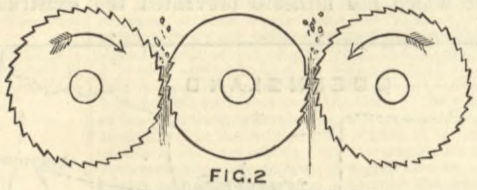


FIG. 2
FIRST BREAK ROLLER MILL.

Not only are spanners of all kinds, levers, strap guides, links, and many other of the lighter articles made in the foundry instead of the smithy, but spindles for many purposes and of many sizes are made of malleable iron, as well as cross beams and rocking arms hitherto made in single, or built up and fitted together wrought iron parts. In wood-working, as well as in some other kinds of machinery, it often becomes necessary to make parts much heavier than would be dictated by reference to stresses visited upon the parts. It is necessary to adopt sizes and sectional areas which will prevent elastic flexure in order that vibration may be reduced to a minimum; spindles must sometimes be made larger than would be necessary to transmit the torsional stress visited upon them, in order that bearings may be large enough to work a long time without appreciable wear, and for the same reasons as those which in the construction of some machines have made it necessary to use tubular spindles. For such work as this it is clear that malleable cast iron may be used in place of wrought iron, and in many cases it may be substituted with advantage, in consequence of the greater facility with which the best form may be given to a casting than to a forging. The gain to the manufacturer is not only in the difference between the cost of the malleable casting and the forging, but in the case of, for instance, short spindles which would be either simply pieces of bar iron cut off and perhaps with ends shouldered down, leaving collars to be turned out of the solid, a very considerable gain accrues

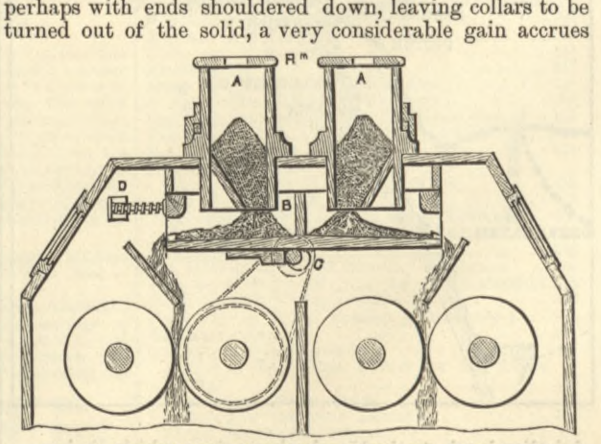


Fig. 5—AUTOMATIC VIBRATING ROLLER MILL FEED.

in the turnery, while in many other details the difference in the cost in the machine and fitting shops may be very large. In most cases no sacrifice of strength is made, for by careful study of the production of the strongest and soundest malleable castings, toughness and high tensile strength has been obtained instead of low tensile strength, accompanied by great and useless ductility. Messrs. Robinson have devoted much attention to this subject, and expect to obtain malleable castings which will excel in most mechanical properties the wrought iron forgings previously used. An illustration of the use of malleable iron in place of very expensive forgings we noticed in the top and bottom crossheads for carrying the saws in some large vertical frame saws in course of completion for the Indian Government for cutting up teak into railway sleepers. These frame saws are fine machines of large proportions, and driven direct by attached steam cylinders.

Amongst other machines of this kind we noticed several deal frames, in which the vertical members of the saw frame itself are made of steel tubes, by which great strength with lightness is secured, making it possible to run these machines at a high speed. For instance, a deal frame capable of working on 24in. deals, and with a 15in. stroke, may be run at 300 revolutions per minute, and the machines with 12in. stroke are all set to run at this speed. Amongst other deal frames ready for delivery were some for France, with a device for returning a deal before being quite cut through. It seems to be a practice in France not to cut the deals quite through as we do in this country. Why this is done, unless it is that purchasers shall not be able to see any but the outsides of the outside boards, we do not know.

In their horizontal double saw timber frame, used chiefly for opening up expensive logs, Messrs. Robinson have made an improvement in the mode of holding and guiding the saws. The little crossheads which carry the saws slide in guides which in plan are placed somewhat thus, the result being that the saws in which the teeth of either half length point towards the ends are in fair cut from centre to heel, and have free octagonal seatings by laborious driving in and out was supposed to be best. The brass with the turned exterior and kept from revolving by a pin seems, however, to have claimed and retained a place for both light and heavy work, and the practice introduced by Messrs. Ransome, of Ipswich, we believe, has gained favour. At the recent Forestry Exhibition Messrs. Robinson were awarded silver or bronze medals, but, like some other of the fifty English makers, they returned them. About 200 medals were awarded to Scotch exhibitors, some of whom received gold medals for rapidly, a continuous stream of material is delivered evenly upon the whole width of the rolls. At the edges of the board over which the feed flows to the rolls are serrated strips of wood, which cause the material to be delivered uniformly over the whole width of the roll. When the flow of material into the hopper increases, it presses down with greater weight on the vibrating board, which, in turn, gradually increases the flow on to rolls. This feed works equally well on wheat or middlings, and its construction is so simple that it cannot very well get out of order. The

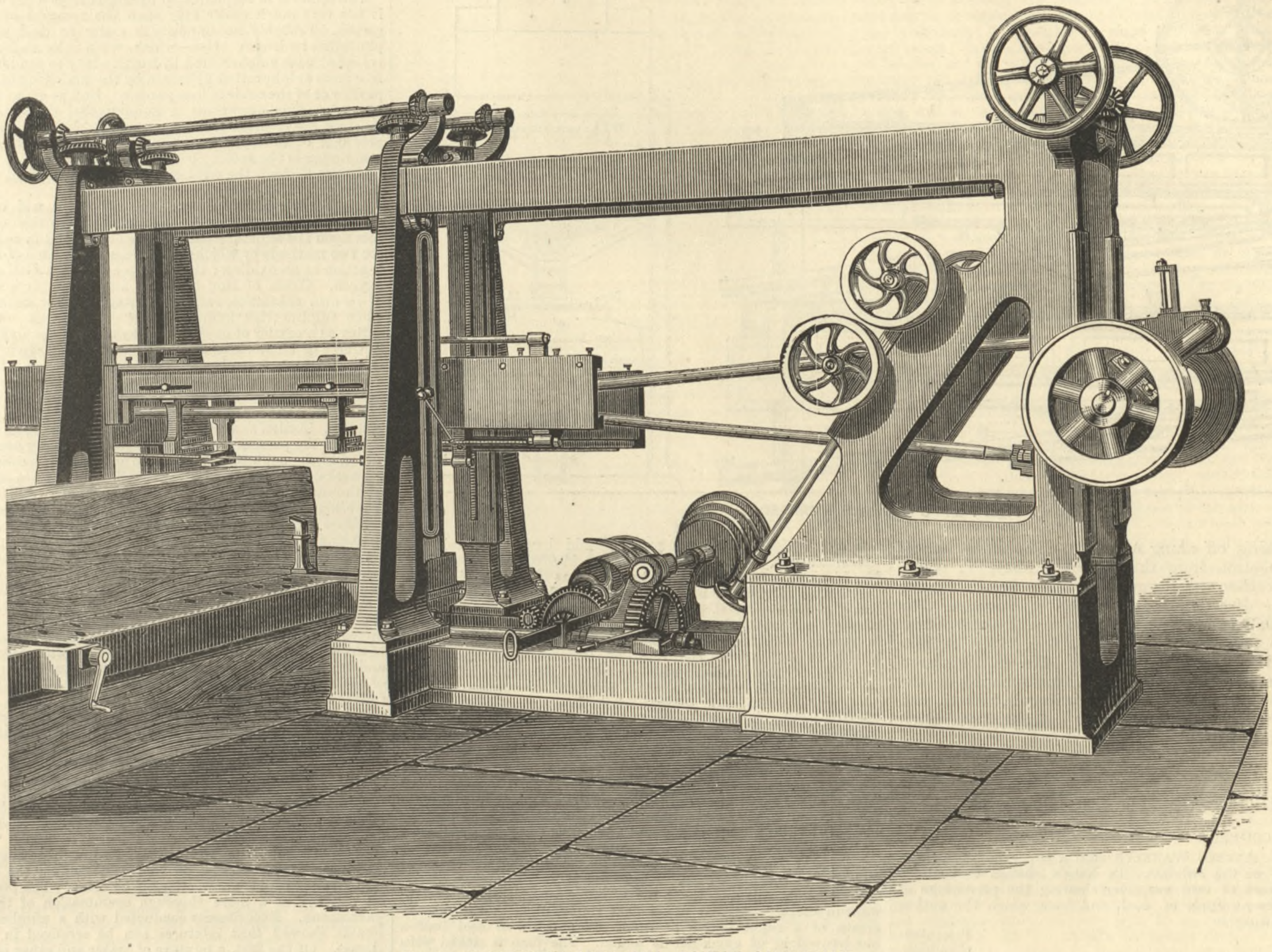


Fig. 1—ROBINSON'S HORIZONTAL DOUBLE SAW FRAME.

return. A double saw of this kind is illustrated by the accompanying engraving, Fig, 1. These horizontal saw frames are gaining much favour, although opinion was at first against them. They are useful for various purposes, and the work of setting a log is much less than on a vertical frame bed, and being made to run at a high speed, they overcome a good deal of work and produce a good surface. The same remark applies to some extent to horizontal band saws.

Throughout the whole of the circular saw benches and in other machines, it is noticeable that where a few years ago it was usual to employ three bearings on spindles

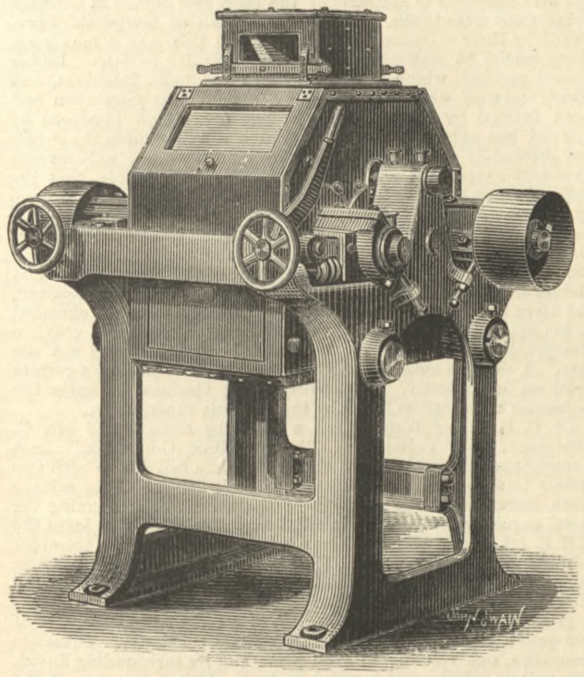


Fig. 3—FIRST BREAK ROLLER MILL.

only two are now used. Experience has shown that three bearings seldom wear alike, and in the strong frames of sawing machinery, as in other places, they were found to give trouble not experienced where but two bearings were used. Slightly heavier spindles have therefore been adopted and only two bearings; the latter are usually of great length, and especially so in the roller mills, to which we shall refer further on. For all purposes Messrs. Robinson are adopting the turned brasses fitted into bored pedestals. This was not at one time thought good work, and the old system of fitting brasses into square or

English machinery, so that it did not seem necessary for the maker to accept a bronze medal for the same thing.

In turning their attention to roller milling machinery, Messrs. Robinson and Sons have adopted several devices not generally used. In their first break rolls, for instance, they use a groove of about half an inch in width instead of, say, an eighth of an inch, two rollers on one stand running against a central roller which is only grooved on part of its circumference, as shown on the left of the sketch, Fig. 2, the centre roll being fixed, while the outer rolls run in the direction shown at about 450 revolutions per minute, the rolls being 9in. diameter. The grains of wheat are by this means broken into two along the crease rather than cut into two, and the wear of the teeth of the

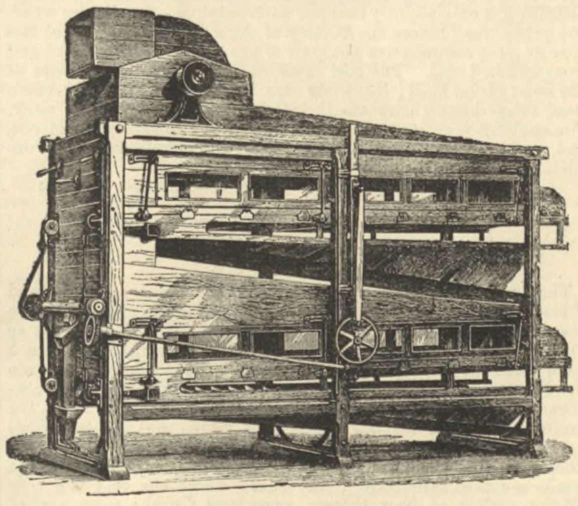


Fig. 6—DOUBLE PURIFIER.

central roller is taken up by moving the roller round so as to present a new tooth to the work.

Messrs. Robinson's mills are shown by the accompanying engraving, Figs. 3 and 4. The construction is clearly seen from these. The rollers are horizontal, the grooves after the first break varying from 0·125in. to a very fine pitch. The adjustment, and the means of instantly separating the rolls, are very simple and strong, and the bearings are made of unusual length. The machines are well and strongly designed, and are fitted with an automatic vibrating feed, as shown in section in the engraving, Fig. 5. In this, A is a hopper, to which the spout is connected which feeds the machine. B is the vibrating board on which the stuff falls from the hopper A, motion being given to this sieve by the excentric shaft C, against which it is pressed by the spring D. On the excentric shaft revolving

gearing in these mills is all cut by machines from the solid so as to obtain smooth and easy running. The arrangement is such that the rollers are easily removed, and the bearings have large oil reservoirs with simple automatic dip feed. The rolls used, like those of other milling machinery constructors, are of American make. Attempt after attempt has been made to produce these rolls in England, but all have so far failed that the best-known machinists buy their rolls in the States. The reason alleged for this is that iron possessed by the Americans not only receives a more uniform chill, but enables the makers to produce a sounder

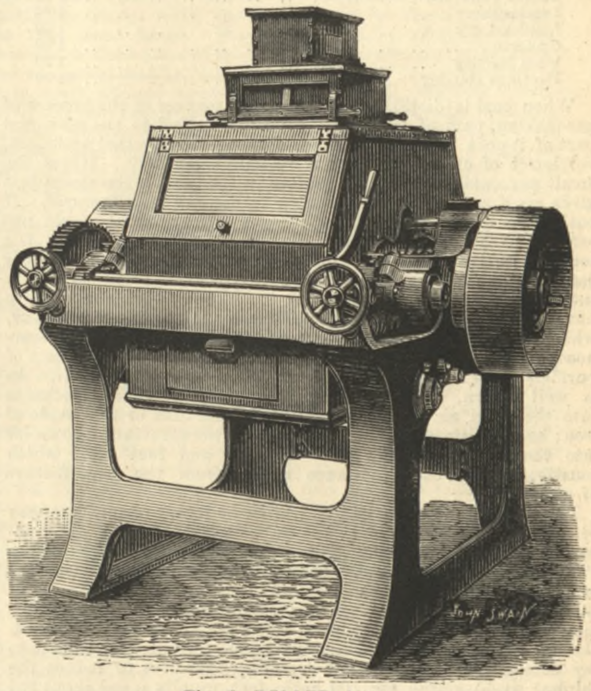
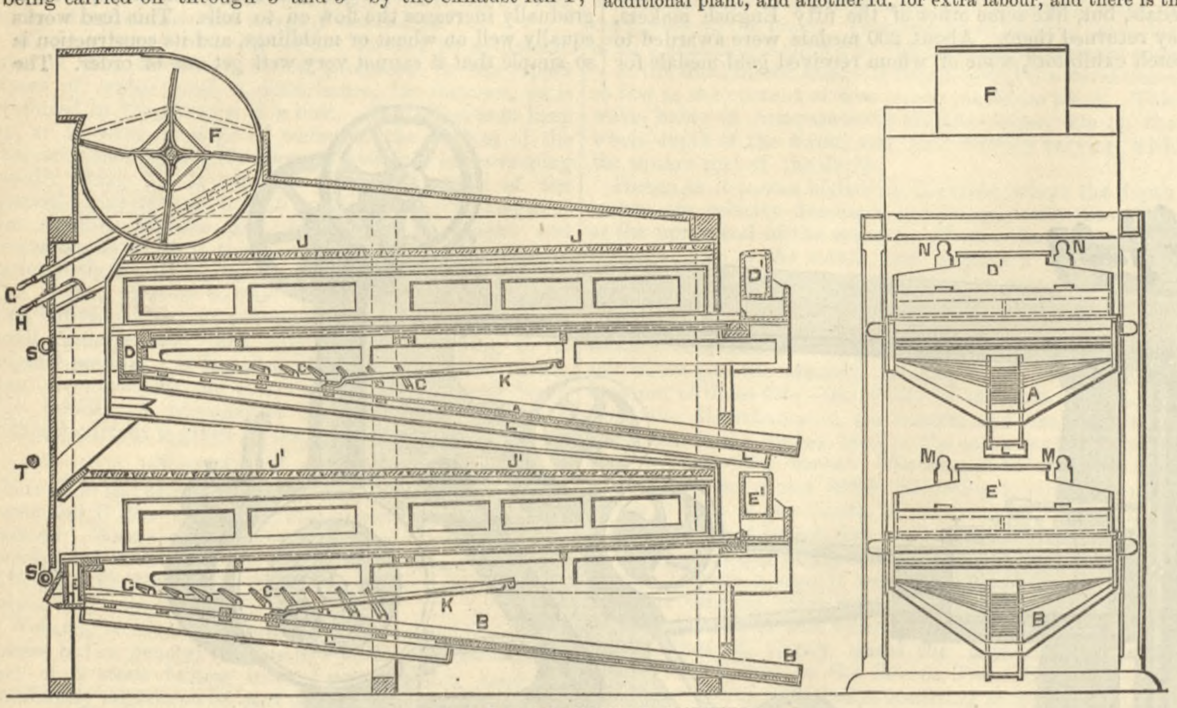


Fig. 4—ROLLER MILL.

casting. Rolls for heavy work, rolls of fine finish for tinplate rolling and finishing, rolls even of considerable length and fine uniform surface and finish for calendering, and rolls for other purposes, are all made successfully in England. Why English makers cannot turn out a roll that will finish up well and take the grooving for roller mills seems really inexplicable. Surely it should not be impossible for English makers to make a mixture of metal which would do all that the American rolls can do. If it will pay American founders to find out what must be done in this matter, it ought to pay English founders to do the same, now that roller milling is making such rapid strides towards general adoption all over the country.

The engravings, Figs. 6 and 7 and 8, illustrate a double purifier, which is a speciality of Messrs. Robinson. Fig. 6 is a perspective view and Fig. 7 and 8 sectional illustrations. From the latter the construction is clearly seen. The middlings fed in at D^1 and E^1 find their way along the sieves towards the ends D and E, and fine material being carried off through J and J^1 by the exhaust fan F,



Figs. 7 and 8—DOUBLE PURIFIER.

the flour passing off along A and B. The sieve frames receive the motion from the excentric shaft T, which actuates the leather straps running over pulleys S S^1, the motion in one direction being effected by springs. The material which has not passed through the upper sieves may be made to pass over the lower one, or the purifier may act as two separate machines. Messrs. Robinson have large premises occupied in the manufacture of the machines referred to, and for the centrifugals, bolters, and all the other apparatus required for complete flour mills on the roller mill system.

THE SOCIETY OF ENGINEERS.

COOPERS COAL-LIMING PROCESS.

PROFESSOR J. ALFRED WANKLYN read a paper on "The Coal-liming Process" on the 3rd inst. In King's treatise on coal-gas numerous analyses of coal are given showing the percentage of sulphur in different kinds of coal, and from which the author quotes the foilowing:—

	Percentage of sulphur in coal.
Derbyshire coals..	0·91
" "	1·14
Gloucestershire coals	0·85
" "	2·67
Lancashire coals..	0·80
" "	2·43
Scotch coals ..	0·32
" "	1·53
Welsh coals ..	0·79
" "	3·95
Newcastle coals, average of eighteen samples from different mines ..	1·24
Old Pelton	0·75
Pelaw	0·85
Washington ..	0·73
New Pelton ..	0·62
Leverson	0·69
Dean's Primrose	0·90
Londonderry	1·64
Londonderry	1·30
Gosforth	1·10
West Hartley	1·20
Hastings Hartley	1·50

When coal is distilled in the ordinary manner in the process of gas-making, part of the sulphur remains behind in the coke, and part of it goes into the gas in the form of sulphuretted hydrogen, sulphuret of carbon, and other volatile compounds. Hence the small percentages of sulphur shown in the tabular statement just given are a source of great trouble to the gas manufacturer. If coal were devoid of sulphur, the gas made from it would not require to be passed through purifiers, and after leaving the scrubber might go directly into the holder. But since coal does contain some 1 per cent. of sulphur, a portion of which enters into the gas, the gas manufacturer has hitherto been compelled to have recourse to a process of purification by means of purifiers, which is very costly, and creates a great nuisance in the neighbourhood of the gasworks. The process of purification by means of purifiers is so familiar that the author need not describe it. As is well known, one of its incidents is the periodical discharge into the open air of large volumes of foul lime or foul oxide of iron; and, as is equally well known, it is the effluvium thrown off into the atmosphere by the foul lime and foul oxide which constitutes the chief nuisance arising from the manufacture of gas.

The cost of the process of purification by means of purifiers may be arrived at by reference to the published accounts of gas companies, and to the evidence given by eminent gas engineers before Parliamentary Committees. The following summary will be found to be in accordance with the facts which have come to light:—Gas companies—for instance, the gas companies of London—which manufacture very pure gas, spend 8 31d. per ton of coal carbonised. Gas companies which do not manufacture very pure gas, that is to say companies which do not trouble themselves to reduce the sulphur to 15 grains per 100 cubic feet, usually spend about the half of that sum on the purification of gas. The author has also to mention that these figures relate solely to the cost of labour and material, and are exclusive of interest on the capital sunk in the erection of the purifiers and the purifying house, and exclusive of ground rents. On this subject the evidence of Mr. George Livesey, of the South Metropolitan Gas Company, is very instructive. The evidence was given on June 17th, 1880, before a Parliamentary Committee, and is quoted by Mr. Spice in his book on the purification of coal gas, page 29. Mr. George Livesey said:—"All I can say on that point is this: If the town wishes to have gas at a maximum of 20 grains of sulphur impurity they must pay for it. It involves double the extent of purifiers that would otherwise be required if there was no restriction, and it involves about double the quantity of materials and the labour of purifying."

Replying to counsel's remark, "You have not considered in this case the question of the standard price," Mr. Livesey said, "I have considered it to this extent, that a certain standard is sufficient without restriction. They would want 2d. more per 1000ft. with these restrictions." Replying to counsel's observation, "You have differed from some of the witnesses who have been called, who say 1d. per 1000ft. would be enough," Mr. Livesey continued: "I take it that 1d. per 1000ft. is interest on the capital expended on the additional plant, and another 1d. for extra labour, and there is the nuisance besides which the public would have to submit to." Inasmuch as a ton of coal yields about 10,000 cubic feet of gas, Mr. Livesey's evidence amounts to this—that the cost of the extra purification requisite to lower the sulphur to 15 grains per 100 cubic feet of gas is about 20d. per ton of coal carbonised, 10d. being for labour and material, and 10d. for interest on capital sunk in plant. This, then, was the condition of the gas industry in this respect up to the date of Cooper's coal-liming process, which the author will presently describe. The coal used in gasworks contains about 1 per cent. of sulphur. When gas is made, part of this sulphur enters into the gas. To rid the gas of this sulphur, and thereby to render the gas fit for the use of civilised society, costs 8d. or 10d. in labour and material per ton of coal carbonised, and 8d. or 10d. in interest on plant, and entails upon the gasworks the creation of one of the worst nuisances in the whole range of manufacturing industry. In this condition of affairs Cooper's coal-liming process supplies a remedy by manufacturing gas up to the London standard of purity, and saving 90 per cent. of the cost of purification and abstaining from the creation of the nuisance. If we could find a supply of non-sulphurous coal, or if we could extract the sulphur before carbonising the coal, the difficulty would be got over. But there is no probability of our accomplishing either of these tasks, and Cooper's process sets to work in another way. It neutralises the sulphur in the coal by means of a slight excess of lime. To one ton of coal half a hundredweight of quicklime is added. The lime is slaked with about its own weight of water and mixed intimately with the coal. At the Tunbridge Wells Gasworks, where the process has been in operation for about twelve months, the lime and coal in the proportions stated are fed into an incorporating mill, in which they are blended by being passed between a pair of toothed rollers. The limed coal falls into a receiver, from whence it is lifted up by elevators to fixed hoppers in the retort-house, where it is stored for use and is supplied to the charging apparatus as required for the retorts. It is a well-known chemical fact that at the temperatures, and under the conditions realised in the interior of the gas-retort, sulphur has a greater tendency to unite with calcium than to unite with hydrogen or with carbon or with oxygen, and if these were absolutely perfect mixture of the lime with the coal, there would be absolutely no escape of any sulphur into the gas. In practice the mixture is only approximate, and accordingly in practice the purity of the gas is approximate. But the approximation is good enough to ensure the most important results. During the two years which have elapsed since Cooper's process was introduced to public notice, ample opportunities have been afforded of demonstrating the efficiency of the process in yielding gas only slightly charged with sulphur. In a paper which the author read before the Society of Arts in the early part of this year he gave comparative analyses of gas produced from limed and from unlimed coal. The coal employed in the experiments was of the most varied kind; the scale was larger, the gas being taken from retort-houses carbonising about 1000 tons of coal a week. The analyses were very numerous, amounting to several hundreds, and, as the following specimens show, the results were quite unmistakeable:—

January 30th, 1883.	Grains of sulphur per 100 cubic feet of gas. Limed coal.	Unlimed coal.
I.	14·4	26·3
II.	17·1	26·3
III.	15·9	

The figures express the results arrived at by the Harcourt method of testing. The effects of the lime on the sulphur compound, even when the mixture of the lime with the coal is imperfect, are so striking that it is hardly possible for any experimenter to overlook them when his attention has been directed to the subject; and even Mr. Hack, whose report to the Birmingham Corporation was conspicuously adverse to Cooper's process, did not fail to show the diminution of the sulphur compounds which that process brings about. At the Tunbridge Wells Gasworks, where the Cooper process, as already stated, has been worked for an entire year, the results are most satisfactory. At these works the coal is a very inferior variety of New Pelton, consisting for the most part of slack, and containing, according to the author's analysis, 1·7 to 1·3 per cent. of sulphur. Under ordinary circumstances, such coal might be expected to yield a gas which—unless purified by the lime purifier—would contain from 25 to 50 grains of sulphur compound per 100 cubic feet of gas. During the year in which Cooper's process has been worked at Tunbridge Wells, and during which there has been no lime-purifier at the gasworks, a mean of less than 13 grains of sulphur per 100 cubic feet of gas has been maintained. The author ought to add that this result has been arrived at without reverting to any specially intimate mixture beyond the incorporating mill already referred to. The West charging machine is used at Tunbridge Wells, but none of the many obvious devices have been resorted to in order to increase the mixing power of the machine.

Viewing the question from a chemical point of view, the intrinsic superiority of coal-liming over the lime-purifier as a means of depriving gas of sulphur is obvious. If it were desired, as in time to come it may be, to manufacture gas with the sulphur reduced to 1 grain per 100 cubic feet, a chemist might hope to accomplish the task by a persevering endeavour to comply strictly with the directions of the Cooper process. By a suitable modification of the generating mass it is by no means an impossible task to generate a gas originally free from sulphuret of carbon. But to absorb the last trace of sulphuret of carbon contained in gas is a very much more difficult undertaking. The inferiority of the lime purifier to coal lining is aptly shown by the rise in sulphur compounds which takes place in winter. In pity for the necessities of the London companies, which have hitherto had to rely upon so troublesome an implement as the lime purifier, the gas referees permit the gas in winter to contain twenty-two grains of sulphur per 100 cubic feet. If coal liming were resorted to instead of the lime purifiers, the London companies would require no such indulgence.

The removal of sulphuretted hydrogen from a gas which contains it is a very much easier task than the removal of sulphuret of carbon. Probably no impurity is easier to deal with than sulphuretted hydrogen. Gas—which, when it issues from the retort, is loaded with sulphuretted hydrogen—may be rendered absolutely free from sulphuretted hydrogen by the action either of the lime purifier or of the oxide of iron purifier. But, as hitherto practised in gasworks, this absorption of sulphuretted hydrogen has always involved the creation of nuisance and the expenditure of a considerable sum of money. An indirect but very important result of coal liming is the accomplishment of the removal of sulphuretted hydrogen without the creation of any nuisance and with diminution of the expenditure.

In order to explain how this comes about, it will be requisite to direct attention to the manner in which the oxide of iron purifier acts upon the sulphuretted hydrogen contained in coal-gas. There are two methods by which this purifier acts. One of these methods is action as an oxidiser; the other method is action as a carrier of oxygen. Oxide of iron acting as an oxidiser gives up oxygen out of its own substance, and in that way produces water and sulphur when sulphuretted hydrogen passes through it. Oxide of iron acting as a carrier of oxygen acts by causing the oxygen contained in traces of air to unite with sulphuretted hydrogen. Both kinds of action have been known for many years, and both kinds of action have been employed in gasworks for many years. Between these two methods of action there is a very vital practical difference. Action as an oxidiser is productive of nuisance, and is costly. Action as a carrier is devoid of nuisance and is economical.

Up to the present time, in most gasworks, very nearly the entire action of the oxide of iron has been action as an oxidiser. In a few gasworks, here and there, about half of the action may have been of the carrier kind. But at Tunbridge Wells—and as yet only at Tunbridge Wells—has the entire action of the oxide of iron been confined to the carrier kind. And this great achievement has become possible through the adoption of the Cooper process, which so far limits the proportion of sulphuretted hydrogen in the crude gas that traces of air become amply sufficient for the destruction of the whole of the sulphuretted hydrogen contained in the gas. In conclusion, the author would observe that the Cooper process is singularly free from drawbacks of any kind. The lime which is mixed with the coal returns more than its money value in the shape of the increased yield of ammonia. The coke is increased in quantity, and improved in quality. There is neither diminution of the volume of the gas, nor deterioration of its quality. There is not even a falling off in the yield of gas per mouthpiece when the process is properly worked. And there is no appreciable destruction of the furnaces which can properly be laid to the charge of the coal-liming process.

THE PHYSICAL SOCIETY.

AT the last meeting of this Society, held on the 8th inst., Professor Ayrton in the chair, Mr. Kavargee was elected a member of the Society; Professor F. Guthrie read a paper "On Certain Phenomena Attending Mixture." In a previous paper Dr. Guthrie had noticed the increase of volume attending the separation of triethylamine and water effected by heat. The present paper is an account of a more thorough examination of this and allied phenomena. Experiments conducted with a number of different liquids showed that mixtures can be arranged in two distinct classes. Of the first, a mixture of water and ether is an example; when shaken up together they mix, heat is evolved, and a diminution of bulk takes place. If any excess of ether present is poured off, and the lower clear liquid heated in a sealed tube, it becomes turbid owing to the separation of the ether. This is accompanied by an increase of bulk and absorption of heat. Triethylamine and water and diethylamine and water are mixtures belonging to this class; the temperature of separation is a function of the ratio in which the two liquids are present. A typical case of the second class is a mixture of alcohol and bisulphide of carbon. These mix with one another in all proportions above 0 deg. Cent. with increase of bulk and absorption of heat. Upon being cooled to about 17 deg. Cent. they separate. The separation of a mixture of ether and water and of a mixture of alcohol and the bisulphide was shown. In these cases the action is regarded as a chemical one, and generally an excess of one liquid or the other is present. To determine the combining proportions two methods were used. In the first a number of mixtures of the same two liquids in different proportions were taken, and the rise or fall of temperature produced by their mixture measured. When this was a maximum there might be assumed to be no dead matter present. In the second method, which is more delicate but more laborious, and which was used when the approximate combining proportion had been formed by the first, the change of volume produced by mixture was noted; when this increment is a maximum the liquids are present in their combining proportions. These experiments gave very concordant and definite results; for example, that the molecular compounds of ether and carbonic sulphide is represented by the formula $C_4H_{10}O$, $2CS_2$; and that of chloroform and carbonic sulphide by $CHCl_3$, CS_2. A striking confirmation of this view is afforded by the behaviour of the vapour tension of a mixture. The temperature being constant, if the vapour tension be plotted with the percentages of the more volatile liquid as abscissæ, the curve is for a mixture of two liquids which have no chemical action upon one another, as the iodide and bromide of ethyl, a straight line. For ordinary mixtures, however, this is not the case. A curve is obtained in which there is observable at a certain point an irregularity. The corresponding abscissæ indicates the molecular combination found by the previous experiments.

Dr. C. R. Alder Wright read a paper by himself and Mr. C. Thompson, on "Voltaic and Thermo-voltaic Constants." In a former paper the authors had stated that in a cell set up with two metals immersed in pure solutions of their corresponding salts, a given increment in the strength of the solution surrounding the metal acquiring the higher potential causes an increment (a) in the E.M.F. set up (c), while an increment in the strength of the other solution causes a decrement (b) in the E.M.F. This law is now substantiated. It is, however, found that for dilute acids instead of metallic salts b may be negative. The authors also find that it is possible to represent the E.M.F. of a cell by the difference of two quantities, which they term the voltaic constants. These are quantities, one relating to each plate and its surrounding liquid. The voltaic constant of a metal and a liquid is a function of the nature of the metal surface, the strength of the solution, and the temperature, but is independent of the opposed plate and its liquid. It is practically defined as the E.M.F. set up when opposed to a zinc plate in a solution of the corresponding zinc salt of the same molecular strength. The authors further conclude that the E.M.F. of a given combination usually stands in no simple relationship to the chemical action taking place in the cell, but that it may be expressed by the sum of the mechanical equivalent of the chemical action per electro-chemical equivalent, and the difference of two quantities, one being related to each metal and its surrounding liquid, and being constant for that metal and liquid, termed thermo-voltaic constants. This thermo-voltaic action may act with or against the chemical action in producing E.M.F. In some cases, as in that of a cell composed of iron in ferrous sulphate and cadmium in cadmic sulphate solutions, the E.M.F. is against and greater than that produced by chemical action; consequently, the cell works backwards with absorption of heat. At the close of the paper Professor Ayrton and Dr. Guthrie remarked upon the apparent exception here shown to the second law of thermo-dynamics.

PROFESSOR ELGAR ON SHIPBUILDING.

PROFESSOR ELGAR entered upon the duties of the John Elder Chair of Naval Architecture on the 11th inst., the introductory address being delivered in the Humanity Class-room of the Glasgow University. There was a fair attendance of students, besides whom Principal Caird, the members of the University Senate, and several of the leading gentlemen connected with the Clyde shipbuilding industry were present; while the two front benches were occupied by ladies, among the number being Mrs. Elder, who, in commemoration of her husband, has endowed the new chair.

