THE MANAGEMENT OF THE ROYAL DOCKYARDS.

IT has long been the opinion of most people acquainted with the systems of management which prevail in well-conducted private shipbuilding establishments that there is something wrong in the internal economy of our Royal dockyards. This view has arisen chiefly from a study of the results obtained at those establishments when compared with the cost of their attainment, and it has been strengthened by the occasional glimpses of information which are afforded the public through the medium of parliamentary debates upon the Navy Estimates. Such opinions have received ample confirmation from the pages of the Blue Book just issued containing the "Reports of Committees Appointed to Inquire into Admiralty and Dockyard Administration and Expenditure." Those who held the dockyard system of management in the least esteem, could little have expected such confessions of failure as those which have recently been made by the officials at the dockyards who have had the administration of that system. It is to the honour of these men that they have been able to keep their intellects so free from the blighting influences of officialism during their many years of bondage thereto as to be now in a position to point out to the Committees the defects and anomalies which should be removed. For this circumstance both they and the country are doubtless indebted to the fact that ships for the Royal Navy are sometimes built in private shipyards by contract, and that dockyard officers inspect the work on such occasions. The officials of Portsmouth and Chatham dockyards, who gave the most valuable and intelligent evidence at this inquiry, were happily in a position to compare the thraldom of a dockyard constructor with the freedom of a private shipyard manager, and correctly to value the financial consequences to the country arising out of the differences in the two cases. It is now clearly seen that the national manufacturing establishments which exist for the purpose of properly maintaining our naval and military defences cannot fulfil their functions economically or efficiently if managed as hitherto, and that unless the Government is prepared to adopt the methods which everywhere prevail in private firms, they had better close the dockyards altogether, and trust to private enterprise and competition for our armaments.

Very wisely, the Admiralty have determined upon taking the former course, and it remains to be seen how far they will adapt their newly-organised scheme of management to the attainment of that end. It is very clear that the changes must be of a radical character in order to be effectual; but it is not, however, so clear that they will be carried out. The first step which has been taken is undoubtedly a favourable omen in regard to the remainder, for almost all the rest are dependent upon it. A responsible manager of the Royal dockyards has been appointed, and the gentleman selected for the post will approach the task assigned him with a mind altogether free from the bias of officialism-routine and red tape. Professor Elgar, LL.D., of Glasgow University, is now Director of Dockyards, and responsible to the Controller of the Navy for all connected with the building and repairing of ships. With Professor Elgar's experience as a private shipyard manager, and his general acquaintance with men and business, we may rest assured that, so far as he is concerned, dockyard management will become a common-sense affair. All that is now needed is that the Director of Dockyards shall have full and unrestricted powers, so as to enable him to bring the business of shipbuilding for the Navy under the operation of ordinary commercial principles.

Centralisation has been the weakest point in past dockyard control. All the strings for moving five dockyards have been pulled at the Admiralty Office, and if the strings held thereat have not been pulled there has been no other source of motion. The evidence of Mr. R. Barnaby, Senior Constructor at Portsmouth, and of Mr. E. C. Warren, the Chief Constructor at Chatham yard, shows that orders for iron and steel plates and angle bars, which may be immediately required for building a ship, have to go through the Admiral Superintendent of the yard, the storekeeper, the Controller of the Navy, the constructive and contract departments. In consequence of all this elaborate procedure and the friction experienced in passing through each department, it happens that months elapse before the material is forthcoming. Such folly as this would soon ruin a private establishment, and had it continued much longer it might and doubtless would have resulted in the ruin of our naval defences. This and other causes of an equally absurd character kept large ironclads in hand seven years before they were completed, while private shipbuilders could insure delivery in less than three years. Why should not the head of a dockyard communicate direct with an iron or steel manufacturer who had already contracted with the Admiralty for the supply of materials at certain fixed rates? This is the suggestion made by an experienced dockyard officer to the committee of inquiry, and one would suppose that no argument could stand in the way of its adoption. The difficulty of getting materials is not confined to such articles as plates and angle bars—which are never kept in stock to a very considerable extent by any shipbuilders—but it extends to nails, screws, and even candles. So careful have naval administrators been in their efforts to secure economy and prevent fraud or waste at the dockyards, that every possible barrier now exists between the stores and those who want to use them. Men are often kept idle while materials are being found for them to work upon, and an army of clerks, writers, storekeepers, "runners," and labourers is employed to perfect the muddle by getting in each other's way and discovering reasons in numberless forms and regulations for not issuing the materials at all. Mr. Warren states that he has often been glad to send out into the town and purchase a few things which could not be got in any other way.

The difficulty of getting stores when they are wanted is, however, not so serious a source of delay at the dockyards in building ships for the Navy as the frequent alterations which are made in the ordnance and other fittings. A private shipbuilder, fulfilling a Government contract, would not consent to these alterations and delays without extra payment, and this fact is found to operate very advantageously in hastening the completion of contract-built ships. But if the Admiralty can restrain the desire of their professional advisers for changes when a vessel is building by contract, surely the same thing can be done when she is turned out at a Royal dockyard. This source of injury to the naval service will now disappear, for the Director of Dockyards occupies the same position, relatively, to the constructive department as does the manager of a private shipyard. The constructors will design a ship, and be permitted to watch her construction in order to satisfy themselves that their intentions are being carried out; but beyond this they will have no control or powers of interference. The Director of Dockyards will receive drawings and take all necessary steps for the speedy and economical completion of the vessel, but he cannot be responsible for the due attainment of these results so long as frequent changes of design are permitted to go on.

It was not generally supposed that idleness was so common among dockyard workmen as the evidence contained in this Blue Book discloses. Indeed, it is rather curious that the heads of the departments in which the idleness occurs should be the source from which the information now comes. Why, it may reasonably be asked, have these officials permitted that which they condemn so strongly in their evidence? The reply to this question comes from the gentlemen themselves, and it reveals a state of affairs which demands far more caustic treatment than that proposed in the Committee's reports. It seems that the constructors at the dockyards have never been permitted to exercise sufficient control over the workmen to make the latter stand in fear of the consequences which should result from their delinquencies. If the manager of a private building yard finds that any of his *employés* are habitually idle or wasteful of stores, he soon settles the matter by summary punishment, either in discharging or fining them. The proprietors or directors may properly leave him full discretionary powers for dealing with such cases, and if they did not, the work of the establishment could not go on with satisfactory results. But at the Royal dockyards no such powers are granted to the chief professional officer. He must bring such matters under the attention of the Admiral-Superintendent, who makes them the subject of inquiry. To show how this system works, it is only necessary to quote the evidence of the Chief Constructor of Chatham Dockyard, who told the Committee that upon one occasion, when some workmen were taken before the superintendent upon the charge of idleness, the latter, addressing the men, said:—"Now, my men, before we begin, I want you distinctly to understand that I stand between you and your officer." As Mr. Warren said, "That alone is sufficient to undermine the responsibility of any officer." Upon another occasion, the same gentleman, in reporting a workman, recommended that his services might be dispensed with; but instead of this suggestion being adopted, the man was told "not to do it again," while the Chief Constructor was reminded that he had "no business to submit what punishment should be awarded." With such mismanagement as that it would be surprising indeed if dockyard officers entered upon their daily duties with zeal and energy, or workmen upon theirs with a wholesome motive for satisfying the reasonable requirements of those who know best what a good day's work is. The Committee of Admiral Graham reports favourably upon the Naval Superintendent system of dockyard management, and no doubt much may be said in its favour upon some grounds. But if these superintendents are retained, it must not be at the cost of effective control on the part of the professional officers. The power of reward and punishment, within certain limits, must be conferred upon the Chief Constructor, if his presence is to be properly realised and felt by his subordinates; and it is satisfactory, therefore, to find that the recommendations of the Committee lean in that direction.

There seems to be a costly amount of friction existing between the heads of the shipbuilding and engineering departments at the dockyards, and this appears to be due to the absence of any well-defined limits of their several functions and responsibilities. In a mercantile establishment working for profit this would not be permitted to exist, nor are such difficulties experienced where a contractor supplies the machinery for a new ship at a dockyard. But at Chatham, it seems, the steam factory contains machinery not in use which might be advantageously employed in the preparation of material for the shipwrights; and yet, because of a want of harmony between the two departments, these machines are allowed to remain idle, and the progress of the ships is hindered. Dockyard officials, whether shipwrights or engineers, should surely bear in mind that they are the servants of the nation, and that the machinery under their charge is the property of the State. At one time the engineering department was put under the charge of the Chief Constructor, but as the system did not work well it was abolished. Now it is clear that somebody must be master or manager, and if the Superintendent exercised his functions properly there would be no difficulty in the matter. It does not seem clear how this evil is to be rectified, but Professor Elgar will doubtless find a way of reconciling the rival parties, and securing from both a businesslike procedure.

While there is every reason for being satisfied with the general outcome of this last shaking-up of the Admiralty office and the dockyards, it is only right to extend to Mr. F. K. Barnes, the late Surveyor of Dockyards, the fullest sympathy in being the victim of circumstances which were beyond his control. It was the system that was at fault, and not the Surveyor of Dockyards, who, while holding the title, was prevented by pressure of other duties from giving adequate attention to the dockyards. For many years he was practically director of naval construction, or at all events fully employed upon the duties of the constructive department. His mistake consisted in consenting to retain the title when prevented by their lordships' arrangements from fulfilling the duties of his office. He tried to do too much, and he now has his reward. His defence, which is published in the Blue Book, is a manly one. It is to be regretted that the Committee should have questioned his fitness for the office he held, upon the grounds of practical inexperience, for all who knew him and the Council of Construction, of which he was a member, are well aware that he is pre-eminently a practical man, and perhaps the most practically qualified among them. Mr. Barnes has rendered excellent service to the nation in his day, both as a scientific naval architect and as a dockyard administrator, and the best wishes and sympathies of all who know him will follow him upon his retirement.

It is to be hoped that under the present Director of Dockyards the work of building ships in our national establishments will be conducted economically and rapidly. Indeed, there can be no doubt that this will be the case. But Professor Elgar must be granted free scope for the exercise of his judgment and professional abilities, and no traditions of officialism and red tape must be allowed to intervene between the manager of the dockyards and the departments which come under his management.

AN AQUATIC CIRCUS.

A CONSIDERABLE sensation has been created in Paris by the opening, on the 12th of February last, of an aquatic circus. The spectacular entertainments in which water played an important part date back to the days of the Roman Emperors. The whole arena of the Colosseum at Rome being flooded, mimic sea-fights took place, in galleys carrying gladiators, who fought to the death. In recent times, at Sadler's Wells Theatre, the stage used to be removed, showing a lake supplied from the stream flowing close by, on and in which performances took place. The Paris circus is remarkable for the beauty of the building and the ingenuity of the engineering details. The following description of it we condense from *La Genie Civil*.

In the Rue St. Honoré is a building known as the Salle Valentino. This has been transformed—almost rebuilt, indeed—into a beautiful and luxurious circus, to which has been given the title *Arènes Nautiques*. It is intended to fill two distinct purposes—namely, to be used as a circus for equestrian, gymnastic, and aquatic performances during the winter, while during the summer it becomes a huge and splendid swimming bath. The engravings on page 222 indicate the general arrangements adopted by the architects, MM. Sauffroy and Gridaine. We have omitted the vestibule, foyer, &c. The building was used until recently to exhibit the panorama of Reichshoffen, and the portion of it with which we are concerned is a great circular hall about 110ft. in diameter. In the lower part of this is a circular tank, 79ft. in diameter, with a gallery running round it. Over this gallery and the water are constructed tiers of seats as shown in the section on page 222.

In the centre is placed an hydraulic ram. To the top of this ram is fixed a huge iron saucer, 44ft. in diameter. This saucer can be sunk below the level of the water, the surface of which is then available for aquatic performances. When raised up, and the water run out of it, it supplies a firm floor for horses and men. All this seems very simple, but the details have required much consideration, and have been very ably carried out.

The building accommodates 3000 spectators. There are six tiers of fauteuils which are surmounted by a tier of boxes, above which, again, is a wide promenade gallery, connected with which is a café which serves as a foyer, and several bars. The orchestra is placed in a large balcony over the entrance to the stables, which last have stalls for twenty horses. In carrying out the internal arrangements the contractors had serious difficulties to contend with. The whole of the fittings are removable, in order that the space may be cleared when the building is converted into a bath. The amphitheatre of seats and boxes is carried on girders, supported on twenty iron columns, united by a circular lattice girder surrounding the space reserved for the saucer. This last had to be so constructed as to be quite rigid under the tread of numbers of horses and men, now concentrated in one place now in another. It must be capable of disappearing during a performance, and without delay. It must during the bathing season be maintained at such a height as to provide a shallow bath for those who cannot swim.

To comply with these conditions, the saucer is built up of twenty radial double-flanged girders, rivetted outside to a continuous ring of plate iron. The girders are floored with stout planks to make the bottom of the saucer. The hub or boss from which the girders radiate is secured to the top of the hydraulic ram in the centre, as shown in the enlarged section at the bottom of page 222. The rise of the ram is caused by the action of a four-barrelled pump. The saucer is guided in its ascent and descent by planed slide bars round its outer rim. When it has attained a little more than its proper height it is caused to rotate slightly on its vertical axis by an endless screw; by this means the ends of the radial girders are brought over twenty shoes, fixed to the twenty columns before mentioned as carrying the inner ends of the inclined girders which support the tiers of seats. Then by letting a little of the water escape, the twenty girder ends settle themselves down firmly on the shoes. The inner portion of the saucer is at the same time carried by five stout columns ranged round the ram at a distance of 5ft. from the centre. Four of these are shown at A, page 222. A star-shaped cross-head or framework loosely embraces the ram at its upper part, where it is retained by a collar; and each ray of the star terminates in a collar, in which is loosely held the head of one of the columns. During the ascent of the ram the vertical columns are raised with it, by means of the star-shaped cross-heads; during its descent the columns enter pipes fixed in the ground, from which they are withdrawn as the saucer rises, until, when it is at its greatest elevation, they hang quite clear from the cross-head. A movement of rotation carries the columns over saddle plates fixed in the foundations, close beside the mouths of the pipes just referred to. Then when, as we have said, a little water is allowed to escape, the saucer settles down, its outer edges resting on supports as described above, and the central crosshead on the five columns. To lower it, it is only necessary to raise it a little, turn it round a little on its axis, and suffer it to fall by allowing the water to escape from beneath the ram. The weight of the whole mass moved is about 25 tons. India-rubber buffers and cushions are used to prevent noise and give the whole an even bearing on its supports.

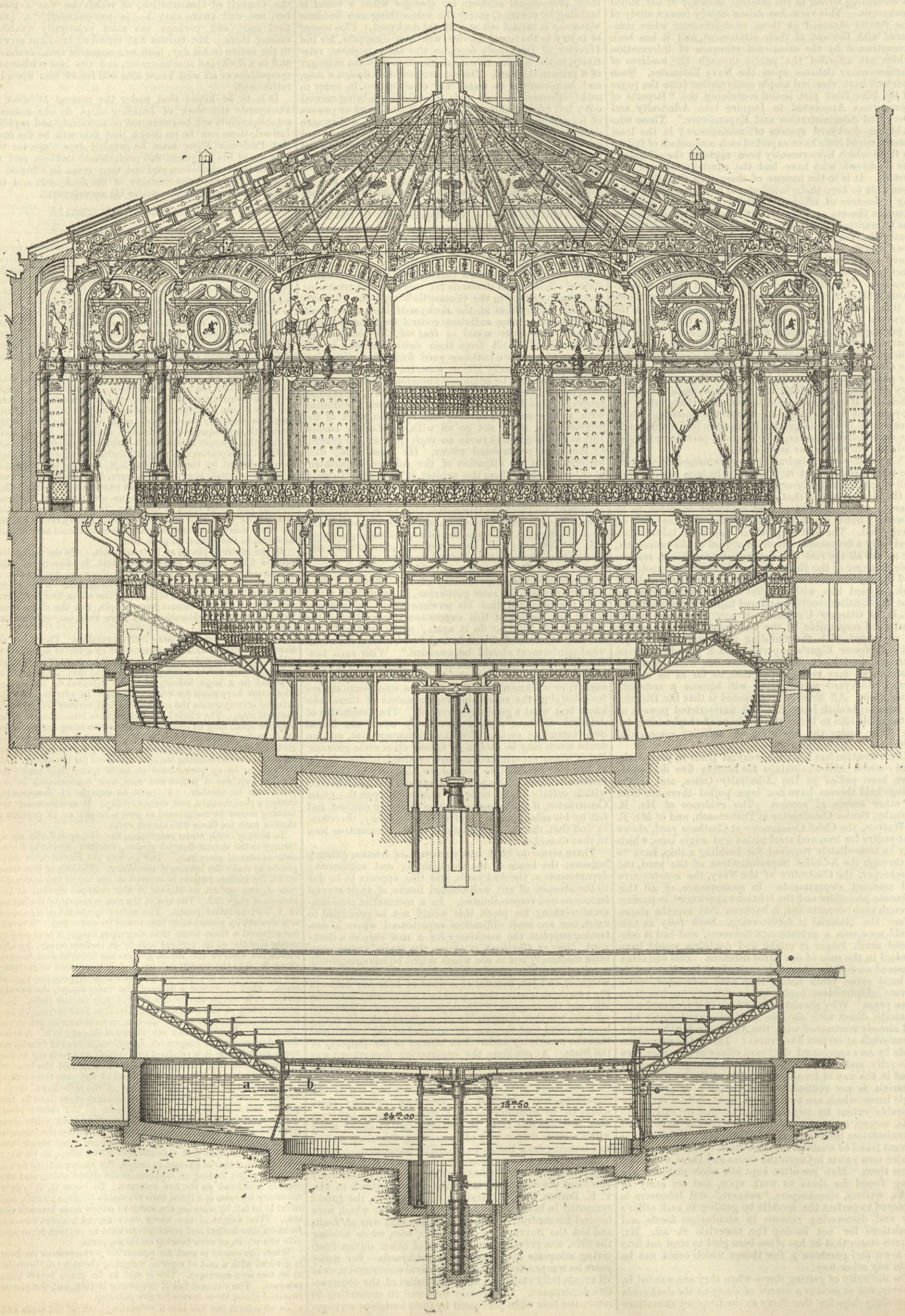
When the saucer is used for equestrian performances its floor is covered with a mat of esparto, weighing about a ton, brought in on two iron carriages. This is said to be much better than sawdust. The rise and fall of the saucer is 10ft., and the power required about three horses for five minutes.

To transform the hall into a swimming bath all the seats and

AQUATIC CIRCUS, RUE ST. HONORÉ, PARIS.

MONS. L. EDOUX, ENGINEER.

(*For description see page* 221.)



boxes are removed, and the saucer is dropped to such a depth below the surface that the water in it is 3ft. deep; all round it outside is the deep water for those who know how to swim.

The ventilation of a building standing over a lake, as this does, the water in which is always kept at a temperature of 77 deg. Fah., presents difficulties. The vapour rising from this, unless immediately drawn off, would render, by condensation, everything in the building damp. To prevent this a powerful fan, fixed in the cellars, draws the air from a turret in the roof, and after forcing it through a heating chamber, delivers it into the hall under the seats at a temperature of about 86 deg. This would appear to be quite warm enough, but when a higher temperature is wanted the lantern on the top of the building is closed, and the air is then caused to circulate twice through the heating chamber.

All the arrangements for renewing the water are very ingenious, and well carried out. An abundance of water is obtained from a well, which supplies about 50 cubic metres, or 1755 cubic feet per hour. There are two distinct deliveries from the bath, one at the surface to draw off scum and froth, and the other at the bottom, which takes off the cooled water which has sunk, leaving the hotter fresh water on the top. The water is heated by the condensers of the electric light engines. M. Solinac is the engineer in charge of this department. Power is supplied by two Corliss 150-horse power engines, driving two alternate-current Maquaire and two Edison dynamos. Steam is supplied by two Collet's water-tube boilers. The lighting is effected by twelve Soleil lamps, six arc lamps, ten Jablochkoff lamps, arranged in a crown in the centre of the hall without globes, and 2000 eight candle Edison lamps, used for decorative purposes.

The whole interior of the building is luxuriously fitted up, and the entertainments provided are of the highest class. On the 12th of February the first part of the programme consisted of that usual in a circus. After the last act the heavy mat was removed, "And then," to quote the words of M. Henri Mamy, "We saw the immense saucer descend slowly, and immerse itself majestically in the waves. When the water began to rush across the flooring in clear view of the audience, the effect was irresistible, and the warmest applause saluted this new attraction, which permitted the audience to realise the progress of modern mechanical science."

LEGAL INTELLIGENCE.

THE JUDICIAL COMMITTEE OF THE PRIVY COUNCIL.

February 2nd, 3rd, and 4th, 1886.

(*Before* Lord Monkswell, Lord Hobhouse, and Sir Richard Couch.)

CHURCH'S PETITION—WILSON'S OBJECTION.

This was a case of considerable interest to engineers, as vigorous efforts have been made for many years to develope the patents for improved slide valves invented by Mr. Walter C. Church, and their leading features are now familiar to the trade. A large number of witnesses was called, some of them well known in the marine engineering world, and the attendance throughout the three days' hearing was large.