Professor Elgar was introduced by Principal Caird. Professor Elgar began by saying that, unlike nearly all the professors whom he had now the honour to call his colleagues, he had no predecessor the records or traditions of whose life and work he could appeal to for encouragement or inspiration, or as a pattern for imitation. He could not speak from personal experience of Professor Rankine's teaching in that University, but he was grateful for the opportunity of paying an humble tribute to his memory. Professor Rankine was a lecturer at the Royal School of Naval Architecture and Marine Engineering, at which Professor Elgar was a student, and he was one of the ablest members of and most regular attendants at the Institution of Naval Architects in London. There were very able men in London in those days. Problems which had previously baffled all attempts at solution, even when made by some of the most eminent mathematicians of this and the previous century, were at length yielding to the genius and methods of modern investigators. The way was led by the late Mr. Wm. Froude, with a paper upon "The Rolling of Ships," read before the Institution of Naval Architects in 1861. Professor Rankine impressed the students in London with the most profound respect and admiration for his great powers, and for the original and masterly way in which he dealt with everything he touched, while he possessed the rare gift of rousing their energies by his own personal enthusiasm and charm of manner. He did not feel, however, that the circumstances of the present case required from him anything of the nature of an apologia. It would, perhaps, be more appropriate to the occasion if he passed on at once to attempt to show how and when it was that the present irresistible demand for improved scientific knowledge arose in the mercantile marine, and that shipbuilders became convinced, not merely of the desirability, but of the absolute necessity, of long and severe courses of preparation of scientific study, such as their forefathers, to all appearances, got on very well without. The demand for scientific knowledge is a comparatively modern one, so far as the mercantile marine is concerned. It has long existed, however, in connection with the requirements of the Royal Navy. Even so long ago as Sir Walter Raleigh's day the builders of ships of war were reproached for want of technical knowledge, and for the errors and failures that were consequent upon it. That celebrated author, in his "Discourses on the Royal Navy and Sea Service," draws attention to the injurious effect upon a vessel's sailing qualities which is caused by over immersion, such as was then a common defect in war-ships. He says:—"That the shipwrights be not deceived herein—as for the most part they have ever been—they must be sure that the ship sinck no deeper into the water than they promise, for otherwise the bow and quarter will utterly spoile her sayling." Such complaints did not merely apply to the war-ships of this country, for we find one of the earliest French writers upon naval architecture, Pere Hoste, saying in 1697 of the ships of the French Navy:—"It cannot be denied that the art of constructing ships, which is so necessary to the State, is the least perfect of all the arts. Chance has so much to do with construction that the ships which are built with the greatest care are commonly the worst, and those which are built carelessly are sometimes the best. Thus the largest ships are often the most defective, and more good ships are seen amongst the merchantmen than in the Royal Navy." It was in the construction of war-ships that the greatest difficulties formerly arose, and that the need of scientific knowledge and improved methods of design was first made manifest. Merchantmen were smaller in size and much more simple and uniform in type and proportions than war-ships until quite recent times. If we look at the mercantile marine of fifty years ago we find that there were then about 750 vessels built in each year. Out of these 750 vessels only about forty were above 300 tons—old builders' measurement—and only ten exceeded 500 tons. The whole number of ships composing the British mercantile marine in 1830 amounted to 19,110, of which but 168 were above 500 tons measurement. Thus more than 99 per cent. were of less than 500 tons measurement. Very few merchant ships were then ever built of over 130ft. in length. Mr. James Laing, of Sunderland, had been good enough to furnish him with particulars of a vessel which was built by his father, for his own use as a shipowner, in 1815. She was interesting as having been one of the first of the free-traders to Calcutta after the breaking up in that year of the monopoly so long enjoyed by the East India Company. The length of this vessel was 109ft. 9in.; breadth, 29ft. 7in.; and depth, 20ft. 6in.; her tonnage being 414 27-94. This is a typical illustration of a fine merchantman of that period, such as was employed upon the longest sea voyages. She was named the Caledonia, and successfully performed her voyage to India and back in about 10½ months, which was considered good work in those days. Henry VII. built several large vessels, one of which measured, according to various accounts, from 1000 to 1500 tons. Of the fleet that sailed out to meet the Spanish Armada there were two ships which exceeded 1000 tons burthen. James I. built a vessel which measured 1400 tons; while the Royal Sovereign, built by Charles I. in 1637, was said to be "just so many tons in burthen as there have been years since our blessed Saviour's incarnation—namely, 1637, and not one under or over." Coming to more recent times, we find that at the commencement of the present century British first-rate ships of the line had increased in size to 2000, and even to 2500 tons measurement. These vessels were heavily laden with top-hamper in the shape of three tiers of decks, which had numerous guns upon them. They were frequently overdraughted and unstable, and deficient in weatherly qualities at sea. No questions ever came before the mercantile shipbuilders of that day of such magnitude, difficulty, or complexity as those which war-ship constructors had to deal with. In this country, where naval designers were much more deficient in scientific knowledge than in France, and where war-ships were notoriously inferior to those of the French, mistakes were general, and were frequently fundamental and serious. Mr. Wilson, a member of the first School of Naval Architecture, gives an instructive and interesting account of the cutting-down of a 64-gun two-decked ship of the line to a frigate of 38 guns in the year 1794. He says that—"So culpably ignorant were the English constructors that this operation, so well calculated when properly conducted to produce a good ship, was a complete failure. Seven feet of the upper part of the topsides, together with a deck and guns weighing about 160 tons, were removed, by which her stability was greatly increased; but by a complete absurdity the sails were reduced one-sixth in area. In her first voyage her rolling was so excessive that she sprang several sets of topmasts. To mitigate this evil, in 1795 her masts and yards were increased to their original size; but as there was no decrease of ballast she was still a very uneasy ship, and, as a necessary result, her wear and tear were excessive. Other sixty-fours were cut down, masted, and ballasted in exactly the same manner, and, it need scarcely be added, experienced similar misfortunes; and although they were improved by enlarging their masts and yards, they were still bad ships. Had their transformations been scientifically conducted, a class of frigates would have continued in the Navy capable from their size of coping with the large American frigates, and thus the disasters we experienced in the late war from the superior force of that nation would, without doubt, have been not merely avoided, but turned into occurrences of a quite opposite character." I may here say in passing that one of the chief reasons why shipbuilders, shipmasters, and others, who require to understand the principles upon which a ship's qualities depend, have often remained for long periods in ignorance of the published information upon the subject, is perhaps to be found in the fact that the style of treatment commonly adopted in works upon naval architecture is one which presupposes, and requires advanced mathematical and highly technical knowledge in the readers. The celebrated mathematician Euler said in 1773, in the dedication of his work entitled "Theorie Complette, de la Construction et de la Manœuvres des Vaisseaux," that—"Although forty years have elapsed since mathematicians have laboured with some success, yet their discoveries are so much enveloped in profound calculations that mariners have scarce been able to derive any benefit from them." This reproach still attaches, I fear, to many writings upon naval architecture; and in removing the cause for it more may be done, in my opinion, for the benefit and enlightenment of students than in any other way. The great want of the time in this department of science is elementary explanations of principles and methods, stated in clear and precise language, but freed as much as possible from advanced mathematical ideas and terms, and from perplexing technicalities. The difficulties of war-ship construction had become so overwhelming at the end of the last century, owing to the causes already named and to others, that radical measures for remedying them could no longer be delayed. No such difficulties, however, be it observed, had arisen, even at a much later date, in connection with the ships of the mercantile marine. Several attempts were made to improve the existing state of things in the Royal Navy, and to promote the spread of scientific knowledge of naval architecture in this country. These resulted in the establishment of the first School of Naval Architecture by the Admiralty at Portsmouth in the year 1811. The second School of Naval Architecture was founded at Portsmouth by the Admiralty in 1848, with Dr. Woolley as the principal; but it was closed after only a few years of existence. The third School of Naval Architecture, which also included marine engineering, was opened at South Kensington in 1864, and is now united with the Royal Naval College at Greenwich. The whole of these schools have been instituted and carried on for the special purpose of training up war-ship designers and calculators for the work of the Royal Navy, and a large number of students, highly skilled in mathematics and in the methods employed in war-ship construction, have been educated in them. Fifty years ago the use of iron for ship construction and the employment of steam propulsion had only been attempted in a few vessels that were employed in coasting or river trades. As regards iron, few people then imagined that it was the material of the future for shipbuilding purposes. Although its use had for some time been advocated by a few able and far-seeing men, and some small craft had been constructed of it, the public and the great body of shipbuilders refused in 1830 to believe that the wooden walls of old England were to be supplanted by a material that would naturally sink. "Who ever heard," it was derisively asked, "of iron floating?" The chief constructor of one of our Royal dockyards, said to Mr. Scott Russell, with a feeling so strong, and with indignation so natural, that the latter never forgot it—"Don't talk to me of iron ships; it is contrary to nature." Steam propulsion was making progress, but was not yet considered suitable for over-sea trades. Mr. David Napier had made engines of 200-horse power, and lines of steamers were plying between Liverpool and the Clyde, and between London and Edinburgh, but it was not thought possible to make long voyages by means of steam propulsion. It was believed by men of high scientific reputation and position in 1835, that in the then state of the marine engine, the project of making a voyage by steam alone directly from New York to Liverpool was perfectly chimerical, and that persons might as well talk of "making a voyage from New York or Liverpool to the moon." The shipbuilders of the old school held back as long as possible from taking the leap in the dark which was involved by undertaking the production of iron steamers. The way was at first led, not by the great shipbuilders of the day, but by eminent engineers, such as Napier, Fairbairn, Brunel, Scott Russell, and others, who investigated and solved the leading structural and other problems which were involved in this great revolution in shipbuilding. It was at the request of Mr. Brunel, and for his guidance in designing the Great Eastern, that his friend, Mr. William Froude, commenced in 1856 his investigations into the laws of motion of a ship among waves. It was not till after mercantile shipbuilders began to build vessels of largely increased sizes beyond what were prevalent fifty years ago that the present demand for improved scientific knowledge began to be felt by them. The truth is, that the modern changes in shipbuilding practice which have followed closely upon the substitution of iron for wood as the material of construction, and by the use of steam propulsion, have not only increased the difficulties of manufacture, but they have gradually brought about a change in the shipbuilder's position with reference to his work, and in the nature of his responsibility for it. Formerly a shipbuilder was merely the builder of a ship in reality as well as in name. No better mechanics have ever existed, or men more skilled in the geometry and other practical sciences which bore directly upon their work, than many of the shipbuilders of the past. They were perfect masters of what they undertook to do, and possessed a vast amount of special knowledge and ingenuity. Many of the processes by which irregularly-shaped pieces of timber were prepared to their required forms involved geometrical processes of an extremely complex and difficult kind. Some of the problems which were dealt with in practice by the old school of shipwrights would now puzzle many advanced students of descriptive and solid geometry. Shipbuilding was then a highly-developed mechanical art, much of the knowledge of which is not now required, and is consequently fast dying out. The business of the shipbuilder formerly was to construct ships of the dimensions and description required by owners, and to build them of good sound wood, well-fitted and fastened together. No elaborate calculations were requisite for determining whether one of these vessels would stand up when light or be stable when laden with homogeneous cargoes, nor were any but the roughest approximate methods necessary even for estimating the displacement or carrying capacity. Owners and masters, as well as the builders, had ample materials, derived from experience and from the observation of many similar vessels, by which to form their own judgments upon such points. Usually these ships would not stand up when fully rigged and light without ballast; and, judging from the proportions usually given to them, they must have required ballast when laden with cargoes which were not composed of heavy deadweight. In most cases iron kentledge was provided for them. Few of these vessels would shift without ballast, except such as were of the old collier type, and were specially built for the coal trade. It is notorious, however, that the chief reason why so many of the ships of that day were very crank is to be found in the operation of the old tonnage laws, which took breadth into account in estimating the tonnage, and ignored depth. Ships were built of great relative depths in proportion to their breadths, and initial stability was deliberately sacrificed in order to reduce the tonnage measurement. The instability of these ships was of such a character, however, owing to their form and proportions, that it could be dealt with and corrected in a practical manner by means of the trained judgment and experience of the masters and stevedores. Any deficiency of stability was fully indicated by initial tenderness; and the curing of this was simply a question of putting ballast into the bottom. The sail-carrying power at sea usually acted as a good test of stability, and the experience thus gained was practically utilised in loading and ballasting vessels of all sizes and classes. It is important to observe that the instability which these vessels possessed was not of that dangerous and treacherous quality which exists in many modern steamers, and which renders them liable to capsize without previously giving obvious indications by which those on board may be sufficiently trusted to judge of their danger. Hence even the mercantile shipbuilder of the present day has problems of a very different and much more complex and difficult character to deal with than his predecessors, and that is why the necessity for improved scientific knowledge is now being so strongly felt. The details of the mechanical work of construction are really simpler, and do not call for the exercise of his own personal skill and ingenuity, so far as the hull of the ship is concerned, to such an extent as formerly. What is now required of him is to predict with great accuracy the weights of complicated iron and steel structures, of various types and sizes, with all their intricate fittings and machinery; the weights of cargo that such structures will carry at sea; the stability they will possess in different conditions of loading, and the treatment which is necessary to insure a safe amount of stability being preserved upon all occasions; the amount of steam power and the rate of coal consumption which will be required to maintain given speeds at sea; and very frequently the strength that is possessed by the hull to resist the straining action of waves. Such problems as these may now be put before a shipbuilder any day for solution, or if he fails to consider them for himself when constructing certain types of vessels, he may afterwards be held to blame for not doing so in the event of some unforeseen failure or disaster occurring. It is a knowledge of principles rather than of results which he should mainly aim at acquiring, because his information requires to be of that well-grounded, broad, and general character such as is readily and directly applicable to novel and ever-changing circumstances, and which can be acted upon with certainty and promptitude in difficult cases. Dr. Woolley stated this point with great force and clearness in a paper which he read before the Institution of Naval Architects in 1864, and, though he was then specially addressing the constructors of war-ships, I cannot find any words more applicable to the present requirements of mercantile naval architecture. He said that the only way in which superiority in shipbuilding can be acquired is:—"By possessing a class of shipbuilders trained in mathematical science, with the powers of their minds invigorated and strengthened by a profound and severe course of study, able to deal with questions to which altered conditions are continually giving rise, not by trial and error, which is most frequently but another name for failure, not with the hesitating and trembling hand of the superficial sciolist, but with the firm grasp and bold readiness of the man profoundly skilled in the scientific principles of all kinds which may be made available to the art of naval construction, who feels himself thoroughly at home in them, and has acquired such power as to enable him to apply his principles readily and exactly, without fear of failure or of overlooking one principle, while anxious to give effect to another."

Economy of time and of cost of production, and how to secure these advantages, are among the chief points which mercantile naval architects require to study, and upon the practice of which their success mainly depends. In war-ship work long periods are frequently occupied in investigating the details of a design which cannot be obtained in the mercantile marine, and which, if insisted upon, would prove an effectual bar to success in business. Again, if we take the practical work of the ship-yard, an accurate and full knowledge of which is invaluable to the naval architect, it will be seen how unsuitable is mere Admiralty teaching to the requirements of the mercantile marine, by a comparison of the relative costs in the two cases. The labour upon the structural iron or steel work of the hull of a vessel which in the ships of the Navy often costs, according to the best information I can obtain, £20 per ton of weight, is carried out upon so much more economical and improved a system, both as regards time and cost of labour, in the mercantile marine, that in vessels which are at least equal in strength and durability to those of the Royal Navy, as is proved by the work they do, the cost of labour often amounts to no more than £5 per ton of weight. The time element is also an equally important factor in these two classes of work, but this is a point which I now cannot pause to consider. In the figures for cost of labour which I have given I am dealing with vessels of as similar construction as possible, with water-tight double bottoms. This difference in cost of production is largely attributable to the slow and costly processes of work which are still followed in the Royal Navy, but which have long been obsolete in the mercantile marine, and have been supplanted by improved methods. It is the two circumstances of the growing requirements which have been felt among shipbuilders for scientific training in naval architecture, and the failure of the Royal Naval College to furnish such training as they require, that have mainly led to the foundation of the John Elder Chair of Naval Architecture.

And now the question arises of the method we are going to adopt, and of the kind of training we shall endeavour to give here. This will depend mainly upon the intelligence and energy of the students, and upon the amount of mathematical and general scientific knowledge with which they may be already furnished when they come there. The course will be adapted, as far as possible, to their state of knowledge and to practical necessities. There is, unfortunately, too great a tendency in many cases to elevate mathematical knowledge and scientific training above its true position, high as is the one which it is legitimately entitled to, and to rely too exclusively upon it for guidance and aid. It is a *sine quâ non* for the modern naval architect, but it is by no means sufficient for all his numerous requirements. It is of little real use unless there underlies it an intimate practical acquaintance with the mechanical operations of the shipyard and engine works, and with the properties and capabilities of the materials which there have to be dealt with. Together with all this, there must also be the faculty, which is more essential than all, and which may be highly cultivated by all open, liberal and generous minds,

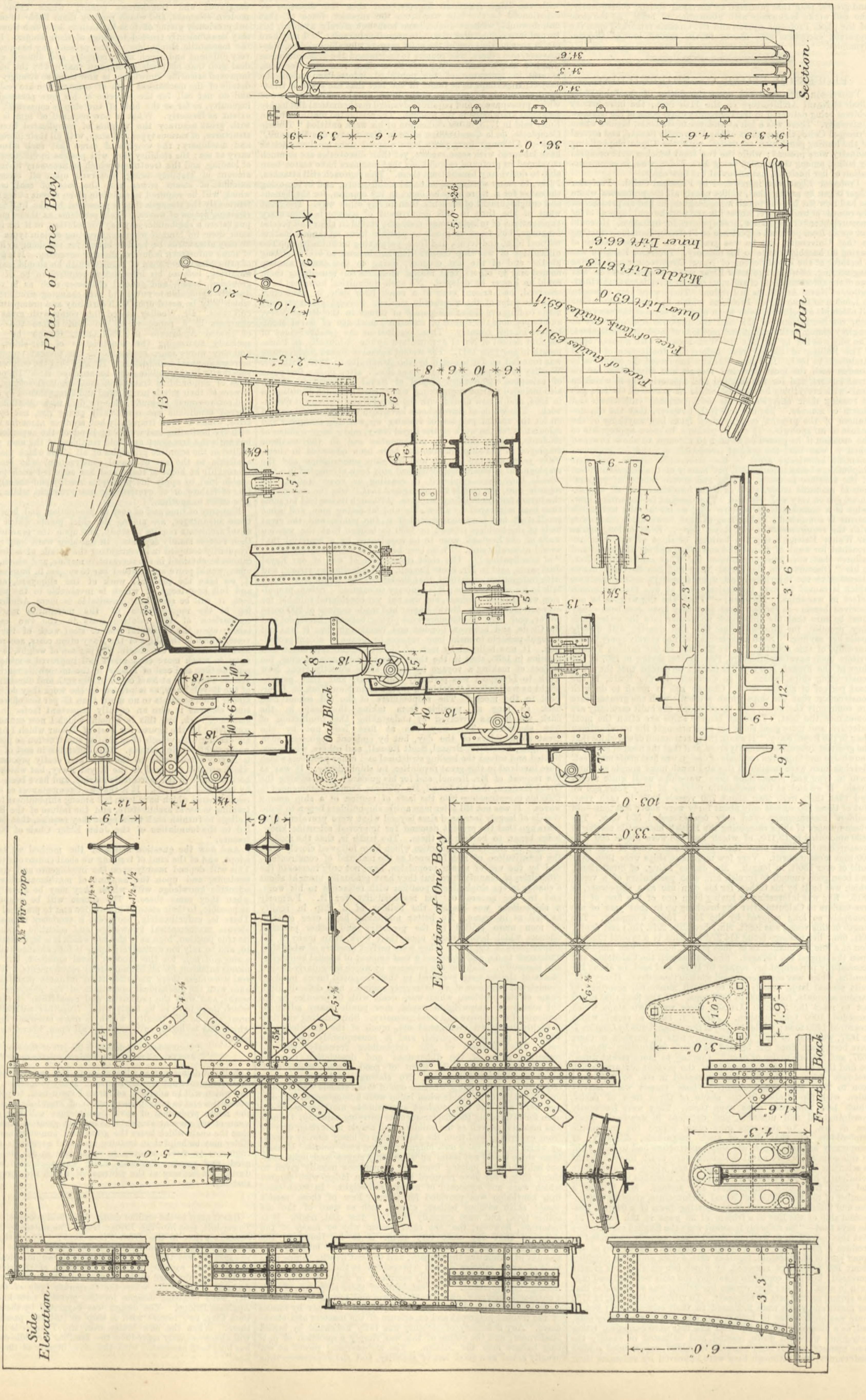
> "Good sense, which only is the gift of Heaven,
> And though no science, fairly worth the seven."

I shall not detain you any longer upon the present occasion. We shall commence our regular course of study to-morrow. It will be one which will be adapted, so far as I know now, to your practical necessities and to your present state of knowledge. I hope that the noble profession of naval architecture will one day reckon some of my present students among its greatest ornaments, and that the chair which bears the great and honoured name of John Elder may be helpful in training up naval architects and marine engineers to rival, or even to excel, him in all that is worthy, good, and great. Professor Elgar was applauded at intervals during the delivery of the address, of which the foregoing is an abstract.

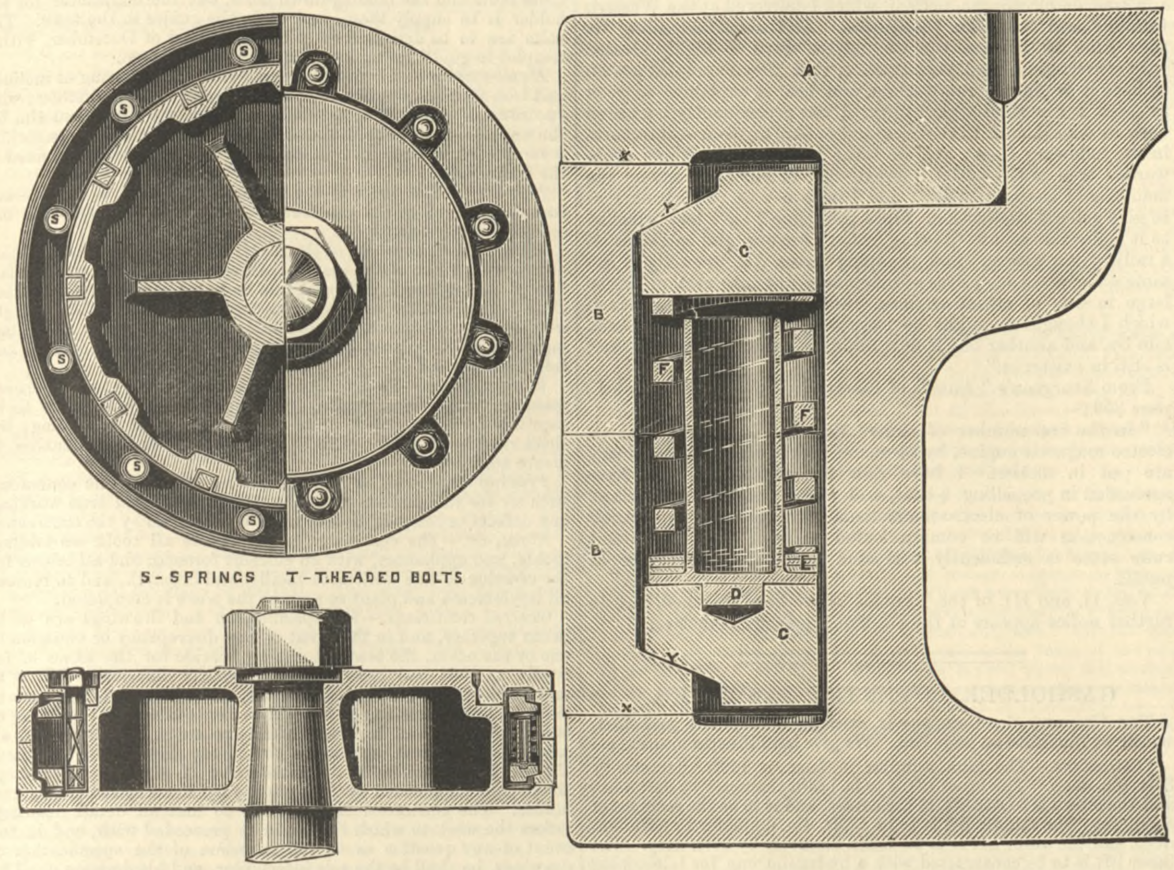
REFERRING to the outline design for a bridge over the Thames at Tower-hill, sent into the Bridge House Committee by Mr. Horace Jones, a writer in the *Irish Times* says: "The design was first submitted to the Common Council in 1878. It is a somewhat remarkable fact that in November, 1876, an identical design, in almost every respect, with the exception of the elevated foot-bridge, was submitted to the Town Council of Cork by Mr. C. L. Jackson White, C.E., when the Corporate body of the southern city were receiving designs for the erection now known as the Anglesea Bridge. The design was suggested by the arms of the Cork City, two towers with a ship in full sail passing between them. When the new bridge over the Thames is completed, it will almost exactly reproduce the familiar heraldic device which has long been associated with the civic dignity of the City on the Lee."

GASHOLDER, COVENTRY GASWORKS.

(For description see page 370.)

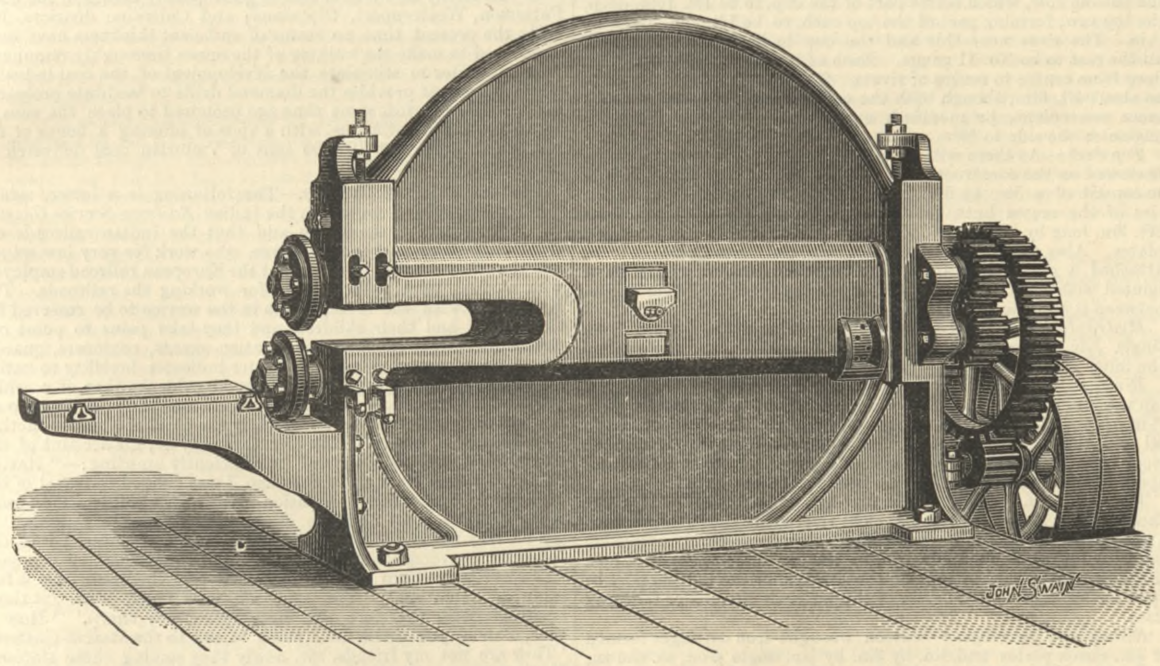


TAYLOR'S PATENT PISTON PACKING.



THIS improved arrangement of piston packing, patented by Mr. J. H. Taylor, of Shirley-road, Southampton, has been fitted in two steamers now running, with excellent results. The pistons are quite steam tight, although perfectly easy to move in the cylinders, the pressure on the walls of the cylinders being reduced to a minimum, producing, we are informed, a beautiful glass-like surface. This packing has, it is claimed, amongst its many advantages, that of being very elastic, with great rang for variation of pressure and adjustment of springs. In th engraving A is the ordinary junk ring, B B packing rings, C (solid rings encircling the piston body, and free to move u and down, D are pins for keeping springs in position at interval as required, E washers for adjusting springs, F spiral springs X steam tight joint, Y bevel for regulating ratio of pressures.

ROTARY SHEARS FOR PLATE WORK.



ROTARY shears have been in use for fine sheet iron cutting for a great many years, but, says the *American Manufacturer*, it is only within the last comparatively few years that general attention has been drawn to them for the purpose of shearing plates. Not many are in use for the latter purpose, but those who have adopted them have been impressed with their utility for cutting plates even as thick as ⅝in., either iron or steel. To be sure, some difficulty has been met with at times in beginning the use of such shears with unskilled men, but wherever the practice has been continued until the workmen have become familiar with the tool, their superiority needs no argument. The advantageous features of rotary shears are rapidity of work and accuracy, either for straight or circular shearing. We illustrate above a rotary shears made by the Lewis Foundry and Machine Company, of Pittsburgh, Pa., weighing nearly 11,000 lb., and is successfully in use at one of the works in that city. The details of this shears are as follows: The knives are 12in. in diameter, the depth of throat 28in., pulleys 30in. in diameter and 6½in. face, intended for a 6in. belt; the driving pinions and shaft are of steel, and the whole is fitted up with special means for adjustment not possessed by any other rotary shears made. One very necessary part of this shears, when the same is used for circular cutting is not shown in the cut, but belongs to the tool, and is sold with it when desired, namely, a pivot bracket, which will allow for the cutting of a circular plate 56in. in diameter, and again as small as 8in. in diameter. This pivot bracket is fitted to and works very nicely on the projecting piece at the left-hand side of the engraving, the whole constituting one of the most complete tools, or perhaps we should say the most complete tool, under the head of rotary shears.

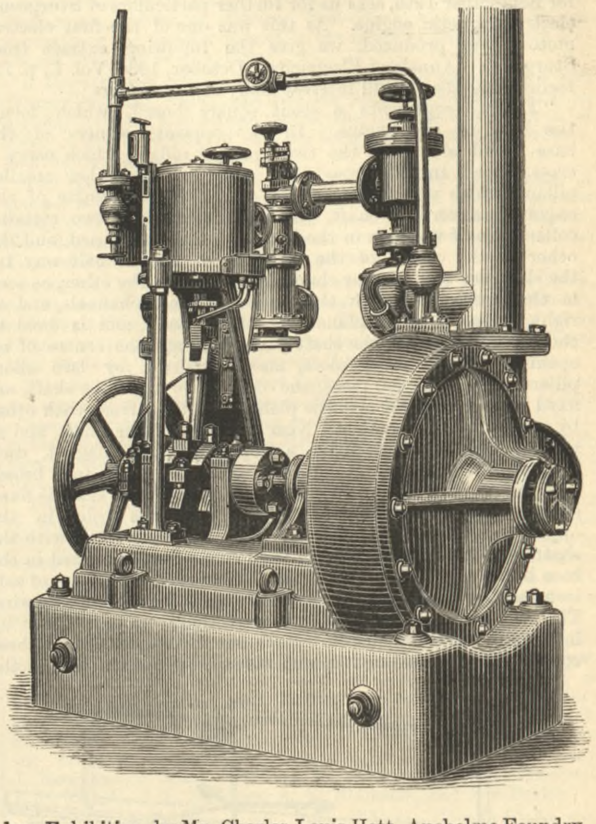
HORIZONTAL BLOWING ENGINE.

THE horizontal blowing engine shown in our engraving has been constructed at the Imperial Government Works—department of Zousenkiokio—Hiogo, Japan, from the designs of Mr. James Lang, superintendent engineer. The engine has one high-pressure steam cylinder of 17½in. diameter and 39in. stroke, being fitted with the ordinary slide valve, with expansion valves on the back, regulated with a right and left-hand screw and hand wheel. The piston of steam cylinder is fitted with junk and packing rings, having the ordinary arrangement of steel springs. The condenser is of rectangular shape, placed alongside the steam cylinder, and is of the ordinary injection class. The air pump is double-acting, worked from the cross-head, and having the same stroke as the engine. The blowing cylinder is 38in. diameter, having same stroke as cylinder. The piston is packed with hard wood, arranged in segments, each segment having a steel spring behind it, and held down by a junk ring in the usual manner. The air valves are of selected thick sole leather, backed with plate iron, the guards also being made of plate iron. The boilers are two in number, of the Cornish type, and are capable of supplying steam at a pressure of 60 lb. per square inch. On the official trial of this engine it worked exceedingly well, giving every satisfaction, the pressure of air being maintained in the reservoir much in excess of the requirements.

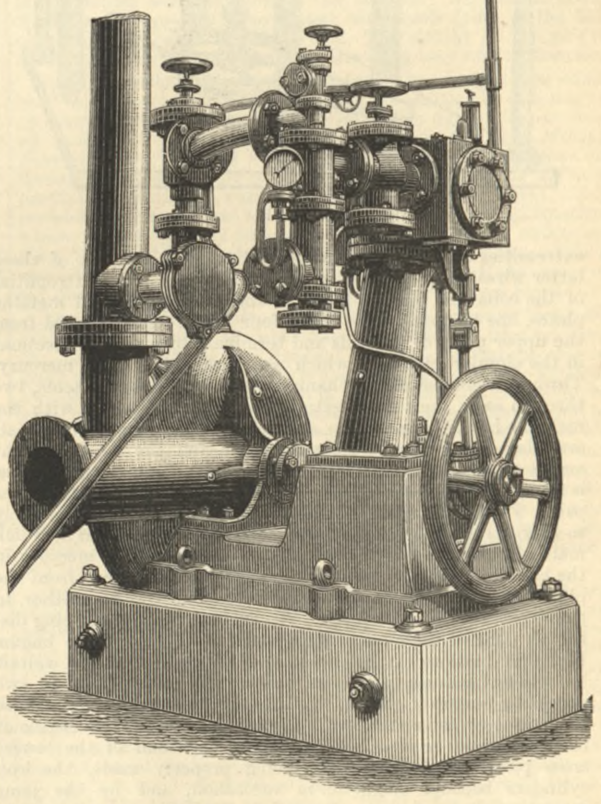
INTERNATIONAL EXHIBITION AT THE ALEXANDRA PALACE.—An International Exhibition is to be held at the Alexandra Palace next year, commencing about the 31st of March, and remaining open for six months. Ten per cent. of the gross receipts from admission money is to be set apart for distribution among the principal London hospitals. For this purpose a committee has been appointed as follows:—Chairman, Colonel Sir Herbert Sandford; vice-chairman, Admiral Sir Edward Inglefield; General Sir Michael Kennedy, Sir Henry Pitman, Sir Andrew Clark, Mr. F. D. Dixon-Hartland, and Dr. George Johnson. The exhibition, like those at South Kensington, will not rely simply upon the attractiveness of the exhibits, but will include amusements of a varied nature. The building and grounds are to be brilliantly illuminated by the electric light. Machinery is to be largely represented. A small charge is to be made for space. Mr. E. Ray, 21, Queen Victoria-street, is the secretary.

HETT'S CENTRIFUGAL PUMP.

THE accompanying engravings illustrate a centrifugal pump nd engine combined, exhibited in action at the recent Amster-



dam Exhibition, by Mr. Charles Louis Hett, Ancholme Foundry, Brigg. The engravings explain themselves. The engines are



fitted with Morton's ejector condenser, and the workmanship is of the usual high-class type we are accustomed to associate with centrifugal pumping machinery.