In his petition Mr. Church asked for an extension of his two existing patents for a further term of fourteen years, and before going further we may summarise the leading facts set forth in the petition. These are that for many years previous to 1872—when the patents in question were granted—the inventor had devoted his attention to the improvement of slide valves and pistons; that the disadvantage under which the ordinary slide valve labours is very great, as the pressure upon it produces great friction, loss of power, and wearing of the surfaces into hollows and protuberances; that engineers frequently made the slide valves small in order to avoid these disadvantages; but this expedient, by reducing the wearing surfaces and increasing the extent of the passages from the ports to the cylinder, introduced greater evils than those it was intended to avoid. The petition then goes on to say that some foreign patents had been granted, and that the two patents for which extension was asked related mainly to the same subject matter. Further, that although a practical engineer of great experience, the petitioner could not either read or write, and that he had been assisted as regards capital and commercial development of his inventions by various partners, the principal of whom appears to have been Mr. J. B. Lockington, who had advanced large sums of money. Various other particulars relating to the money transactions of the patents are then set forth, including the loss by Mr. Lockington of £3000 and the payment to Mr. Church of £5 per week, and it is stated that in the years 1878, 1879, 1880, and 1881 licenses were respectively granted to Messrs. Fowler and Co., of Leeds, Messrs. Beyer, Peacock, and Co., of Manchester, and Messrs. Marshall and Co., of Lincoln, and that some of these licenses were still in force, although the licensees had discontinued acting upon them. Latterly the commercial development of the inventions appears to have been transferred to a limited cpmpany, who had also sunk a considerable sum over and above the receipts. It was also set forth in the petition that first prizes had been awarded to the invention by the Royal Agricultural Society, and at the Tynemouth Exhibition, and that an engine on the London and South-Western Railway fitted with Church's slide valves had run 120,000 miles with them, and that the use of these valves in H.M.S. Camel since 1877 had induced the Admiralty to give orders to fit them in other vessels of the Navy; and, further, that Messrs. Caird and Co. had fitted them in the P. and O. steamers Bengal and Coromandel in engines on the triple expansion principle. It was therefore urged in the petition that the proper development of the invention was only now being commenced, especially as high pressures and triple expansion were being introduced, and that there was every prospect of reaping sufficient remuneration if the patents were extended. Appended to the petition was a voluminous statement of account, the summary of which showed that in the fourteen years of the patents' currency £12,278 had been expended, and £8334 received and receivable. The expenditure included £3558 paid to the inventor by way of salary or allowance for his time.

The application was opposed by Messrs. Alexander Wilson and Co., of the Vauxhall Ironworks, Lambeth, the makers of Payton and Wilson's patent slide valve, and after taking the usual formal objections, the opposers stated in the pleading that they relied upon the patent specification of Mr. F. W. Webb of Crewe, dated 1869, as an anticipation of all that was useful in Church's patent.

The counsel engaged in the case were:—For the petitioner, Mr. Aston, Q.C., and Mr. Lawson; for Messrs. Wilson and Co., Mr. Moulton, Q.C., Mr. McCall, and Mr. Edward Dove; and for the Crown, the Attorney-General—Sir R. E. Webster, Q.C.—and Mr. R. S. Wright.

Mr. Aston opened the case at great length, and with much clearness emphasised the grounds of the petition as above quoted. From his speech and the patent specification itself, we have prepared the following description of the essential points of the invention, as shown in the No. 563 patent of 1872:—The patent 2469 of 1872 appeared to be of much less practical importance, and little attention was paid to it during the trial. Mr. Church's invention may be divided into three sections:—(1) A circular slide valve with specially formed ports and relieved from back pressure by an arrangement described later on, and deriving its rectilinear motion from a bridle attached to the end of the slide valve spindle, the slide valve itself being free to revolve in the bridle of the valve spindle; (2) a new method of constructing piston packing rings; and (3) an application to rectangular slide valves of the arrangement for relieving the back pressure.

In order to show the dissimilarity of Church's arrangement from that of Webb, and the merit of Church's invention, the following evidence was called:—

Mr. Imray explained the action of the slide valve, and the ingenuity of the arrangement at the back of the valve for relieving the pressure. He showed that the circular shape of the slide valve and its freedom to revolve while at work caused the rubbing surfaces to continually change their relation to each other, and so prevented the grooving or scoring common in valve and cylinder faces, and that this action was, as he illustrated, exactly the action used in polishing glass. He further considered the invention a very useful one, as the pressure on the backs of slide valves with very high-pressure steam amounted in some cases to several tons, and great difficulty had been experienced in obtaining a satisfactory arrangement for relieving this pressure. He also pointed out that circular-shaped steam ports reduced the length of the passages between the valve face and the cylinder, and consequently saved steam. In cross-examination by Mr. Moulton, Mr. Imray admitted that there was no novelty in the general mode of equilibrating slide valves by a telescopic arrangement at the back; that there was no novelty in slide valves of circular shape, nor in circular ports. He stated, however, that the novelty was in the packing ring as applied in combination with the junk ring, and in the L-shaped cap riding over all on springs, and having the power of slight oscillation so as to accommodate itself to the surface of the steam-chest cover. Mr. Imray admitted that Church's provisional specification contained no reference to any special form of curvature of the steam ports, and that there was no difference in the lengths of the steam passages under the patents of Webb and Church. In cross-examination by Sir R. Webster, Mr. Imray added that Church shows a new way of shaping the steam ports, that Webb's specification would not have shown an ordinary workman how to make the curved port, but he would not go so far as to say that Webb's arrangement would not work.

Mr. Rennie stated that his firm had fitted Church's slide valve to one of her Majesty's ships, and experience had proved them to answer their purpose extremely well. The L-shaped cap was in his practice assisted by placing under it a few turns of Tuck's packing. In cross-examination, Mr. Rennie admitted that the springs which held the L-shaped cap up to its work against the steam chest cover were not S-shaped, but were U-shaped, after the manner of a carriage spring, and that these latter were what he understood to be Church's valves. He further stated that the details of the patent drawings differed somewhat from the valves he had fitted, but he emphasised the value of Church's invention as giving a satisfactory back balance.

Mr. Manuel, of the Peninsular and Oriental Steam Navigation Company, stated that Church's valves had worked very well in the two ships of his company, and that he knew no other way than Church's of making a flat slide-valve workable under the high pressures common in triple expansion engines. He laid great stress upon the automatic action of Church's arrangement in accommodating itself to the steam chest cover; because the former practice of setting a ring down on the back of a slide-valve, by means of set pins through the steam chest cover, was liable to the danger of some set pins being more tightened than others, and the uniformity of the action of the balancing ring was thereby destroyed.

Mr. Archibald Thompson and Mr. Neville Evans confirmed Mr. Manuel's conclusions from experience in the Athenian, of the Union Line, and in one of the ships of the Leyland Line. In both these ships the valves were, they said, working splendidly, as also in H.M.S. Camel. In cross-examination these witnesses admitted that there were U-shaped springs and not S-shaped springs in the valves they referred to, and that the arrangement in these valves was almost, if not quite, the same as shown by the drawings of Church's 1867 patent.

The chief and second engineers of the Athenian spoke of the good working of the valves in that ship.

Mr. Church stated that he had been engaged a great many years in perfecting his system of balancing valves. He had tried his earlier patents on the Midland Railway and on the Great Northern Railway, but he had never been able to produce anything that would work satisfactorily until he devised the arrangement shown in his patent of 1872, for the extension of which he was now petitioning. He stated that he had never seen Webb's specification until after his own provisional specification in question had been filed, and in his opinion Webb's slide valve would not work, because it would clog with grease; steam would leak past it, and Webb's patent drawing showed a wrong setting of the valve. Beyer, Peacock, and Co. had paid him a royalty on engines constructed by them under Webb's specification, and the Great Eastern Railway had also paid him a royalty under threat of legal proceedings, but they have not used any of his valves since. Mr. Wilson, who was opposing this petition, had applied to him about his slide valves, and he had designed a valve in Mr. Wilson's drawing-office.

In cross-examination by Mr. Moulton, Mr. Church stated that the important features of his patent were the mode of forming the edges of the port faces, the L-shaped packing ring, and the combination generally. He admitted that Payton and Wilson, the opposers, do not use an L-shaped packing ring nor an S spring. Messrs. Jack and Co., of Liverpool, were fitting an engine with his valve.

In cross-examination by the Attorney-General, Mr. Church stated that the reason that Messrs. Fowler and Co. and others had discontinued to use his valves was that they lasted too long. The form of ring as shown in Webb's specification was not the same as his patent. Webb did not in his patent desire a lunar-shaped port, as he showed the outside edge struck from a common centre.

In re-examination by Mr. Aston, the witness said he had never known a lunar-shaped opening before. Small differences in a combination of this kind made all the difference between success and failure, and the merit of his patent lay in the peculiar combination. A dispute had existed between himself and Fowler and Co., and Sir Fredk. Bramwell had represented Messrs. Fowler and Mr. Imray had represented himself.

The case for the opposer was opened by Mr. Moulton in a very long speech, the most important parts of which were that, with the exception of the packing ring, there was no novelty in the specification that had been put into use; the S spring, upon which emphasis had been laid in the specification, had never been used at all, and the packing ring had been patented by Church in earlier and expired patents. The law was very generous to patentees, as it allowed an inventor to group together any number of well-known parts, or even to add to a well-known grouping a single additional part, provided such new combination contained merit. But the law was also very strict in the sense that it insisted in the use in practice of every one of the parts forming a combination which was the subject of a patent; and if it were shown that a single material part of such a combination was not included in the practice of his patent by the inventor, the law said that merit could not be claimed under such a patent. Now, it had been shown that the S spring, upon which so much stress had been laid, was not used in any one of the examples brought before the court to prove merit; and he submitted that the petitioner had departed in practice from his combination as patented, and had really been manufacturing something not properly connected with his patent or included in it. The learned counsel then described the action of a slide-valve, and pointed out what he considered features of identity in Church's patent and Webb's patent, previously published.

Mr. Flannery was the principal scientific witness called by the opposition, and he stated that, in his opinion, Webb's patent had anticipated Church's, as Webb clearly described a circular slide-valve, capable of revolving automatically within the band that gave it the rectilinear motion requisite for opening and closing the ports. Webb had also described a system of making the curvature of the ports to a greater radius than the curvature of the edge of the slide valve, and Church had adopted the same principle, and had merely stated in his patent an empiric amount of increase in the radius of the curvature of the ports as patented by Webb; but Church had shown no new system of proportion. The witness further stated that Webb's system would counterbalance the pressure on the back of a slide valve, and in all essential particulars, except the use of a junk ring on the back of a slide valve, and except the S-shaped spring, the two patents were identical. The witness also stated that the piston packing as described by Church could not possibly work, but would jamb the ring, and cut the walls of the cylinders.

In cross-examination by Mr. Aston, Mr. Flannery admitted that small differences were very important in mechanical arrangements, and that the L-shaped packing ring was not arranged in the same manner by Church as by Webb. Also that he had never personally witnessed the working of valves constructed by Webb.

In examination by the Attorney-General and Mr. Moulton, the witness stated that the action of a U-spring to press the telescopic part of the back of the valve against the steam chest cover, was essentially different to the action of an S-spring, as described for the same purpose by Church's specification.

Mr. Beldam, consulting engineer, produced a drawing of an arrangement which he had made for the engines of the White Star steamers when he was manager of the Vauxhall Foundry, Liverpool, and which he stated was the same as Church's patent. He also stated that the use of Tuck's packing in the cavity of the L-shaped ring, as described by Mr. Rennie, would transform the ring practically into one of rectangular section, as Tuck's packing became quite hard and solid during use.

Mr. Wilson and Mr. Payton also gave evidence to call the attention of their lordships to what they considered the identity of Webb's and Church's patents.

In the course of a short, but exceptionally clear speech, the Attorney-General regretted that the petitioner's case had not been presented to their lordships with more candour, as it had been so opened as to lead to the impression that certain features of undoubted merit were of the petitioner's invention, whereas it had been afterwards made clear that the petitioner's merit, and his patent, lay in combination; for example, the use of a circular valve was not new, the differential radii in forming cylinder ports were not new, nor, indeed, was any other important detail claimed as novel, except in combination with each other. It was pertinent to the question before their lordships to inquire why such important firms as Fowler and Co., Beyer and Peacock, and Marshall and Sons, had used the patent for a time, but had afterwards withdrawn, as, surely if it had contained the great merit claimed, some reasonable explanation for discontinuing its use would be given. That, however, as well as the practical value of the contention that the spring used in combination differed from that of the patent itself, would be entirely a question for their lordships. If they thought merit had been shown, coupled with insufficient reward, they would no doubt recommend the extension for which the petitioner prayed.

Lord Monkswell, in giving judgment, said that the essence of the opposition lay in the comparison between Webb's and the petitioner's patents, and the difficulty that their lordships had in considering them similar, lay chiefly in the practical fact that it had not been shown that Webb's arrangement could or did work in practice, whereas much evidence had been called to show that Church's arrangement had worked in practice. If Mr. Webb, or someone who had actually seen his arrangement at work under steam, had been brought forward, their lordships would have attached more importance to the alleged similarity, but no such evidence had been given. On the other hand, the Admiralty, and the Peninsular and Oriental Steam Navigation Company, and others, had been shown to be using the valve under the petitioner's patent, and great weight of evidence had shown that it worked well. It seemed therefore that there was a prospect of the inventor reaping a further reward by the use of his patents in these directions, and on the whole, their lordships had decided to recommend the extension of the patent for a further term of five years.

In response to Mr. Aston's application for costs, Lord Monkswell said that the case was a very doubtful one, and therefore he would not allow costs against the opponents.

COURT OF SESSION — FIRST DIVISION.

Friday, March 5th.

(*Before the* Lord-President, Lords Mure, Shand, and Adam.)

R.N.—JOHN GWYNNE *v.* DRYSDALE AND CO.

The pursuer, the sole partner of the firm of John and Henry Gwynne, hydraulic and mechanical engineers, Hammersmith, Middlesex, asked the Court to interdict the defenders, Drysdale and Co., Bon Accord Engine Works, London-road, Glasgow, from infringing letters patent dated 23rd July, 1878, said to have been granted to the pursuer for an invention of "improvement in pumping engines," and, in particular, to have them interdicted from "making, selling, or using without the pursuer's consent, any mechanism relating to pumping engines in which the pumps are driven by steam power, and having for its object to enable their suction and discharge pipes to be swivelled and set at any angle without interfering with the driving engine, and constructed in the manner described in the letters patent." The pursuer averred that the defenders had, from 1st January, 1884, until the raising of the action, manufactured and sold, or caused to be manufactured and sold, pumping engines which were so constructed as to form a direct infringement of the letters patent. The defenders pleaded that the letters patent founded on were null and void, in respect (1) that the alleged invention was publicly known and used prior to the date of the letters patent; (2) that the invention was of no practical utility; and (3) that he fails in his letters patent to distinguish what is new and not claimed by him from what is new and claimed. They further pleaded that they had not infringed the letters patent founded on. In the Outer House, Lord M'Laren and Professor Tait, as skilled assessor, were not of opinion that Drysdale and Co. had infringed the patent, and consequently they were entitled to be absolved from the conclusions of the action, and to have the action dismissed with expenses. At the same time they found that the pursuer's patent was quite valid.

The pursuer reclaimed to the First Division, and their Lordships to-day unanimously adhered to the Lord-Ordinary's interlocutor, and gave additional expenses. The Lord-President said that the objection to the validity of the patent stated on record had not been insisted on, and the only question remaining was whether the defenders had infringed the patent. On that point he agreed with the Lord-Ordinary that no case of infringement had been made out. The pursuer's patent was a combination of known mechanical features, and the law in regard to such patents was that to constitute an infringement all the essential parts of the combination must be adopted. The essential feature of pursuer's patent was a flange-to-flange arrangement of the pump case with tee-headed bolts and a circular groove, enabling the pump case to turn all round to any angle. The defenders, however, did not use the tee-headed bolt and groove, and their machines, while possibly capable of being turned to certain definite angles—though that had not been proved—did not admit of swivelling, and therefore were no infringement of pursuer's patent. Lord Shand, concurring, said that defender's pumps had never been bought or sold as swivelling pumps; had never been so used, and, what was of more importance, were not capable of being so used. The defenders, by the adoption of a D-shaped instead of a circular flange, had made a distinct disavowal of any intention to manufacture swivelling pumps.

Counsel for pursuer and reclaimer: The Lord-Advocate, Mr. Guthrie Smith, and Mr. Young. Agents: Adam and Sang, S.S.C.

Counsel for defenders and respondents: Mr. Pearson and Mr. Ure. Agents: Fodd, Simpson, and Marwick, W.S.

THE MATHER-THOMPSON BLEACHING PROCESS.

MESSRS. MATHER AND PLATT, MANCHESTER, ENGINEERS.

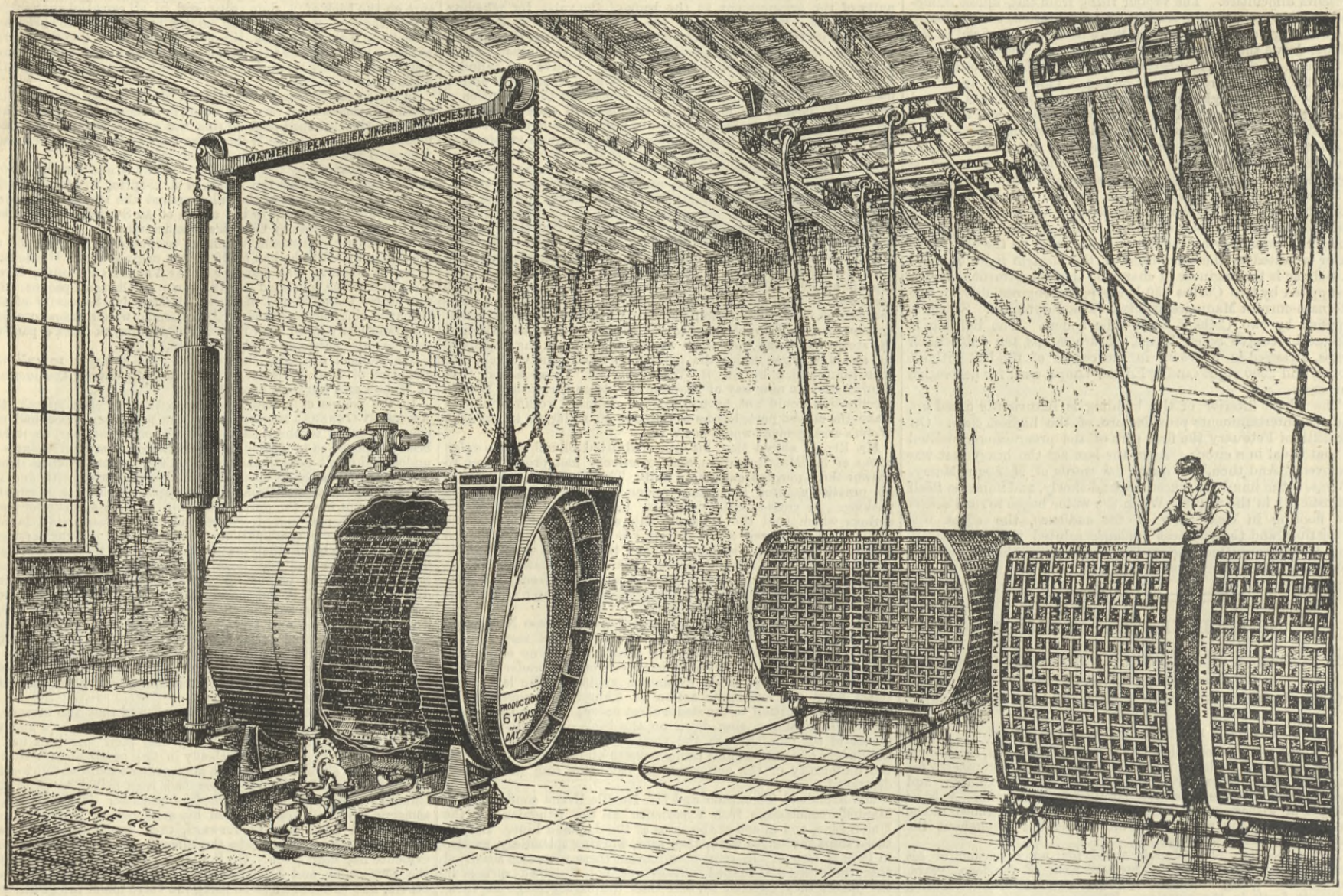


Fig. 1.—MATHER'S STEAMING KIER.—TREATING CLOTH IN THE ROPE STATE.

THE MATHER-THOMPSON PATENT BLEACHING PROCESS.

By a combination of improved processes, partly mechanical and partly chemical, Mr. W. Mather, M.P., of the Salford Ironworks, Manchester, and Mr. J. B. Thompson, of New-cross, Kent, have introduced what may be fairly described as a new method of bleaching textile fabrics. This new system is termed the Mather-Thompson bleaching process, and the successful working of the several operations for completing the process we had recently an opportunity of seeing practically demonstrated at the works of Messrs. Ainsworth, of Halliwell, near Bolton. The main features of the changes which have been introduced are that in the first stages of the bleaching, after the usual cleansing from size and loose impurities, the entire alkali treatment is completed in one operation, in Mather's patent steaming kier, and the use of lime and soda ash in successive long continued boilings is entirely dispensed with, whilst the subsequent whitening of the cloth is effected instantaneously in passing through the Mather-Thompson continuous chemicking machine. The appliances for carrying out the Mather-Thompson process of bleaching are shown in our illustrations herewith and on next page. Before, however, entering into a detailed description of these appliances, the special features of the Mather-Thompson process will perhaps be better understood if we give a brief outline of the ordinary practice of bleaching with which the new process is to be contrasted. The bleaching of textile fabrics consists in the main of two operations—first, the treatment with alkaline solutions; and, secondly, the whitening process, the agent employed for which purpose is almost exclusively a solution of bleaching powder. These two operations under the ordinary system involve, however, eight different treatments with re-agents, with eight attendant washings, and the whole process will be most readily set forth in tabulated form as follows:—

Alkali.	*Bleach.*	*Acid*	*Machine Washes.*
( ) Lime stew			(1) Wash.
		(2) Sour.	(2) Wash.
(3) Grey bowk. (Soda ash.)			(3) Wash.
	(4) I. Chemic.		(4) Wash.
		(5) Sour.	(5) Wash.
(6) White bowk			(6) Wash.
	(7) II. Chemic.		(7) Wash.
		(8) Sour.	(8) Wash.