BALANCING WHEELS AND CYLINDERS.—For wheels of large diameters and wheels and cylinders of great velocity accurate balancing is required. It is not yet determined that a standing balance and a running balance can be made identical, especially when a belt is used, as on the fly-wheel of an engine, or the momentum of a crank is to be overcome. But for many purposes the standing balance is near enough to accuracy to prevent tremor and injurious jar in running. When the wheel can be turned inside as well as outside, the rim balancing is not always necessary if the arms approach uniformity in size; but there are cases where inside turning is impossible, and balancing becomes a necessity. There are three methods of balancing in use, the most common being the suspension of the cylinder or wheel on the centres of an arbor or shaft. This is not always accurate, as, if the wheel is very heavy, the centres must be set up too hard to allow the wheel or cylinder to turn easily. A better way is to suspend the wheel by the journals on which it is to run; but if these are seated in boxes, the same objection will exist. To obviate this, the journals are sometimes mounted on friction rollers; but a much more accurate method is to mount them on two parallel bars, planed and filed to exactness and fixed perfectly level. These are long enough to allow the journals to travel far enough to make a complete revolution of the wheel or cylinder shaft, 3in. diameter requiring bars something over 9in. long. By this method the degree of accuracy obtained is very great, as the journals bear on the bar at only one point, and the mass rolls at a touch. There is still another method, especially applicable to large turned wheels, as the fly-wheels of steam engines. In this the wheel, after being bored and turned, is suspended by the central hole, so that the wheel hangs horizontally. The wheel is held by an eye bolt accurately turned, having mounted on it two discs with shoulders turned to fit the bore of the wheel; thus the eye of the bolt is in the mathematical centre of the wheel. The wheel is then suspended by a crane, and a spirit level laid on the turned edge of the rim. If the wheel hangs true, the level will show no declination; but the slightest variation of weight will deflect the rim. Pieces of iron are hand clamped on the opposite side, and when accuracy is attained the clamp and weight are weighed, and a pattern for a casting to go inside the rim is made accordingly.—*Scientific American.*

DESCRIPTION OF AN ELECTRO-MAGNETIC ENGINE FOR TURNING MACHINERY.

A correspondent, referring to a statement made in our issue for September 19th, asks us for further particulars of Sturgeon's electro-magnetic engine. As this was one of the first electro-motors ever produced, we give the following extract from Sturgeon's "Annals of Electricity," October, 1836, Vol. I., p. 75, feeling sure that it will interest many of our readers:—

"Fig. 17 represents a stout square board, which forms the base of the engine. In two opposite corners of the base board are fixed the two upright pillars, which carry a cross piece. In this cross piece are fixed two other smaller pillars, which also carry a cross piece. In the centre of the engine is a vertical shaft, which turns freely in two metallic collars, one of which is in the centre of the base board, and the other in the centre of the cross piece. About half way up the shaft are two circular channels, one above the other, as seen in the figure. Through the centre of these channels, and at right angles to their planes, the shaft passes, and is fixed to them. Lower down, the shaft passes through the centre of an opening in the cross piece, also supported by two short pillars. On this cross piece, and concentric with the shaft, are fixed four quadrantal metallic plates, separated from each other by narrow radial openings. Near the top of the shaft, and at right angles to it, is fixed a compound bar magnet, each magnet of which is about eighteen inches long, one inch broad, and half an inch thick. Near to the bottom of the shaft is fixed another similar compound magnet, with its poles in the opposite direction to the former. In a circle concentric with the shaft, and at an equal distance from each other, are fixed in the base board the lower extremities of four cylindrical bars of soft iron, each of which is enclosed by six coils of copper wire. The coils round each cylinder are separated from each other by intervening cases of oil silk. Each set of extremities of these copper wires is soldered to one stout copper wire; hence the

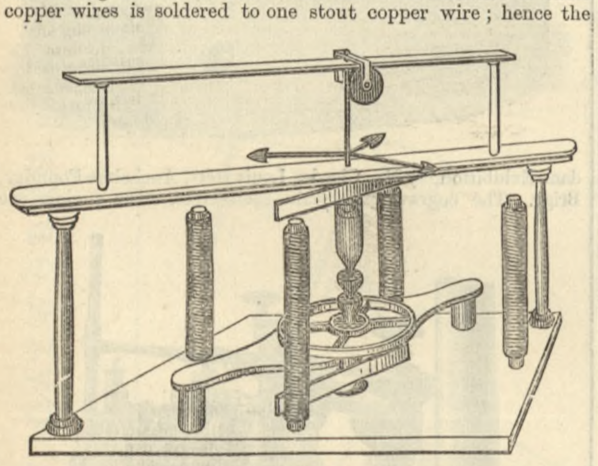


Fig. 17

extremities of the twenty-four coils terminate in eight of these latter wires, four of which proceed from the lower extremities of the coils, and are soldered to the four quadrantal metallic plates, one to each. The other four stout wires proceed from the upper parts of the coils and terminate by proper connections in the circular channels, which are partly filled with mercury. Through the sides of the channels pass four metallic stems, two through each, their inner extremities being in contact with the mercury in their respective channels. The stems of each pair are placed at 90 deg. from each other, and the whole at right angles to the shaft. The right angle which the upper pair forms is on the opposite side of the shaft to that formed by the lower pair. From each stem hangs a metallic wire, reaching obliquely to its respective quadrantal plate on the cross piece *d d*, which maintains a connection between these plates and the mercury in the circular channels, transferring the electric current from one plate to another, and consequently from one coil to another, in their progress of revolution. To prevent the figure being distorted, none of these connecting wires are drawn. The engine is put in motion by the application of two cylindrical voltaic batteries of a single pair each, the metals being placed in two porcelain jars, each of which holds about three pints. These batteries are connected with the conductors of the engine at their terminal cups—one battery at each end of the lowest cross piece. The connections being properly made, the iron cylinders become magnetic in succession, and by the joint attractive and repulsive forces of the permanent magnets, and the temporary magnets, the former, with the shaft and appendages, are pulled and driven round, the action being carried on in the following manner:—Imagine that the pole N^1 of the permanent magnet is placed directly between the poles *s* and *n* of the temporary magnets; it will by this means be attracted by the former, and at the same time repelled by the latter. Hence it will be urged by both these forces towards the pole *s*. If now the contrivance be such that the voltaic connections be broken just before the pole N^1 arrives at *s*, the extremity *s* of the iron bar will become neutral; but the momentum of the machine will carry the pole N^1 to beyond this neutral point. Now conceive that the pendant wires have been carried from their last quadrantal plates to the next in succession. The currents by this means have been reversed in all the coils, and a corresponding inversion of polarity has taken place in the vertical iron bars; hence when the pole N^1 has just passed the first bar, and whilst still in motion by its acquired momentum, it will again be urged on by two other forces, in a similar manner as by the two first. For the extremity having changed its polarity, it will now repel the pole N^1 and drive it onward, whilst at the same time it will be attracted by the next bar in succession. And in consequence of similar changes of polarity taking place in all the four bars, the pole N^1 is kept continually revolving. All that has been said respecting the pole N^1 applies equally to the opposite pole S^1 of the same magnet. So that by this means the magnet and its appendages are continually urged on by four forces, two attractions and two repulsions; and by considering that the lower maget N S is, by the contrivance also urged on at the same time and in a similar manner, by four other like forces, it will easily be understood that the two magnets, with the shaft to which they are attached, are kept in motion by eight forces, four of which are attractive and four repulsive. Such is the contrivance for keeping the machine in motion. To the upper end of the shaft is attached a vertical spindle, carrying an endless screw near its upper extremity, and revolving as the shaft revolves, in a collar in the upper cross piece. Near to the lower end of this spindle is a fly with three arms, equidistant from each other, and each terminating with a heavy brass crescent. It was originally the fly of a roasting jack. The endless screw works in the teeth of a brass wheel, also a part of the old jack. The arbor of this wheel runs in a frame attached at right angles to the upper cross piece. This engine was constructed in the autumn of 1832, and was exhibited for the first time in London, on March 21st, 1833, in a lecture on electro-magnetism, which I delivered at the Western Literary and Scientific Institution. And notwithstanding its then rude appearance, the Committee were so highly pleased with its structure and performance, that they expressed a wish to have it brought forward again, and hear it explained as soon as there was another opportunity. I was consequently honoured with an engagement to continue and extend my course of lectures in the following June; and in those lectures my engine again worked well, and excited a great deal of curiosity among the members of the Institution; and I believe was so fortunate as to give general satisfaction. Since that time I have had attached to it contrivances for drawing water, wagons, and carriages on a railway, for sawing wood, pumping water, &c., upon about the same scale as we see pieces of machinery put into motion by the large models of steam engines. But as I saw several parts in which I thought it might be improved, it has long since been lain by, and another one is now building. The old one, however, is still in existence."

From Sturgeon's "Annals of Electricity," April, 1837, Vol. I., page 250:—

"In the first number of these 'Annals,' I have described an electro-magnetic engine, by means of which pieces of machinery are put in motion. I have now to announce that I have succeeded in propelling a boat, and also a locomotive carriage, by the power of electro-magnetism. The particulars of their construction will be communicated as soon as their present rude state is sufficiently corrected for their appearance in public. "W.S."

Vols. II. and III. of the "Annals" have been searched, but no further notice appears of the electro-maguetic locomotive.

GASHOLDER, COVENTRY GASWORKS.

The Coventry Gas Company is erecting a three-lift gasholder, which we illustrate on page 368. We give here the specification:—

Dimensions.—The tank, annular in form, is 140ft. diameter by 34ft. 6in. deep. The inner lift is to be 133ft. diameter by 34ft. 6in., and the crown is to rise 8ft. in the centre, and is to be the segment of a sphere. The middle lift is to be 135ft. 4in. diameter by 34ft. 3in. deep, and the outer lift is to be 138ft. diameter by 34ft. deep. The inner lift is to be constructed with a hydraulic cup for telescoping hereafter, instead of the ordinary form of curb, to which is to be attached the guide rollers, with their carriages, which will ultimately be fixed on the bottom curb of the outer lift. These are to be packed out from the cup with oak or cast or wrought iron packings, as may be most convenient.

Gasholder—Inner Lift.

Crown sheeting.—To be of 10 gauge plates, 5ft. by 2ft. 6in., arranged as shown on drawing to break joint. The making-up pieces next the inner ring of ¼in. plates to be No. 9 gauge, and the outer ring is to be formed with ½in. plates, 2ft. wide, butt-jointed with ½in. cover plates, and double-rivetted both at these joints and to the angle iron of the top curve, of which it forms a part.

Side sheets.—The side to be formed of thirteen rows of sheets, the bottom row, which forms part of the cup, to be 1ft. 10in. deep, the top row, forming part of the top curb, to be 1ft. 6in. deep by $\frac{5}{16}$in. The rows next this and the cup to be No. 9 gauge, and all the rest to be No. 11 gauge. Each of these rows to be 2ft. 10in. deep from centre to centre of rivets. The length of the sheets to be about 4ft. 6in., though both the width and length may, if found more convenient, be modified, subject to the approval of the engineer; the side to form a true and even cylinder.

Top curb.—As there will be no roof framing, great care must be bestowed on the construction of this important member, which is to consist of a 5in. by 5in. by ¾in. angle iron, opened to suit the rise of the crown butt, jointed with suitable angle iron covers 2ft. 3in. long by ¾in., and double rivetted to the crown and side plates. Also at the inner edge of the ½in. crown plate is to be attached a continuous angle iron ring 6in. by 3in. by ½in. butt, jointed with suitable covers, with a packing piece 3in. wide by ½in. between it and the top plates.

Hydraulic cup.—To be 8in. wide by 18in. deep, formed from single $\frac{7}{16}$in. plates turned on George Piggott's plan, stiffened in the inner edge by a 2½in. by ½in. bead iron.

Rivetting.—All the seams of the 9 and 10 gauge sheets to overlap not less than 1¼in., and the 11 gauge 1⅛in., to be rivetted with $\frac{5}{16}$in. rivets, 1in. pitch, to be jointed with 1in. tape will soaked in oil and red and white lead. The other rivetting throughout the work to be proportioned both as to the size of rivets and distances apart to the thickness of the sheets and angles as usual.

Vertical stays.—Thirty-two in number, to be formed of 11 gauge sheet iron, as shown in drawing, close rivetted to the sheeting, with a gusset piece of the same form and substance securely attaching them by means of an angle iron to the top curb; there is to be a 2in. hole cut in the bottom of these stays, or the bottom may be open for the ingress and egress of the water as the holder falls and rises.

Rollers and carriages.—Sixteen wrought iron carriages formed of ½in. cheek plates and 4in. by 3in. by ½in. angle iron, as shown, to be securely bolted to the ½in. plate of the top curb, the holes to receive the 1¾in. turned roller steel pins to be made oblong to allow for adjustment, the two cheeks to be attached to each other by two cast iron distance pieces with bolts through them. The carriages, thirty-two in number, that will be required when the second lift is erected, are to be fixed to the bottom of the cup and the stay, as shown, but without the rollers and pins. At present, for the purpose of guiding the holder in the tank, the thirty-two carriages and rollers formed as shown on drawing, that will ultimately be fixed on the third or outer lift, are to be secured by suitable packing pieces to the outside of the cup of the inner holder. All the rollers are to be of tough cast iron and to be turned and bored, and all the pins square under the head are to be of steel, accurately turned and fitted with a split pin through the screwed end to prevent the nut coming off. All the holes for the roller pins in all the carriages are to be oblong and rectangular in form for the purpose of adjustment.

Manholes.—Three in number, one of the ordinary form, to be fixed over the inlet and outlet pipes, and one on another part of the crown, also on the opposite side of the crown; to the inlet pipe is to be fixed two 9in. blowing-out pipes, formed of 12-gauge sheet iron, dipping to within 3in. of the water-line, with a suitable cover fixed with screw bolts like a manlid.

Middle and Outer Lifts.

As these are not at present to be erected, it is not necessary to specify them further than by saying that their form and dimensions are shown on the drawing. The portion now to be constructed must be done in such a manner as will facilitate the putting in of the remaining parts of the holder.

Guide Framing.

The guide framing is to consist of sixteen wrought iron standards, with three tiers of struts and diagonal bracing, as shown in all its details on the drawing. It is, when completed, to be 103ft. high, but is for the present to be stopped as shown in red; just above the first tier of struts the members forming the standards are all to break joint, and at the top, when finished, is to be an iron wire rope trussing. The base is to be of cast iron, secured to the tank by three 2in. square holding-down bolts with 2½in. screwed ends. These bolts are to be 12ft. long, held down by a cast iron plate with square holes in the usual way. The holding-down plates and bolts are to be delivered on or before the 1st of December.

Tank guides.—Thirty-two cast iron channel guides, 6in. by 3in. inside, with lugs for the bolts at the sides, to be secured to the tank by jagged Lewis bolts. The contractor for the tank will fix these bolts and the holding-down bolts, but the contractor for the holder is to supply them, and to fix the guides in the tank. The bolts are to be delivered on or before the 1st of December, with a templet to guide the tank contractor in fixing them.

Hand-railing and ladder.—A hand-railing, consisting of inclined cast iron standards bolted to the top edge of the inner holder, with two rows of wrought iron tubing—¾in. for the lower and 1in. for the upper—is to be supplied and fixed. Also, when the gasholder is completed, a wrought iron ladder is to be provided and fixed to the framing.

Painting.—The whole of the wrought iron work to receive one coat of boiled oil at the contractors' works, and the cast iron one coat of red oxide paint.

Materials.—The whole of the materials used in the construction of this work to be of the best of their several kinds, to the satisfaction of the engineer. The cast iron to be of a quality for making clean tough castings, and free from any imperfection. The wrought iron to be capable of sustaining a tensile strain of 21 tons to the square inch—all sheets, plates, bars, and angles to be smooth, sound, and free from any defects.

Workmanship.—To be done in the best and most approved manner: where bars, angles, or plates butt joint, they are to be carefully faced or fitted, so as to have an uniform bearing; the sheet rivet holes to be punched by means of multiple punches, to insure accuracy.

Proving holder.—The holder is to be raised by the contractor with air for the purpose of testing its soundness and true working; any defects or leaks so discovered to be remedied by the contractor.

Plant, &c.—The contractor is to provide all tools, scaffolding, tackle, and appliances, with an efficient foreman and all labour for the erection of this work with facility and dispatch, and to remove all implements and plant so soon as the work is completed.

General conditions.—The specification and drawings are to be taken together, and in the event of any discrepancy or omission in one or the other, the contractor is to provide for the same in his tender as if it had been more particularly described. He is to make a thoroughly efficient gasholder, and to complete the work in every respect, according to the full and true intent and meaning of the specification and drawings, which are made to scale, but in all cases where figured dimensions are given, they are to be taken. The work is to be done to the satisfaction of Mr. George Livesey, the engineer appointed by the company for the erection of this gasholder. The contractor is to submit to him all detail drawings before the work to which they refer is proceeded with, and in the event of any question as to the intention of the specification or drawings, he shall be the sole interpreter, and his decision shall be final and without appeal. Payments to be made at the rate of 75 per cent. of the value of the work done on the company's premises, to be certified by the engineer, the company having the right to retain 25 per cent. of the whole amount of the contract until three months after the holder is completed and successfully at work. The contractor is to be responsible for any damage he may do to the tank, and in the event of such damage, it is to be made good, either by him or at his expense.

Time.—The whole is to be finished and proved and ready for the reception of gas by the 1st of August, 1885. The tank will be ready by the beginning of the year 1885.

In the colony of Victoria coal of good quality occurs in the Cape Patterson, Westernport, Gippsland, and Coleraine districts, but up to the present time no seams of sufficient thickness have been discovered to make the working of the mines thoroughly remunerative. In order to stimulate the development of the coal industry the Government provides the diamond drills to facilitate prospecting, and, it is stated, some time ago promised to place the sum of £5000 upon the estimates, with a view of offering a bonus of 5s. per ton for the first 100,000 tons of Victorian coal delivered in Melbourne.

Hindoo Railway Guards.—The following is a letter, signed "Diogenes," which appears in the Indian *Railway Service Gazette*. In explanation, it should be said that the Indian railroads are employing more and more natives, who work for very low wages, and that they are thus elbowing out the European railroad employés, who at first were indispensable for working the railroads. The Europeans wish the better places in the service to be reserved for themselves and their children, and they take pains to point out the shortcomings of the native station agents, engineers, guards, &c. The tone of "Diogenes'" letter indicates hostility to native guards, but its language is pretty good evidence that, if a white man, he is a Eurasian—born in India and brought up among natives, and not among Europeans—very likely the child of a native mother by a European father. However that may be, his account of the discipline of the "Baboo guard" is sufficiently amusing:—"Having missed the mail train a few days ago, I was obliged to travel in the goods brake-van, which the station-master very kindly allowed me. After all was right and line clear received, the train started. I got on very nicely for the first few stations, and entered into the following conversation with the guard: 'I say, Baboo.' 'Yes, sar.' 'You are very sharp at stations, much like the mail; only a few minutes' detention.' 'Yes, sar; not very much work got these small stations, therefore line clear given very sharp.' 'How is that, Baboo, you don't have much to say to the station-masters.' 'They are not my friends, sar, newly they coming these stations. If they be my friends I will stop one few minutes and smoke hookah.' 'Are you long on this line, Baboo?' 'Yes, sar, I am now about five years.' 'Getting good pay, Baboo?' 'What pay, sar, giving very small—not enough to live, one small family.' 'Have you many children, Baboo?' 'No, sar, I got only seven.' 'By-the-by, seven children!' 'Yes, sar; besides I got, sar, my wife's mother and sister, my brother and his wife and three children.' 'All supported on your pay?' 'Yes, sar, very small family, indeed, what can do, sar. Your kind gentleman must keep favour.' Arrived at the next station, Baboo meets his friend the station-master. 'How are you, my friend? very long time I never did saw you. Being going anywhere to perform any ceremony?' 'No, my friend; traffic make very slack, therefore I never come.' 'Sit down; I will order for hookah and pawn.' Baboo sits down, has a smoke and some pawn. 'Train detained fifteen minutes beyond time. Give line clear; I will go.' 'What your hurry, my friend; long time I no see you; take one nother smoke, a few more draws give line clear.' 'I got too many friends to meet; they will also ask me to take hookah and pawn, therefore must go and oblige. What time I book?' 'You must know, what I can tell must book right time.' 'I say, Baboo, you have booked right time; will the driver accept of that line clear?' 'Yes, sar, he very good gentleman, he no grumble, he will make up the time, he one first-class driver, he no one coal-saving driver; he always telling time is money, and he make too much running.' 'I think you are really very lucky, Baboo, to have a driver to make up the time you waste at stations talking to your friends.' 'What, sar, only one two minutes I make smoking and talking.' As we were getting along the detentions at some of the stations began to increase in shunting, putting in and taking out packages at some stations, and meeting intimate station-master friends at others. I thought the Baboo was imposing on the driver, for as he kept making up the time the Baboo lost it again. I saw the driver talk to the Baboo, and he wanted to know the cause of such detentions. 'What can I do, sar? Too much work got putting in and taking out packages, making delay. Look sharp, Baboo, or I will not make up one minute.' What I have experienced for one trip in a goods train I can fully see, were it not for the drivers, mostly all trains would not keep time. I think it would be far the best, and cheaper in the long run, to employ Europeans or Eurasians as guards; for such delays would not occur, and the wear and tear to machinery and rolling stock would not be so great, for an excess of speed must exceed for to pull up the unnecessary delays caused by Baboo guards."

RAILWAY MATTERS.

THIS week the new branch line of railway which has been constructed by the Great Western Company, between Oldbury and Langley, is in full working order. The branch connects Oldbury with the Stourbridge extension and the main line.

WE are informed that 200 hands, out of several hundreds under notice, were discharged last week from the Great Western Engine Works at Swindon, and the remainder put on short time because locomotives can be procured more cheaply from Germany than they can be made at home. Some people contend, however, that in the long run it is cheaper to spend one pound in labour at home than to send nineteen shillings abroad, and it certainly does seem that in the one case twenty shillings are added to the national wealth, but not so in the other.

A RECENTLY published Spanish official report refers to the completion of the line of railway from Corunna to Madrid, and it is stated that the line has been more than twenty-five years under construction. It is also reported that the section of the railway from Orense to Monforte is rapidly approaching completion, as well as the whole of the line from Gijon, in Asturias, to Leon, and these will join the main line to Madrid and Paris. Moreover, great activity is being displayed in completing the international bridge over the Mintro between Tuy, on the Spanish boundary, and Valenza on the Portuguese territory, thus bringing the magnificent port of Vigo within eight to ten hours of the thriving seaport of Porto.

SOME statistics relative to the proposed new railway between Wolverhampton and Kidderminster have been published. It is stated to be probable that if the line should be made the Hyde Ironworks, Kinver, will be started again. The tonnage would amount to about 50,000 a year, and at Cookley nearly the same figure, while there are other works to swell the total. The length of the line would be about twenty-seven miles, and the population affected not far short of 200,000. The total coal production of South Staffordshire is about 10,000,000 tons yearly, of which the proposed new line would get a fair share. If these statistics have good foundation there is no cause for surprise that the project is being vigorously pursued.

EARLY on Saturday morning a collision occurred at King's-cross Station. The driver of the last train from Enfield, named Wade, was returning with his empty train to the terminus station at King's-cross, and when approaching the station he saw some empty carriages on the line on which he was running. He immediately applied his vacuum brake and blew the whistle for the guards to apply their brakes also. This was done, but from some cause unexplained the brakes failed to act, and the result was that the train rushed into the empty carriages with great force. The fireman, David Bates, seeing that the collision was unavoidable, jumped off the engine on to the platform, and was severely injured. The driver remained at his post and escaped without injury, but had a very narrow escape from death after the collision by the top of one of the carriages falling on him.

MR. CONSUL-GENERAL-NATHAN, of Vienna, reporting on the trade of Austria Hungary during the past year, mentions that marked progress was noticeable in railway affairs, particularly in reference to the laying down of new lines, and that the total railway net of the monarchy has now a length of more than 20,000 kilos. The Government policy of acquiring private lines has been energetically carried on, and is partially now being brought to a close. A very considerable portion of the Austrian railways are now owned by the State, and it is reported that beneficial results, in consequence of the Government's low tariff policy, has been already experienced in trade and industry. Mr. Nathan also mentions that great credit is due to Austrian railway engineering through the tunnelling of Mont Arlberg whereby Austria acquires for her exports a direct route quite independent of the action of German tariff policy.

AT a recent meeting of the St. Louis Engineers' Club a paper was read by Mr. J. B. Johnson, on "The Creeping of Rails on the St. Louis Bridge." Mr. Johnson said that on the St. Louis Bridge proper the rails had been known to creep 260ft. in one year, and on the bridge approach 400ft. "This creeping varied with the amount of traffic or with the weight carried over the rails. On the St. Louis Bridge, the rails crept in the direction with traffic. These rails were supported from their base. The reason given by Mr. Johnson for the creeping was, that the rail, being held fast on the extended ties, is caused to measure its length across the bridge on its extended flange, whenever a heavy weight passing over it causes a wave in the rail. This wave has been known to raise the rail between the two trucks of a car ⅜in., and the creeping has been measured and at times has amounted to from ½in. to ¾in. If the rail is supported at a place above its neutral axis, the creeping will be opposite in direction to the traffic."

THE Board of Trade returns just published for the year ending December last, shows that 189,485,612 tons of minerals were carried, and 76,897,356 tons of goods and merchandise. The total receipts from minerals and goods amounted to £38,701,319, and from miscellaneous sources to £2,852,218, making, with the £29,508,733 received from passenger traffic, a grand total earned of £71,062,270 from all sources in the twelve months. From this has to be deducted the working expenses, which amount to a total of £37,368,562, leaving a balance of profit amounting to £33,693,708. The average cost of working during the year 1883 amounted to a little over 2s. 8d. per train mile, the exact cost being 32·17d. per train mile. The receipts per train mile were over 5s. 0¾d.—the exact sum being 60·88d.—leaving a clear profit of nearly 2s. 4¾d.—28·71d.—upon every mile run. The proportion of expenditure to receipts was, therefore, 53 per cent. The total capital paid up and raised by loans and debenture stocks amounts to £784,921,312. As regards ordinary capital the rate of dividend is very nearly the highest average which has been paid for ten years, as, if the interest were equally divided, it would suffice to pay an average of £4·68 per cent. upon the whole of the ordinary capital. About 70 per cent. of capital receives dividends ranging from 3 to 5 per cent.; £74,928,678 of capital receives dividends of between 3 and 4 per cent.; and £73,927,160 receives dividend between 4 and 5 per cent.; while £165,000 of stock pays no less than 17 per cent., which is the highest point. The capital of constructed lines upon which no dividend is paid amounts to £8,817,918.

A GENERAL classification of August railway accidents in America is given by the *Railroad Gazette* as follows:—

	Collisions.	Derailments.	Other.	Total.
Defects of road	—	12	—	12
Defects of equipment	5	10	6	21
Negligence in operating	21	7	—	28
Unforeseen obstructions	2	4	1	7
Maliciously caused	—	4	—	4
Unexplained	—	17	—	17
Total	28	54	7	89

As usual, negligence in operating was the cause to which the largest proportion of accidents is attributed, 32 per cent. being charged directly to that account. Defects of equipment came next, causing 24 per cent. of all the accidents. Of the total number of accidents, fifty-three are recorded as happening in daylight, and thirty-six at night. The persons killed and injured were as follows:—

	Killed.			Injured.		
	Employés.	Others.	Total.	Employés.	Others.	Total.
In collisions	5	3	8	9	21	30
In derailments	18	3	21	26	52	78
In other accidents	7	2	9	2	2	4
Total	30	8	38	37	75	112

Employés thus formed 79 per cent. of the killed, 33 per cent. of the injured, and 45 per cent. of the total number of casualties—an unusually small proportion. It will thus be seen that derailments still cause the largest proportion of deaths in the States.

NOTES AND MEMORANDA.

At a recent meeting of the Paris Academy of Science a paper was read on "The Laws Determining the Penetration of the Rolled Plates of Ironclads by Projectiles," by M. Martin de Brettes.

AT a recent meeting of the Paris Academy of Sciences a note was read on the employment of hydrosulphuric acid for discharging colours, by M. A. Gérardin. This acid, discovered by M. Schützenberger, and now extensively employed, produces remarkable effects, acting by reduction, contrary to chlorine and oxygen, which act by oxidation. This property is supposed to be capable of important industrial application.

A NOTE on distilled water used for drinking purposes was recently read before the Paris Academy by M. A. Hureau de Villeneuve, in which the author argues the importance of the use of distilled water, and that the price might be greatly reduced by obtaining it from steam engines at work in mills. He considers it is neither unpalatable nor difficult to digest; that it generally contains a sufficient quantity of air, and that the absence of calcareous salts is rather an advantage than a drawback.

DURING the week ending October 18th, 1884, in thirty cities of the United States, having an aggregate population of 7,107,300, there were 2915 deaths, equivalent to an annual death-rate of 21·3 per 1000. The rate in the North Atlantic cities was 20·3; in the Eastern, 22·8; in the Lake, 17·6; in the River, 20·8; and in the Southern cities, for the whites 17·8, and for the coloured 30·9 per 1000. Of the decedents, the American *Sanitary Engineer* says, 40·6 per cent. were children under five years of age.

AT a recent meeting of the Chemical Society Mr. S. U. Pickering read a paper entitled "Isomeric Modifications of Sodium Sulphate." The author has determined the heat of dissolution of sodium sulphate. He has used the apparatus of Berthelot—Mec. Chim. I., 140. He allowed a large quantity of sodium sulphate to effloresce till nearly anhydrous. Various portions were then dried at different temperatures. From the author's results it is evident that there are two modifications of sodium sulphate. All the specimens not heated above 150 gave 57 cal. as the value of the equation $Na_2SO_4 + 420 H_2O$. Specimens heated above this temperature up to the fusing point indicated the existence of a modification dissolving with + 760 cal. The existence of the salt in two different forms may explain the discrepancies in the results arrived at by various authors.

AT the last meeting of the Chemical Society a paper was read on "Magnesium Hydrosulphide Solution, and its Use in Chemicolegal Cases as a Source of Hydrogen Sulphide," by E. Divers and Tetsukichi Shimidzu. The authors, wishing to obtain a regular stream of pure hydrogen sulphide, found that this could be effected by gently heating a solution of magnesium hydrosulphide. Ordinary hydrogen sulphide, from ferrous sulphide and hydrochloric acid, is passed into water containing magnesia in suspension. The gas is absorbed and the magnesia dissolves. The decanted solution is colourless, and when heated to 60 deg. or 65 deg. evolves a steady stream of hydrogen sulphide free from hydrogen and hydrogen arsenide. The magnesia which is precipitated during the evolution of the gas can be reconverted by cooling and passing hydrogen sulphide.

MR. T. MELLARD READE, C.E., who has devoted much attention to chemical denudation of the earth's surface, in his presidential address to the Liverpool Geological Society this session, dealt with "The Denudation of the Two Americas." He showed that 150,000,000 tons of matter in solution are annually poured into the Gulf of Mexico by the river Mississippi; this, it was estimated, would reduce the time for the denudation of 1ft. of land over the whole basin—which time has hitherto been calculated solely from the matter in suspension—from 1ft. in 6000 years to 1ft. in 4500 years. Similar calculations were applied to the La Plata, the Amazons, and the St. Lawrence, Mr. Reade arriving at the result that an average of 100 tons per square mile per annum are removed from the whole American continent. This agrees with results he previously arrived at for Europe, from which it was inferred that the whole of the land draining into the Atlantic Ocean from America, Africa, Europe, and Asia contributes matter in solution, which if reduced to rock at 2 tons to the cubic yard, would equal one cubic mile every six years.

MR. F. SIEMENS' investigations have led him to the conclusion that combustion can only be perfect, and be maintained perfect, if the space in which it takes place is sufficiently large to allow the gases to combine out of contact with solid materials. Having proved that solid substances interfere with the formation of flame, and that flame injures solid substances with which it comes in contact, he brings forward an hypothesis to account for the phenomena. According to the electrical hypothesis which Mr. Siemens prefers, flame is the result of an infinite number of exceedingly minute electrical flashes, the flashes being due to the exceedingly swift motion of gaseous particles, and a solid body which opposes itself to these flashes is cut by them, whilst, the motion being more or less arrested by the solid body, the flame is damped. Mr. Siemens insists that flame must not be allowed to impinge upon bodies to be heated, but must simply heat the bodies by radiation, and furnaces must be so constructed as to allow the flame to develope out of contact, not only with the substance on its bed, but with the walls and roof of the furnace itself; it thus follows that large furnaces must replace small ones.

THE total output in the New South Wales collieries for 1883 exceeded 2½ million tons, the exact figures, 2,521,457 tons 1 cwt., being 412,175 tons in excess of the output for 1882. The average price per ton in 1883 was 9s. 6·40d. as against 8s. 11·97d. per ton in 1882. There has been considerable activity in the search for coal during the year, and there is reason to believe that several new collieries will be shortly opened up. A new coal company has been formed, and has started working a seam of coal between four and five miles from the Mittagong Railway Station; and one has been formed to work a coal seam about three miles from the Erith Colliery; the seam is said to be 7ft. or 8ft. thick; and a seam of coal, 5ft. thick, has been struck by boring about one mile south of the Erith Colliery. The Berrima Coal Company, while working the upper seam, is boring for another seam of coal some 60ft. or 70ft. deeper. A seam of coal is reported to have been discovered at Bungawalbyn, about twenty-five miles from Lismore, but nothing has been done on it yet. A seam of coal, 2ft. thick, containing 15in. of good, bright, clean coal, was passed through at Grafton, at a depth of 183ft., while boring for water. Coal of the best quality, and in very large quantities, is said to exist in the Coolah Valley.

THE underground electric light cables for lighting several of the streets in Greenock under the Provisional Order obtained by the Police Board are to be of three types, namely, the main cable, consisting of thirty-six strands of copper wire, 1·5 millimetres in diameter; the branch main, consisting of twelve strands of 1·6 millimetres; and the leads for the lamp-posts, consisting of one strand of 1·2 millimetres diameter. The cables will be of the Berthoud-Borel type, insulated with Berthoud-Borel material, and incased in a double sheathing of lead, the two sheathings being separated by a layer of gas-tar. A conductivity of 96 per cent. and an insulation of 1000 megohms per mile at the ordinary temperature are guaranteed. These cables will not be laid in any troughs or pipes. They are to be supplied by the Kinetic Engineering Company, and will be tarred, and then laid on a layer of fine sand placed in the bottom of the trench, and covered with the same to a depth of about 4in. A plank of wood or layer of bricks will be placed on the sand to indicate the presence of the cable to workmen afterwards taking up the street, and save it from injury by their tools. Large quantities of these cables have been laid in many of the principal continental towns, and give complete satisfaction. Admitting of this method of laying, the Berthoud-Borel cables affect a great saving in time and labour in placing them underground.

MISCELLANEA.

THE official announcement has been made of an exhibition to be held in Paris in 1889.

HER MAJESTY'S Office of Works have placed the contract for the next 3½ years for the general repairs to all the Palaces, Houses of Parliament, Courts of Justice, Post-offices, and civil buildings generally in the London district, in the hands of Messrs. Perry and Co., of Tredegar Works, Bow.

A BIRMINGHAM correspondent writes that the Birmingham and Worcester Canal, which runs over the Midland Railway, burst on Monday morning and flooded one of the tunnels to the depth of 25ft. A great quantity of dirt has been carried into the workings, and the damage is enormous.

THE Teddington Local Board, having sought the opinion of counsel with regard to the proposed construction of a suspension bridge over the Thames within their district and obtained a favourable statement from Mr. Glen, have requested the sanction of the Thames Conservancy Board to the project.

A THIRD experiment in balloon steering was made in Paris, on November 8th, by Captains Renard and Krebs at Meudon, and resulted in a complete success. The æronauts went as far as Billancourt and returned to Meudon, descending at the spot whence they started. The voyage occupied three-quarters of an hour.

THE town of Gisborne, New Zealand, was lighted with gas on the night of the 18th of August for the first time. The quality of the gas was pronounced very good. Mr. Atkinson, of Auckland, is the consulting engineer, and Mr. Hawley local manager and engineer. Nineteen years ago the Auckland Gas Company commenced with thirteen shareholders, and the present capital is £150,000.

THE Birmingham, Tame, and Rea District Drainage Board met in Birmingham on Tuesday, when it was determined that the Handsworth and Smethwick Local Boards should be allowed to construct sewerage works of two miles in length. The dimensions of the sewers will vary from 4ft. 6in. high by 3ft. 4½in. wide to 3ft. high and 2ft. wide. The estimated population provided for is 25,000, and the drainage area is 1700 acres.