In going through the above process the cloth is actually in work forty hours. By the Mather-Thompson system the processes are practically reduced to three, as shown in the following table, (2) and (2*a*) being merged into a single process by means of a continuous machine, and the period during which the cloth is actually in work is reduced to twelve hours:—

Alkali.	*Bleach (chemic).*	*Acid.*	*Machine Washes.*
(1) Saturate. Steam			
(2)	(2) Continuous (chemic) machine (or kier if for yarn, &c.)		
		(2*a*) Machine or pit sour.	
			(3) Wash up for finishing.

The first operation of the Mather-Thompson process, and which embraces the patented improvements introduced by Mr. W. Mather, is the Mather's patent steaming kier, shown in Figs. 1 and 2, which represents respectively the method of working cloth in a rope state and in full width state. The cloth or yarn to be bleached is first passed through a hot solution of caustic soda. It is then deposited in galvanised iron open framework wagons, each holding about a ton in weight, and these are run upon rails into what is termed a "steaming kier." This steaming kier is an apparatus which completes in one operation the full alkali treatment of the cloth in bleaching. It replaces the ordinary kiers, whether of high or low pressure, and enables all boiling in alkali to be dispensed with for every kind of cloth or textile material. By means of this apparatus all descriptions of cloth or yarn can in a space of from five to eight hours be thoroughly "bottomed" and made ready for the

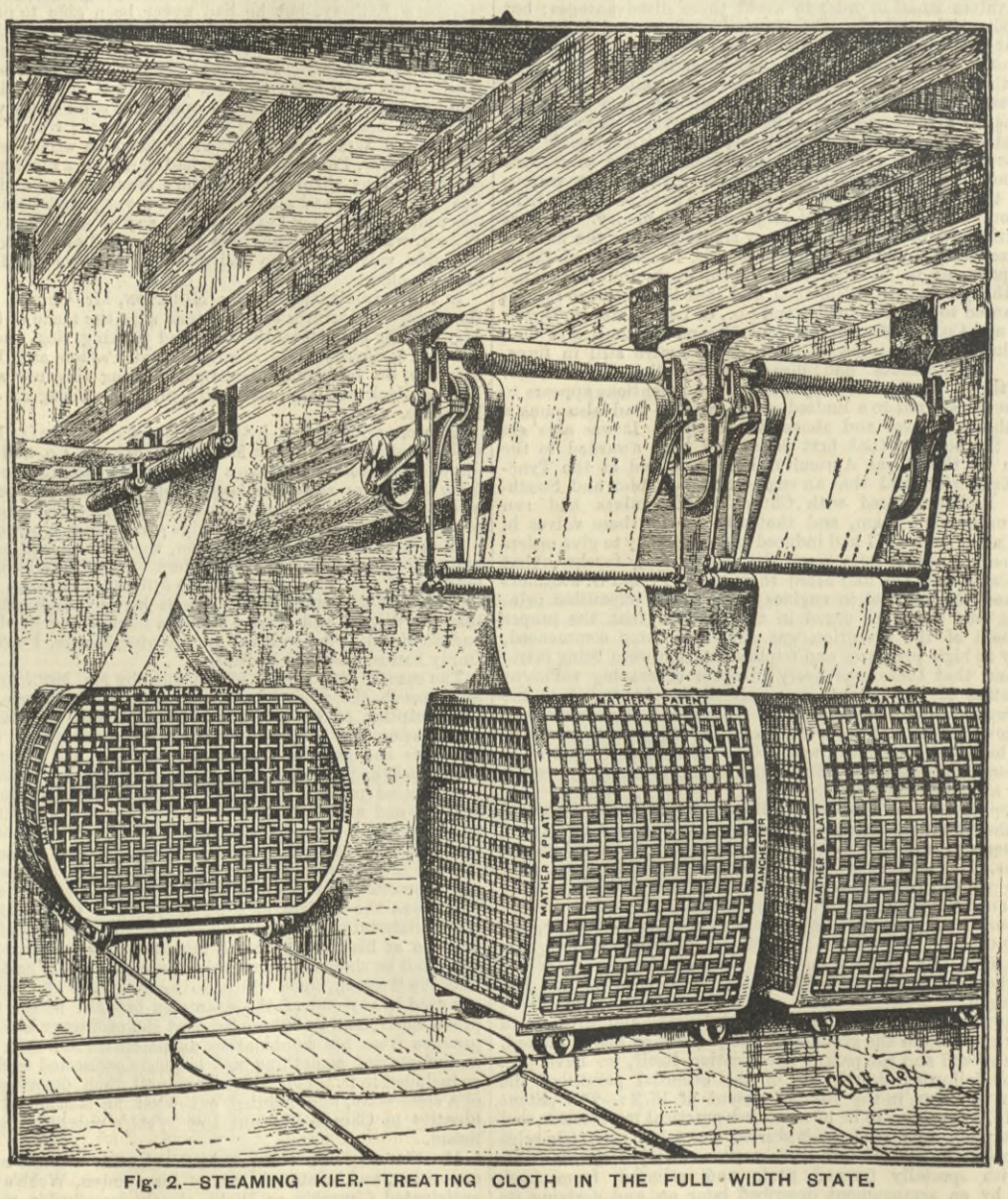


Fig. 2.—STEAMING KIER.—TREATING CLOTH IN THE FULL WIDTH STATE.

THE MATHER-THOMPSON BLEACHING PROCESS.

MESSRS. MATHER AND PLATT, MANCHESTER, ENGINEERS.