AT an examination held on November 6th and 7th, at the Sanitary Institute of Great Britain, twenty-seven candidates presented themselves, eight as local surveyors and nineteen as inspectors of nuisances. The Institute's certificate of competency to discharge the duties of local surveyors was awarded to B. R. Phillipson, J. E. Worth, and Gilbert Thomson; and to discharge the duties of inspectors of nuisances to W. Daley, J. Brooks, J. Houghton, J. Keal, T. Wheat, W. Fraser, J. Loach, J. Marshall, F. S. Winsid, J. T. Simpson, A. H. Rollinson, and Ben Potter.

A NEW pier at Clarecastle, Port of Ennis, County Clare, constructed by the Board of Works six months ago, at a cost of £5000, has, the *Contract Journal* says, collapsed. The whole structure, which was built of large blocks of concrete, is in such a tottering condition that no vessel can sail near it, and there is danger that it will topple over, and impede the channel. All the sea-going traffic is consequently stopped, and the vessels lying at the old quay have no chance of sailing out. The sinking of the pier is attributed to imperfect piling, the piles being only 7in. in diameter.

THE United States Treasury Department has decided that silver ore "which has been advanced in value or condition by grinding or by other process of manufacture, is liable to a duty of 10 per cent. *ad valorem*." This the *American Engineering and Mining Journal* says, "injures many American mining enterprises in foreign countries, notably in Mexico, and may lead to the loss of a profitable business to a number of American smelting works. It is certainly no 'protection' to silver mining interests in this country, which, if they had any feelings on the subject, would rather see some high grade concentrates go to our reduction works. It is a small matter, of course, but it illustrates pretty well that some of the provisions of the tariff are a nuisance rather than a blessing."

AT a meeting of the Executive Council of the Inventors' Institute, held at their rooms, Lonsdale Chambers, Chancery-lane, on Monday, the 10th inst., it was resolved,—"That the first meeting in every month should be devoted to the consideration of the Patents, Designs, and Trade Marks Act of 1883; that the Act should be gone through regularly by sections, and that a report should be drawn up of the result of the discussions, and that visitors should be invited to attend these meetings." The Executive Council then proceeded to elect new members. The first meeting for the consideration of the Act will take place on Monday, December 8th. The chair will be taken at eight p.m. by vice-president Admiral Selwyn, when Parts I. and II., as far as Section 7, should time permit, will be discussed. The secretary is authorised to issue a few tickets of admission.

ON the 11th instant, Messrs. Edward Finch and Co., of Chepstow, ran a very successful trial trip of the powerful steel twin screw salvage tug, Bulldog, built for the Bristol Docks Committee. The principal dimensions are:—Length over all, 92ft.; breadth, 20ft.; depth, moulded, 10ft. She is admirably fitted for salvage purposes, being supplied with a 5-ton swing crane, placed amidships; a steam driven-capstan and winch combined, forward; and an 18in. centrifugal pump, placed just aft amidships, and strong towing gear at end of boiler casing. The crew are berthed in after part of vessel, under deck. A complete chequered iron deck runs fore and aft, and Barlow rail belting entirely around the hull, which is of steel, the thickness required by Lloyd's for iron. Two steel boilers, designed for 120lb. working pressure, and two pairs of compound surface condensing engines of 30 nominal horse-power each, have been fitted by the builders. The boat and the whole of her machinery has been built from the design and under the superintendence of Mr. John Ward Girdlestone, engineer to the Bristol Docks.

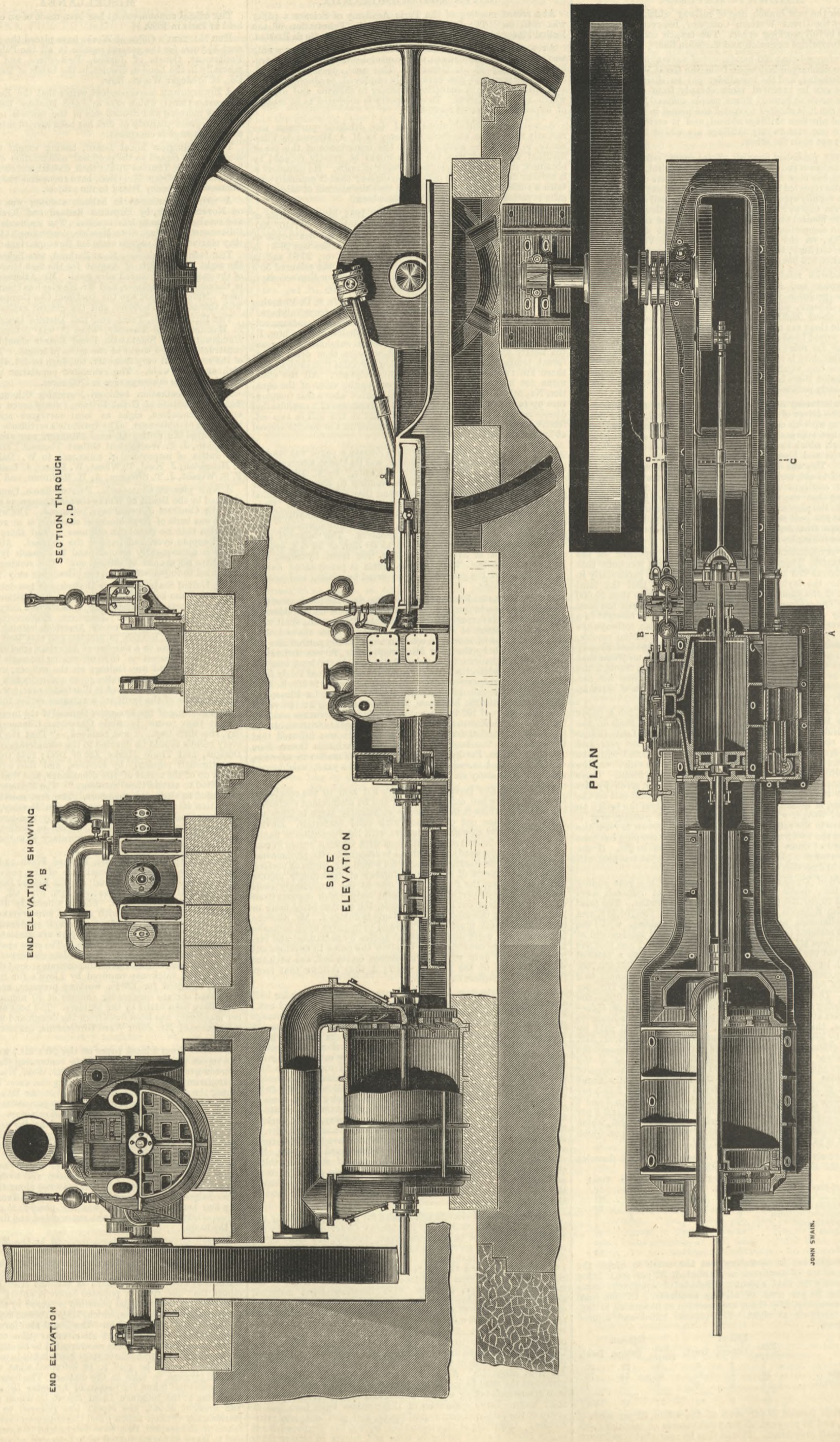
QUOTING from a local paper on the 24th ult., we gave publicity to a report which exaggerated facts concerning the Boston Dock. According to the report of the engineer, Mr. W. W. Wheeler, M.I.C.E., arrangements had been made for letting the water in at high water during the spring tides, which occurred on the 18th ult., through a gullet which had been prepared for the purpose in the upper part of the old river bank which had acted as a dam during the construction of the lock. At high tide on the day named the water, however, found its way through the lower part of the bank, a short distance from this gullet along some timber, the remains of an old sluice which had formerly existed at the place, and caused a breach about 30 yards wide, through which the water poured with sufficient velocity to fill the dock 23ft. deep, and to drive some large lumps of very hard clay and other material along the lock pit, and these lodged in the depression of the gate platforms. Until this clay had been cleared out it was not possible to close the gates; consequently, for some days the water ebbed and flowed in and out of the basin.

A COMMUNICATION has been received by the Town Council of Leicester from the Local Government Board, enclosing a copy of Major Tulloch's report after his investigations into the alleged pollution of the Soar by the borough of Leicester. The report states that although the Board is satisfied from Major Tulloch's report that the river is polluted before it enters the borough of Leicester, yet the principal pollution is caused by the effluent from the borough sewage works, which, Major Tulloch says, is practically sewage in an unpurified state. The Board also learned from Major Tulloch that the condition of the river for miles below the outfall of the borough sewage works was reported to be offensive, and such as to call for some immediate steps being taken to mitigate the evil. The Board would be glad to be informed what steps the Town Council propose to take in the matter. The terms of the report have somewhat taken the people of Leicester by surprise, but at a meeting of the Belgrave Local Board, by whom the late inquiry was brought about, the report was referred to as a complete justification of their action; and the chairman stated that, having taken up the matter, they were determined to secure a clean river, and to leave it contaminated with Leicester or any other sewage no longer than was absolutely necessary.

HORIZONTAL BLOWING ENGINE.

CONSTRUCTED AT THE IMPERIAL GOVERNMENT WORKS, HIOGO, JAPAN; MR. JAMES LANG, ENGINEER.

(*For description see page 369.*)



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

X.—*The Commissioner in England for the New Orleans Exhibition is Mr. Pine, care of the American Exchange,* 449, *Strand.*

ROTARY.—*The velocity of the steam passing through a port should not exceed* 100*ft. per second. You can calculate your port areas from this.*

J. M.—*We believe the largest stationary engine ever built was made by Messrs. Hick, Hargreaves, and Co., Bolton, for a cotton mill in Bombay. It consisted of a pair of engines capable of indicating* 2500-*horse power, each engine being very similar to that of* 1000 *indicated horse-power made by the same firm for Messrs. Illingworth and Sons, Bradford, and illustrated in* THE ENGINEER 29*th April*, 1881.

J. J. T.—*We cannot advise you to attempt to secure an American patent for yourself, because the chances are a hundred to one that you will fail to get it. It is almost indispensable to have an agent on the spot to convince the examiners that you have a novel invention. The cost of an American patent is nominally about* £7; *you will be lucky if you protect your invention for* £30. *You should apply in the first instance to some trustworthy patent agent here.*

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MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, Nov. 18th, at 8 p.m.: Ordinary meeting. Paper to be discussed, "Electric Lighting for Steamships," by Mr. A. Jamieson, Assoc. M. Inst. C.E., F.R.S.E.

CHEMICAL SOCIETY.—Thursday, Nov. 20th, at 8 p.m.: Ballot for the election of Fellows. "On Some New Paraffins," by Khan Bahadur Dr. Bomanji Sorabji. "On Additive and Condensation Compounds of Di-ketones with Ketones," by Dr. F. R. Japp and Dr. N. H. Miller. "On a New Method of Determining the Vapour Pressures of Solids and Liquids," by Dr. W. Ramsay and Mr. Sidney Young. "On the Action of the Halogens on the Salts of Trimethylsulphine," by Dr. L. Dobbin and Mr. Orme Masson, M.A., D.Sc. "Note on the Sulphates of Polassium and Lithium," by Mr. Spencer U. Pickering. "Researches on the Application of Iron Sulphate in Agriculture," by Dr. A. B. Griffiths.

ROYAL METEOROLOGICAL SOCIETY.—Wednesday, Nov. 19th, at 7 p.m., the following papers will be read:—"A New Method of Reading the Direction of the Wind on Exposed Heights and from a Distance," by Mr. Hugo Leupold, F.R. Met. Soc. "Description of a Component Anemograph," by Mr. Alfred N. Pearson, F.R. Met. Soc. "On the Injury by Lightning, April 28th, 1884, to the Monument to the first Duke of Sutherland at Lilleshall, Shropshire," by Mr. C. C. Walker. "On the Mechanical Characteristics of Lightning Strokes," by Col. the Hon. Arthur Parnell.

THE ENGINEER.

NOVEMBER 14, 1884.

BOILER EXPLOSIONS.

THE Wolverhampton boiler explosion supplies another example of the quasi-mysterious catastrophe. We have a concatenation of improbable circumstances presented to us for consideration; and although, pending the coroner's inquest on those killed, it would be inexpedient to say much, there is nothing to prevent us from dealing in at least general terms with the puzzle presented to us. The facts are very simple. Three boilers exploded almost at the same instant at the Staffordshire Steel and Ingot Iron Company's Works, Wolverhampton. The coroner's inquest has been adjourned to the 20th instant, when Mr. Marten's report will be presented. Meanwhile an inquiry has been carried out for the Board of Trade by Mr. Peter Samson and Mr. Ramsay, from which we derive nearly all the information at present to be had on the subject. It appears that the boilers were new in June, having been made of Sir John Brown's B iron, according to the company's specification. They were egg-ended cylindrical boilers. The water supply came from the canal adjoining the works, and appears to have been very bad. The boilers had to be cleaned out every week, six or seven buckets-full of mud being taken out of each at a time. There were ten boilers in the battery; the set had been repaired since June, and some had been repaired twice or three times. A piece of one of the boilers which burst was pointed to by several of the witnesses as bearing evidence of having been red hot.

The chief evidence at the opening of the inquest, not given in the foregoing paragraph, was that the boilers which exploded were the three first in the battery in which they were all connected. Eight of them were under steam at the time, two being off for repairs. The boilers before they were sent away from the works of Messrs. Pigott, of Birmingham, who made them, were tested up to 120 lb., and they usually worked at 70 lb. or 80 lb. Up to half-past five on the afternoon of Wednesday week—the day of the accident, which last occurred at eight at night—the pressure was from 60 lb. to 75 lb., and it was 61 lb. when, at half-past five, they were handed over to the attendant who had come on for the night turn. The water supply was at the time good. It was obtained through a pair of pumps, a main pipe leading to each boiler. If any misadventure should happen to these pumps, a powerful pump capable of doing their work was available. A glass gauge and three test cocks were fitted to each boiler, as well as two safety valves. Half an hour after the boilers were handed over to the engineman on the night turn, the pressure had dropped to from 50 lb. to 55 lb., and at this pressure the pumps in the engine-house would not work. Twenty minutes before the accident the water was still in the glasses of both No. 1 and No. 2 boilers, and stood in the glass of No. 1 at 1in., and in the glass at No. 2 at $1\frac{1}{2}$in. The engineman by the use of a piece of rod iron which he thrust into the taps cleared the gauges, and then the water rose certainly in one of the glasses. While this was going on the blowing engines were standing. The available information extends no further. Three men were killed, five injured.

We have here a typical multitubular boiler explosion, and such events are by no means rare. Nine multiple boiler explosions were recorded in the books of the Manchester Steam Users' Association up to June, 1879. In 1862 three boilers burst at once at the Fenton Park Ironworks. In 1863 five boilers gave way simultaneously at the Moss End Ironworks, Glasgow. In 1864 two externally-fired boilers burst together at the Aberaman Ironworks. In 1866 two boilers exploded on board a tug boat. Two externally-fired boilers burst at the Blair Ironworks, in Ayrshire. In 1872 three boilers exploded out of five at St. Helen's; they were externally fired. A seventh case occurred at Hollen Bank Mill, Blackburn, two perfectly new Lancashire boilers bursting simultaneously on the 7th March, 1874. Two Lancashire boilers exploded in 1876 at the Caledonian Bleach Works, Pendleton. On the 19th March, 1879, six boilers burst at once at an ironstone pit near Coltness, in Scotland. The six boilers formed part of a series of ten, set side by side, all of the plain cylindrical externally-fired class. In the Wolverhampton case the boilers were new, only having been at work for a few months; so that corrosion has had nothing to do with the matter. Concerning the cause of the first explosion, indeed, we have little at present to say. The question is, Why did two other boilers follow the first?

These boilers were new and presumably strong. If we suppose that they were injured by the giving way of the boiler which first exploded, it by no means follows that they must of necessity explode too. Many experiments have been made at various times to ascertain whether the sudden release of pressure such as must take place if a steam pipe coupling two boilers was fractured by the explosion of one of them would or would not cause an explosion of the other. The results have been negative. Several years ago a committee of the Franklin Institute got up steam to a high pressure in a cylindrical boiler, and they then fired a cannon at it—a six-pounder, we believe. The projectile struck the boiler, and passed through it. All the steam and water rushed out through the holes made by the ball, but there was no explosion. In the United States several other experiments have been made with a similar object, particulars of most of which will be found in our columns. In one or two instances violent explosions were obtained by suddenly opening a large valve and permitting steam to escape in large volumes; but it must be admitted that at the time the point of rupture had very nearly been reached. Many explosions have occurred just after an engine has been started, and steam taken rapidly from the boiler. On the Hudson River some years ago a disastrous explosion occurred in this way, after the engines of a steamer had made a couple of revolutions, the pressure at the time being normal. On the whole there is reason to believe that the sudden release of steam from the top of a boiler *may* cause an explosion; on the other hand, the sudden liberation of water certainly will not. It is quite unnecessary, we think, to detail again the well-known theory that the sudden release of pressure permits the expansion of the steam within the water in the boiler, and that the water is then violently upheaved and shot, as it were, against the top of the shell, rending it to pieces. This theory is very generally received, and has much to recommend it, but we do not think that it covers the whole ground. It no doubt serves very well to explain why a boiler explodes violently, but it does not follow that other causes may not produce a similar result; nor is it quite clear that the violent rising of the water necessary should be produced in half-a-dozen boilers by the explosion of another in close proximity. It is, at all events, a useful working hypothesis, and this is, perhaps, all that Mr. D. K. Clark will feel disposed to claim for it.

Without attempting for the moment to put forward any theory of our own, we wish to direct attention to phenomena of every-day occurrence which deserve an explanation which they have never received. When the cork of a soda-water bottle is set free it escapes with considerable violence and noise. It behaves in a manner like a projectile shot from a gun. There is this great difference, however, between the projectile and the cork—that the whole of the projecting work must be done on the latter after it has left the neck of the bottle. In the case of a gun, the work is done on the shot while it is moving up the barrel and acquiring velocity. The motion of the cork is extremely slow until it escapes from the bottle. The motion of the projectile from the gun is most rapid at the moment it leaves the muzzle. We have a strict analogy between the flight of a soda-water bottle cork and that of a bit of boiler plate. The cast iron top of the dome of a Great Northern locomotive was a few years ago blown clean through the roof at Bishop's-road station, on the Metropolitan Railway. No one was hurt. The engine was standing in the station at the time attached to its train. All the bolts securing the dome top gave way, and sailed away through the air to distances of some hundreds of feet. Now, it is very easy to say that the flight of this mass of cast iron is easily explained. "It was blown into the air," "It was violently forced off by the steam," "The steam shot it off," and a dozen similar explanations(?) may be given. But engineers do not rest content with vague statements of this kind. They see that the cast iron must have been put into very rapid motion indeed in a very minute fraction of time, and they want to know how the motion was actively impressed on it. As soon as we begin to use figures, we discover that vague generalities really convey no adequate idea at all of what takes place. Let us suppose, for the sake of illustration, that the cast iron dome was 18in. in diameter, 254in. area, and that it weighed 100 lb. Also we shall assume that it was projected to a height of 100ft. In order that it should attain to this altitude, it must have an initial velocity at least as great as that which it would acquire if it fell 100ft. Allowing a little for the retarding influence of the air, the initial velocity must have been 82ft. per second. The boiler pressure being 120 lb. on the square inch, the total effort lifting the dome would be 30,480 lb. We have therefore a force of 30,480 lb., a velocity of 82ft., and a weight of 100 lb. Through what space must this force operate on the weight? A very simple calculation suffices to show that the force of 30,480 lb. must act through a space of about ·32 of a foot. It will be seen from this that the steam must have exerted its full pressure of 120 lb. on the square inch until the lid of the dome had been parted from it by a distance of about 4in. In boiler explosions the same thing happens. The pressure follows, so to speak, the flying fragments for a certain distance after disruption takes place. In the same way, the column of escaping carbonic acid gas rising from the neck of a soda-water bottle imparts a high velocity to the cork after this last is quite free of the bottle. It is in this way that the projection of fragments to a great distance is brought about, and we do not think it is necessary that water should be called into play for the mere projection of portions of the plates. As we should state the case, the phenomenon of a boiler explosion would be somewhat as follows:—First, rending takes place through a weak joint or corroded plate; secondly, there is a violent outburst of steam; thirdly, there is a fall in pressure; fourthly, portions of the water are propelled with great violence against the boiler shell, which is shattered thereby; fifthly, the steam rapidly generated from the liberated water imparts, in the way we have tried to explain, high initial velocities to the fragments, converts them into so many projectiles, and spreads ruin around.

The point worth special notice about all this is that the steam keeps together, so to speak, and does not escape by fissures or cracks. It might be thought that the moment the steam dome cover, which we have already used for the purpose of illustration, was raised at all, the steam would all rush out sideways, and that the cover would be projected but a few feet. This is not the case; the steam does not diverge to the right or left; its molecules advance each in a straight line, behaving like a minute projectile; and this columnar advance of a gas, free to diverge right or left, but going straight on, is the main cause of the violence of boiler explosions as manifested by the flight of fragments to great distances.

PROFESSOR HERSCHEL ON THE EFFICIENCY OF FANS.

SOME months ago we had occasion to refer to a discussion concerning the efficiency of fans which took place at a meeting of the South Staffordshire Institute of Mining Engineers. It will be remembered that at the time, and subsequently, we published a voluminous correspondence on the subject. Mr. Capell engaged the services of Mr. D. K. Clark, C.E., to examine and report on the performance of the Capell fan, and this report was also published in our columns. It was not suffered to pass uncriticised, because the figures obtained by Mr. Clark apparently showed that the fan gave out more power than it received from the engine, which is absurd. Mr. Clark, however, when attacked on this point, put forward an explanation which may be taken as quite satisfactory, although the disputants were not unanimous on this point. Indeed, there was no unanimity among them on any point, and the result of the long correspondence to which we have just referred was simply nothing. No one seems to have been convinced of anything of which he was not quite positive before. We venture to hope, however, that those who watched the combat, without being oppressed by its din and fury, learned something. Although the correspondence terminated, so far as our columns were concerned, it must not be supposed that matters in dispute were set at rest. To say nothing of fan makers and fan inventors, the South Staffordshire Institute remained dissatisfied, although not much was said. Mr. Alexander Smith, M.I.C.E., entered at last into a lengthy correspondence with Professor Herschel on the subject of fans, and finally he threw his own ideas and those of Professor Herschel into the form of a paper entitled "On a Description, by Professor A. S. Herschel, M.A., F.R.S., of a New Rule for Testing Fans." This paper was read before the South Staffordshire and East Worcestershire Institute of Mining Engineers on the 3rd inst. No particulars concerning the discussion have reached us, save that it was adjourned. Our excuse for reopening the whole subject in our columns lies in the circumstance that whatever Professor Herschel may say is worthy of attention, and that he has very sharply criticised THE ENGINEER. We venture to think that in what we have written on the subject we were indisputably right, and that Professor Herschel has either misunderstood what we have intended to convey, or that he is wrong in the view he takes of the work done by a fan, and this we hope to prove before we have done.

It appears that Mr. Smith sent to Professor Herschel a copy of an article on the efficiency of fans, which appeared in our impression for Dec. 7th, 1883, Professor Herschel has returned this article to Mr. Smith with his comments on it. We reproduce a portion of the article and his comments. We wrote: "The work done by a fan consists in imparting to a certain weight of air, previously at rest, motion at some velocity. A paddle-wheel does for water what a fan does for air—it puts a weight of it in motion." On this Professor Herschel writes: "Wide classes of difference in mode of action exist between fans, paddle-wheels, screw propellers, and turbines, working reversibly or unreversibly, which quite prevent any strict reasoning from analogy between their effects. To show this in detail, and to disprove the proposition that visible motion given to air—which is not really 'at rest' originally as it appears to be—measures the work of a fan upon it, would, however, lead very far beyond the limits and scope of the discussion intended in the present paper." We went on: "In order to ascertain what is the net work done by a fan, we must ascertain the weight of air and the velocity of it discharged from the fan, in a minute or an hour, or other suitable interval; with these figures in our possession, the rest is easy." Professor Herschel says: "This mode of estimation neglects the vacuum raised at the fan inlet, which is a considerable element of a fan's work performance." To illustrate our meaning, we gave an example taken from Mr. Capell's figures, and we added: "The work stored in this air could not be greater than the power expended in putting the air in motion." Professor Herschel says: "This cannot possibly be affirmed without consideration of the accompanying vacuum which existed at the place of measurement of the high velocity." We then gave the formula for calculating the work accumulated in the air, namely, $W = \frac{M v^2}{2g}$, where M is the weight of the air put in motion in pounds, v is the velocity in feet per second, $2g$ is 64·4, and W is the accumulated work in the air moved. Now, let us see what Professor Herschel's criticisms come to.

To begin, we did not attempt to say that the rule quoted would give the whole power expended on the fan. It gives, and is intended to give, only an amount of power less than which cannot possibly be expended on the fan. If, for example, the rule shows that the equivalent of 10-horse power is stored in the air as it leaves or enters a fan, then less than 10-horse power could not cause the revolution of the fan at the stated speed under the given conditions, and twice as much might be actually needed. The nearer the actual power expended approaches to the power stored by moving it in the air, the greater is the efficiency of the fan. Professor Herschel has in his first comment evidently overlooked this fact; because no matter what the mode of action of a screw propeller, paddle-wheel, or fan may be, its efficiency is represented by its power of putting a body of fluid or liquid in motion, the only difference between a propeller and a fan being that because in the case of a screw the object had in view is the propulsion of a ship, we aim at a somewhat different result from that which *may be*—we do not say always is—sought for in using a fan; and we design propellers or paddle-wheels to push astern the largest possible quantity of water at the slowest possible velocity for reasons which have been fully set forth by Rankine in the pages of this journal. Professor Herschel is, in fact, opening up side issues which have nothing whatever to do with the main fact. In his next comment he refers to the vacuum raised at the fan inlet, which he regards as a considerable part of the fan's performance. It would be very easy to show that this same vacuum is mixed up inextricably with the work stored in the air; that, in short, its influence reappears in another form in the work in the moving air. But we shall not, simply because this also is a side issue. If we concede that the inlet vacuum presents 50-horse power, while the work in the passing air is but 10-horse power, our statements are in no way modified. We have said that the work done by the engine cannot be *less* than that stored in the air. We have never stated that it could not be more; but, on the contrary, have shown that it must be more. Further down, Professor Herschel again refers to the vacuum. To this note what we have just said will equally apply. So far, then, we think it is clear that Professor Herschel has misunderstood us, and that we have said nothing which is not strictly accurate. We have now to see what Professor Herschel says, and consider whether he is equally accurate.

Professor Herschel has carried out some experiments with the Capell fan, and he has sent the results of his investigations to Mr. Smith. In calculating the power expended, Professor Herschel uses a new rule, and this we give in his own words. One of the fans tested was 14in. diameter, with a 7in. inlet; the blades were 6in. wide, and have an area end of 267 square feet. This fan "drew $1\frac{3}{4}$in. W.G. (= 9·1 lb. per square foot) at open end of a 5ft. round, straight zinc tube of same diameter as the inlet of the fan; with air speed there by Casella's anemometer 4400ft. per minute = 1176 cubic feet per minute through the tube. Horse-power in the air $= \frac{9{\cdot}1 \times 1176}{33{,}000} = \frac{10{,}702}{33{,}000} = \frac{1}{3}$-horse power nearly, or 10,702 foot-pounds per minute, by the ordinary rule. By the new rule, however, there is to be subtracted first from the observed W.G., what is due to air speed at the point where it was taken; computation of which can be made nearly enough by the rule —if v is the air speed in feet per minute, and H the air speed gauge required—

$$H = \frac{1}{68} \times \left\{ \frac{1}{64} \times \left(\frac{v}{60}\right)^2 \right\} = \left(\frac{1}{66}\right)^2 \times \left(\frac{v}{60}\right)^2$$

very nearly; supposing that 68ft. head of air would balance in. of water-gauge; $= \left(\frac{v}{60 \times 66}\right)^2 = \left(\frac{v}{3960}\right)^2$ very nearly $= \left(\frac{v}{4000}\right)^2$ very nearly; or more exactly $= \left(\frac{v}{4000} + 1 \text{ per cent. of } \frac{v}{4000}\right)^2$ very nearly. In the case of this experiment Y = 4000ft. per minute, air speed; and $\frac{v}{4000} + 1$ per cent. of $\frac{v}{4000} = 1{\cdot}1 + {\cdot}011 = 1{\cdot}111$, whence $H = (1{\cdot}111)^2 = 1{\cdot}234$in. fictitious water-gauge. Real residual W.G. = 1·75in. — 1·234in. = ·516in.; or resistance to air current = 0·516 × 5·2 lb. per square foot = 2·68 lb. per square foot. Work of resistance overcome = 1176ft. × 2·68 lb. per square foot = 3152 foot-pounds per minute = 0·095-H.P. (between 1-11th and 1-10th of a horse-power only.)" Lest it should be thought that we have not done Professor Herschel justice, we quote the following explanation which he supplies of the theory of his new rule.

"The head due to onward velocity, and the barometric head, taken together at any point of an air-stream, constitute its 'dynamic head' at the place of measurement; and in a complete circuit—like that of a mine, fan, and outer air—it is the air's dynamic head alone, at every point, which measures the work there stored or accumulated in the air. To start air or water round a returning channel at any prescribed speed requires—apart from friction—no expenditure of work upon it if the fluid's dynamic head at every point remains the same as it was when the fluid was at rest. Friction absorbs, and fans supply, dynamic head. Whirling velocity is a part of the dynamic head which fans give to air between their inlet and their outlet points; but without special contrivances, either of the fan-cover or of its blades, to convert this kind of velocity either into onward velocity or into barometric head, it is of no use to conquer friction in the circuit, as its natural course either in a duct or in the atmosphere is to waste itself in friction. It should be said that mechanical ventilators can only raise energy of dynamic head in an air—or water—course by impressing both onward and whirling impulse together to the stream, either in a visible or in some hidden way which satisfies the dual nature of the stream's dynamic store. Fans, and all kinds of manomoters whose whirling impulse leaves them in the visible form of whirl or spin given to the current that they make—unconverted into onward velocity or barometric head—are single-power motors only, as half their expended power is useless for anything but winnowing effects. Fans which conceal the whirling impulse that they use are double power from the greater efficiency of their work to propel a stream against resistance."

Let us now compare the results obtained by Professor Herschel with those which our mode of calculation supply. We shall take Professor Herschel's quantities as correct. We have then 1176 cubic feet of air per minute, or 19·6 cubic feet per second, the weight of which is approximately 1·5 lb. The velocity was 4400ft. per minute, or 73·3ft. per second. Then $\frac{1{\cdot}5 \times 73{\cdot}3^2}{64{\cdot}4} = 12{\cdot}5$ foot-pounds of energy per second in the moving air, or 720 foot-pounds per minute, or $\frac{1}{45}$ of a horse-power nearly. We think that these figures will suffice to convince Professor Herschel that our rule does not give the work done on a fan as in excess of what it really is, seeing that the Professor's own rule gives the work at about four times as much as ours. It is proper to add here that Professor Herschel does not wish it to be understood that his new rule is of invariable application, and he does not appear to think that it will suit the greater proportion of ventilating fans having large speeds at their outlets. We have endeavoured to ascertain exactly what Professor Herschel means by an explanatory passage quoted by Mr. Smith, and as we have failed to arrive at any satisfactory result, we quote the passage entire, lest we should do Professor Herschel an injustice. Here it is:—"It would cause me very much regret if the first imperfection of the rule—which was only casual and does not really belong to it—should, from obvious insufficiency which it involved to meet the conditions of performance of by far the greater proportion of ventilating fans having large air speeds at their outlets, lead either to the rule's rejection as a fallacy by practical overseers of mine ventilation, or else to its incurring from them such critical castigations for its defects as I could not, at least profitably for the matter's useful discussion in its present state of quite inadequate exploration by theory and experiment, show the rule's real exemption from with anything like the plain brevity and cogency with which I found it very fortunately possible to elicit and prove a strictly rigid form which it has for all cases in the letter which I just lately wrote you. The suspicion of the rule, which I entertained and tested in my first letter, confirms itself so completely when its mode of use is examined as you suggested at different points along the air-way of a mine, by leading directly when this way of interrogating the point is used, to the simple consequence that it is only in the fan's chamber—between its inlet and its outlet—where the whole driving work of the course or air-circuit is done and generated, that the allowance for air speed—entering operatively and going out inoperatively—has to be taken account of, and made use of as a water-gauge correction, that this easy rectification of the ordinary method of reckoning 'horse-power in air' by water-gauge and volume, will, I hope, be understood and resorted to hereafter."

For the present we shall make no comment on Professor Herschel's rule. In the first place, because we have not space, and in the second, because we are not sure that we as fully comprehend Professor Herschel's line of argument as is desirable. Indeed, it may perhaps be hinted that he does not as yet quite understand the matter himself. Possibly he will excuse our want of perspicuity if we use as our apology his own words, addressed to Mr. Smith: "The problem of fan ventilation has much the same principles guiding it that the transmission of power by electricity has; and a complete explanation of one will probably be in a great measure the explanation of the other. There is no discredit therefore to anybody's scientific knowledge not to be conversant with the capricious features presented by ventilators in their various forms, and not to be able to account for all of them. No manual or even Treatise on Physics that I can tell you of so much as touches remotely a subject so extremely difficult; so that perusing any of them that are in ordinary use will not open your way at all through the discussion."

CHEMICAL MANUFACTURES IN SOUTH DURHAM.

It was understood when Messrs. Bell Brothers began the working of salt in South Durham, that they had the further intention of producing also chemicals, and the works have now been completed, and the production of soda ash commenced. The process is that known as the ammonia process; the older chemical trades on the Tyne using invariably the Leblanc process. In South Durham, however, there is the supply of brine needed for the newer method of manufacture, and thus within forty miles or so we have the two rival processes at work, instead of as before having the breadth of our island between the makers on the east coast and the producers more to the west. The change is one that may be very important. As yet, however, we must remember that the area of the deposits of salt in South Durham is not defined; three bore holes have successfully reached salt, but one to the west of these has proved that salt is not present there at a depth considerably deeper than that at which in the others it had been pierced. If it is found that there is a considerable area of salt, there will be unquestionably the creation of other trades than that of the tapping of these salt deposits, and hence the various bore holes that are now being put down are being watched with very great interest. It is on the results of their working that the opening up of the chemical trade on a large scale will depend; meantime the fact that there has been an opening up of the soda trade by the newer and the cheaper process is not only interesting, but important to the two sets of makers. Ultimately the area of the profitable working of each of the two processes will be defined, and that decision will be best attained by experience. The experience of the ammonia soda works in South Durham will unquestionably contribute to the knowledge that will decide this point.

LITERATURE.

Principles of the Manufacture of Iron and Steel, with some Notes on the Economic Conditions of their Production. By I. Lowthian Bell, F.R.S. 8vo., pp. 744. London: Routledge. 1884.

This work, according to the explanatory statement contained in the introduction, has grown out of a request made by the board of management of the British Iron Trade Association to the author for a report on the then present condition of iron and steel manufacture, as illustrated by the International Exhibition of 1878 in Paris. The author's investigations into points connected with the action of the blast furnace being then still unfinished, he preferred to await their conclusion, in order that he might include a statement of the general results in a complete form, together with some considerations of a more commercial character than those usually found in scientific or technological works. This has now been done, and the result is a volume that will be welcomed by all persons interested in iron and steel manufacture, as a record of the author's labours in the chemistry and physics of iron-making.

The general scope of the work may be briefly described as follows:—After a short introductory statement, the author proceeds to mention the principal improvements in iron-making in chronological order; the direct methods of making malleable iron, and the preliminary treatment of materials for the blast furnace, *i.e.*, coking, charcoal burning, and the calcination of ores, in as concise a fashion as possible, after which a space of 280 pages is devoted to the discussion of the working of the blast furnace, and the consideration of hot blast, fuel requirements, chemical changes, heat equivalents, function of hydrogen and its compounds, and similar accessary subjects. The matter in this part is substantially a reproduction in a condensed form of the author's numerous published memoirs in the "Journal" of the Iron and Steel Institute, and his former work on the "Chemical Phenomena of Iron Smelting." The conclusion formerly arrived at, namely, that in well-proportioned furnaces about 80ft. by 20ft., with blast heated by iron pipe stoves to about 1000 deg. Fah., an economy of fuel is realised which is not likely to be substantially improved upon, is maintained; and the cases where further economy is reported as having been obtained after the adoption of brick stoves are critically examined. As the result of his investigation upon a furnace of the above dimensions, and 11,500 cubic feet capacity, burning 20·4 cwt. of coke per ton of pig metal made, the author computes that the actual loss of heat in the escaping gases represent a fuel equivalent of 1·26 cwt. of coke, which quantity represents the only margin available for further saving; while raising the blast temperature from 1000 deg. to 1700 deg. Fah., supposing such an increase possible, would only save 1 cwt. of coke. He therefore concludes that no substantial amelioration of the performance of well-appointed and well-managed blast furnaces is likely to be effected.

The subjects of malleable iron and steel manufacture are treated in about 100 pages—sections xii.-xiv.—in which various matters of detail in connection with the refinery puddling and open-hearth furnaces and the Bessemer converter are discussed both on scientific and economic grounds. Among the points of more especial interest is the description of the investigation that lead to the author's "purifying process" for dephosphorising pig iron by the action of melted magnetic oxide in a rotating furnace, which was afterwards adopted on a working scale by Krupp and described by Holley as the "pig washing process," a Pernot furnace being substituted for the Danks rotator. The author expresses a high opinion of the latter furnace for puddling, or rather for the water jacketted form of it as used at Creusot. The mechanical rabble receives but slight notice. It is vaguely stated to be in use in the "western portion of the German Empire"—p. 528—but no details are given. The basic process of dephosphorising is discussed at some length, a useful compilation of the results obtained by Mr. E. W. Richards and

Messrs. Massenez and Pink being given, with diagrams, showing the progressive removal of phosphorus, carbon, and silicon in the different methods of fining, as well as computations of the heat development and absorption in the Bessemer process. These latter, however, depend upon assumptions as to the temperature of the products for which there are no experimental data. The Siemens furnace receives a short notice, and numerous analyses are given showing the high quality of its products.

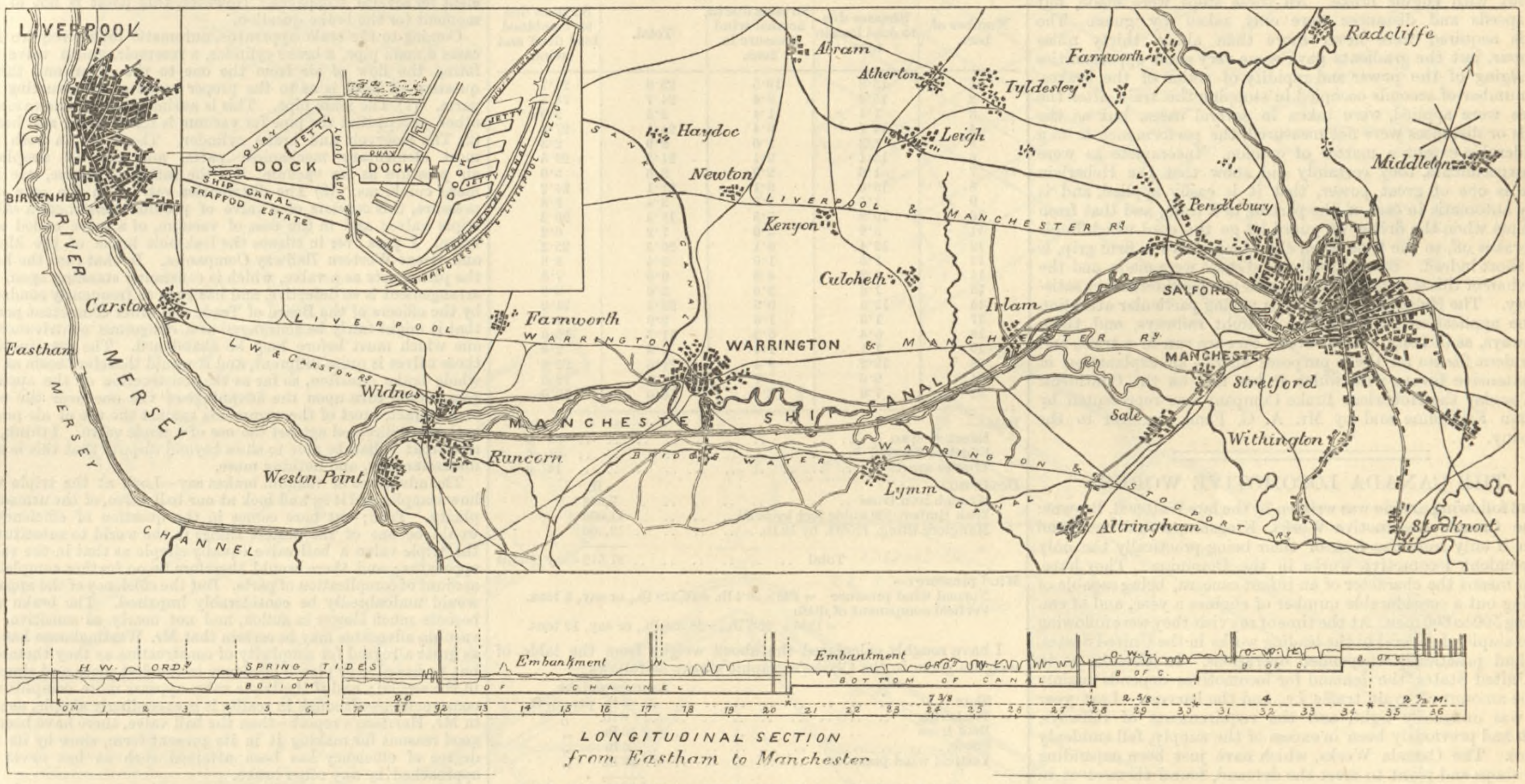
The latter part of the volume is devoted to economic questions, such as statistical returns of the make of different countries, the comparison of British labour with that of the continent of Europe on the one hand and of the United States on the other, and of the natural resources of the chief iron-producing countries of the world. These sections contain a vast amount of interesting matter, but their value is lessened by their unsystematic arrangement. This is especially the case in the statistical details which are given for different localities for all sorts of epochs from 1874 or 1876 to 1882; while in many cases the present tense is used in describing conditions that obviously refer to some former period. Thus, on page 653, it is stated that "it is possible that moderate quantities of Bilbao ore may now find their way to Westphalia at 18s. to 20s. per ton;" whereas it is actually a subject of complaint among the Siegen spathic ore miners that Bilbao ore at 15s. per ton delivered at Ruhrort has completely spoiled the market for their produce, which costs from 10s. to 13s. 6d. at the mines when calcined. Other defects are the persistent omission of the names of localities, and the extraordinary geographical looseness. For instance, in describing the iron-making resources of the different countries, the spathic ores of Siegen are entirely ignored, or that district is confounded with the Lahen Valley, which is alone noticed, and the iron and copper mines of Lake Superior are so mentioned as to lead to the inference that they occur in the same district. Indeed, so much space is devoted to the copper mines, that the author has none left to describe the nature of the iron ore deposits. This is very like commencing an account of the Furness iron district with a notice of Coniston copper mines, and then omitting any description of the red ores on the ground of want of space. Indeed, there would be more to be said for the hypothetical case so put, as Coniston is considerably nearer to Ulverston than Marquette is to Houghton, and the copper and iron districts have as little to do with each other in the one case as in the other. The account of the secondary iron ores of England also leaves much to be desired in the way of accuracy. Thus the geological measures found in the Cleveland hills are said to pass in a south-westerly direction through Lincolnshire and Northamptonshire on the way to the English Channel, where they reach the sea in the county of Wilts. Apart from the latter geographical puzzle, which will remind the reader of Shakespeare's "coast of Bohemia," the author here considers the Cleveland and Northamptonshire ores as identical in position, which they are not, and omits Oxfordshire and Leicestershire, which are both producers of oolitic ores. The author's type of a Northamptonshire working is also said to be near Bletchley, which is in Buckinghamshire, but the name is not given.

The section devoted to the comparison of wages in different countries is also of the highest interest, especially those portions which relate to the earnings and expenditure of the author's own workmen. We are glad to see that while he considers that the habit of drinking is far too prevalent, he deprecates the extravagant language of writers on the temperance question, and criticises their proposal for stopping drunkenness by suppressing public-houses, by giving an amusing instance of the working of the latter in America, where the men of a large works situated in the prohibited area, after the pay, transferred themselves and their wages to a town twelve miles off, where they not only drank to excess, but brought back large supplies of whiskey for home use. Whether the information concerning foreign workmen is always accurate, may be doubted, as in many cases it is derived from newspaper writers, whose opinions are likely to be more or less biassed by protectionist proclivities, especially in the United States. How very wrong it is possible to go in statistical matters when using second-hand information, may be instanced by the figures relating to the export and import of coal in the United States, which are thus given for 1882 at p. 449: "Received, *nil*; exported, 650,000 tons." A foot-note states that "it is doubtful whether this return is quite correct, as vessels occasionally take out small quantities of coal to the United States. In 1876 the importations were, according to Pechar, 407,000 tons." Now, the imports in the latter year were 488,132 tons, and for 1882 the figures returned are: Receipts, 774,425 tons; exports, 945,007 tons. So that the author's doubts as to the correctness of the returns might have been more decidedly expressed. No doubt, for the author's purpose—*i.e.*, for iron making—it may be assumed that no coal is imported into the United States; but a glance at the original authorities would have shown that the bulk—six-sevenths—of the imported coal goes to Pacific ports from England, Vancouver's Island, and Australia, while nearly all the remainder is Nova Scotia coal used in the New England manufacturing districts; and would have explained a problem which is only raised by the author, but not solved. After considering the questions of railway rates and royalties in different countries, the author attempts to establish a basis for the comparing of the competing power in the world of the different European ironworks by calculating the cost of the materials—ores, fuel, and flux—required to produce a ton of pig iron, which are expressed in percentage terms of No. 3 Cleveland pig at Middlesbrough. The highest figures obtained are those of Southern and Central France—156—230 per cent.; while the cost in the Luxemburg oolitic district is estimated at 90 per cent., and at Ilsede at 80 per cent. of the Cleveland price. Towards the end of the volume the question of the introduction of iron shipbuilding into Norway, which was brought forward by the author in his address to the Institution of Mechanical Engineers, is noticed.

The practical conclusions arrived at by the author appear to be as follows:—That there is no probability of any such great improvement being made in iron manufacture as would lead to the cheapening of production in this country, and therefore further economy, if necessary, would have to be sought in the reduction of royalties upon minerals, railway charges for transport, and wages. Whether these conclusions will be generally acceptable to the interests concerned may be doubted, but there can be no doubt as to the ability of the author's discussion of the various economic points and of the value of the work, both as a scientific and economic contribution to the history of our greatest mineral industry. It is noteworthy that the fashionable panacea of technical education for the workmen as a means of meeting foreign competition is nowhere mentioned.

THE REVISED SCHEME FOR THE PROPOSED MANCHESTER SHIP CANAL.

The promoters of the Manchester Ship Canal have this week sent out, to the subscribers towards the expenses of again seeking parliamentary sanction for the scheme, a short pamphlet and coloured map, in which are set forth the revised plans that have now been adopted for the construction of the canal, and which have been laid down specially with the object of overcoming the objections that proved fatal to the project before the House of Commons Committee. The canal, so far as its course from Manchester to Runcorn is concerned, remains without material alteration from the scheme laid before Parliament; but below the point of Runcorn it is proposed to construct an entirely new channel altogether outside the estuary of the Mersey. This new channel, skirting the estuary of the Mersey along the Cheshire shore, is shown in the map above, and the new works are described in the pamphlet as follows:—"The character of these works is completely changed in the new plans. Instead of training walls constructed in the centre of the estuary, the canal, which formerly terminated at Runcorn, will be continued to Eastham, partly along the Cheshire shore and partly through the adjacent land. It will pass through the outer basins of the Mersey and Irwell Navigation Company above Runcorn, and be thence continued along the Runcorn shore, widening out so as to form a dock and wharves for Runcorn, passing under Runcorn Bridge, and alongside the outer walls of the Runcorn and Western Point Docks, across the mouth of the river Weaver, into the Frodsham marshes. Passing through the marshes, and nearly parallel with the river, it will skirt the shore near Ince and pass inland across Stanlow Point and in front of Ellesmere Port, thence inland again until it nearly reaches Eastham Ferry, where it enters the river in deep water. These tidal locks will maintain at low water a uniform level of a neap tide from Eastham to Latchford, a distance of twenty miles. The water will be kept in the canal, where it runs along the shore, by embankments faced with stone on either side. Where the canal is inland it will also be faced with stone. The embankment will be constructed several feet above high water of spring tides, so as to protect the canal from storms, and render it easy of navigation at all times. At various points long weirs will be formed in the embankment to allow of the tide rising or falling into the canal at the same rate as it does in the estuary, and also to allow of the waters of the river Weaver or other streams flowing as at present into the estuary. These weirs will be at a level which will effectually provide for the passage of floods. The small quantity of water used at low tides, for locking purposes, at Eastham, will be tidal water stored in the canal. Except at low tides the lock-gates will be open, and vessels will pass into or out of the canal without locking. The channel below Eastham locks will be dredged into the deep waters of the Sloyne. Lock-gates will be provided through the embankment opposite the existing docks at Runcorn, Weston Point, and Ellesmere Port, to enable vessels to pass in or out of the estuary. As sea-going vessels can now only reach the upper Mersey ports at high water of spring tides, the canal will be of great advantage, as enabling them to reach their port without waiting in the lower Mersey as they are now obliged to do at neap tides. The canal will be thirty-five miles long, and will be lighted and buoyed where necessary to enable vessels to pass up and down any hour, night or day." Another important alteration, which, however, does not affect the canal on a basis that is likely to provoke any opposition in Parliament, is the laying out of the docks at Manchester, for which a revised scheme is put forward, avoiding altogether the Manchester racecourse, which promised to be a very expensive item in connection with the purchase of the land originally required. The new docks, as set forth in the revised plans and the pamphlet, "have been entirely remodelled, and instead of one large dock on the racecourse site, three docks have been designed, as shown on the accompanying plan. They are proposed to be called the Manchester and Salford Docks, and they will afford a greater length of quay space than the dock first adopted. The docks will be entered from the canal by large ship locks below Trafford Bridge. Vessels will at once pass into the Salford Dock, which will be constructed on the land between the racecourse and Trafford-road. A cut crossed by a swing bridge, which will be opened by hydraulic power in about a minute, will allow of ships entering the middle dock from the Salford Dock, and thence passing across the river Irwell, which will be considerably widened on the Manchester side, into the Manchester Dock, which is formed by a series of wide jetties and basins on the site of the Pomena Gardens and the adjoining property. All these docks will allow of steamers of large size to unload at their quay, 26ft. depth of water being maintained by the entrance locks, which will raise vessels to the existing level of the river above Throstle Nest weir, which will be near the future level of water in the docks. Barge traffic can pass under Trafford Bridge into Manchester Docks. The river will be widened and deepened to Woden-street foot-bridge, up to which point large vessels will be able to pass. It will also be dredged from that point to Hunt's Bank as deep as the bridges and adjoining property will allow, so as to enable large barges to lighter goods to or from the shipping to any wharf or warehouse on the river."



THE MANCHESTER SHIP CANAL—REVISED SCHEME.

THE HEBERLEIN AUTOMATIC CONTINUOUS BRAKE.

On Tuesday a number of railway engineers and proprietors and others, including Major-General Hutchinson, interested in continuous brakes, assembled at Chappell Junction to witness the working of the Heberlein automatic brake, on the Colne Valley and Halstead Railway. The experimental train leaving Chappell Junction was made up of (1) tank locomotive, with screw hand brake, and with the friction rod for controlling the brakes of the train by means of the brake cord; (2) composite carriage with automatic brake, working with brake-blocks on both sides of wheels; (3) third-class carriage with automatic brake, with brake-blocks on one side of wheels only; (4) third-class carriage with cord guides only; (5) third-class carriage with cord guides only; (6) guard's brake-van with automatic brake – brake-blocks on one side only—and fitted with brake reel for the guard to control the whole of the brakes of the train, as well as that of the tender, supposing that an engine with tender were coupled to the train. Total weight of train exclusive of passengers, about 60 tons, divided as follows:—Engine, 33 tons; vehicles with brakes, 16 tons; vehicles without brakes, 11 tons; total, 60 tons. The train had been made up with a heavy open goods wagon, and weighed 67 tons, but this had to be taken out on account of the shortness of buffers and length of the couplings, thus reducing the weight of the train to about 60 tons.

The stops made with the brake were made during a run from Chappell to Haverhill. The programme was as follows:—(1) Driver to stop train on an incline of 1 in 75 before reaching a level crossing, using both train and engine brakes and shutting off his steam. (2) Similar trial, down 1 in 110, with steam shut off, but without using engine brake. (3) Train to be stopped by the guard from the rear van, the engine-driver shutting off the steam and applying engine brake on feeling the train brakes applied. (4) Train to be stopped at a station without using the engine brake. (5) Train to run into station, down 1 in 80 incline, and to be stopped with train and engine brake. (6) The rupture of a coupling on a rising gradient of 1 in 75 to be simulated, and the train to be stopped automatically by the rupture of the cord. (7) Train to be eased down the bank 1 in 75—80, without the engine. (8) The vehicles without brakes to be shunted out of train, and the train, then having all axles under brake power, to be run on and stopped at given signals:—(1) With steam shut off, but without engine brake; (2) with steam shut off, but with engine brake. All these stops were made, but the speeds and distances were only taken by guess. The speeds acquired were never more than about thirty miles per hour, but the gradients gave some very good opportunities of judging of the power and rapidity of action of the brakes. The number of seconds occupied in stopping the train after the brakes were applied, were taken in several cases, but as the speeds or distances were not measured, the performance is to a considerable extent a matter of opinion. Incomplete as were the experiments, they certainly did show that the Heberlein brake is one of great power, that it is easily applied, and is really automatic in case of the parting of a train, and that from the time when the driver or guard let go the cord which holds the brakes off, to the time when the blocks have a firm grip, is very short indeed. Several really good stops were made, and the behaviour of this simple and cheap brake was considered very satisfactory. The Heberlein Company is paying particular attention to the application of the brake to light railways, and those tramways, as in Italy, where several cars are run in a train, and its evident fitness for these purposes affords an explanation of the extensive favour with which it has met on the Continent. On Tuesday the Heberlein Brake Company was represented by Captain Fairholme and by Mr. A. G. Fenn, engineer to the company.

THE CANADA LOCOMOTIVE WORKS.

THE following article was written by the late Walter R. Browne:—The Canada Locomotive Works, Kingston, would command notice if only from the fact of their being practically the only independent locomotive works in the Dominion. They have, by no means the character of an infant concern, being capable of turning out a considerable number of engines a year, and of employing 500 to 600 men. At the time of my visit they were following the example of several of the leading works in the United States, and had practically suspended operations. In Canada, as in the United States, the demand for locomotives depends mainly on the amount of grain traffic, *i.e.*, and the harvest. Last year this was unusually light, and the requirements of railways, which had previously been in excess of the supply, fell suddenly to zero. The Canada Works, which have just been expanding their shops and plant to meet the demand, found themselves in the alternative of working at a loss or not working at all. Being rich enough to choose, they naturally took the latter course, looking forward, however, to an early resumption of operations, when the splendid harvest now in course of realisation has to be handled and distributed. Hence the shops were all but empty, and the 500 men who were employed here a year ago are scattered in various quarters, chiefly, of the United States. The company have, however, no fear of losing them permanently, or of not being able to recall them when wanted. As most of them are owners of their own houses in the town, they have left their families behind, and have thus given sufficient pledge of their return. This, together with the easier settlement of all wages' questions, forms the incontestable advantage derived from having the works in a comparatively small town where there are no others to compete with them. In other respects the position of the works is exceptionally fine, as can be seen at a glance. Lying between the Grand Trunk Railway and Lake Ontario, they have their erecting shop connected directly with the former, while their coal, &c., is stored on wharves, having 30ft. of water outside them, not fluctuating with the tide, but always the same. The coal comes entirely from the United States, that of Nova Scotia, spite of the absence of duty, being unable to compete with it. The iron, on the other hand, comes entirely from Scotland, the produce of American works, in consequence of their protective duties, being higher by some cents per lb. Lastly, the tools, which were numerous and modern, were with few exceptions of Canadian build, chiefly from McKenzie and Bertram's works at Dundas, near Hamilton. These tools, whose surfaces are either left bright or lined out in gay colours, give the fitting shop—230ft. in length—a much more festive appearance than is usual in Great Britain. Mostly they conformed closely to English types. A simple and ingenious emery polisher, for coupling-rods, &c., hanging from a shaft, and driven by ropes, was the only decided novelty. In the yard was a specimen of a recent Canadian invention, viz., a "raking snow plough," in which a kind of many-sailed windmill, made to turn about a horizontal axis, shaves off the snow with its front edges, sweeps it inside, and finally delivers it through an opening at the top with force sufficient to throw it to a considerable distance. But on the whole there was very little about the place to tell me that I was not in an English locomotive works, unless it were the complete system of protection against fire, the electric bell connection below each shop and the offices, and the parqueted floor and polished wood fittings of the latter, contrasting in their coolness and fragrance with the drowsiness and dust inseparable from the British *régime* of brick and plaster.

LETTERS TO THE EDITOR.

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

GOODS SHED ROOF, CARNAC BRIDGE TERMINUS, GRAPHIC CALCULATIONS.

SIR,—I send you herewith the design of a goods shed roof constructed at the Carnac Bridge terminus, with diagrams of stresses, from which you will perceive that the method adopted for finding maximum stresses in the roof truss is the one now usually adopted by the engineers, which slightly differs from that of Mr. Graham. The effective span of this truss is 80ft., and the depth 21ft. 6in. The trusses are placed 13ft. 6in. apart, centre to centre. The roof covering is composed of Manglore tiling laid on 1in. teak sheeting fixed on transverse purlins.

The Manglore tile covering is thought a very suitable material to cover with, as it is much lighter than any of its kind, and it being a non-conductor of heat is much cooler than corrugated iron covering, which not only gets heated in tropical climates, but also gets affected by sulphurous vapours and deposition of carbon from the smoke. The pitch of the roof might be considered high on the principle of economy, as a high-pitched roof requires more material; the length of its parts increases, and being more exposed to the wind, they require extra rigidity and strength to resist the force; but the pitch of 30 deg. is adapted to suit the tile covering, and is thought by authorities as the best one.

The form of the truss which is known as the Belgian or French roof truss has been preferred, for the sake of economy, and in consequence of the arrangements of its members, which are such that they come under direct tension and compression, so as to make the sectional areas of the bars bear uniformly distributed stresses, and thereby offering maximum resistance.

To come to an accurate result as to the dead load of the roof, I have calculated the weight of the truss, purlins, boardings, tilings, &c., first from the assumed dimensions and then revised according to the calculated dimensions. This is the only way to arrive at dead load, with due regard to accuracy, and not the one adopted by Mr. Graham in treating the roofs of Didcot provender stores, Bristol goods' shed, &c., by assuming 45 lb. per square foot for dead and accidental load on the authority of M. Levy.

Number of bars.	Stresses due to dead load in tons.	Stresses due to normal wind pressure in tons.	Total.	Stresses due to combined load dead and wind.
1	13·3	10·5	23·8	24·7
2	15·3	9·4	24·7	28·5
3	1·1	1·4	2·5	2·0
4	14·7	9·4	24·1	27·4
5	1·3	1·6	2·9	2·3
6	12·1	9·1	21·2	22·5
7	1·6	2·0	3·6	3·0
8	13·0	8·1	21·1	24·2
9	1·5	1·9	3·4	2·8
10	10·8	7·5	18·3	20·2
11	3·2	4·0	7·2	6·2
12	12·4	8·1	20·5	23·2
13	1·5	1·9	3·4	2·8
14	4·2	4·8	9·0	7·8
15	1·6	2·0	3·6	3·0
16	12·8	9·5	22·3	24·0
17	1·3	1·6	2·9	2·3
18	5·4	6·3	11·7	10·0
19	1·1	1·4	2·5	2·0
20	12·2	9·4	21·6	22·8
21	6·6	7·7	14·3	12·3
22	7·0	3·0	10·0	13·0

Data:—

	ft.	in.
Effective span	80	0
Effective depth	21	6
Trusses apart	13	6

Dead load:—

	lb.
Wrough iron truss	7,952
Teak timber, 220 cubic feet by 50 lb.	11,000
Manglore tiling, 1256ft. by 10 lb.	12,560
Total	31,512 = say 15 tons

Wind pressure:—
Normal wind pressure = $628 \times 26\cdot4$ lb. = 16,579 lb., or say, 8 tons.
Vertical component of ditto = $1256 \times 22\cdot8$ lb., = 28,636 lb., or say, 13 tons.

I have roughly calculated the above weight from the table of weights given in the Clarke's graphic statics as follows:—

	Average weight.
Slate	8 lb. per sq. ft.
Timbering	6 lb. ,,
Roof truss	10 lb. ,,
Snow	6 lb ,,
Vertical wind pressure	22 lb. ,,
Total	52 lb. ,,

which nearly agrees with that of the anonymous correspondent whom Mr. Graham criticises.

In the above approximation of the weight the variable items are the wind pressure—which varies according to the pitch of a roof—and the weight of a truss—which varies according to the square of the span. The old practice of taking the wind pressure as an uniformly distributed vertical load was universally accepted under the influence of Mr. T. Tredgold, but at that time little was known about the wind pressure. Since the experiments of Hutton, made with his whirling machine, and the theory of the pressure of the wind on roofs expounded by Professor Unwin, whose results agree with those of Froude and Newham, it is universally accepted and taken up by the profession and authors that the wind pressure should be taken as normal.

Messrs. Dubois and Clarke have also taken up Professor Unwin's exposition, and have found out, in their "Graphic Statics," maximum stresses in roof trusses by drawing two separate diagrams—one for vertical load and another for normal pressure.

To find the effects and maximum stresses due to different disposition of load on the truss of the roof in question, I have drawn three separate stress diagrams, one for vertical, another for normal, and the third for both, taking the dead and accidental loads as vertically distributed load, and tabulated the stresses due to them as shown in the table, from which it will be perceived that the stresses on bracings due to normal pressure are much more than was found for combined vertical loads, at the same time the combined load gives more stresses on other members. The stresses on some of the bars of the truss are checked by Ritter's "Method of Moments." The stress diagrams are drawn in the usual way, and as there is nothing new in them the process of drawing them is not described.

This brings me up to the proportioning of the parts of the truss, and as I have some remarks to offer about them, I will communicate them in my next. DORABJU B. RABADINA.

Bombay, 2nd September.

PRESSURE OR VACUUM FOR CONTINUOUS BRAKES?

SIR,—"*Bien poser une question, c'est presque la résoudre.*" The battle of the brakes has so far been fought on ground which left room for great diversity of opinion, since the combatants were constantly trying to compare things which were utterly incomparable.

The question was until recently: Should brakes be automatic or non-automatic? or, Were the officers of the Board of Trade right in recommending automatic brakes, or not? There is no doubt that such a question opened a large field for arguments, *pro* and *con.*, and the under-estimation of advantages and over-estimation of disadvantages has made it a matter of the utmost difficulty to arrive at a settlement. The Westinghouse Brake Company has all along consistently supported the principle of automatic action, whereas the Vacuum Brake Company represented the opposition by defending non-automatic brakes. The Vacuum Brake Company, however, has since the Penistone disaster suddenly changed front, and has now openly declared that "on the whole an automatic brake is desirable." This declaration has somewhat startled the technical world, and great thanks are due to the Vacuum Brake Company for its frank and open statement; the more so, because it, to a great extent, simplifies this much-vexed brake question.

Indeed, the question is no longer, Must brakes be automatic or non-automatic? but simply, Must automatic brakes be worked by compressed air or vacuum? This changes the whole aspect of the problem, and I think it will not be difficult to show which is the proper answer to give. In order to be clear, it should be explained that automatic compressed air brakes and automatic vacuum brakes both use air pressure as the motive power for actuating the brakes. In other words, air pressure brakes use air of a greater pressure than the surrounding atmosphere, and vacuum brakes use air of less pressure than the atmosphere. The difference might be still more correctly explained by using the words positive and negative air pressure; but in both cases the medium is air of a certain pressure.

In the case of vacuum brakes the pressure available on the brake piston cannot very well be more than 8 lb. or 10 lb. per square inch, whilst in the case of compressed air brakes 50 lb. or 60 lb. is quite common, and could even be increased if necessary. This great difference in the pressure necessitates the use of vacuum piston surfaces about seven times larger than those for air pressure, and the apparatus consequently becomes much more bulky and weighty. To this point I shall refer again hereafter.

This being established, it is further necessary to distinguish between the two elements in the construction of continuous brakes, viz., the apparatus to produce the motive power, and the brake apparatus itself. The first is generally an air pump for compressed air, and an ejector for producing rarefied air. Sometimes it is also preferred to use air pumps for the production of rarefied air, which shows that on this head there is not much room for logical dispute, the one being considered as good as the other. This, however, might be said against ejectors, that one is never certain that it will act at the moment when required, and there is no store of power; whereas in the case of the air pump used for compressed air it is always evident whether the pump is working or not, and besides there is a store of power which can be relied upon in the shape of a main reservoir, constantly filled with compressed air and sufficient for several stoppages. However, this point is not of great moment for the brake question.

Coming to the brake apparatus, automatic brakes require in all cases a main pipe, a brake cylinder, a reservoir, and a valve regulating the flow of air from the one to the other, and the only question at issue is as to the proper mode of constructing these parts. (1) The main pipe. This is as simple in the one case as the other, except that the pipe for vacuum is much larger and heavier. (2) The reservoir and brake cylinder. These are in both cases most elementary mechanical parts, and are as simple for air pressure as for vacuum, but the latter, of course, are much more cumbrous. (3) The distribution valve. In the case of air pressure, this consists of a valve of peculiar construction called a triple valve; and in the case of vacuum, of a valve called a ball valve. I pass over in silence the leak-hole brake of the Midland and Great Western Railway Companies. In that case the hole in the piston acts as a valve, which is constantly standing open. This arrangement is so defective, and has been so frequently condemned by the officers of the Board of Trade and other competent persons, that it might fairly be considered as a dangerous contrivance, and one which must before long be abandoned. The construction of these valves is quite different, and it would therefore seem as if the whole brake question, so far as the construction of the apparatus goes, would turn upon the advantage of the one over the other; and, in fact, most of the arguments against the use of air-pressure brakes are directed against the use of a triple valve. I think, however, that I shall be able to show beyond dispute that this is a misunderstanding, and nothing more.

The advocates of vacuum brakes say—Look at the triple valve, how complicated it is; and look at our ball valve, of the utmost simplicity. True; but here comes in the question of efficiency. It would be one of the easiest things in the world to substitute for the triple valve a ball valve equally simple as that in the vacuum apparatus; and there would therefore be no further complaint on account of complication of parts. But the efficiency of the apparatus would undoubtedly be considerably impaired. The brake would become much slower in action, and not nearly as sensitive. The vacuum advocates may be certain that Mr. Westinghouse has quite as great a regard for simplicity of construction as they themselves, but he has always placed efficiency in the first place and simplicity in the second; and if the triple valve appears more complicated in construction—although in reality it is exceedingly simple, as shown in Mr. Harrison's report—than the ball valve, there have been very good reasons for making it in its present form, since by its use a degree of efficiency has been attained such as has never been approached by any other brake.

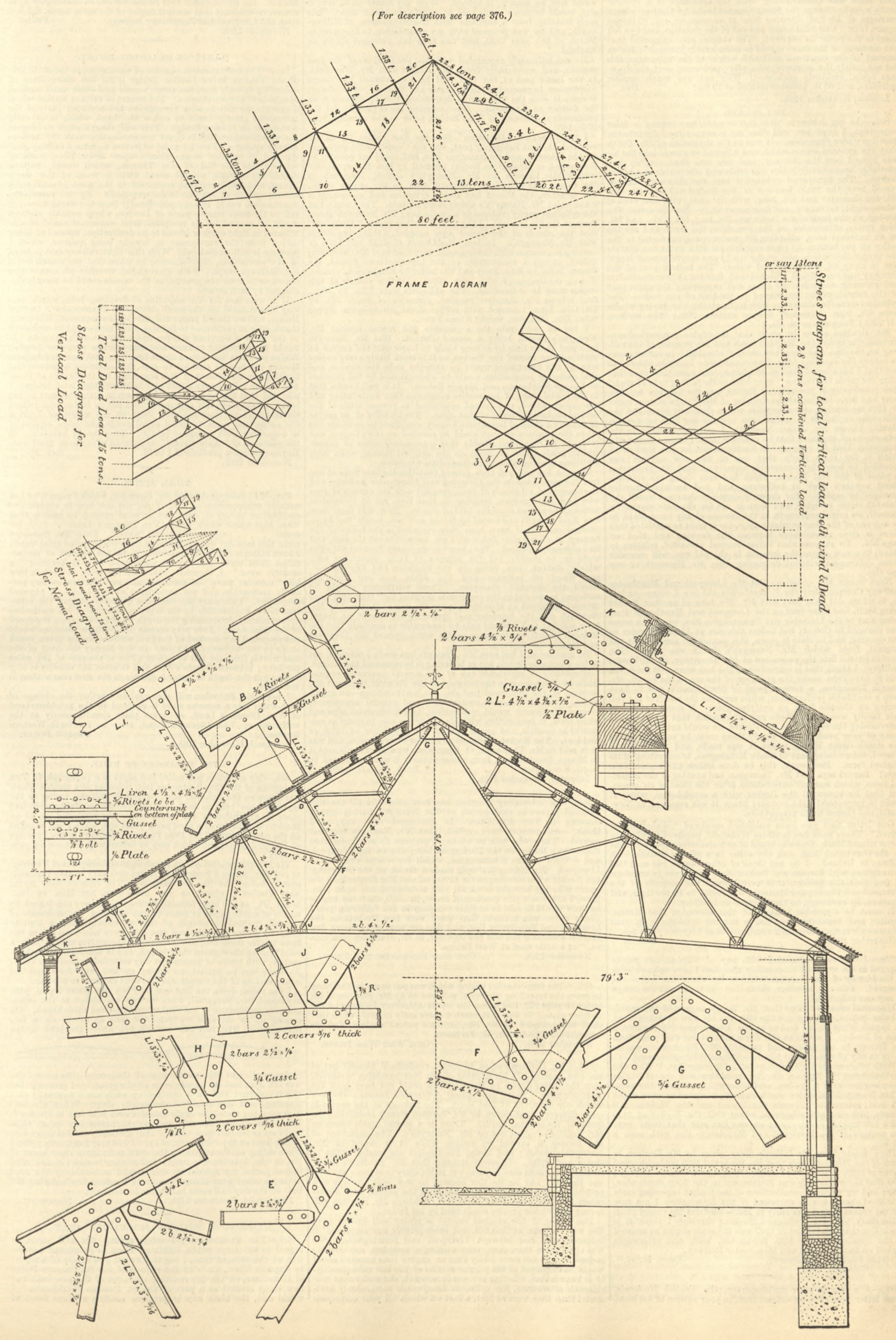
It is very easy for Mr. Martin to say that his company's automatic vacuum brake is equally efficient as the Westinghouse, but it is impossible for him to prove this, because it is simply untrue. The laws of nature are opposed to it. To any man of common sense it must be evident that a longer time is required to exhaust or fill a brake pipe and brake cylinder than is necessary to exhaust or fill the brake pipe alone, and this only partly; and if Mr. Martin wishes to make an effort to bring his vacuum apparatus up to anything like the Westinghouse brake, he will, in the first place, have to substitute for the ball valve a triple valve quite as complicated as the Westinghouse triple valve, in order to render it possible to act on the brake pipe alone for applying and releasing the brakes. Mr. F. W. Webb's utterance at the Euston meeting of 1881, that the principle of working the vacuum brake appears to work out much simpler than the pressure brake, is simple nonsense; and it is astounding that a man of Mr. Webb's standing should risk his reputation as an engineer in putting forward such an absurd theory.