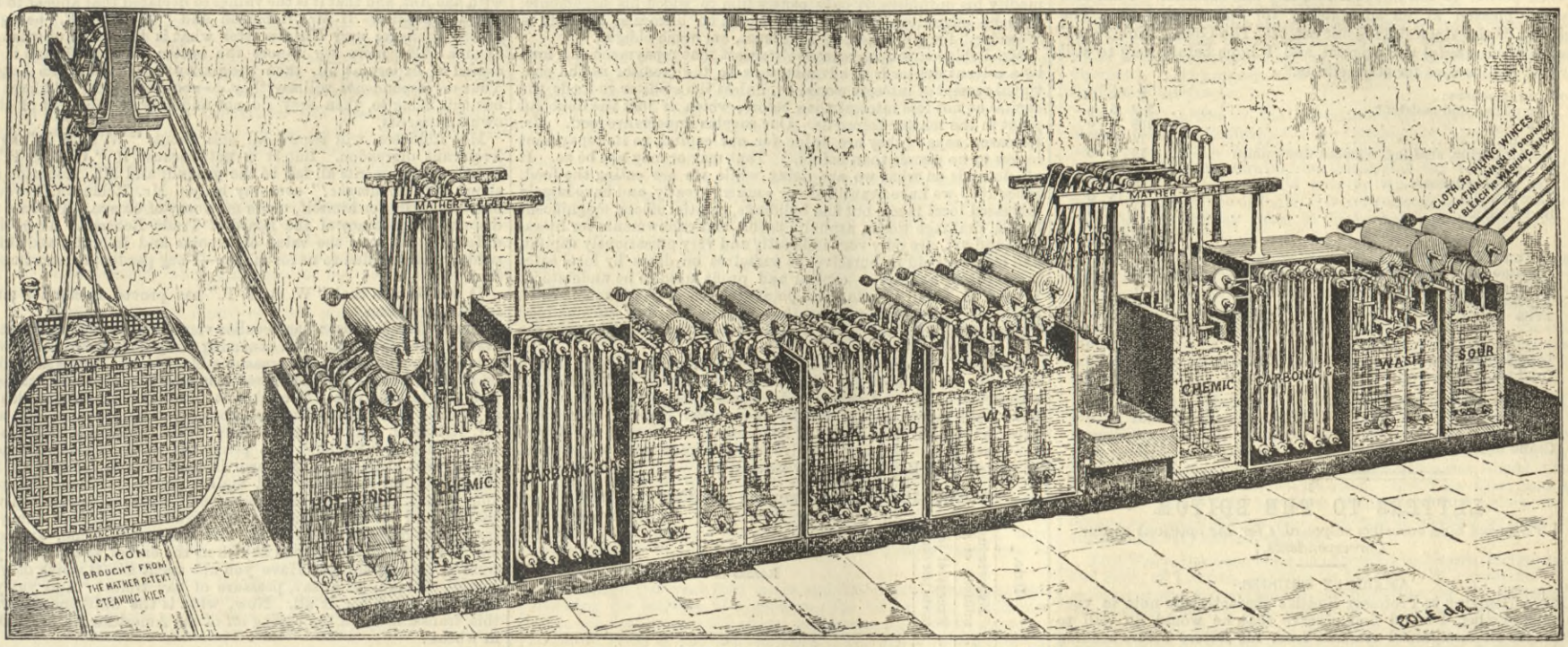


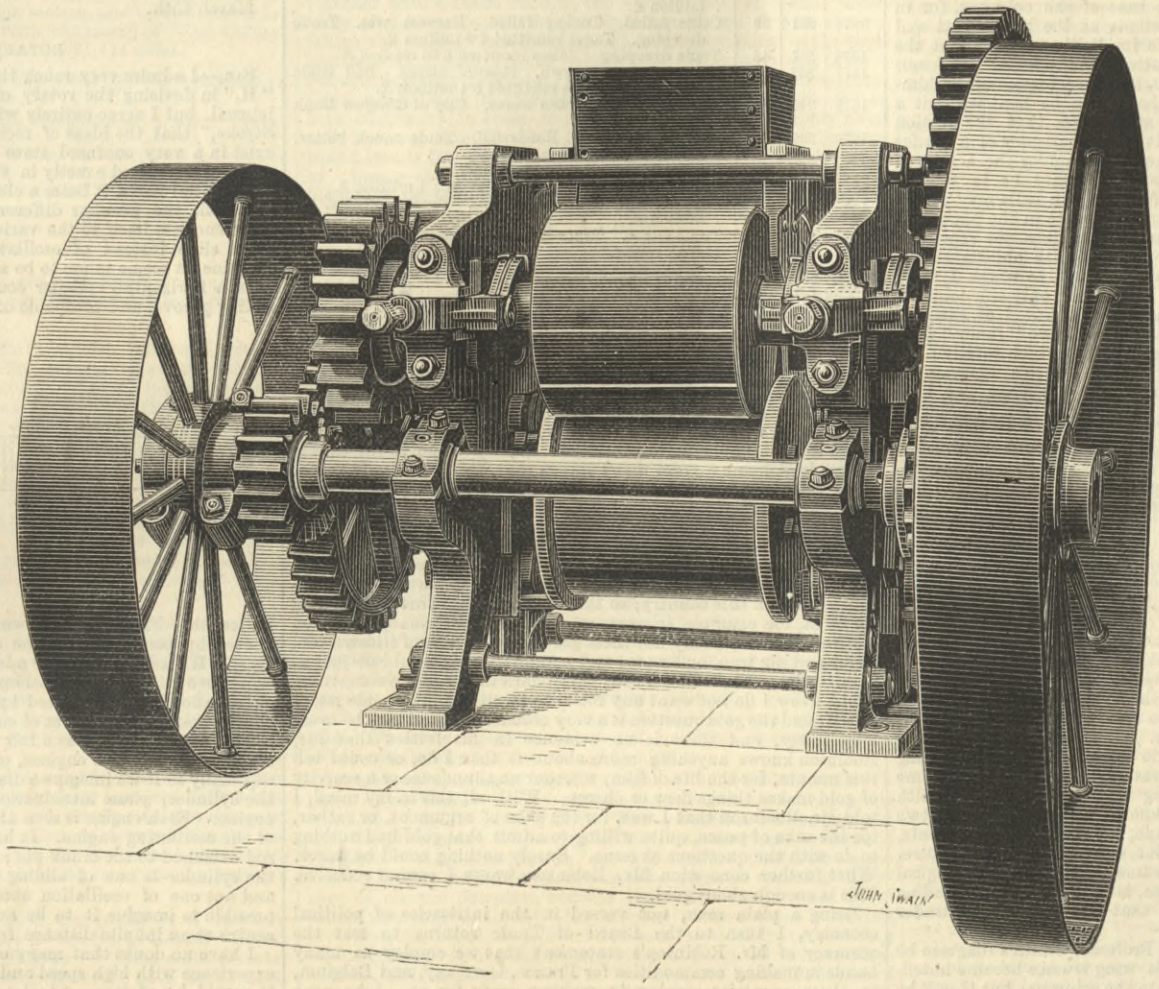
Fig. 3.—THE MATHER-THOMPSON CONTINUOUS CHEMICKING MACHINE.

chemic and sour treatment in bleaching. The entrance door to the steaming kier is raised and lowered by steam or water pressure, and the joint is made tight by a self-acting arrangement without the use of bolts. The loaded wagon having been enclosed in the kier, the soda held in solution in the cloth does its work with the aid of steam under a pressure of not more than 4 lb. to the square inch, a light sprinkling of a weak solution of caustic soda being kept up from the top for the purpose of preserving the cloth moist and preventing damage from dry heat. Before being removed from the kier the cloth is thoroughly washed in hot water by a circulating pump, and as one set of wagons is taken out, another set filled with cloth immediately takes their place, so that there is no pause throughout the day in the use of the kier. This one operation, as already stated, completes the entire alkali treatment, and lime is wholly dispensed with, as well as the boiling in kiers. The cloth is then passed on to the Mather-Thompson continuous chemicking apparatus, shown in Fig. 3, the main feature of which is Mr. Thompson's invention for the direct application of carbonic acid gas to cloth previously saturated with a solution of ordinary bleaching powder, the result of this application being the immediate oxidation of the colouring matter of the fibre, and its consequent instantaneous whitening. Our illustration so clearly shows the operation of the continuous chemicking apparatus through the order of treatment: (1) saturation with weak chemic, squeeze and passage to gas chamber; (2) wash (running); (3) soda scald; (4) wash; (5) repetition of (1), but with weaker chemic; (6) wash; and (7) souring; that further detailed description is scarcely required, and we need only add that as the cloth travels through the continuous machine in four strands in the rope state or in the open state at the rate of 60 to 80 yards per minute, the actual chemicking process is practically completed in a period of not more than two or three minutes. The next and final operation—that of souring—which is as essential to this as to every other system of bleaching, can either be included in the continuous process or made a distinct operation, as may be the most suitable to meet requirements.

The advantages which are secured by this new method of treatment are that only one-fifth of the water is required for washing, as compared with the ordinary system, and a saving of about one-third the chemicals is effected; there is also a great saving of time and fuel, whilst there is not one half the wear and tear. In addition to these direct advantages, the use of lime being wholly unnecessary, the cloth is less liable to the usual stains in bleaching, whilst it undergoes considerably less handling during the process.

Out of all the economy of time, labour, and material which has been effected, the great saving in the quantity of water required by the new system may, however, be regarded as perhaps one of the most important features of the Mather-Thompson process. Long since all the suitable and available streams for bleaching have been appropriated; and in some instances bleachers have been compelled to get a portion of their supply by pumping from the water-bearing strata below the surface. With, therefore, the limited sources of water supply, a discovery which so greatly minimises the quantity required is of incalculable value. It is even thought that, with the present charges for bleaching, it might be found possible to establish works in Manchester or other manufacturing centres, and, with the small quantity of water required, obtain this from the ordinary water supplies, which will indeed be something like a revolution in the bleaching industry.

In closing our description of the Mather-Thompson process—which we have dealt with as a combination of practically two classes of improvements, by the alkali treatment in the "Mather Steaming Kier," and "Mather-Thompson Treatment" in the chemicking process—we may add that the alkali treatment is just as applicable for use in connection with the ordinary "chemic and acid" method of bleaching as with new "continuous chemicking process." It will therefore be available for calico printers and dyers as well as for bleachers, who do not care to make the necessary alterations for adopting the latter machine; and it is, indeed, in the "steaming kier" and the caustic soda treatment, which is the really novel and striking feature of the new process, that the greater part of the saving is effected.



HALL'S GRADUAL REDUCTION CEMENT MILL.

HALL'S CEMENT ROLLER MILL.

THE above engraving is a perspective view of the roller cement mill described in our last impression, and conveys a more complete notion of the exterior design.

ELECTRIC LIGHT IN THEATRES.

EVIDENCES of the practical, as well as photometric, superiority of the electric light over all other illuminants wherever it can be employed, or wherever a sufficient number of lights are required to make its adoption economical, are growing with great rapidity. The light is now without doubt in that state in which its merits alone will push its adoption, and that it is being adopted much more extensively than is generally thought. A good illustration of the satisfactory way in which the light is now at work is given by that in the Prince's Theatre. This installation has now completed its second year of working, and this it has done for the two years without a breakdown or any mishap in the light. The plant consists of a 12-horse power Clerk's gas engine, manufactured by L. Sterne and Co.; a Siemens L.D. dynamo and E.P.S. storage cells; and there are 350 Swan lamps, 108 volts, 16 C.P.

From Mr. E. L. Berry, of E. L. Berry and Co., by whom the installation has been carried out, we learn that the engine has maintained its high character for this work, and has during the year run for 2559 hours, and has not given the slightest trouble, either in starting or when at work. The great advantage secured by this engine is its regular and smooth action, resulting from an impulse at every stroke. It was overhauled in December last, and the water jacket cleared of its deposit of lime, an operation which is not perhaps as often attended to as the use of hard water makes necessary. The only renewal has been a few piston rings. Besides doing its ordinary work of driving the dynamo, it is used frequently for pumping water into the tanks to supply the hydraulic fireproof curtain and the lift.

The accumulators have given satisfaction; but as a difficulty was experienced in the leaking of the teak boxes, it was decided about six months ago, while making a change, to put in some of the new cells, containing all the latest improvements and supplied in glass boxes; and of these new cells, although put to very severe tests, not one, we are informed, has failed. Several of the original teak boxes have been packed with new positive plates and lead connections, and these have answered admirably. Up to January 16th of this year Mr. Berry informs us that he had one cell of the old type, which has been in constant work for two years, and had not on any occasion failed; it had not been repaired or attended to in any way, and he says it is evident from this that there is no reason why, when carefully made, the accumulators should not last throughout this length of time without being in any way renewed, and it is expected that this result will be attained with the later cells put down. The dynamo has run very well. A new commutator was put on in December last, the old one during its run was turned up three times. There have been ten pairs of brushes used during the twelve months. The lamps show a somewhat better average than last year, on account of the electricians being able to get thirty of the broken-looped carbons repaired. During the year seventy-eight lamps were renewed, from the following causes: Thirty-eight failures of carbons, ten by accident, and thirty by loops breaking off. The explanation of the fact that so many loops were broken off is that eighteen lamps were used to light up a scene of "The Great Pink Pearl" for six months, the constant moving about breaking the loops, and occasionally one got broken by a fall. There are several lamps that were originally put up still burning, having run for 2500 hours.

On the next page will be found an abbreviated account of the working expenses, and also the repairs and renewals for the year, which have been handed to us by Mr. Berry. This works out to 37s. 8d. per day, taking 300 days per year, and if we take only 300 of the lamps as at work, we have a cost per day each lamp of 1·5d., which, considering the number of hours worked and the number of lamps destroyed owing to the special circumstances of their employment, may be taken as very satisfactory, and as showing that the electric light, with all its advantages, costs but little more than gas, and places in the hands of theatre managers a light of very varied applications and attractiveness, to say nothing of its healthy coolness and sanitary superiority.

The following certificate from Mr. Edgar Bruce as to the

working of the installation is of interest:—"I have great pleasure in again certifying to the successful working of the electric lighting at the Prince's Theatre. It has been in operation for more than two years, and during the whole of that period it has not failed on any one occasion. I am also greatly pleased at its adaptability for stage purposes. The lighting of the stage during one act of 'The Great Pink Pearl' was most successful and original, and I hope before long to still further try its uses for stage effects."

	£	s.	d.
Working expenses:			
Electrician and assistant	239	5	6
Gas	188	4	0
Lamps	14	5	0
Oil for engine, shafting, dynamo, and pumps	10	0	0
Waste	1	12	6
Ten pairs brushes	2	10	0
Lamp shades	0	15	0
Sundries, &c.	4	0	0
	£460	12	0
Repairs and renewals:			
Dynamo	12	9	0
Engine	7	0	0
Accumulators	187	9	6
Belts	11	5	4
	£218	3	10
Total for working	460	12	0
Total for repairs, &c.	218	3	10
	£678	15	10
Previous year	452	10	0
Grand total for two years' working	£1131	5	10

LETTERS TO THE EDITOR.

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

AMERICAN BRIDGES.

Sir,—Replying to Professor Smith's characteristic note in your current number, I would first observe that he would do well to eliminate all undignified remarks from his letters before sending them to press. With regard to his statement that the British public—of which Professor Smith deems himself to be the very soul, oracle, and cynosure—heartily enjoys my graphic constructions as good jokes. I need only mention that immediately after the publication of my Statics, which is the embodiment of these "good jokes," I received letters from several professors, English and foreign, congratulating me upon its value and usefulness. Amongst others, the late Professor Fleeming Jenkin, who, I understand, was Professor Smith's mentor in the subject, wrote expressing his appreciation; and, later, in a signed review, commended the book "as an original work, not a mere compilation from other books," useful to students, &c.

I must also resent the peculiar touch of familiarity about the phrase, "who do not know Mr. Graham as well as we do," for I am totally unconscious of any acquaintance with Professor Smith, whose knowledge of me is entirely limited to whatever acquaintance he may have with my writings, in which respect he is on no better footing than those American engineers, who, he tells us, are diligent readers of your paper.

Coming now to the more serious part of his letter, Professor Smith is entirely wrong in supposing that Professor Waddell assumes no bending moment at the base of the columns, for in taking the sum of the horizontal reactions at the base equal and opposite to the total round load, he implicitly assumes that the free end of the section bends over relatively to the base. Professor Smith follows him in this assumption, and therefore commits himself to the absurd deduction that a beam can be bent without a bending moment. The alternative assumption that the section moves sideways as a whole, places it in the category of a girder fixed at both ends and bulging in the middle under the action of wind, in which case the leeward column would be in tension instead of compression. What Professor Smith calls my "fancy stress diagram" was shown—as I expressly state in the paper—to fit one of Professor Waddell's formula, and does not represent my own treatment of the case. Professor Smith objects that I have no right to take the joint K as a pin joint, to which I reply that in his own "ideal" diagram he treats not only the joint K, but every other joint in the section as a pin joint. Not satisfied with that, he imagines the section flanked with two "fancy" wing trusses, which have no existence in reality, and which totally alter the distribution of wind load. Professor Smith's diagram is based on the following three assumptions:—(1) That two king post roof trusses must be added to the real section in order to bring an additional and indirect load equal to P + P to bear upon the strut D4; (2) that the reactions at the base of the columns are inclined instead of vertical; and (3) that the rafters of his "ideal" wing trusses and reaction lines must have just that particular slant which permits the constant direction of D C in the stress diagram to bisect the line O4. Now, deny the first assumption, and the other two collapse.

Lastly, Professor Smith charges me with not knowing the distinction between plus and minus, insomuch that I ignore the principle that the moments on opposite of the section at A are equal but of opposite sign. Here, again, Professor Smith overlooks the fact that I was handling Professor Waddell's tools, and that, therefore, I sought to use them in his fashion. As a matter of fact, I hold that there is no moment whatever at A except that arising from the buckling of the strut under shear. The only way in which I could imagine a bending moment to arise at A from other forces was by implicitly changing their signs. Of course, it was perfectly absurd and ridiculous on my part to do so; but then I was dealing with an absurd supposition, and I was obliged to discover some reason to account for it. By changing my signs, Professor Smith merely brings us back to the well-known principle that, if two equal and opposite couples act in a plane, the sum of their moments, $Pd - Vb$, vanishes not only for any point, such as A in the structure, but for any point whatever in the same plane; the only logical consequence of which, in this instance, is that there is no bending moment at the point A, other than that due to buckling under shear.

In conclusion, I would add that, if Professor Smith's diagram be correct, it should still hold when his wing-trusses become indefinitely small so as almost to vanish into the columns; but it will be seen that in this case the points O A B C E and F pass to infinity, and, therefore, by assuming the wing-trusses indefinitely small so as to approximate to the real shape of the structure, we arrive at the precious result that the stresses in both columns are of infinite intensity. Under the influence of such mighty stresses as these it is not astonishing that Professor Smith's diagram, together with his fancy wing-trussed castle, should vanish into thin air.

March 15th. R. H. Graham.

FREE TRADE AND NO TRADE.

Sir,—For the information of Mr. H. Robinson, I may say that the U.S.A. Treasury estimated in 1869 that 600,000,000 dols. of their bonds were held in Europe. Last year the estimate by the same authority was 12,000,000 dols. registered bonds. If bonds, and registered bonds, mean the same thing, and if these estimates are worth anything—points on which I can express no opinion—then we have exported to the States about 98 per cent. of the bonds we held in 1869, which was probably not less than nine-tenths of the above mentioned six hundred millions.

Doubtless we have purchased in exchange title deeds to land and miscellaneous securities, but not to nearly the same amount. The balance has been paid to us in food, and this accounts for part of our surplus imports from the United States. Similar facts may apply to other countries.

Mr. Robinson replies to all this by anticipation, and says "it does not matter," but this is not fair on his part. He has hitherto maintained that our surplus imports are revenue payments of freights and interest, and profit. Now he sees that they may be partly repayments of capital, but instead of this leading him to modify his optimism, it only causes him to widen his arguments; thus he commits a sin like that which he blames so severely in "Trader," for whose letters I, at least, am much obliged.

Mr. Robinson cannot reasonably assert that repayment of a loan by a solvent debtor is as advantageous to the creditor as the continual receipt of interest would be, unless the creditor re-lends the capital at not less interest than before, which is just the doubtful point in the matter before us. Our surplus imports are food. Mr. Robinson says "they are value for our capital, so its repayment leaves us no poorer than before." That may or may not be so. It all depends on what we are doing while we are eating the food. Since 1869 we have beautified our country greatly, and have largely increased local rates; but fine buildings, palatial offices, magnificent hotels, drainage works, asphalte paths, and endowments for literature and art, are only very indirectly and very precariously capital, and interest paid by ourselves to ourselves on debts by local rates is not profit, at least as capital and profit used to be understood. If need be, I will go into these points in greater detail again. Such figures as I have seem to show that we are not now turning food into profit-bearing capital by well-directed and steady labour at the rate we used to do.

I annex a table of exports and percentage surplus of imports, and remarks. It conclusively shows that the latter quantity is no measure of profit on foreign trade whatever else it may be. We have made money on the whole, though our imports exceed our exports. The United States of America do so too with the figures the other way. Can any one give us the highest and lowest prices of Scotch G.M.B. pigs annually since 1860?

1860 *to* 1884 *Exports, Imports, and State of Trade.*

Date.	Exports in millions of £.	Excess of imports per cent.	Remarks on trade.
	£	%	
1860	164	28	Generally prosperous.
1861	160	36	U.S.A. Civil War commenced; trade quiet.
1862	166	36	Cotton famine. Taxes remitted 1·8 million £.
1863	197	26	Tranquil prosperity. Taxes remitted 0·1 million £.
1864	213	29	Steady progress in trade. Taxes remitted 4·6 million £.
1865	219	24	Civil War ends. Cattle plague begins. Taxes remitted 3·2 million £.
1866	239	24	Overend & Gurney failed. Trade outrages at Sheffield. Gloomy year. Taxes remitted 5·3 million £.
1867	225	22	Gloomy year. Bank rate 1 to 2 per cent. Taxes remitted 0·6 million £.
1868	227	30	Trade depression continues. Harvest excellent. Taxes imposed 1·3 million £.
1869	237	24	Suez Canal opened. Trade still dull. Taxes imposed 1·45 million £.
1870	244	24	Franco-German War. Trade prosperous. Taxes remitted 4·7 million £.
1871	283	11(!)	Great prosperity. Taxes remitted 4·5 million £.
1872	314	13	Prosperity great. Prices rise. Taxes remitted 3·0 million £.
1873	311	19	Steady trade. Crisis in U.S.A. French indemnity paid. Taxes remitted 3·9 million £.
1874	298	24	Trade dull. Prices falling. Taxes remitted 3·4 million £.
1875	281	29	Collie failed. Turkey failed. Harvest wet. Trade drooping. Taxes remitted 4·6 million £.
1876	257	46	Trade drooping. Taxes remitted 0·06 million £.
1877	252	56(!)	Harvest worst known. Masons' strike. Bad trade continues. Taxes remitted 0·4 million £.
1878	245	50	Harvest better. Trade worse. City of Glasgow Bank failed.
1879	249	46	Miserable harvest. Rents fall. Trade much better. Taxes imposed 4·3 million £.
1880	286	44	Miserable harvest. Trade worse.
1881	297	34	Miserable harvest. Taxes imposed 3·1 million £.
1882	306	35	Fair harvest. Trade uncertain. Taxes remitted 2·0 million £.
1883	305	40	Trade worse. Taxes imposed 2·8 million £.
1884	295	32	Bad all round.

The London Institution, Finsbury-circus, March 15th. Wm. Muir.

Sir,—My reply to Mr. Robinson will be very brief. He is like one of those garrulous witnesses who cannot stick to the point when giving evidence. He compels me to recapitulate in order that the discussion may remain intelligible.

I started with the proposition—(1) That the country in which there is most employment is best off. (2) I went on to say that if we made at home a great many things that we import ready made, work would be found for hands now unemployed. (3) I asserted that an import duty on such goods would cause capitalists, for whose use and by whom they are imported, to buy them at home instead of abroad.

To this, Mr. Robinson replied that I was wrong concerning propositions 2 and 3, because we paid for what we imported by commodities made in this country; so that if Germans, let me say, worked for us at, for example, scissors, we worked for Germany at cotton cloth—of course, I only use these goods for the sake of illustration; sugar and pig iron, or brooms and perambulators, would do just as well. Also, Mr. Robinson said many hard things of me concerning gold. Now I do not want any mists to be stirred up, or side issues raised; and the gold question is a very obscure one, and may be made very misty, and there is no evidence in his letters that Mr. Robinson knows anything more about it than I do, or could tell this minute, for the life of him, whether an abundance or a scarcity of gold makes things dear or cheap. With all this in my mind, I told Mr. Robinson that I was, for the sake of argument, or rather, for the sake of peace, quite willing to admit that gold had nothing to do with the questions at issue. Surely nothing could be fairer. What further concession Mr. Robinson wants I cannot conceive. This is enough about gold.

Being a plain man, not versed in the intricacies of political economy, I turn to the Board of Trade returns to test the accuracy of Mr. Robinson's statement that we employ as many hands in making commodities for France, Germany, and Belgium, as those countries employ in making goods for us. I have no means of getting at the actual number of men employed, but I think I shall err on the right side if I assume that £1 worth of German, French, or Belgian commodities represents as much labour as does £1 worth of English commodities. I find that we imported £78,000,000 worth of goods in 1884, and that we exported to pay for them—as I understood Mr. Robinson—£33,000,000 worth of goods. Naturally I expressed extreme incredulity, and I now find that my incredulity was quite justifiable. According to "W. A. S. P." the Board of Trade figures mean nothing; they are simply a delusion. They represent nominal values. "When the whole world is taken into account, the two sets of figures are two different valuations of the same identical goods."

Lest I should make any mistake, will "W. A. S. P." kindly tell me whether the Board of Trade Returns do or do not supply satisfactory evidence as to the real value of our exports and imports—of, in short, our trade transactions? Whether he means that his arguments should do so or not I cannot tell, but they conclusively prove that the Board of Trade Returns are valueless; and I fancy that this discussion is well worth the space it has occupied if so important a fact has been made clear by it. When I read the returns for Sheffield, for instance, in future, I shall do so with a smile, giving thanks to "W. A. S. P." knowing that they have no real meaning, that they are fictions, day dreams which will break like soap bubbles at the touch of a politico-economical finger, and this although I know that importers and exporters or their agents are bound by law to declare what they consider to be the value of goods landed or shipped at the ports where these operations take place; the declarations being made under the provisions of the Act 39 and 40 Vict., cap. 36; a penalty being imposed in case of non-compliance with the Act, and that it is the values so declared that appear in the official statistics. If Mr. Robinson and "W. A. S. P." be right, indeed it makes very little matter what is the value of what we export. The more we import the better we are off, and if we ceased to export at all, then prosperity would be at its height Your correspondents will say they do not mean this. Perhaps so; but this being so, then they do not understand the drift of their own arguments.