Long before Mr. Martin thought of automatic brakes with ball valves, Mr. Westinghouse had passed over and left that ground. The foregoing clearly proves that all the objections to the so-called complications of the Westinghouse brake and its triple valve fall to the ground when properly investigated. The best proof that all the arguments used against complications are worthless is that in practice the triple valve—which is considered the most complicated part of the Westinghouse brake—gives really no trouble at all; whereas the simplest part of the apparatus—viz., the hose pipe—is the only one causing trouble. This, however, is only a question of material, and is sure to come right in the course of time. It will be clear to all impartial men that automatic vacuum brakes must be just as complicated as automatic pressure brakes if they are to approach to the same degree of efficiency. I say "approach," because, even if vacuum brakes are provided with triple valves, they can then never reach the high efficiency of the Westinghouse brake, for they cannot be so quick in action on account of the low-pressure used, and the necessarily large capacity of the pipes and other apparatus. Low-pressure entails slow action, high-pressure means quick action. Vacuum brakes have the further disadvantage of great bulk and weight of the apparatus.

Nothing has yet been said about the cocks in the main pipe, but the reasoning is precisely the same. The advocates of vacuum brakes point to these cocks as a complication which they have not in their apparatus. They wilfully forget that the Westinghouse brake could very well omit these cocks if those using it were willing to put up with the inconvenience which results from the absence of such cocks, and which is daily experienced by the users of the automatic vacuum brake. Such arguments are very absurd, and it is very surprising to find that otherwise clever engineers in this country have attached any value whatever to them. One may, perhaps, account for their ostrich-like policy by mentioning that the Vacuum Company could not conveniently put cocks in the main pipes, even if they would; and it does not require much to prove

GOODS SHED ROOF, CARNAC BRIDGE TERMINUS.

(For description see page 376.)



that they would be very glad to do so if they could. This, therefore, is another disadvantage of the vacuum apparatus.

Finally, a little anecdote might here be given, for the purpose of illustrating what has been said above:—An engineer of much common sense was endeavouring, with the assistance of a vacuum brake-man, to arrange the Smith vacuum brake for the heavy bogie carriages of his line, allowing 20in. of vacuum, or, say, 10 lb. per square inch. One Smith sack was out of the question, and two fell short of the power he required. The vacuum man suggested that the diameter of the sacks should be considerably increased; but on account of the enormous bulk and weight of the apparatus, this did not satisfy the engineer, who, after pondering over the drawings again, suddenly exclaimed: Why not use much smaller cylinders, and 60 lb. pressure instead of 10 lb.? DUX.

London, November 12th.

THE ROCKET.

SIR,—As my letter in your last number may convey a false impression, I hope you will allow me to enter more fully into the question under discussion. It was at the suggestion of Mr. Booth that the exhaust steam which was allowed to escape into the air was turned into the chimney, and this was done roughly and hurriedly immediately before the trials and afterwards in a better fashion. The Sanspareil exhausted into the chimney. Let us record here the main features of the Rocket:—The boiler was 3ft. 4in. diameter and 6ft. long, with flat ends, with four rows of tubes—eight, seven, six, and four respectively—3in. diameter. The fire-box at the back of the boiler was 2ft. long, 3ft. wide, and 3ft. deep inside, surrounded on the two sides, the front, and the top by an external case, affording 3in. water space, connected to the boiler at the bottom by pipes supplying it with water to maintain the proper circulation, and at the top by one curved pipe of larger size to carry off the steam and water. The bottom part of the chimney was curved and bell-mouthed, forming at once smoke-box and chimney, enclosing the tubes and supporting the upper part of the funnel, which was stayed to the back of the boiler. The cylinders were 8in. diameter, with 16½in. stroke; the driving wheels were 4ft. 8½in. diameter; fire-box surface, 20ft.; tube surface, 117·75ft.; fire-grate area, 6ft.

Mr. Boulton seems to assert that the engine was worked continuously between the Rainhill trials and the opening of the railway on the line, and from the word "identical" in italics seems to convey the meaning that it was unaltered; I may be allowed to say that I have heard George Stephenson say more than once that after the trials the engine "went back to the factory to be altered." One peculiarity of the original Rocket was the flat, low top fire-box; and here, looking at the drawing of Mr. Phipps in your paper of 12th September, the alteration seems distinctly given and the difference explained by a first step towards the high top firebox. Having known Mr. James Nasmyth, I can bear witness to the correctness of anything that he recorded, and I cannot accept the suggestion that he mistook the Northumbrian for the Rocket. I think it far more likely that one of the new engines was intended to bear the honourable name and lead the procession in place of the real Rocket, which had been doing—as stated—about a year's work at ballasting, and had sustained sundry damages by upsets. The drawing certainly does not recall the Rainhill victor to mind, and were it not for the note signed by himself, we might suppose it, in the absence of any name-plate, to be any one of the Northumbrian type, for it must be admitted that there is close resemblance between the drawing and that on page 359. To suppose that better counsel prevailed, refusing to attach to a new engine the interest in the old one, will reconcile these differences without detracting from Mr. Nasmyth or any one else.

Next comes the question: Did the Liverpool and Manchester Railway Company buy the Rocket?—the old one I mean—and if so, to whom did they part with it? We hear of another Rocket being built, and after trial on the Liverpool and Manchester line, being sent to the Leicester and Swannington line, where the name was changed to Comet; but unless this was at Liverpool, prior to the opening, and no date is given, this cannot be accepted as the original, from which Mr. Nasmyth's sketch was made. The Rocket passed into the possession of Mr. Thompson, of Kirkhouse Colliery—I think that is correct—and the last journey it made was said to have been under the guidance of the son of the owner, Mr. Joseph Thompson, a former pupil of Stephenson's, and to have been a creditable performance, while carrying the result of the poll during an election from an outlying place. If some member of this family would contribute any information that may assist in determining the identity of the Rocket, he would confer favour on many of your readers; and surely there must be some record at the South-street Works, where it was made, and where it was altered, before being sent to South Kensington, to something of its original form. How could this be done unless there were some data? Report says that Mr. Thompson had another of the historical locos, which was left out-of-doors after the close of its career, but that he honoured the Rocket with a coach-house, where it could be inspected by the curious; hence it was removed to Newcastle, and thence to its present site.

One letter that you have published speaks of "Wakefield the driver." There were two brothers Wakefield, pupils of Stephenson—one named Mark. One was heard of as locomotive superintendent on the Greenwich line, and the other in a similar position on a railway in Ireland. I do not think of other names, but each had two engines, with fireman and brakesman. I shall not be surprised to find that the Rocket, if it ever became the property of the Liverpool and Manchester Railway, was found to be too light, and returned, by exchange, to the inventor and builder.

It must be a notable incident of this discussion that Messrs. Boulton and Stannard have had a mutual hand-shake in your columns while narrating their recollections of fifty-five years ago.

November 10th. BOILER.

SIR,—I was not acquainted with any of Stephenson's people engaged in the works at Newcastle; therefore I have no knowledge of the history of the Northumbrian, or by whom the boiler was designed. I do not, however, think that the boiler was the design of any one individual.

Historical records tell us that Mr. Booth suggested the multitubular system, and whether the idea was his own or taken from M. Seguin is not clear; and as to the Rocket and Northumbrian class of fire-box, it seems at this day a natural and easy jump from the former to the latter, and probably Mr. Stephenson was as likely as any of those about him to originate the improvement.

With reference to "Philo's" question in your last, "Why the Northumbrian?" Because the Northumbrian was one of six or seven engines with a fire-box, and otherwise practically the same as Mr. Nasmyth's sketch; which engines, as stated in mine of the 5th inst., intervened between the Rocket and the Planet. All records, historical and otherwise, admit that the Rocket of 1829 had a low-topped fire-box, and no one has said that there were two engines on the Liverpool and Manchester line with such a fire-box.

The extracts from his father's diary, given by Mr. Boulton in yours of the 7th inst., says that the Rocket of 1830 is the identical engine of 1829; thus we have written memoranda made in 1829 and 1830 that there was only one Rocket up to the 15th September, 1830; and my personal recollections of the Rocket beginning early in 1833—I should not be surprised if the information I am now seeking proves that it was early in 1832—confirms the record given in the diary, viz., the low-topped fire-box; therefore I think it is conclusive that the Rocket of 1829 was the same engine as assisted at the opening on the 15th September, 1830, and afterwards worked on the Liverpool and Manchester Railway.

Gorton Foundry, Manchester, THOS. HUNT.
November 10th.

SIR,—A writer in your contemporary, the *English Mechanic*, whose letter you gave an extract from in your edition of 1st inst., signing himself "Historian," has referred to my father as being able to prove the existence of two Rockets, one of which was deported from the Liverpool and Manchester Railway, and, after being altered, sold to the Leicester and Swannington Railway, which line, he asserts, it opened. Were my father alive, few, if any, would be more easily able to satisfy the public mind. His early training, from a boy, was with the Stephensons at Killingworth, and he was removed with my grandfather to Liverpool in March of the year 1830, and was then the youngest driver in England.

He was intimately acquainted with the peculiarities of the first engines, and occasionally drove the Rocket with Mr. Wakefield. In the latter part of the year 1831 he was selected by George Stephenson to proceed to the Leicester and Swannington Railway, to open it with the first engine despatched thither directly from the factory at Newcastle. After erecting the engine, he did the preliminary ballasting at West Bridge, prior to the opening, June 17th, 1832.

I beg to assure "Historian" that the first engine my father received at West Bridge, by boat, was the Comet, built expressly for the Leicester and Swannington line, and could not possibly be the second or mysterious Rocket claimed by him to bear such a remarkable likeness to Mr. Nasmyth's sketch, inasmuch as the Comet was of quite a different type to the sketch given. For instance, the Comet had inside cylinders and necessarily a crank axle; Mr. Nasmyth's shows them outside. The Comet had the cylinders partly enclosed in a smoke-box; Mr. Nasmyth shows them at the fire-box end. I beg to still further assure "Historian" that the wheels of the Comet were coupled, a thing impossible with Mr. Nasmyth's. In fact, the Comet of 1832 had little or nothing in common with the suppositionary Rocket of Mr. Nasmyth; indeed, it was a combination of the Liverpool and Planet, the former built by Edw. Bury and the latter by Stephenson, almost, if not, contemporary with each other. Further details of this engine may be interesting. The cylinders were 12in. by 16in., four wheels 5ft. diameter coupled, diameter of boiler 3ft. by 7ft. 1½in. long, mounted with copper dome, ninety-seven copper tubes 1⅝in. diameter, weight 9 tons 9 cwt.

I beg to enumerate the arguments and reason against Mr. Nasmyth's sketch being a second Rocket. Was Mr. Nasmyth informed at the time by anyone likely to know that the engine he sketched was named the Rocket, as it is most likely every engine seen by the uninitiated would be thought to be the Rocket, and that notion or supposition would be strengthened by the presence of George Stephenson and his son Robert? It is well known that in the initial stage of locomotive enterprise that both father and son superintended, and indeed conducted in person, trials of the several engines delivered at that time. The identity of an engine in so early a stage of locomotive history would not be so easily lost when the numbers at work could be counted on one's fingers, and it would be highly improbable that a secondary series of experimental trials would be made on the original Rocket, when later additions required their more immediate attention.

Now, it has not yet been proved that two Rockets were at one and the same time on the Liverpool and Manchester Railway, and the absence of all proofs of such, coupled with the denials of men who had their earliest training on that line, are in themselves sufficient to almost clear the field of doubt. Now, had there been two Rockets built and tested by father and son, surely the hypothetical one would have been duly recorded in the books of the factory at Newcastle; but such I am assured is not the case, and its existence is denied. That two contemporary Rockets did exist there is no doubt; but the spheres of their operations were widely distant, one being on the Stockton and Darlington—see Wood on railways—and the other one our historical friend the Rainhill champion. These particulars should be sufficient to show that the arguments adduced by "Historian" and others to establish an identity between the engine sketched by Mr. Nasmyth and the Leicester and Swannington Comet no longer have weight; and it would only be reasonable to conclude that the Rainhill Rocket was the same engine which opened the Liverpool and Manchester Railway.

In conclusion, I feel sure Mr. Nasmyth has made a mistake, not in his admirable sketch, but in believing it to represent the Rocket. Undoubtedly it represents one of the several improved engines made by Stephenson in the interim of the Rainhill trial and the opening of the line, most probably the Northumbrian—an engine which, from its superior construction and general appearance, George Stephenson would not neglect, by experimental trips and other tests, in conjunction with his illustrious son, to make as successful as possible, and guard against the possibility of hitch or accident. The Rocket continued to run for several years, and was then sold to Mr. Thompson, of Brampton, who afterwards sent it to Messrs. Stephenson's, from whose custody it was transferred to South Kensington. ROBT. WEATHERBURN.

Leicester, November 11th.

SIR,—An interesting question has been raised in all the mechanical papers in consequence of Mr. Nasmyth having sent a drawing to THE ENGINEER. In the most rude way, as I think, some persons have replied, that Mr. Nasmyth was not correct. Those who talk so off-hand, perhaps do not know that there was a Rocket on the Darlington line; one on the Liverpool, and a third on the Swannington, which for a time ran on the Liverpool. Mr. Nasmyth simply made a sketch of the Swannington Rocket when standing on the Liverpool and Manchester line; the result is he has brought down all this correspondence upon him. How, I ask, could this gentleman know, in 1830, that the engine he drew would be sold to another company in the following year? There never was a doubt that there were two Rockets on the Liverpool and Manchester line, and that one went to Leicester, but there is a doubt if she was put together, as Mr. Williams' book tells us, "at a little shed at West Bridge."

November 12th. ONE WHO REMEMBERS THE FACTS.

SIR,—The four-wheeled engine which was put down in East Shop to move the travelling platform, referred to by Mr. Boulton in his letter on page 272, had borne the words Aylesbury Railway on her number plate. It was first started there early in 1847, when that shed was occupied by Mr. Stephenson's patent engines, and his separate staff, under Mr. W. Ferguson.

November 10th. ONE WHO WAS THERE.

SIR,—Mr. Boulton has, so to speak, condemned himself out of his own mouth. If his drawing of the Northumbrian is correct, then the engine drawn by Mr. Nasmyth could not have been the Northumbrian. There are radical differences between the two which are apparent at first sight. The framing of the engine is quite different, than shown by Mr. Boulton closely resembling the frame of the original Rocket. There is a second small dome on Mr. Boulton's engine, not on Mr. Nasmyth's. The smoke-box of the former is carried up square, while it is round in Mr. Nasmyth's sketch; and lastly, the tenders are totally unlike in shape and finish. It seems strange that Mr. Boulton's father should have taken care to point out in his diary that there was only one Rocket. Did he do this because he saw with the eye of a prophet that questions would be asked on the subject and doubts raised fifty-four years after he wrote? Perhaps Mr. Boulton will favour us with the precise words used by his father.

The career of the original Rocket is pretty well known now. She won the prize at Rainhill, and subsequently was employed in ballasting the line between Liverpool and Birmingham. She was upset more than once, once turning a complete somersault; indeed, it does not seem likely that an engine thus knocked about would be employed in the regular service of the line subsequently. It is known that, whether she was or was not, she underwent considerable alterations, her cylinders being made more nearly horizontal than they were at first, a fact on which all your correspondents are silent.—Did Mr. Boulton, senior, or Mr. Hunt know this?—It seems more probable that an improved Rocket was built, and opened the line, and was sketched by Mr. Nasmyth. This fact would not prevent Mr. Hunt from repairing the original Rocket. The circumstance that he has worked on that engine is, of course, no evidence that another engine of the same name did not open the Liverpool and Manchester Railway. PHILO.

November 12th.

THE BLOCK ON LONDON BRIDGE.

SIR,—The centralisation of miles of warehouses on the south side of the Thames below London Bridge is for the convenience of unloading directly from the steam vessels and other craft moored alongside of the warehouses. The stream of carts or lorries which distribute the merchandise throughout the northern parts of the metropolis greatly tends to create the block which is of daily occurrence on London Bridge. This will always occur so long as the warehouses are not in direct communication with the various railway systems. I see no great objection to form a railway constructed of metallic beams placed upon screw piles, sunk or screwed into the bed of the Thames, which would, with a double set of rails, project about 24ft. in front of the warehouses, and which could be connected to the most advantageous railway system or systems in the metropolis. By this means the merchandise would be conveyed directly from the warehouses per rail to the most remote parts of London, where suitable stations would be erected for its reception, from whence it could be distributed in light carts or lorries to its destination, instead of being carted from the warehouses in heavily laden wagons, which I presume is still carried out. With this light railway laid in front of the warehouses, objections may be taken that the vessels could not discharge cargo. With overhanging movable jib cranes this objection falls to the ground, as the vessels could be readily discharged by such means.

If it were not for the objection of breaking bulk, warehouses may be extended on the south side of the Thames above London Bridge, and we should prefer the railway as a means of filling the storehouses in preference to lighters, and which would be connected to the most convenient site for unloading from the vessels. It would be interesting to know how many lorries pass over London Bridge per diem northward direct from the southern storehouses. Hoping you may be enabled to give the maximum numbers, and trusting you will accept of this suggestion for the benefit of those who fear to roll up approaches of 1 in 50 over high level bridges, I may add that the larger a main approach to such a viaduct is the better, as the more side approaches that can be introduced relieve the traffic where most needed. With all the wealth of London the authorities seem to dread aerial roads, and more especially in connection with overhead bridges. They should have some of the gradients of "Auld Reekie" to contend with; even their own Haymarket has a gradient of 1 in 36. ROB ROY.

November 12th.

TIDAL ACTION.

SIR,—If I misapprehended Mr. Snowdon, which I regret, he has entirely misapprehended me. I did not ask him to explain the equilibrium theory of tides, but on what ground he asserts that "the high-water which passes Van Diemen's Land . . . becomes . . . simply a monster wave." Does Mr. Snowdon mean this monster wave is different from the so-called tidal wave? I have hitherto supposed high-water to be the summit of the so-called tidal wave, and cannot understand how it becomes "a monster wave." I, therefore, asked Mr. Snowdon to explain how his "monster wave" is produced, and consider my inquiry perfectly reasonable, and not anticipated in text-books on physical geography. I am sorry Mr. Snowdon is unable to give the reference to the explanation by Sir William Siemens of his method of approximately determining the depth of the ocean from the speed of the tidal wave. I am very certain Sir William Siemens would not propound any method of the kind without having given much study to the subject of the tides. In the Mersey the crest of the tide travels from the Bar to George's Pier at the rate of 28½ miles per hour; between George's Pier and Garston the velocity is fifty miles; yet the depth of water is greater in the first course than in the other.

I hope Mr. Snowdon will also explain whether the change of high-water into a monster wave is confined to the neighbourhood of Van Diemen's Land, or takes place simultaneously at the antipodes of Van Diemen's Land, that is, in North-Western Europe. JOSEPH BOULT.

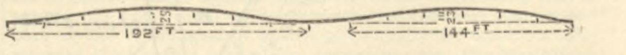
Liverpool, November 10th.

THE EXPANSION OF RAILS.

SIR,—My attention was called last night to a paragraph in THE ENGINEER of the 12th September last, referring to a trouble which has arisen on the Irchester and Sharnbrook Railway, owing to the laying of the rails in cold weather without providing sufficient space for expansion at the joints. This has reminded me of an incident that occurred a good many years ago, when I was engaged on the construction of the Dom Pedro II. Railway, in the Province of Rio de Janeiro, and which may be interesting to some of your readers.

We had constructed a long low straight embankment of "barro," or red clay, across a swamp, and it was necessary to take materials over it before the line was ballasted. The rails we were laying were Barlow's, which, as you are aware, are 11in. or 12in. broad /\ at the base, forming their own sleeper; are joined by means of saddle pieces or fishes of the shape of the underside of the rail, rivetted to the ends of the two metals, and are kept to gauge by means of angle iron ties. Grooves had been cut in the bank top for these ties, so that the rails themselves should have a solid bearing throughout their length, and in this condition a locomotive, with trains of permanent way material, passed over them. As there was no ballast, no boxing up had been done, and the whole surface of the metals was therefore exposed to the sun.

I was riding down the line one very hot day about 2 p.m. with my friend, Mr. Brentnall, when we were astonished at the extraordinary appearance of the road several hundred yards ahead. On coming up to the spot we found the rails up in the air in two places, thus. The first rise was 2ft. 9in. above the bank in the



centre, and eight 24ft. metals were off the ground; the second rise was 2ft. 3in., and six lengths were off the ground. I presume that this bit of road had been rivetted up early some unusually cold morning, and was therefore abnormally short. When the heat expanded the metal the angle iron ties were held fast in the hard-baked grooves, and the rails had no alternative but to set their backs up as we had seen them. They gradually settled down into their places as the evening came on. I had very frequently noticed when riding on the engine in the early morning a clear space of ½in. to ¾in. between the outside rail of a curve and the fine sand ballast packed up against its side, caused no doubt by the road having worked over laterally so as to lengthen itself during the heat of the day and come back again in the night.

Hampstead, November 11th. JAS. MANSERGH.

FIREPROOF BUILDINGS AND CAPTAIN SHAW.

SIR,—The question of the safety against fire and panic, in regard to our large public buildings, being so prominent a question at the present time, I beg to forward you a copy of a report by Captain Shaw, made at the request of the St. Pancras Board of Guardians, on the fire-resisting character of the new buildings now being erected as a part of the St. Pancras Workhouse. I would add, the block now in progress consists of four floors of wards, 80ft. by 40ft. each, two wards on each floor, with staircase, lift, and attendants' rooms between them; a ground floor, appropriated to administrative purposes, and an upper central story of nurses' rooms, together with wings at the extreme ends for baths and w.c.'s—in all, six stories.

The floors throughout are constructed on the ligno-concrete system by Messrs. Clark, Bunnett, and Co., which, whilst being proof against fire, from its solidity from floor to ceiling, though only 6in., 7in., and 8in. thick respectively, also appear perfect from a sanitary point of view.

In my opinion, if the example of the St. Pancras guardians were followed by all other bodies having control over the erection of large public buildings, of first obtaining a report or receiving suggestions from the chief officer of the Fire Brigade—always freely and courteously afforded—we should soon cease to hear of the differences and conflicts in regard to altering and adapting existing buildings to meet the requirements of public safety, and fewer, if any, of the disastrous fires and panics which are continually occurring. If, moreover, it were imperative to obtain such reports, and, when obtained, to act upon them, the satisfaction would be still more complete. I have no doubt the guardians will adopt the only improvement suggested by Captain Shaw, of an external staircase for the use of firemen, though probably of iron instead of wood, for there is always more to be feared from the results of panics, as has been frequently exemplified, than from the danger of fire itself.

H. H. Bridgman.

42, Poultry, London, E.C., November 8th.

THE ELECTRIC ENGINE.

Sir,—We regret not having noticed Mr. Willans' letter on our electric engine, which appeared in your issue of October 31st, before this. We are somewhat surprised Mr. Willans should have asked you to occupy your valuable space by inserting what appears to our minds such an inconsistent letter, and we recommend and invite any friends who are at all interested in our engine, before they adopt Mr. Willans' expedient, to visit these works, where we should be able and willing to show them a very cheap, effective, regular working and compact engine, which will bear most favourable comparison with either of those suggested by Mr. Willans.

Coalbrookdale Ironworks, Shropshire, C. G. Mountain.
November 12th.

"APPOINTMENTS OPEN."

Sir,—I have been advertising in The Engineer for a situation, and am glad to tell you have just been successful. I have received a letter, with the *Engineering Review* stamp on back and front of the envelope, and No. 6169. Judge my surprise on opening to find an application from a gentleman for a situation. I am returning this to him at once, to show him the value of the information he has evidently received.

Foreman.

November 12th.

COMPOUND ENGINES.

Sir,—I have frequently noticed what appears to me to require explanation in diagrams, especially of these engines; and now again, on page 352 in your last paper, a diagram shows the final pressure in a 12½in. cylinder less than the initial pressure in the larger, of 22in. diameter! Perhaps this may account for the small cost of fuel, 2s. 3½d. per day, as stated on the previous page—£34 7s. 9d. for the year of, say, 300 days. What is coal worth per ton at Stockton?

Graduate.

November 10th.

South Kensington Museum.—Visitors during the week ending Nov. 8th, 1884:—On Monday, Tuesday, and Saturday, free, from 10 a.m. to 10 p.m., Museum, 11,002; mercantile marine, Indian section, and other collections, 3691. On Wednesday, Thursday, and Friday, admission 6d., from 10 a.m. to 4 p.m., Museum, 1550; mercantile marine, Indian section, and other collections, 284. Total, 16,527. Average of corresponding week in former years, 13,810. Total from the opening of the Museum, 23,510,155.

The Liquefaction of Gases.—The process of liquefying gases, such as oxygen, has been recently advanced a considerable step by the labours of M. Cailletet, who has communicated to the *Comptes Rendus* a brief preliminary account of his successful use of marsh gas for this purpose. The author recounts that, by the use of boiling ethylene, MM. Wroblewski and Olszewski have succeeded in obtaining the meniscus of liquid oxygen, which he has not himself been able to detect in any of his previous experiments. It appeared to M. Cailletet, however, that if he could find liquid bodies boiling at a temperature below that of ethylene it would thereby be possible to liquefy oxygen without being compelled to use pneumatic machines for the purpose of lowering the boiling point of the refrigerating liquid. All the necessary conditions for this purpose are fulfilled by marsh gas. In effect, this gas, slightly compressed and cooled in ethylene, boiling under the ordinary atmospheric pressure, produces a colourless, exceedingly mobile liquid, which in resuming the gaseous state causes a cold sufficient for the instant liquefaction of oxygen. Under those conditions the liquefaction of oxygen becomes one of the simplest laboratory operations. M. Cailletet announces this discovery at the earliest possible moment, in order to secure priority of date; reserving the description of his methods and actual results until he has completed a course of experiments upon which he is at present engaged.

Great Western Railway Stafford Road Works Junior Engineering Society.—This Society was established about twelve months ago by the pupils and apprentices at Stafford Road Works of the Great Western Railway Company, for the purpose of reading and discussing papers on engineering and kindred subjects. Papers have been read on automatic brakes, valve motions, history of the locomotive, electric lighting, machine tools, and Great Western Railway coupled express engines. A meeting of this Society was held on Wednesday evening in the Red Cross-street Board Schools, when an interesting paper was read by Mr. James Cross on "Electricity as the Motive Power of the Future." Mr. Waister presided over a highly appreciative audience. Mr. Cross at the outset pointed out that in many cases electricity might be utilised as a motive power at a far less expense than steam, and cited the Giant's Causeway Electric Railway as an instance where water power is used to generate electricity by means of turbines. Electricity, although we do not know what it is, has several properties with which we are acquainted; it can be produced by means of friction, concussion, chemical action, heat, steam and dynamic power. The lecturer, in describing the dynamo, pointed out the rapid improvements which have been made in this machine as regards utility; formerly the magnet used for exciting the current in the armature was an ordinary permanent magnet; the current developed from this class of machine is obviously limited. In the dynamo at present in use, a soft iron or temporary magnet is used, coiled with insulated copper wire.| The wires of the armature, in addition to being connected to the circuit, pass round the magnet. A slight trace of residual magnetism always existing in the soft iron magnet, it follows that when the armature is set in motion the residual magnetism excites a slight current, and this augmenting the power of the magnet produces a still greater current; this augmentation goes on until the machine has attained its maximum efficiency. Mr. Cross then described the Cuttris, and Griscombe motors, showing the striking resemblance between them and the dynamo. In the lecturer's opinion electricity was adaptable for high speed on railways, and when it is used as the motive power on all our great railway systems, we shall be able to travel 1½ miles in one minute with greater facility than we travel one mile per minute at the present time. In conclusion Mr. Cross pointed out the value of electrical power for domestic purposes in the way of lighting, small domestic motors, &c. An interesting discussion followed, and the meeting terminated with the customary votes of thanks.

LEGAL INTELLIGENCE.

JUDICIAL COMMITTEE OF THE PRIVY COUNCIL.

(*Present*—Lord Fitzgerald, Sir Barnes Peacock, Sir Robert Collier, Sir Richard Couch, *and* Sir Arthur Hobhouse.)

DUNCAN AND WILSON'S PATENT.

The hearing of this case, which was a petition for the prolongation of letters patent, dated the 19th of November, 1870, to Messrs. George Duncan and William Ashley Wilson, both of Liverpool, for the invention of improved machinery or apparatus for doubling, cutting off, separating, and folding paper as delivered from rotary web printing machines, was resumed.

Mr. Aston, Q.C., Mr. Chadwyck Healey, and the Hon. R. H. Manners Sutton were counsel for the petitioners; the Attorney-General, Mr. R. S. Wright, and Mr. Danckwerts appeared for the Crown.

This was the petition of the Victory Printing and Folding Machine Manufacturing Company, carrying on business at Liverpool as printing machine makers and machinists, who are the assignees of Messrs. Duncan and Wilson. The company was registered in August, 1872, and was established for, among other things, the manufacture and sale of "The Victory Printing and Folding Machine," which was the subject of the letters patent. The invention related to machinery for printing upon paper forming part of a continuous web or roll, and for cutting off the printed sheet from the web and folding it in one conjoined operation at a high rate of speed. The petition stated that it was not new to print on a web of paper and cut off sheet after sheet at the date of the patent. That was proposed by Nicholson, the celebrated mechanic, during the last century; but the fact was that at the date of the petitioner's patent there were only some few experimental machines in the country, namely, in the *Times* office, and those did not pretend to fold the sheets. The great necessity of the period was to obtain folded papers in large numbers in a short time. Some of the leading newspapers of the world were now printed by the patent machines, namely, the *Globe*, *Manchester Guardian*, the *Melbourne Age*, the *Liverpool Daily Courier*, the *Glasgow Mail*, the *Moscow Courier*, the *Liverpool Echo*, the *Hamburg Fremden Blatt*, and the *Correspondencia de Espana*. These newspapers varied in size, and were printed, cut off, and folded at one operation; the larger ones at speeds varying from 12,000 to 14,000 impressions an hour, and the small evening issues from 20,000 to 25,000 an hour. The number of attendants necessary for working one of the machines, whether printing a large or small paper, was practically the same, only two being required. Some offices employed two men, others a man and a boy, and the cost for wages of printing and folding 1000 copies of newspapers of the size of the *Times* by the machine, the subject of the patent, was only 2d. At and prior to the date of the letters patent it was the usual practice to feed sheets to a rotary machine by hand, the best of the machines of that kind at that time being that made and supplied by Messrs. R. Hoe and Co., of New York. The maximum number of perfected copies which a machine of that class would print, with ten feeding attendants and four taking-away attendants, would be 8000 an hour. For folding the 8000 printed copies five folding machines would be required to keep pace with the printing machinery, and at least five attendants for these machines. Thus nineteen men were required to print and fold 8000 copies an hour with the best Hoe machines in 1870, while only two were required for the petitioners' machine. The cost for wages of printing and folding 1000 copies by the Hoe machine was estimated at 1s. 4d., while that of the petitioners was only 2d. Taking a newspaper issuing 200,000 copies a day, the saving in wages alone would be £11 13s. 4d., or, on 313 working days, the large sum of £3650 15s. 4d. in one year. The petitioners ascertained from Mitchell's Newspaper Directory that there were now published in Great Britain and Ireland, the Channel Islands, and the Isle of Man, 3200 newspapers and serials, which, for convenience and economy, should be folded immediately after being printed. Some of these publications, such as the *London Journal* and the *Family Herald*, would require a large number of machines. It was estimated that about 1000 machines made in accordance with the invention the subject of the letters patent could be profitably employed in the United Kingdom. The patentees and subsequently the petitioners had done everything in their power to procure a considerable sale for the improved machines. Users of printing machinery were not slow to discover the merits of the patented machinery, and they might now be said to be universally admitted; but notwithstanding that fact, it had been found to be a matter of great difficulty to induce users to abandon their plant for the time being in use, and to effect a re-arrangement of their establishment at a very considerable cost, having regard also to the fact that the machines so discarded would sell only at a very great reduction upon their cost. The petitioners had also suffered from the acts of infringers, but in every case where an act of infringement had been discovered, the petitioners had threatened or actually taken proceedings, and always with success. For the reasons before stated, and from the expense incurred in introducing, neither the patentees nor the petitioners had received any adequate remuneration for the labour, time, thought, and capital expended, but the failure to obtain any such remuneration had not been attributable to any fault of the petitioners or the persons through whom they claimed. If the term of the patent should be prolonged, there was every reasonable prospect that the petitioners would be able to obtain a fair reward. The petitioners had always been ready to grant licences for the use of the invention, and to supply to all desiring purchasers the patented machines on fair terms. The petitioners in these circumstances prayed that her Majesty would be pleased to grant them a prolongation of the letters patent for a further term of fourteen years, or for such other term as her Majesty might think fit.

Sir Frederick Bramwell, F.R.S., the eminent engineer, was called as a witness on the part of the petitioners, and spoke highly of the ingenious and meritorious nature of the invention.

The Attorney-General intimated that the Crown did not dispute the meritorious nature of the invention.

After a long and minute investigation of the accounts, and after consulting together for some considerable time in private,

Their Lordships, whose judgment was delivered by Sir Barnes Peacock, said that they were of opinion that the invention was an exceedingly ingenious and meritorious one, as the Attorney-General had admitted, and on that point there would have been no objection to extending the patent. The question then came whether the patentees or the assignees of the patent had received sufficient remuneration, or whether the accounts which had been prepared showed to the satisfaction of their Lordships that the remuneration had not been sufficient. The company was formed, not merely for the sole purpose of manufacturing the machines, but for carrying on also a manufacturing and jobbing business. It was necessary, therefore, that the petitioners, according to previous decisions of that committee, which had been cited, should keep the accounts in such a manner, if it became necessary eventually to apply for a prolongation, as to show everything which could apply to the patent business. After reviewing the details, as supplied, of the receipts and expenditure of the company in regard to the patent and the other part of the business, their Lordships were of opinion that accounts had not been kept in such a manner as to lead them to the conclusion that the amount stated was the only profit made from the patent. In all the circumstances, looking at the state of the accounts, their Lordships were of opinion that they could not recommend her Majesty to grant the prayer of the petition.

Penzance Floating Docks, three acres in extent, were opened on Monday morning by the Mayor, Mr. Charles C. Ross, M.P., this being the last formal act of his mayoralty. The docks have been five years in building, and have cost about £70,000.

AMERICAN NOTES.

(*From our own Correspondent.*)

New York, November 5th.

Activity in all branches of manufacturing has declined to an extremely low ebb, as is usual prior to every general political campaign. Careful inquiry among those who are well informed as to large enterprises shows that a great deal of business is likely to be done during the winter in the way of contracting for materials for railways, elevated railway work, bridge work, building, and general engineering work. An opinion obtains in manufacturing circles and among capitalists, who contemplate large investments, that prices during the coming year will advance slightly, that a general demand will set in, that much idle capacity will be employed, and that a better condition of things will prevail. This opinion is based on several facts, such as the restriction which has been going on during the past year in all branches of manufacturing; on the natural increase of requirements of a growing country; on the fact of the large wheat and corn crop and cotton crop, although the latter is likely to fall at least 500,000 bales below the maximum crop limits. The manufacturing interests are particularly pleased that the Presidential campaign is about over. There are large blocks of capital idle in this city. There are several large enterprises sufficient in magnitude to engage it, and the probabilities point to its use in the contemplated channels. Bradstreet's failures for the past week show the usual average, of which nine-tenths are of traders doing business with 5000 dols. or less.

The total number of miles of railroad constructed this year foots up 2932, against 4947 miles to same date last year, and 8314 miles for the same time in 1882. Out of a mileage of 121,592 miles, default was made upon a mileage of 15,986, representing defaulted bonds amounting to 315,283,000 dols., which is 9·12 per cent. of the total cost of the railways, based upon an actual cost of 30,000 dols. per mile. The whole number of companies in default now is forty-two, and none of these ever had a very strong basis. During the first six months of the current year the losses by fire in the United States and Canada have been heavier than for any preceding like period. The loss was 57,000,000 dols. this year, against 47,000,000 dols. for the same time last year. This year's losses are likely to foot up 128,000,000 dols. This is unquestionably a severe drain on the insurance companies, and reduces their profits to almost nominal figures.

Merchants and manufacturers look for reviving activity very soon, but in this they may be disappointed. Wages have been reduced in nearly all handicrafts throughout the country, and particularly within the past month. The disemployment of skilled labour has been taking place to an extent which calls forth comment upon the part of the public press. The iron trade is extremely sluggish. The steel rail mills are better situated than any other branch of the industry, and all the mills in Pennsylvania and a few mills in the West are well supplied with orders until January next.

Iron statistics show forty-six completed converters, with three building, which will give an annual ingot capacity next year of about 2,600,000 tons, besides a capacity of 600,000 tons of open-hearth ingots from sixty-three works, of which five are yet to be completed. The increase of pig iron capacity is 1,300,000 tons within two years. The present capacity in blast is about 3,750,000 tons per annum.

Activity in the building trades is probable next season. Special interest is being taken in the shipping problem. A good many regrets are expressed over the necessity which led to the sale of the American line to British shipping interests. It is stated that the transfer is merely nominal, that the purchasers are Pennsylvanians, and that the sale was made in order to place the line under the British flag. Congress will be called upon this winter, by the commercial element in New York and Philadelphia, to legislate in favour of subsidised lines between Atlantic and Gulf ports, and the ports of Mexico, Central and South America. The sentiment in favour of subsidised lines is growing. The vast amount of idle machinery, capital and labour, throughout the States, is developing a sentiment in favour of an export trade, and the first impulse of the commercial spirit is to seek Government aid to establish lines in advance of any commercial necessity for such shipping facilities.

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

(*From our own Correspondent.*)

It not infrequently happens that October and November bring a considerable addition of shipping orders to the finished ironworks, but this year the addition has been very small. Unless an increase should occur during the next week or two, the year will close up very quietly. Nevertheless, makers do not take a desponding view of prospects, and at present the works are mostly pretty well employed.

Specifications for sheets, under orders placed some little while back, are coming forward freely from merchants and from galvanisers, and these mills are fully on in all descriptions. Medium and common quality bars are in moderate demand, but the orders for hoops and plates are disappointing alike on home and export account. Angles and tees and girder iron are selling, but in less bulk than would happen if competition from other centres was less active.

Renewed complaints are heard this week on almost every hand of this competition. Steel in its unfinished forms is coming into this part of the kingdom in increasing quantities, to be rolled down in the mills, and at the same time finished steel and common manufactured iron is arriving with some amount of vigour from other districts. North of England makers are offering their productions delivered here at such prices as:—Steel bars, for rolling into tin-plates or sheets, £5 10s.; soft steel plating bars, finished, £6; wrought iron angles, up to 5in. by 5in., £5 10s.; Crown plates, not, however, suitable for flanging purposes, £5 15s.

Welsh makers are offering hurdle and rivet bars at £5 10s. delivered, as against £5 12s. 6d. asked by local makers. Welsh puddled bars are £3 to £3 2s. 6d. delivered, with but a small demand. Scrap iron was never realising so low figures as to-day. Consumers hereabouts are unprepared to give more than 47s. 6d. for Welsh sheet shearings, but vendors ask 49s., and declare that never before have sales been made under 50s.

The manufacture of sheets lately begun in the North of England is another source of competition. Middlemen on 'Change to-day—Thursday—in Birmingham stated that sheet orders for which Staffordshire works had asked £7 10s. and £7 15s. delivered London, they had instead placed Middlesbrough producers at £6 15s. delivered in the Thames. That the North of England quality was equal to what would have been obtained from Staffordshire was not stoutly contended for, but middlemen declared that the former answered every necessary purpose.

Staffordshire common plates were to-day priced at £7 at works. Merchant sheets were £6 15s. for singles; and galvanising sheets, £7 to £7 5s. singles; and £7 7s. 6d. to £7 10s. doubles. North Staffordshire common bars were £5 12s. 6d., and South Staffordshire mostly £5 15s.

It is not in all instances that the complaint about the leanness of business is fully justified. Buyers of working-up and stamping sheets, of tin-plates, of strips, and of some descriptions of light angles, assert that it is well known that where steel blooms and billets and bars instead of puddled iron are being used up at

Staffordshire works for these manufactures substantial profits are resulting.

Large quantities of common pig are being consumed by the heavy ironfounders, but the pig market on the whole remains dull and weak for all except special qualities. Sellers to-day largely outnumbered buyers, but wisely enough they did not press orders. To do so would only be to depress prices. Some brands of Wiltshire were quoted 42s. 6d. for grey forge and 44s. for foundry delivered, but the figure was too high. Hematites were 55s. delivered, with a tendency towards firmness as a result of the recent considerable addition to the orders in the hands of the heavy steel producers.

Coal and other minerals are without animation, and prices still favour buyers. Welsh, Derbyshire, and Yorkshire cokes are 15s. to 16s. 6d. delivered, and Durham foundry sorts 18s. to 24s. Hematite red ore was 13s. to 13s. 6d., without sales.

Constructive engineering is affording full employment at specific works in the Dudley district, but in some South Staffordshire yards there is less pressure.

The nut and bolt makers cannot report much improvement. In the Darlaston district certain American machinery is in course of erection to facilitate the manufacture of machine-made fastenings.

Export orders for hardwares received by the chief mails this week have not been generally conspicuous in either bulk or value, but here and there they indicate a slight advance of the purchasing capabilities of the leading colonial markets, and the pushing forward of enterprises for the development of wider trade areas, by which the Midlands are certain to be advantaged. At home the orders are about balancing themselves.

South Staffordshire manufacturers view with not a little dissatisfaction the results of a reception which was accorded to a deputation last week of the Railway and Canal Freighters' Association by the chairmen of the London and North-Western, Great Western, and Midland Railway Companies. The deputation represented the iron-making, ironfounding, fire-brick, and other staple trades of Staffordshire, and they anticipated that a satisfactory answer would have been forthcoming to their application for substantial relief in the present freightage charges. What was their surprise, however, to be informed by Mr. Moon that the companies were still unable to agree to any arrangement on the main points, namely, the rates to London, Liverpool, and Hull. The only gratification which the deputation had was that some trifling concessions had been granted. The Freighters' Association appear to have now no other source open to them but to pursue the spirited policy of opposition which they promised when the Association was formed.

Another striking instance of the manner in which the Midland local industries are handicapped by heavy railway rates is afforded this week. It seems that the rate for tin ingots carried between Cookley, in Worcestershire, and London is 25s. 10d. per ton, compared with 20s. 10d. between London and Neath. The Cookley district has, it is true, a canal running through it, but there has been an advance in the water rates of 30 to 40 per cent. Moreover, when in the winter the canal has been frozen up, as much as 4s. per ton has had to be paid for cartage from Kidderminster.

There was a great mass meeting at Hanley on Monday of potters, who have received from six leading firms notices of a revision in wages, tending to reductions varying from 1 to as much as, in some cases, 50 per cent. About 7000 workpeople are affected. Resolutions opposed to the reductions were passed.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—Moderately large sales of forge pig iron are reported to have been made during the past week or ten days to consumers in this district, and the upward movement in the Glasgow market has induced a disinclination on the part of some of the makers to enter into further transactions of any weight just at present. There is, however, no really stronger tone in the market here, and the recent advance in Scotch pig iron is generally treated with indifference by buyers, as being due more specially to temporary causes than to any actual improvement in the demand. Buyers here are certainly not disposed to follow any upward movement in prices, and although a little more has to be paid for Scotch iron where consumers are compelled to place out orders, there is no buying beyond absolutely imperative requirements.

There was only a slow market at Manchester on Tuesday, and the inquiry was small for both pig and finished iron. With regard to Lancashire pig iron there was no material change to report, either as regards price or demand. Local makers still hold to 41s. to 42s., less 2½ per cent., for forge and foundry qualities delivered equal to Manchester, and offers at under this figure have been declined; but there is only a small weight of trade doing, which is barely sufficient to take away the present limited output of the few local furnaces that are making common iron. Some of the district makers are showing rather a firmer tone, but there are still low sellers, and Lincolnshire iron delivered here can be bought at about 41s. to 42s., less 2½ per cent., for forge and foundry qualities, with Derbyshire brands quoted at about 1s. to 1s. 6d. per ton above these figures. For north-country iron very little inquiry is reported, and prices remain much the same as last week, forge qualities being obtainable at about 42s. 4d. and foundry at 44s. 4d. net cash delivered equal to Manchester. In Scotch iron some brands are quoted at 1s. per ton above the prices which were being taken last week, but this has had little or no effect upon buyers here, who are not at all disposed to follow the upward movement.

In the hematite trade prices have gone up slightly, and 6d. to 1s. per ton above the late minimum rates is now being quoted; prices, however, are still very low, and there are good foundry brands to be got at about 52s. 6d. to 53s., less 2½, delivered here.

There is only a slow business doing in the manufactured iron trade, but the local forges are generally kept tolerably well employed, and prices are maintained on the basis of £5 12s. 6d. for good qualities of bars delivered into the Manchester district. Makers are, however, in some cases showing themselves more anxious to secure specifications, and there is, if anything, rather a want of firmness generally.

The condition of the engineering trades continues generally depressed, although no worse than I have previously reported. The returns just issued by the Amalgamated Society of Engineers are of much the same character as the report which I gave last week from the Steam Engine Makers' Society. There is still a slight increase in the number of unemployed members, but there has not been that serious increase of members reporting themselves out of work as was shown in the returns for the previous month, and the donation benefit returns remain at about 4½ to 5 per cent. of the total membership throughout the country. It is still in the shipbuilding centres that the condition of trade continues the most unsatisfactory; but, except that tool makers and locomotive builders are kept fairly well employed, the condition of the engineering trade and of merchants generally is quiet, and it is only very exceptional when the branch reports return trade as good, moderate, declining, or bad, representing the general average of the returns. With the exception of the old-standing dispute at Sunderland and the strike in the Barrow district, where the men are apparently determined to resist to the uttermost the reduction demanded by the employers, there is no serious wages question at present disturbing trade; but with a continuance of the present depression it would scarcely seem possible that the rates now ruling can be very long fully maintained.

An interesting paper on special machine tools for making the wrought iron underframes of railway wagons was read by Mr. John Craven—Messrs. Craven Bros., Manchester—at the meeting of the Manchester Association of Employers and Foremen, on Saturday. Mr. Thos. Ashbury, C.E., the president, observed that iron was superseding wood to a large extent in the construction of the underframes of railway rolling stock. Some time back attempts were made to introduce iron in the place of wood, but there were then serious difficulties in the way, which had interfered with its development, and to overcome these difficulties the production of special machines had become necessary. Mr. John Craven, in introducing his paper, said the requirements of railway companies, especially in connection with their rolling stock, had rendered it necessary that special machine tools should be employed to turn out a large quantity of work of the best class with all the parts interchangeable at a minimum cost, and he then described a series of specially designed horizontal and vertical multiple drilling machines with other plant—to which I have previously referred in my "Notes"—that his firm had recently put down at the Swindon Works of the Great Western Railway Company for making wrought iron under-framing of railway wagons. By these machines the whole of the parts are prepared and finished, ready for putting together, with comparatively little or no hand labour being required, Mr. Craven added that some idea of the enormous requirements of a large railway company might be formed from the fact that the Great Western Company had 40,000 wagons of the class which these machines were specially designed to construct; and with an output of fifty wagons per week, which they had been laid down to turn out, it would take sixteen years to renew the entire stock. He considered that the complete series of machines that had been laid down formed a good example of the employment of special tools, making a triumph of mind over physical force, as the whole of the work was, comparatively speaking, done without the sound of a hammer. In the discussion which followed, Mr. Parker, of the Manchester, Sheffield, and Lincolnshire Railway, expressed the opinion that before another ten years had passed, iron underframes would become universal, if for no other reason than the cost of timber; and the President observed that the large introduction of iron underframes, which was already practically universal in hot climates, would bring this class of work into prominence as an important branch of industry. In conclusion, Mr. Ashbury added a few hints with regard to railway engineers, which evidently met with general approval from the members present. Inspection, he observed, had been carried to a length that was altogther absurd, and if railway engineers would consult a little more with the contractors and the tool makers, and make their designs a little more practicable, some uniform system might be adopted. He thought it was high time that some of these high-flown engineers took a turn in the contractor's shop, and there carried out their own designs.

In the coal trade business is very quiet for the time of the year; very few of the collieries are working more than an average of four to five full days a week, and at many of the pits stocks are being put down. Quoted rates nominally remain without change, but there is a good deal of underselling, and for sales in quantity to clear away stocks low prices are being taken. At the pit mouth mouth best coal averages 9s. to 9s. 6d.; seconds, 7s. to 8s.; common house fire coals, 6s. to 6s. 6d.; steam and forge coals, 5s. 6d. to 6s.; burgy, 4s. 6d. to 5s.; good slack, 4s.; and common sorts about 3s. per ton.

Shipping has been dull during the past week, and steam coal delivered at the high level, Liverpool, has been offering at 7s. per ton, with some of the better qualities quoted at 7s. 6d. per ton.

Barrow.—I have to report no special change in the iron trade of this district. No further improvement is noticeable, but the change for the better which has existed for some weeks is maintained. Prospects on the whole are encouraging, and makers are expecting that during the coming winter they will be better employed. From present appearances perhaps some dependence may be placed on this expectation, and no doubt with the New Year we shall have a revival. Some of the makers are not so anxious to commit themselves to large engagements, as prices have an upward tendency, but makers are indifferent, and are only buying for immediate wants. The output of the district has scen no further restriction. Shipping returns show a slight increase. Quotations this week are firmer than they have been for months, and have slightly advanced, mixed Bessemer samples being priced at least 1s. per ton in advance of last week. Although some good orders have been received at the steelworks, no special activity is noticeable. Steel rails are in better demand all round, and prices are more favourable to makers. Other departments are fairly well employed. Shipbuilders have some good contracts in hand, and it is expected that if the winter is a mild one there will be no severe depression. Coal and coke are quiet. Shipping inactive.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THE downward course of trade, so far as Sheffield goods are concerned, still continues. An examination of the exports for October, as disclosed in the Board of Trade returns, show the totals of hardware and cutlery for October of 1882, 1883, and 1884 to be £349,010, £328,141, and £284,856 respectively. The increasing markets are Germany, Holland, and Australasia; all other countries show a decided falling-off—France, from £17,513 in October, 1883, to £11,416 last month; the United States, from £39,285 to £25,985; Brazil, from £22,843 to £12,351; British Possessions in South Africa, from £8245 to £5955; and British East Indies, from £33,855 to £27,379.

Bar, angle, and bolt show an increase on October of 1883, the respective totals being £169,424 and £188,533. The British East Indies, from £20,389 to £35,547; British North America, from £37,072 to £24,262; and Australasia, from £19,936 to £35,062—being the chief increasing markets. In pig iron the total value in October, 1883, was £385,192, and last month £282,910. Russia, which took a value of £41,836 last month, is the only market which shows an improvement. The United States has dropped from £94,964 to £29,579; British North America, from £23,231 to £17,323; Holland, from £55,298 to £44,861; Germany, from £95,677 to £75,489. In hoop iron and plates there was exported last month a value of £333,450, as compared with £365,832 for October of last year. The increasing markets are Germany—from £10,860 to £11,982—and Australasia—from £73,764 to £92,143. Italy shows a heavy drop—from £25,985 to £9976; Russia, from £27,829 to £25,899; British East Indies, from £40,340 to £37,791.

Steel rails fluctuate very curiously in the demand for foreign markets. Russia, after a long blank, is again a customer, to the trifling extent of £409; Sweden and Norway, which took £15,988 in October, 1883, now takes £275; Germany, which had not taken a rail in October of 1882-3, had a value of £300 last month, and that sum precisely represents the amount sent to Spain and Canaries in October of 1883, while last month it was increased to £9193. Italy's figures for October, 1882-3-4 show values of £42,087, £13,347, and £349—this is whittling away to the small end of nothing—but these diminishing values are eclipsed by the United States, which took in October, 1882, a value to the extent of £153,146; in October, 1883, £30,388; and last month, £2141. Mexico, which was a customer in October of 1882-3 to the value of £28,915 and £23,193, had nothing at all last month; Holland has been blank for three Octobers, and Egypt has done nothing in that month since 1882, when a value of £6947 was sent. To the British Possessions in South Africa a value of £31,049 was sent in October, 1883; last month only £2816. British East India decreased from £45,846 to £31,067; while, on the other hand, British North America increased from £24,303 to £54,019, and Australasia from £55,489 to £60,839. The total values for October of 1882-3-4 were £529,369, £329,635, and £230,392. In railroads of all sorts the total value for last month was £345,539, as compared with £448,698 for October, 1883.

Steel, unwrought, keeps diminishing for foreign markets. France's figures for October, 1882-3-4, are £14,467, £11,991, and £9089; the United States, £53,751, £25,725, and £25,176. The totals for similar periods are £136,505, £120,251, and £97,414.

Mr. George Wilson, chairman of Charles Cammell and Co., Cyclops Steel and Ironworks, has written a letter to one of the local papers on a most interesting subject, the contract which subsists between his firm and the Russian Government. Mr. Wilson states that the direct effect of that agreement is to bring every year to Sheffield a large amount of work, over a very considerable period of time, none of which would otherwise have come to this country. The contract, it should be mentioned, is for the production of "Wilson" compound armour plates, at Kolpino, near St. Petersburg, where Sheffield workmen are at present engaged in armour plate making. Mr. Wilson could give some very interesting information on this score if he pleased.

A somewhat serious accident occurred at the works of Messrs. Henry Bessemer and Co., steel manufacturers, Carlisle-street East, on Monday afternoon. A number of blanks, or ingots, used for making tires, were in a furnace, and the heat being too great, it was found necessary to put down the damper. A short time afterwards, five labourers gathered round the furnace to take out the blanks. The furnace door was opened, and the men were in the act of taking one of the ingots out, when some gas, which had accumulated at the back of the furnace on account of the damper being put down, exploded. The men were seriously injured in the faces and arms, two of them so severely that they were received as in-patients at the General Infirmary.

Hitherto in the Colonies the McCormick and the W. A. Wood—both American—reapers and binders have carried all before them. Messrs. Richard Hornsby and Sons, of Grantham, have been only three years engaged upon the production of these machines, and consequently have had a good deal of leeway to make up. However, in 1883 they beat W. A. Wood and Howard, the only competitors at the Highland and Agricultural Society's Show, winning the £100 prize. This year they took the first prize at the Royal Show at Shrewsbury, beating McCormick, Wood, and other well-known makers. It was then said that the Americans would beat all opponents in Australia. The result, however, is quite otherwise, for again Messrs. Hornsby carry off the leading honours. For their binder they have been awarded first prize at the Royal Agricultural and Horticultural Society of South Australia, beating McCormick, W. A. Wood, Samuelson, and Deering; and they have also been awarded first prize at the National Agricultural Society of Victoria —Government trial—beating W. A. Wood, Osborne, McCormick, and four others.

Messrs. J. and G. Tomlinson, contractors, of Derby, have just completed, after two years' work, the new line of railway in the Doe Sea Valley, just below Bolsover. Last week, Mr. Needham, traffic manager for the Midland Railway Company, with Mr. Underwood, the company's engineer, accompanied by others interested in the undertaking, went over the line for the purpose of inspection, and on Monday the Midland Company "took it over," and commenced to run their own engines. The railway has been constructed under the personal superintendence of Mr. J. Tomlinson, Mr. Drabble Tomlinson, and Mr. Taft. At the Chesterfield Town Council, on Menday, it was stated that surveys were being made for a joint line to be constructed by the Manchester, Sheffield, and Lincolnshire, the Great Northern, and the London and North-Western Railway Companies from Kiveton Park to the Brewery Meadows at Chesterfield. The Dore and Chinley Railway, in North Derbyshire, is to be shortened by half-a-mile by alterations in the two long tunnels, and at the Dore end another curve is to be formed so as to admit of traffic from the Manchester direction, proceeding direct south without touching the station. For this purpose a fresh Bill will be necessary.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

NOTWITHSTANDING that the Glasgow market was reported firmer, there was no excitement at the market held at Middlesbrough on Tuesday last. Prices were, however, maintained at previous levels. No. 3 g.m.b. for prompt delivery could not be had from either makers or merchants for less then 36s. 3d. per ton. Those producers who are well sold for the remainder of the year are asking 36s. 6d. for No. 3. There are now numerous inquiries for delivery over the first six months of 1885, and consumers are ready to pay 36s. 6d. per ton for that period. Makers, however, are shy, and avoid committing themselves so far ahead. They hope to do better when the shipping season re-commences. Orders for forge iron are plentiful, and less than 34s. per ton is nowhere accepted.

The nominal value of warrants is 35s. 9d. per ton, but they seldom change hands.

Messrs. Connal and Co.'s stocks of pig iron, both at Middlesbrough and Glasgow, continue steadily to decrease. At the former place, the stock on Monday last was 53,314 tons, being a reduction of 110 tons for the week, at the latter place there was 580,432 tons, being a decline of 356 tons.

The shipments of pig iron from the Tees are but moderate this month. The quantity exported up to Monday last was 22,212 tons, or about 6000 tons less than during October, and about 18,000 less than during November, 1883, corresponding periods being taken.

The demand for finished iron has slightly improved, but there is no alteration in prices. Orders for ship plates can easily be placed at £5 per ton, and angles at £4 15s. on trucks at makers' works, less 2½ per cent. discount. Bar iron has for some time been in better request than plates, and the price is firm at £5 2s. 6d. per ton. Messrs. Jones Brothers' rolling mills are again closed, the orders which had accumulated having been completed. There is a growing demand for steel for various purposes, and the local works which manufacture it continue to be fairly well employed. Prices are, however, exceedingly low, and show no signs of stiffening.

At a meeting of the River Tyne Commissioners, held on Thursday last, it was reported that seventy-eight vessels were idle in the Tyne at the end of October. At the end of September the number idle was ninety-seven.

It is reported that the directors of the Western Railway of France are about to erect eighty Simon-Carvé's coke ovens near Rouen for the manufacture of coke for their locomotives. These are expected to carbonise about 200 tons of coal in twenty-four hours, and will be fitted with the latest improvements for collecting the bye-products.

Messrs. the Tees Side Iron and Engine Works Company, Middlesbrough, have in hand an order for a large quantity of steel rail rolling plant for a firm in Spain. The rail finishing mill will be capable of making rails of the heaviest sections, and up to 180ft. long. The roughing and blooming mills are exceptionally strong, the standards of the latter weighing 20 tons each, and the rolls about 15 tons. A bloom shearing machine is also in hand, which will be capable of cutting steel blooms 12in. square. The weight of this machine will be 75 tons. The above firm are also engaged on plant for a large steel-making company in the North of England.

It has been decided that the arbitration to determine ironworkers' wages in connection with the North of England finished iron trades shall take place on the 20th inst., but the place of meeting is not fixed. Dr. Watson will be asked to fix the rate of wages for four months.

The first meeting for the session of the Cleveland Institution of Engineers was held at Middlesbrough on Monday evening last. The report and balance-sheet for the previous session were presented and adopted. It appears that the membership is now about 310, including members, associates, and graduates. There is a balance of £102 to the credit of the Institution, after paying all liabilities, but, as was pointed out, the financial position would not have been so favourable had not a number of the leading members come to the rescue about a year since, and voluntarily paid double subscriptions. The retiring president, Mr. E. F. Jones, vacated the chair in favour of the president-elect, Mr. Alfred C. Hill, general manager of the Clay-lane Ironworks, and one of the original founders of the Institution. A hearty vote of thanks was passed to Mr. Jones. Mr. Hill then delivered an interesting address, in the course of which he made various statements on matters interesting to metallurgical engineers. He alluded to the statistics given by Mr. I. L. Bell in his recently published work, showing what a large proportion of the cost of pig iron is appropriated by the owners of the royalties of minerals, amounting, as it does, to 3s. 9d. per ton on pig iron. He commented on the fact that in no other country do the payments on this account exceed 9d. per ton, and urged that the great thing to be desired to meet the present depression in the iron trade was a substantial lowering of mineral royalties.

The programme just issued by the Institution is an unusually attractive one. It promises a paper from Mr. Mansergh upon the new Hury Reservoir, about to be constructed to his designs for the Stockton and Middlesbrough Corporation Water Board. The reservoir is part of various and extensive works they are about to undertake in order to supply their district with pure water, without pumping more than sixty million gallons per week direct from the river Tees.

Mr. Heenan, of Manchester, will read a paper on Tower's spherical engine, the patent for which he has purchased, and which he is now manufacturing on a large scale. This paper will be illustrated by an engine in motion, and a dynamo and electric lamps of various kinds will be superadded.

A paper on grinding corn by means of chilled rolls will be read. Also one upon engine slide valves, by Mr. Thos. Westgarth, and another on forgings by Mr. T. Putnam, of Darlington. Altogether there is abundant evidence that the activity of this vigorous institution is in no degree abated.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE excitement in the Glasgow warrant market, noticed in last report, has continued during the present week. No fewer than six firms dealing in pig iron have suspended payments, in consequence of the rise in prices. But if the business they were doing had been of a legitimate instead of a highly speculative nature, a rise in price would have been an advantage to them, as it has been a benefit to others. Those who have failed are mostly young men not long in business, and they had their accounts oversold to an extent which could not have been anticipated. The discovery of the character of their speculations has induced a fear in the market that there may be others in a similar position; and many brokers have, therefore, been proceeding with great caution in their transactions.

The fluctuations have in one or two cases been exceptionally large, there having been, for example, a rise of 1s. a ton on Monday afternoon. The demand for pig iron for shipment is slack, and the shipment rather unsatisfactory, amounting for the past week to 6783 tons, as compared with 8949 in the preceding week and 7574 in the corresponding week of 1883. Since last report an additional furnace has been put in blast at Langloan, so that there are now ninety-six in operation against 101 at the same date last year. The decrease in Messrs. Connal and Co.'s stock of pig iron was less than usual, being only about 260 tons for the week.

Business was done in the warrant market on Friday at 43s. 1½d. cash, and on Monday from 43s. to 44s. 4½d., receding at the close to 44s. 1½d. A fair business was done on Tuesday forenoon at 44s. 4½d. to 43s. 9d. cash, the afternoon prices being 43s. 10d. to 43s. 8d. and 43s. 9d. cash. The market was flat on Wednesday at 43s. 10d. to 43s. 3d. cash. To-day—Thursday—very little business was done, and the quotations were 43s. 3½d. cash.

Although there has been less doing in makers' special brands, several advances in price have taken place, and the figures as a whole are well maintained. The quotations are now as follow:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 55s. 6d.; No. 3, 50s. 6d.; Coltness, 59s. 6d. and 52s. 6d.; Langloan, 58s. and 52s. 6d.; Summerlee, 54s. and 47s. 3d.; Calder, 54s. and 48s.; Carnbroe, 51s. and 47s. 6d.; Clyde, 48s. 6d. and 45s. 3d.; Monkland, 44s. 6d. and 42s.; Quarter, 43s. 9d. and 41s. 6d.; Govan, at Broomielaw, 44s. and 42s.; Shotts, at Leith, 54s. 6d. and 52s. 6d.; Carron, at Grangemouth, 49s. (specially selected, 53s. 6d.) and 48s.; Kinneil, at Bo'ness, 44s. and 43s. 6d.; Glengarnock, at Ardrossan, 50s. 6d. and 43s. 6d.; Eglinton, 45s. and 42s.; Dalmellington, 48s. 6d. and 44s.

The total shipments of Scotch pig iron to date for the year are 479,275, as compared with 566,363 tons in the corresponding week of last year. There is now in the Glasgow warrant stores an aggregate of 580,000 tons, as against 587,000 tons twelve months ago. At the present moment the production is understood to be considerably larger than the consumption.

Notwithstanding the dull times through which we have recently been passing, fortunes are, it seems, still made in the iron trade. The late Mr. Walter Neilson, ironmaster, Summerlee, has left £300,777; and Mr. James Donald, ironmonger, Kilmarnock, £15,085.

In the malleable iron department there is a fair amount of business doing, but prices continue very low.

The past week's shipments of iron and steel manufactures from the Clyde included three locomotives for Bombay, valued at £5000; machinery to the value of £17,500; sewing machines, £2100; steel manufactures, £11,000; rails, £5550; plates and bars, £2100; other iron goods, £38,000.

The coal trade in the Glasgow district has assumed a quiet phase. In the past week the shipments have been 15,205 tons at the General Terminus, and 6776 tons at the Queen's Docks; at Ayr, 6842 tons were shipped; Troon, 7128; Irvine, 1134; Greenock, 142; Leith, 5000; and Grangemouth, 8200. Free on board at Glasgow, splint coals are quoted at 6s. 6d. to 7s. a ton; main, 5s. 9d. to 6s. 3d.; ell, 6s. 6d. to 7s. 6d.; steam, 8s. to 8s. 3d. The prices at the pits are from 1s. to 2s. less. On the east coast business lacks animation. Short time is being worked at some of the collieries in Fifeshire. The prices for shipping coal, f.o.b. at Burntisland, range from 6s. 9d. to 7s. 3d. a ton. There is rather more demand for household sorts, but the inquiry for furnace coal is quiet.

During the last week or two, contracts have been concluded with Clyde shipbuilders for the construction of several sailing vessels. These are, however, quite insufficient to place the trade generally in a better position. At the end of last week a large number of additional workmen were discharged from the yards, and it is estimated that, in the Glasgow district alone, there are just now from 3000 to 4000 shipyard operatives without employment. Messrs. Elder and Co. have placed their men on short time—forty-five hours a week—in order to keep as many in their employment as possible.

WALES & ADJOINING COUNTIES.

(*From our own Correspondent.*)

THE Secretary of State has deferred to the influential deputation who waited upon him respecting shot firing in collieries—so far as this, that he has directed Mr. Wales, the inspector, to select a test case, and try a fiery colliery "in such a way as he may think dangerous." Of course due precautions will be taken so as not to jeopardise life.

The autumnal season, with its falling barometer and murky air, has been again attended with colliery disaster. This time it has been one of the Tredegar Company's collieries, called the Pochin Colliery. There, on Saturday night late, a terrible explosion occurred, and either seventeen or eighteen men have perished, and forty-three horses. A good deal of damage has been done to the pit. The manager is Mr. Stratton, a gentleman of experience, and whose management has been characterised with marked immunity from these disasters. How the explosion occurred is as yet only a matter of speculation; but the opinion tends to "accumulating gas after the shift had ceased working, and smoking by one of the road men."

Activity continues in all the railway undertakings of the district—the various channels in formation for sweeping away the coal output of Wales; but I regret to add that the output itself continues, so far as the east of Glamorganshire is concerned, a little below the former totals. Prices are not only easy, but orders few.

Taking Cardiff, I find that in January last the coal shipments for that month came up to 620,132 tons. In October they only reached 571,298 tons. For the year, including October, the total coal sent from Cardiff has reached a trifle over six million tons. Newport, which has a good background of house coal, shows better in proportion, and its weekly averages are fairly maintained. The total coal sent from Newport up to the end of October has been 1,407,246 tons. From Swansea, which also maintains its average, 796,496 tons.

The Newport total, like those of Cardiff and Swansea, does not include coastwise shipments. Amongst the Newport coals, one of special value deserves to be named—the black vein of Abercarn. Of this coal a half million tons were despatched during the year by foreign and coastwise routes. The quietness which has fallen upon the coal trade is particularly confined to the valleys trenching upon Cardiff, and is more perceptible in steam than house coal. Yet I do not draw gloomy forebodings from it. Contracts are beginning to run out, and naval operations are looming which will tend to keep coaling stations well stocked. I see that the Pacific (Liverpool) Company have just concluded a contract with the Bute (Rhondda) Colliery Company for 20,000 tons. Others are expected. House coal is getting firmer in price, and leading qualities required are increasing; but there is no change in seconds or in small steam, and as long as coke is slack in demand this will continue.

The unfortunate fellows at Pochin Colliery had, I hear, withdrawn from the Miners' Provident Fund—another sad instance of thoughtless inconsideration. During the past week we have had numerous accidents—two at Tylor's Town, three at Dinas—and all are striking warnings of the necessity for joining this fund. At the next colliers' meeting, on Monday, for the settlement of local questions, I hope that this will be brought on.

The iron and steel trade remains in the same depressed condition as I have so long recorded. Half or a third time and small orders are the prevailing signs. I recollect as much done in a month as is now done in twelve. During the whole of the present year the consignments of iron have been as follows: From Cardiff, 74,706 tons; from Newport, Mon., 98,754 tons; from Swansea, 3667 tons. Orders are moving about, but whether any of importance will come here is uncertain.

The "steel ring" includes England, Germany, and Belgium. Fracne and the United States are getting a few who resent the "ring;" hence the necessity of making it wider, and including America and France.

Tin-plate is in moderate demand. Ruling price of ordinary coke, 14s. 6d. Penclawdd Works, with three mills, starts this week.

A fine rope was turned out at Elliott's, Cardiff, last week, for the North British Railway Company. It weighed over 24 tons, and was 5in. in diameter.

The viaduct on the joint Rhymney and Great Western line over the Taff, at Quaker's Yard, is practically complete, the keystone of the last arch being fixed this week. Mr. Lundie, of the Rhymney Company, was present at the ceremony, and was presented with a silver trowel as a memento of a very important work. Meakin and Dean, the contractors of the work, have been most energetic and successful in the undertaking, which has taken just one year to accomplish. The total length of the viaduct is 115ft.; seven square arches, semicircular, 47ft. span, and one skew arch, 52ft. span. The centre span is elliptical, and the structure commends itself to the professional eye as strong and symmetrical. This will give another route to Penarth, and connect Cyfarthfa works both with its collieries at Pontypridd and the various railway systems.

The increase in the patent fuel industry of Wales is strikingly shown by the last returns. During the year Cardiff has exported 142,000 tons, and Swansea 177,000 tons. Iron ore continues a drug. Pitwood dull; prices about 17s. 6d.

The agitation of enginemen continues, and threatens to become serious. They want assimilation of wages, and reduced hours.

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.

3rd November, 1884.

14,501. Bullets for Small-arms, &c., J. J. Talman, Harbledown.

14,502. Weaving Ornamental Fabrics, W. Strang, Glasgow.

14,503. Rails, &c., for Street Tramways, W. Deighton, Sheffield.

14,504. Differential Axle, F. M. and E. C. S. Moore, Dover.

14,505. Table Cutlery, C. H. Wood, Sheffield.—*11th October*, 1884.

14,506. Bottles with Distinctively Coloured Mouths, D. Rylands, near Barnsley.

14,507. Protractor and Scale, T. F. S. Tinne, Liverpool.

14,508. Secondary Batteries, A. H. Reed.—(*E. Commelin, G. Bailhache, A. L. de Virloy, and L. de Bousignac, Paris.*)

14,509. Gas-producer Furnaces, L. A. Groth.—(*W. Backer, Budweis.*)

14,510. Brake Apparatus for Tram-cars, &c., T. Utley and J. Liddiard, London.

14,511. Intermittent Flushing Apparatus, F. Cuntz, London.

14,512. Igniting Gas Engine Charges, E. R. and H. N. Prentice, London.

14,513. Machinery for Burring, &c., Wool, H. H. Lake.—(*C. Obozinski, Brussels, and A. Darolles, Antwerp.*)

14,514. Raising, &c., Builders' Materials, &c., W. H. and G. Hutchins, London.

14,515. Nut-lock and Bolt, J. T. Foster, London.

14,516. Films, &c., for use in Photography, A. J. Boult.—(*G. Eastman and W. H. Walker, United States.*)

14,517. Impelling Fluids, F. Frick, London.

14,518. Soles for Boots, &c., H. Wilkie and W. Kaye, London.

14,519. Rapidly Printing Race Results, &c., F. R. Spark, London.

14,520. Governing the Speed of Compound Marine Engines, C. Burnett, London.

14,521. Filtering Rain Water, H. Curzon, London.

14,522. Atmospheric Door Closer, F. Jupp, London.

14,523. Supporting Casks, &c., W. Walker, London.

14,524. Lifting Apparatus, G. Allix and H. G. Trudgett, London.

14,525. Combination of Ladies' Stays and Bustle, F. Francis, jun., London.

14,526. Extracting Mechanism of Drop-down Small-arms, J. Deeley, jun., London.

4th November, 1884.

14,527. Petroleum Lamps, D. Allport, London.

14,528. Tuning Pianofortes, T. G. Barnes, Guernsey.

14,529. Obtaining Radial Lines, J. B. Foxwell, Manchester.

14,530. Arrangement of Refrigerating Chamber, W. P. Thompson.—(*J. F. Hanrahan, United States.*)

14,531. Manufacture of Railroad Spikes, &c., W. P. Thompson.—(*L. Acheson, J. M. Duncan, and H. L. Fox, United States.*)

14,532. Driving Gear for Bicycles, &c., D. Roper, Liverpool.

14,533. Manufacture of Salt from Brine, H. Whitehead and R. Hodgson, Liverpool.

14,534. Printing Machines for Textile Fabrics, F. A. Gatty, Manchester.

14,535. Spreading India-rubber on to Woven Fabrics, H. Markus, Manchester.

14,536. Preventing Wood Keys used for Securing Rails in their Chairs from Working Out, T. Richmond, Nottingham.

14,537. Invalid's Air Bed and Fixtures, E. A. Scott, London.

14,538. Safety Pin for Neckties, J. J. Rugg, Birmingham.

14,539. Velocipedes, W. Spence and R. E. Phillips, London.

14,540. Velocipedes, J. Sharp, Birmingham.

14,541. Locking Nuts of Screw Bolts, D. Smith, Birmingham.

14,542. Taped Furs, F. Vorck, London.

14,543. Smoke Consumers, G. W. Mears, London.

14,544. Machine for Cutting Embroidered Fabrics, C. White and M. Holzman, London.

14,545. Wringing and Mangling Machines, J. Mackey, London.

14,546. Twin Ships, W. J. Riley, London.

14,547. Incandescence Electric Lamp Holder, S. J. Coxeter and H. Nehmer, London.

14,548. Electric Batteries, P. M. Justice.—(*F. Van Rysselberghe, Brussels.*)

14,549. Treatment of Alkaline Chlorides, P. M. Justice.—(*L. E. Thomas, Paris.*)

14,550. Mechanical Calendar for Lockets, &c., J. Comte, London.

14,551. Manufacture of Coke, J. Jameson, London.

14,552. Mercurial Air or Vacuum Pumps, G. Davidson, R. C. Jackson, and J. B. Duncan, London.

14,553. Carbons for Incandescent Electric Lamps, G. Davidson, R. C. Jackson, and J. B. Duncan, London.

14,554. Air Tide Ventilation, J. Trolley, Northampton.

14,555. Gas Burners, A. J. Parsons, London.

14,556. Covers for Retorts, H. Simon.—(*The Berlin-Anhaltische Maschinenbau-Actien Gesellschaft, Berlin.*)

14,557. Information Tables for Railway Stations, C. A. Day.—(*Messrs. Brandon, United States.*)

14,558. Railway Brakes, H. J. Haddan.—(*H. Flad, United States.*)

14,559. Guns, H. J. Haddan.—(*A. Eastman, U.S.*)

14,560. Galvanic Battery, H. J. Haddan.—(*Electrotechnische Agentur Richard Blänsdorf, Frankfort-on-the-Main.*)

14,561. Purifying Vegetable Extracts, J. Doutreleau, London.

14,562. Cooling Butterine, &c., M. Philips, London.

14,563. Production of Aluminium Chloride, W. White, London.

14,564. Tubes, E. de Pass.—(*P. E. Secrétan, Paris.*)

14,565. Mats, R. B. Black and W. Jones, London.

14,566. Carriages Propelled by Foot Power, J. Bickmore, London.

14,567. Roof Windows, G. Connell, London.

14,568. Bicycles, J. White and J. Asbury, London.

14,569. Velocipedes for Two Riders, M. D. Rucker, London.

14,570. Velocipedes, M. D. Rucker, London.

14,571. Preventing Waste in Wool, A. H. Illingworth and J. Tarbotton, London.

14,572. Fever Ambulance Carriages, O. Polenz, London.

14,573. Attaching the Saddle to Velocipedes, F. S. Liley, London.

14,574. Shuttles, A. G. Brookes.—(*C. G. H. S. Petzold, U.S.*)

14,575. Brakes for Railway Carriages, M. Schleifer, London.

14,576. Umbrella Rib Machines, G. F. Redfern.—(*D. M. Redmond, U.S.*)

14,577. Automatic Cut-off Valves, G. Fletcher.—(*J. H. Man, U.S.*)

14,578. Paddle-wheels, J. Bramall, London.—*30th September*, 1884.

14,579. Heels for Boots and Shoes, G. F. Redfern.—(*H. Baumgarten, Vienna.*)

14,580. Shoe Brush, G. F. Redfern.—(*M. Clunet, sen., Lyons.*)

14,581. Guide Boards of Frames for Spinning, &c., J. H. Clapham, London.

14,582. Mechanical Toy Railway, G. F. Lütticke, London.

14,583. Studs, Buttons, Solitaires, &c., W. Buckwell, London.

14,584. Closing the Mouths of Hollow Vessels, W. Buckwell, London.

14,585. Boring and Excavating, &c., W. Buckwell, London.

14,586. Cases for Goods for Storage, &c., W. Buckwell, London.

14,587. Artificial Leather, A. M. Clark.—(*H. Schwabacher, Paris.*)

14,588. Pneumatic Dispatch Apparatus, H. H. Lake.—(*H. Clay, U.S.*)

14,589. Turnstile Registering Apparatus, H. H. Lake.—(*F. O. Deschamps and the Philadelphia Patent Rights Company, U.S.*)

5th November, 1884.

14,590. Making External Threads upon Bottle Necks, &c., S. Skerritt, Sheffield.

14,591. Rowel for Petroleum Burners, W. K. Fulleylove, Rugby.

14,592. Safes and Strong-room Doors, G. O. Talbot, Birmingham.

14,593. Increasing the Efficiency of Steam Boiler Furnaces, J. Whittle, Bury.

14,594. Securing Sliding Doors, G. H. W. Alderson, Brimington.

14,595. Automatic Governor to Prevent Racing in Marine Engines, J. Glover, jun., Southport.

14,596. Coolers, Refrigerators, &c., W. Tait and A. Lilley, Burton-on-Trent.

14,597. Spinning and Doubling Cotton, &c., W. Leach, Halifax.

14,598. Hydrants, W. L. Baker, London.

14,599. Weaving and Cutting Velvets, &c., J. Knowles, Blackburn.

14,600. Game of Trap-bat and Ball, W. Warburton, Lee.

14,601. Dynamo-electric Machines, G. F. Chutter, Birmingham.

14,602. Castrating Lambs, W. J. Gregory, near Bletchley.

14,603. Obtaining Sulphur from Alkali Waste, J. Plummer, Glasgow.

14,604. Hoisting and Traversing Heavy Bodies, J. Meiklejon, Glasgow.

14,605. Packing for Pipes, S. Turner and J. Bell, Manchester.

14,606. India-rubber Hose Pipes, S. Turner and J. Bell, Manchester.

14,607. Asbestos-metallic Cloth, S. Turner and J. Bell, Manchester.

14,608. Stretching Woven Fabrics, J. Roberts, Manchester.

14,609. Apparatus used in the Manufacture of Paper, J. Robertson, Manchester.

14,610. Spinning and Doubling Cotton, &c., R. Curtis and J. Wain, Manchester.

14,611. Automatically Regulating the Closing of Doors, J. Howard, Erith.

14,612. Self-locking Check and Plain Fishing Reel, S. Allcock, Redditch.

14,613. Wire Spring Fastener for Umbrellas, &c., L. Turnock, Stockport.

14,614. Opening and Closing Windows, W. Corteen, London.—*25th September*, 1884.

14,615. High-pressure Water Filters, J. Howlett, Hull.

14,616. Glazing Horticultural Buildings, &c., E. Shrimpton, London.

14 617. Paring, &c., Boots and Shoes, T. Gare, London.

14,618. Stench Traps, A. Parkinson, London.

14,619. Candlestick, F. W. Brampton, Birmingham.

14,620. Cigarettes, H. Hand and W. J. Venables, London.

14,621. Artificial Stone, J. Hatfield, London.

14,622. Torpedoes, A. W. Slater, Blackheath.

14,623. Steering Ships, R. R. Symon, London.

14,624. Shallow Draft Canoe, G. J. Tagg, London.

14,625. Audible Signalling Apparatus, J. Steven and T. Burt, London.

14,626. Braces, J. Scrimgeour, London.

14,627. Looms, F. Ratcliff and J. Batley, London.

14,628. Gunlocks, J. B. Bull, London.

14,629. Portable Steel Saloon for Saving Life at Sea, W. Hutchings, London.

14,630. Railroad Switches, W. E. Gedge.—(*E. Gordon, United States.*)

14,631. Hook and Eye, H. W. R. Strong, London.

14,632. Shaft Tug for Harness, T. W. Hill, London.

14,633. Grinding Mills, W. N. Nicholson and W. Mather, London.

14,634. Closing the Tapholes of Beer Casks, &c., J. E. Minnitt and J. H. Vickers, London.

14,635. Street Railways, A. J. Boult.—(*G. Pardy, United States.*)

14,636. Buttons, &c., A. J. Heys and S. Salkeld, Manchester.

14,637. Preparing Hanks or Skeins of Thread, B. J. B. Mills.—(*J. M. Bonnière, Charlieu.*)

14,638. Desiccation of the Air Supply of Furnaces, C. Cochrane, London.

14,639. Effecting the Transfer of Designs from Plates or Lithographic Stones to Metal Rollers, G. R. Hugon, London.

14,640. Cleaning Cotton, A. M. Clark.—(*G. A. Risler, Cernay.*)

14,641. Boots, &c., M. Sesenwine, London.

14,642. Moulds for Casting Cylindrical Forms in Steel, &c., J. Whitley, London.

14,643. Umbrella Frames, W. Hoyland, London.

14,644. Ice Machines, H. Walker, London.

14,645. Nozzles of Beer Engines to Prevent Waste, A. E. Adlard, London.

6th November, 1884.

14,646. Chairs, J. Davenport, Manchester.

14,647. Compressing Apparatus for Silos, Sir J. T. S. Richardson and R. G. Morton, Glasgow.

14,648. Metallic Roofing Slate, J. Samuel.—*Messrs. M. and L. Samuel, Benjamin, & Co., Canada.*)

14,649. Telephonic Apparatus, J. Stephen, Glasgow.

14,650. Taps, E. Reynolds, Sheffield.

14,651. Weaving Calico, &c., W. Jepson, Blackburn.

14,652. Telephonic Apparatus, J. Stephen, Glasgow.

14,653. Damasks, J. McCullagh, Donacloney.

14,654. Fittings with Tarpaulin Coverings of Railway Wagons, W. Hayward, London.

14,655. Use of Voltaic and Induced Electric Currents, F. Tremain and A. Pike, London.

14,656. Cigar, &c., Boxes, J. Anderson, Glasgow.

14,657. Combined Crinolette and Skirt, L. A. Robotham, South Wimbledon.

14,658. Heel Plates for Boots and Shoes, J. Marrison, London.

14,659. Winding Yarns, R. Broadbent, Halifax.

14,660. Weighing Scales, O. Kneist, London.

14,661. Drinking Glasses, H. S. Whitaker, London.

14,662. Boots and Shoes, T. Laycock, London.

14,663. Spring Power for Driving Machinery, E. Marshall and G. Phillips, Birmingham.

14,664. Rifle Sight Elevators, &c., J. H. Steward, London.

14,665. Wet Spinning Frames, J. Erskine, London.

14,666. TRIMMING for CLOAKS, &c., L. Simmons, London.
14,667. PUNCHING HORSESHOE NAIL BLANKS, P. A. Nilsson, London.
14,668. FINISHING HORSESHOE NAILS, P. A. Nilsson, London.
14,669. MAKING HORSESHOE NAILS, P. A. Nilsson, London.
14,670. OPENING and CLOSING the DOORS of HANSOM CABS by the DRIVERS, E. A. Olley, London.
14,671. ANCHORS, R. Pollok and J. Mitchell, Glasgow.
14,672. RECOVERY of TIN from TIN-PLATE SCRAP, &c., H. J. Haddan.—(*A. Lambotte, Bruxelles.*)
14,673. COVERING ELECTRICAL CONDUCTORS with PLASTIC MATERIALS, G. C. Taylor and E. T. Truman, London.
14,674. VELOCIPEDE, G. Coles, London.
14,675. LOWERING GOODS on WHARVES, &c., E. A. Olley, London.
14,676. DRAWING-OFF CHAMPAGNE, &c., J. and W. W. Brierley, London.
14,677. MARINE SIGNAL LIGHTS for VESSELS, G. T. Parry, Philadelphia, U.S.
14,678. FILTERING PARAFFINE OILS, B. H. Remmers and J. Williamson, London.
14,679. WATERPROOF COATS for DRIVING, &c., J. Bales, London.
14,680. STOPPERS for BOTTLES, A. W. Birt, London.
14,681. SOAP, C. R. A. Wright, London.
14,682. RAILWAY BRAKES, &c., E. J. C. Welch and W. P. Smith, London.
14,683. ADVERTISING, W. A. Roberts, London.
14,684. PRODUCING MOTIVE POWER by STEAM, M. P. W. Boulton, London.
14,685. ILLUMINATING LIGHTHOUSES by GAS, &c., J. R. Wigham, London.
14,686. ILLUMINATING LIGHTHOUSES by OIL, &c., J. R. Wigham, London.
14,687. SUPPLYING FRESH AIR to DWELLING-HOUSES, W. R. Lake.—(*L. Delore, Lyon.*)
14,688. UTILISING CARBURETTED AIR as a MOTOR, W. R. Lake.—(*C. C. Lallement, Paris.*)
14,689. SCREW PROPELLERS, B. Dickinson, London.
14,690. EQUALISING the TEMPERATURE in CAST STEEL INGOTS, F. J. Brougham.—(*A. Sailler, Witkowitz.*)

7th November, 1884.

14,691. COOP for REARING CHICKENS, H. Walker, Brockley.
14,692. COUPLINGS for RAILWAY CARRIAGES, &c., W. H. Adcock, Fazeley.
14,693. AUTOMATIC REGISTRATION of NUMERALS by ELECTRICITY, C. Ford, Halfax.
14,694. PREPARING FININGS for BEER, &c., T. Horsburgh, Birmingham.
14,695. SELF-ACTING MULES, J. Macqueen, Manchester.
14,696. BRASS FENDERS, E. Horton, Birmingham.
14,697. VENTILATORS and CHIMNEY COWLS, G. J. and S. T. Messenger, London.
14,698. REINS for HORSES, J. Westaway, Barnstaple.
14,699. OPTICAL INSTRUMENTS, T. Bayley, Birmingham.
14,700. DISTILLING FATTY SUBSTANCES, W. P. Thompson.—(*M. Julien and M. Blumski, Odessa.*)
14,701. WRINGING MACHINES, W. H. Blackwell and W. Chantler, Hooley.
14,702. CURTAIN POLES, E. Davidson, Sheffield.
14,703. SCREENING ASHES, &c., W. J. Green, Sudbury.
14,704. WIREWORK of SCREEN made in ONE PIECE, W. J. Green, Sudbury.
14,705. HAND LANTERNS, W. Sandbrook, London.
14,706. SUSPENDING CARDS in WINDOWS, &c., M. Turnor, London.
14,707. FASTENINGS for DRIVING BELTS, J. Maddock, London.
14,708. SPINDLE or FEATHER VALVE, J. J. and T. I. Day, London.
14,709. FIRE EXTINGUISHING APPLIANCES, J. C. Merryweather and C. J. W. Jakeman, Greenwich.
14,710. TRAMWAY LOCOMOTIVES, J. C. Merryweather and C. J. W. Jakeman, Greenwich.
14,711. GRINDING and SHAPING BRICKS, A. Mackie, London.
14,712. FIRE and EARTHQUAKE-PROOF HOUSES, J. N. Moerath, London.
14,713. MAKING BREAD, P. Pfleiderer.—(*Messrs. Werner and Pfleiderer, Cannstatt.*)
14,714. STEAM, AIR, or GAS ENGINES, S. Robinson, London.
14,715. CLEANING, &c., WINDOW SASHES, W. W. Nicholls, London.
14,716. CUTTING and BUNDLING FIREWOOD, F. Kingston, London.
14,717. ORNAMENTAL SURFACES of COMBINED METAL and GLASS, A. Swan, London.
14,718. RECORDING CASH RECEIVED, S. Firth, London.
14,719. FILLING and WEIGHING SACKS, E. P. Alexander.—(*Cailleaux Brothers, Gironville.*)
1',720. KETTLE, D. H. S. Brown, London.
14,721. CEMENT, H. E. Devaux.—(*I. Farinaux, Lille.*)
14,722. PUNCHING MACHINES, P. Jensen.—(*K. Hesteskofabrik, Copenhagen.*)
14,723. ELECTRIC GENERATORS, C. Parsons, London.
14.724. CASES for HOLDING BISCUITS, &c., A. Watson, London.
14,725. RENDERING TEXTILE MATERIALS WATERPROOF, A. J. Boult.—(*O. B. E. Hiller, Berlin.*)
14,726. VESSELS for PRESERVING LIQUIDS, W. R. Lake.—(*A. J. Gay, near Coulaure.*)
14 727. CLEANING and SCOURING GRAIN, T. Inglis, London.
14,728. PORTABLE BATH, J. Webber, Greenwich.

8th November, 1884.

14,729. INJECTORS, S. Borland, Manchester.
14,730. FABRIC for CATAPLASMS, &c., C. Leslie, Manchester.
14,731. STRETCHING CLOTH, &c., H. S. H. Shaw, Clifton, and W. E. Kerslake, Bristol.
14,732. WATCHES, G. F. Jacot, Neuchatel.
14,733. HOBBY HORSES, J. Mosedale, Burnley.
14,734. SODIUM and POTASSIUM, J. Anderson, Broughty Ferry.
14,735. TREATING VEGETABLE SUBSTANCES, &c., T. G. Young and J. Pettigrew, Glasgow.
44,736. STEEL, &c., J. Riley and W. Crossley, Glasgow.
14,737. EXPLOSIVE CHARGES, E. J. Mills, Glasgow.
14,738. TIEING-IN WARPS, J. P. Binns, Halifax.
14,739. LOOMS for WEAVING VELVETS, &c., J. Cryer, Manchester.
14,740. METAL DOOR MAT, T. B. Burns, Camelford.
14,741. DOBBY for WEAVING FANCY GOODS, P. H. Hartley, Keighley.
14,742. SELF-CLEANSING CISTERNS, J. Cornelius, London.
14,743. ROLLING, &c., BARS of METAL, T. L. Ellis and J. Cherrie, Glasgow.
14,744. COCK SAWS, A. Breuker, Barmen.
14,745. ELASTIC GIRTH, T. Humbel, Barmen.
14,746. SEWING MACHINES, J. W. Ramsden and H. S. Ellis, London.
14,747. TRANSFERRING INGOTS, &c., E. W. Richards, London.
14,748. CRAMPING or COMPRESSING, M. Amos, London.
14,749. CREATING ARTIFICIAL DRAUGHT in STEAM GENERATORS, N. Evans, London.
14,750. TIRES and WHEELS of CARRIAGES, &c., J. Pearson, London.
14,751. ADVERTISING, A. H. Martin, London.
14,752. VENTILATING SEWERS, W. Paulson, Loughborough.
14,753. FIRE-EXTINGUISHING COMPOUND, C. H. Royce, London
14,754. VESSELS LINED with LEAD, &c., C. J. Galloway and J. H. Beckwith, London.
14,755. DRIVING GEAR for SEWING MACHINES, J. P. M. Millard.—(*E. Petzoldt and O. G. Deil, Dresden.*)
14,756. MANIFOLD COPYING APPARATUS, J. P. M. Millard.—(*O. Steuer, Dresden.*)
14,757. SELF-SUPPLYING WATER BRUSHES and BROOMS, G. F. Sheath, London.
14,758. CANDLE-SHADE HOLDERS, G. T. C. Beaumont and N. Maurice, London.
14,759. EMBROIDERY for GLOVE-MAKING, W. E. Gedge.—(*L. Rondet and Co., Grenoble.*)
14,760. SPRING MOTORS, H. J. Allison.—(*The Motor Sewing Machine Company, U.S.*)
14,761. FITTING of HAMMOCKS and COTS, G. Turner, London.
14,762. CARRIAGES, &c., G. Turner, London.
14,763. COATS, &c., G. Turner, London.
14,764. SHEET METAL CANS, E. Edwards.—(*E. Norton, U.S.*)
14,765. GAS ENGINES, J. McGillivray, London.
14,766. BOAT DISENGAGING GEAR, D. Gray, London.
14,767. DRIVING MECHANISM for VEHICLES, &c., H. J. Haddan.—(*D. Barnier, Libourne.*)
14,768. TYPE WRITERS, A. J. Boult.—(*C. Spiro, U.S.*)
14,769. TAPS for MEASURING LIQUIDS, &c., J. Dalgairns, London.
14,770. FILTERING, &c., MEDIUM, G. H. Ellis, London.
14,771. BALL VALVES, W. C. Brett, London.
14,772. AUTOMATICALLY OPENING and CLOSING the DOORS of HOIST WELLS, T. Dryden, London.
14,773. ROLLERS for COMPRESSING SHAPED METALLIC PIECES, J. Lardon, London.
14,774. GAS FROM HYDRO-CARBURETS, A. H. Reed.—(*A. Michaux, Paris.*)
14,775. LAYING WOOD PAVEMENT, J. Halley, London.
14,776. COATING METALLIC SURFACES, &c., A. Parkes, London.
14,777. COMBINED BOTTLE STOPPER and INK-SPREADER of ENDORSING STAMPS, E. M. Richford, London.
14,778. DOOR KNOBS, H. C. Webb, London.
14,779. DYNAMO-ELECTRIC MACHINES, W. R. Lake.—(*L. Bollmann, Vienna.*)

10th November, 1884.

14,780. ARMOUR BELT for SHIPS of WAR, E. Kent, London.
14,781. CARTRIDGES, T. P. Wood, London.—*12th March*, 1884.
14,782. REVERSIBLE SWING COT, J. Green, London.
14,783. VALVE MOTIONS for ENGINES, R. Wyllie, London.
14,784. METRICAL STRIKING of CLOCKS, H. H. A. Smith, Market Rasen.
14,785. KILNS for CALCINING FLINTS, &c., H. H. Redfern, Hanley.
14,786. LOCOMOTIVE STEAM ENGINES, E. Hunt.—(*W. J. Hammond, Brazil.*)
14,787. ROLLER BLINDS for WINDOWS, W. Lindsay, Glasgow.
14,788. MECHANICAL TABLE for FORMING OVAL, &c., FIGURES, J. P. T. Slade, Manchester.
14,789. FASTENING TIPS to BOOT HEELS, J., P., and A. Cave, Higham Ferrers.
14,790. CONVEYING AIR, &c., BELOW the SURFACE of MOLTEN METAL, J. R. Turnock, Loughor.
14,791 SHARPENING SLATE PENCILS, C. and W. T. Smith, Birmingham.
14,792. HEATING DYE POTS, D. Dawson and H. Broadbent, Halifax.
14,793. STRAINERS for PAINT, MILK, &c., T. Batty, Drighlington.
14,794. TELESCOPE FORM of RAILWAY UNDER-CARRIAGE, W. Corteen, London.
14,795. PERAMBULATING ADVERTISER, W. Corteen, London.
14,796. COCKS, R. Daelen, London.
14,797. CYCLE CLAMP, C. Spratt and A. C. Churchman, London.
14,798. ROTARY CHEQUE, &c., PRINTER, &c., F. Sandillon, London.
14,799. HAND-PRESSURE ROTATING APPARATUS, A. Schmid, London.
14,800. FURNACES, J. E. Bott, London.
14,801. MOULDING, J. E. Bott, London.
14,802. TABLETS for ALIMENTARY, &c., PURPOSES, J. Hooker, London.
14,803. SEALING TINS, J. Hooker, London.
14.804 HANDLES for TABLE CUTLERY, &c., C. Ibbotson, Sheffield.
14,805. EMBOSSED WOOD-GRAINED PAPER, A. and C. de Bourbon, London.
14,806. STEAM DRYING MACHINE, A. and C. de Bourbon, London.
14,807. REED-MAKING MACHINES, C. A. and H. Kitson, London.
14,808. ORNAMENTAL SCREEN, &c., G. Tuck, London.
14,809. PETROLEUM, &c., LAMPS, P. Jensen.—(*F. S. Svenson, Sweden.*)
14,810. INCREASING the BRILLIANCY of COAL GAS, J. H. Weston, London.
14,811. BICYCLES, J. K. Starley, London.
14,812. PRESSURE REGULATORS, R. R. Beard and W. H. Oakley, London.
14,813. RAILWAY COUPLING, A. M. Clark.—(*C. L. and C. E. Green, U.S.*)
14,814. BILLIARD MARKERS, A. M. Clark.—(*T. C. Jenkins, New Zealand.*)
14,815. PILE SHOES, A. Harris and J. Copley, London.
14,816. OPENING, &c., of SLIDING SASHES, &c., F. R. Strickland, London.
14,817. STEAM ENGINES, J. Kirkaldy, London.
14,818. CURRENT REVERSER, H. C. Harold, Lewisham.
14,819. CRANK SHAFTS, J. Patterson, jun., London.
14,820. SAFETY GEAR for STARTING WHEELS of ENGINES, C. Clayton and J. Bryan, London.
14,821. RUBBER HOSE, J. Y. Johnson.—(*J. H. Cheever, U.S.*)
14,822. PURIFICATION of WATER, J. Y. Johnson.—(*A. R. Leeds, U.S.*)
14,823. DRIVING BELTS, J. McDougall, London.

SELECTED AMERICAN PATENTS.

From the United States' Patent Office Official Gazette.

305,520. SHAPING AND PLANING MACHINE, *George Juengst, New York, N.Y.—Filed October 9th*, 1883.

Claim.—(1) In shaping and planing machines, the combination, with the reciprocating tool slide F, the shaft L, provided with disc N, the crank H, the connecting rod I, the stud J, of the crank pins O and *a*, the link *b*, the shaft X, provided with gear Z, arranged excentrically and adapted to operate with the shaft L to secure the to-and-fro motion of the cutting tool, as herein set forth. (2) The arrangement and com-

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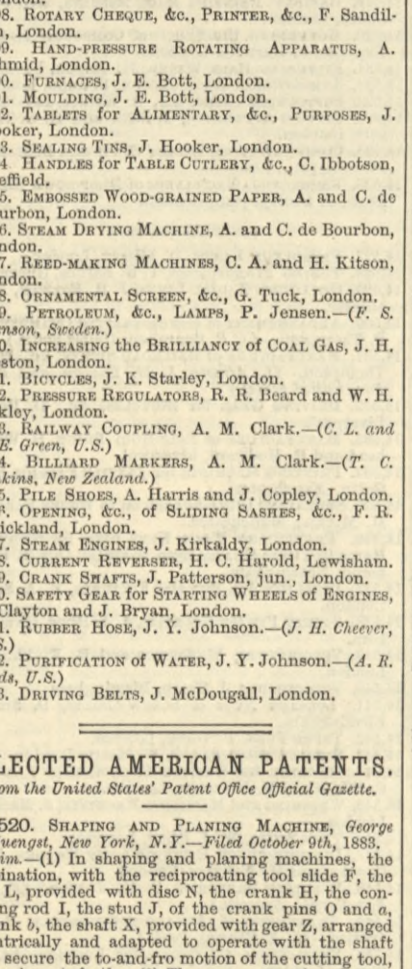

bination of the tool slide F, the shaft L, provided with disc N, the crank H, connecting rod I, the stud J, the feed-screw *n*, the bevel gear R, the shaft Q, and pinion P, the ratchet wheel *p*, the pawl *t*, lever *s*, and nut *l*, with the crank pins O and *a*, the link *b*, the shaft X, provided with gear Z, relative with the shaft L, sub-

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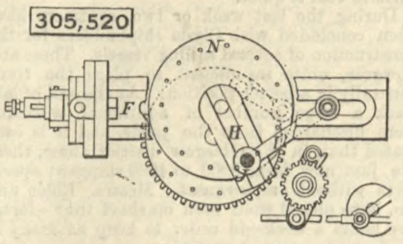

stantially as and for the purpose herein described and shown.

305,537. FOLDING SKELETON GUN STOCK, *Frederick Schwatka, Vancouver Barracks, Wash. — Filed February 21st*, 1884.

Claim.—(1) A folding skeleton gun stock or gun stock extension pivotted to swing upon a smaller stock or body part of the gun, and arranged to fold beneath the same, substantially as specified. (2) The articulated folding skeleton gun stock in pivotted and jointed and sliding connection with a smaller stock or body part of the gun, and arranged for operation in relation therewith essentially as described. (3) In a folding skeleton gun stock, the combination of the waved or irregular-shaped bars B C, the jointed butt

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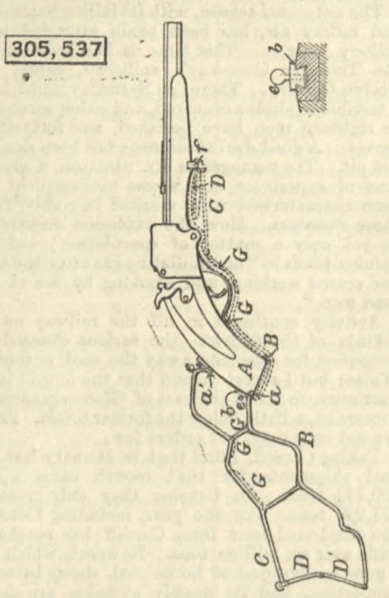

plates D D^1, the fixed pivot *a*, the slide *b*, with its pivot a^1, and the fastenings *e f*, all arranged for operation in relation with each other and the smaller stock or body part of the gun, substantially as and for the purposes specified. (4) In an articulated folding skeleton gun stock, arranged for operation as described, the combination, with the bars B C, of one or more pivotted struts or braces G, essentially as and for the purpose herein set forth.

305,545. DRIP CUP AND BINDER FOR PAINT BRUSHES, *John T. Sutton, Urbana, Ill.—Filed February 12th*, 1884.

Claim.—The combination, with a paint brush and an elastic binder D, fitting close around the base of the handle and the head of the brush, of the drip cup

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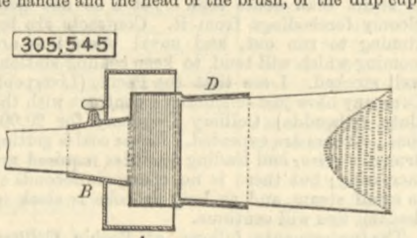

A and rigidly-attached sleeve B, said sleeve resting on that part of the binder around the base of the handle to form a packing to prevent the paint from getting between the sleeve and handle, substantially as set forth.

305,633. HAND HOLE SEAT FOR BOILERS, *Nathaniel W. Pratt, Brooklyn, N.Y., and Campbell P. Higgins, Philadelphia, Pa.—Filed April 22nd*, 1884.

Claim.—(1) A raised hand hole seat consisting of a ring of metal secured in position by means of an expanded nipple. (2) A ring forming a raised hand

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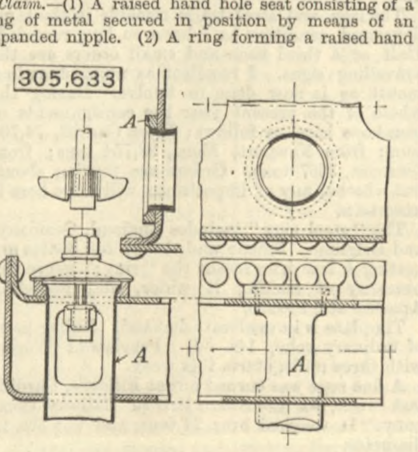

hole seat on one side of a sheet of metal and a stiffening ring on the opposite side, in combination with a nipple expanded into the inside and outside rings and the intermediate plate.

305,655. PULLEY-BOX, *James M. Aubery, Chicago, Ill.—Filed July 19th*, 1884.

Claim.—(1) A pulley-box A made of cast iron or metal or equivalent material, constructed with a rim or bearing D to fasten the box to the frame which

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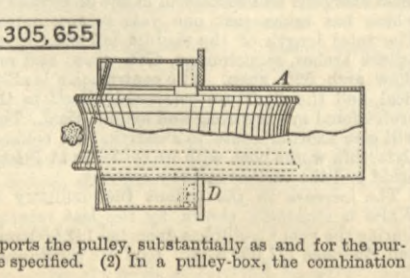

supports the pulley, substantially as and for the purpose specified. (2) In a pulley-box, the combination and construction of the cover F, with aperture G, and the oil-box E, all substantially as set forth.

305,667. CHAIN PUMP BUCKET, *Christie Chase, Johnstown, Ohio.—Filed November 28th*, 18

Claim.—In a chain pump bucket, the combination with the flat disc *h*, of flexible material, having the perforation *l* near its margin, of the threaded and shouldered pin *a*, and the under concave metallic cup

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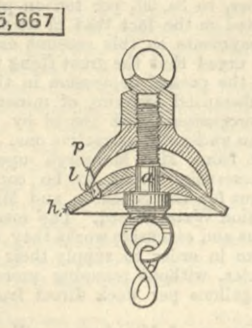
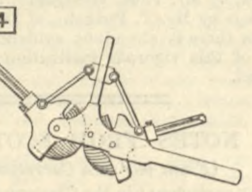


having a perforation *p*, near its lower edge, to coincide with the perforation of the disc *h*, and a central threaded aperture to engage the threads of the pin, whereby the disc may be adjusted to the walls of pump tubes, substantially as specified.

305,714. GEARING DEVICE, *Hermann Schulze-Berge, Rochester, Pa.—Filed January 11th*, 1884.

Claim.—(1) Globular gear wheels having cog teeth extending from one pole to the other, the pitch-line

305,714



of the teeth of which is in the surface of a sphere of the diameter of the polar axis of the globe, in combination with a shaft extending through or in line of its polar axis.

CONTENTS.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—William Siddorn, chief engineer, to the Rifleman; James J. Walker, engineer, to the Cherub; and William Hudson, engineer, to the Palmira.

THE export of fine tin from New South Wales in 1883 exceeded that of any previous year since the tin-fields opened; but the export of tin ore is less than that of any previous year, which is an important fact, as evidencing the progress made in smelting tinore. Taking ingots and ore together, the export as regards quantity exceeds that of any previous year.