Mr. Robinson will regard all this about "W. A. S. P." as an irrelevant digression. But it is not, because if "W. A. S. P." is right, my arguments all fall to the ground, and Mr. Robinson can shout "*Io Triumphe!*" over my body. Mr. Robinson, however, has, unluckily for himself, made me a way of escape. He does not dispute the accuracy of the Board of Trade Returns. There is a difference between the value of exports and imports, and this is paid by interest due to us for money—I beg pardon, commodities—lent.

It will be seen that "W. A. S. P." has proved rather too much for Mr. Robinson.

I fancy Mr. Robinson has peculiar views concerning capital at all events. He confounds with charming simplicity consumable with non-consumable value. In smashing Mr. Muir he brings his cudgel on his own head. America owes England money, and pays regularly the interest due. She takes it into her head to pay this off in wheat. When the wheat has been eaten we are no poorer, says Mr. Robinson, than we were before. "It passes my understanding to learn how England is a penny the worse because America has at last paid us £1000 down instead of the interest of it." Ingenuous Mr. Robinson. Let me ask you a question. Suppose you hold £1000 worth of London and North-Western Railway shares, and exchange these shares gradually through the year for commodities such as food, and coals, and wine, and gas, and boots and shoes, are you as rich at the end of the year as you were at the beginning? Have you not spent £1000 worth of your capital through, let us say, pressure of bad times? And yet you have had value for it all. Now, what is the difference between this transaction and the paying off of the American National Debt in wheat?

Mr. Robinson will find very few political economists or business men of common sense to take his view of the matter.

A great increase is reported in the total of French exports. In February last year they amounted to 234,000,000f. This year they rise to 271,000,000f. Manufactures have increased from 108,000,000f. to 147,000,000f. There is a considerable diminution in imports. Will Mr. Robinson or "W. A. S. P." tell me whether this is a good thing for France or a bad thing, or neither? Also what paid for the extra exports. If your correspondents would concentrate their attention for a little while on my second proposition above, I think we might get on faster. Let us discuss one thing at a time. It gives me no pleasure to defeat "W. A. S. P." or Mr. Robinson in a war of words. I want to see what I regard as a tremendous problem discussed so that we may get hold of some practical information. I know very little about it. I do not believe that anyone knows much. Certainly the ordinary cut-and-dry political economist does not. Is it or is it not a fact that our men are out of work because we import what we ought to make at home? This is the question, and it is mere waste of time to bandy words concerning side issues, such as whether I did or did not make a mistake about gold.

March 15th. Trader.

ROTARY ENGINES.

Sir,—I admire very much the ingenuity of your correspondent, "H." in devising the rotary machine recently described in your journal, but I agree entirely with the opinion expressed by "Long Stroke," that the ideas of reciprocating and rotary motion must exist in a very confused state in his mind. I cannot recall any engine constructed exactly in the same way, but when reduced to its essential parts, it bears a close analogy to the oscillating engine, but with the peculiar difference that the cylinder, in order to accommodate itself to the various positions of the connecting rod, must slide instead of oscillate. So far as I have grasped the machine, it seems to me to be similar to that represented in Fig. 1. A is a horizontal cylinder constrained to move vertically in a sliding groove, and incapable of any movement in the direction of

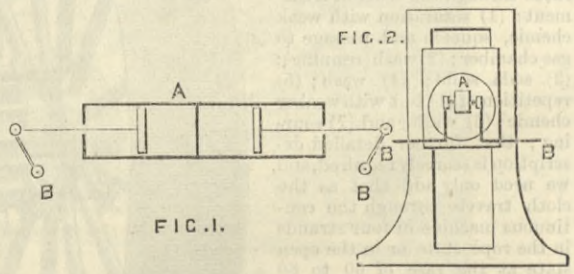


FIG. 1.

FIG. 2.

its length. Pistons, as shown, work in each half, and are connected by piston-rods to the crank-pins of two revolving shafts, B_1 B. If steam be suitably admitted to the pistons, the two shafts will move in opposite directions. It is not necessary that the two shafts should be connected by external attachment, though this course would relieve them of considerable strain.

This being accepted as a fair deduction from "H.'s" engine, we see it consists of two engines, one to the right and one to the left; especially so if we imagine a diaphragm block crossing the centre of the cylinder, whose introduction will not modify the action of the engine. Each engine is seen also to be very much of the character of the oscillating engine. It has, as with that engine, its piston-rod attached to the crank-pin; but the accommodating motion of the cylinder is one of sliding along the groove, shown in Fig. 2, and not one of oscillation about a fixed centre. It is, however, possible to imagine it to be an oscillating engine turning about a centre at an infinite distance from it.

I have no doubt that many of your readers have some practical experience with high speed and rotary engines, and I should think it would be of interest to learn from these the points they have observed with regard to their durability and general working. The publication of such experience would, I believe, in no sense go against such a class of engines, but would, on the contrary, serve to render them more familiar and popular. Many of them have an established reputation, and have shown that if not always better than the usual form of engine, yet that they are as good. I should not myself be surprised to see these engines adopted for more general work as they became better known; the engine described in your recent article on rotary engines serves to show that they may be as much at home for slow speeds as for high speeds.

March 16th. Rotary.

[*For continuation of Letters see page* 234.]

Royal Institution.—Professor Dewar, F.R.S., will begin a course of four lectures on "Electro-Chemistry," on Thursday next, March 25th; and Mr. Howard Grubb will give the first of two lectures on "The Astronomical Telescope," on Saturday, March 27th. Professor W. C. Roberts-Austen will give a discourse on "Certain Properties common to Fluids and Solid Metals," on Friday, March 26th. The subject of the discourse to be given by Sir Henry Roscoe, M.P., on Friday, April 16th, will be "Recent Progress in the Coal Tar Industries."

RAILWAY MATTERS.

THE Glasgow Underground Railway was opened on Monday. Two hundred trains will be run daily. The line starts from Queen-street and goes through Partick to join the Dumbartonshire Railway.

THE American Consul-General at Panama, Mr. Adamson, has telegraphed to the Mayor of New Orleans, requesting him to stop all shipments of labourers thence for the work on the Panama Canal, as they have been induced to go by deception. Large numbers have gone, but have failed to find employment.

THE ironwork for the Lancashire and Yorkshire Company's exchange station at Liverpool is being made by Messrs. Simpson and Wood, who are the sub-contractors referred to in this column of our last impression, and are also contractors for the Liverpool Exhibition building.

THE Board of the Buenos Ayres and Pacific Railway Company announce that the rails have been laid from Mercedes to Villa Mercedes—that is, for the whole length of the line—and that the Government on the 15th of February sanctioned the opening of the railway under their guarantee as far as Orellanos — 250 kilometres.

THE *Railroad Gazette* record of train accidents in the States, published from month to month during 1885, contained brief notes of 464 collisions, 681 derailments, and 72 other accidents ; a total of 1217 accidents, in which 307 persons were killed and 1530 injured. Derailments thus continue to form a large proportion of the whole of the accidents.

THE directors of the Preston and Wyre Railway, which is jointly owned by the London and North-Western Railway Company and the Lancashire and Yorkshire Railway Company, have determined to erect at Kirkham a new station to cost over £30,000. It is also intended to double the up and down lines from Kirkham to Preston as soon as the operations at the former place have been completed.

ROLLING stock for the tramway trains, which are to be run between the ordinary trains, at more frequent intervals and with more numerous stopping places, on portions of the Belgian State Railways, has been ordered for speedy delivery of the principal manufacturing firms of Belgium. On Tuesday, MM. Dubois, Blainquaert, Raymaeckers, and Goffint, of the State Railway Administration, proceeded to Quievrain, on the French frontier, and then on to Valenciennes, to make themselves acquainted with the working of tramway trains on the Banlieue line of that city.

RECENT numbers of the *Times of India* and the *Bombay Gazette*, contain accounts of the newly completed terminal buildings of the Great Indian Peninsula Railway, erected from the designs and under the superintendence of Mr. F. W. Stevens, A.M.I.C.E. F.R.I.B.A. who has built several noted buildings in India, including the Royal Alfred Sailors' Home. The new terminal station at Boree Bunder includes a great hall, booking offices, administrative offices, and all other features of a great terminal station. It is built in Italian mediæval Gothic with Indian stones. The design was exhibited in the Royal Academy in 1881.

LINESMEN may not walk many miles per day, but a few years record makes one wonder how many miles some men walk in their lives, and compare their life mileage with that of an engine. An American paper records that "Henry Skehan has been an employé of the Erie road for many years, and was one of the hands who laid track between Attica and Portage during the months of March, April, May and June, 1852. When the track was laid he went to work on the Linden section under its first foreman, Charles L. Beman, of Attica, October 1st of the same year. Since then he has been track-walker on the Linden section, and up to October 1st had covered 189,924 miles. This beats the record of Wm. Colary, of Hinsdale, N.Y., recently published, by 61,444 miles.

A GENERAL classification of the American railway accidents in December last is given as follows:—

	Collisions.	Derailments.	Other	Total.
Defects of road	—	12	—	12
Defects of equipment	12	3	3	18
Negligence in operating	23	5	—	28
Unforeseen obstructions	2	3	2	7
Maliciously caused	—	—	—	—
Unexplained	—	9	—	9
Total	37	32	5	74

Negligence in operating is thus charged with 38 per cent. of all the accidents, defects of road with 16 per cent., and defects of equipment with 24 per cent.

THE half-yearly report of the North British Railway Company mentions that the expenditure for the half-year of £274,244 includes £100,000 for the Tay Viaduct. The receipts per railway mile amount to £1353·84, as against £1396·75. The receipts per train mile for passenger trains are 43·38d., as against 46·36d., and for goods and mineral trains they are 59·22d., as compared with 59·89d. The working expenses amount to 45·99 per cent., as against 45·49 per cent. for the corresponding period. The miles worked by the company's engines were 1147·5, the passenger train mileage 2,747,222, and goods 3,214,744. The total cost of the locomotive power was £156,758 13s., of which coal and coke cost £39,348 14s ; office expenses, general superintendence, and salaries cost but £770 2s. 9d., but the same expenses in the way and works department reach £1860 15s.

NOW that the Bulgarian question is on the point of being settled, the Austrian press has begun again to take a lively interest in the completion of the junction railways to Constantinople. These were to have been ready, according to contract, by the end of next October; but the events of the last six months in the East have interrupted the works, so that their completion cannot be expected till next year. The *Neue Freie Presse* recommends the Government to imitate France in the Eastern Roumelian Customs question, and to withhold its definite ratification of the Turco-Bulgarian Convention until Bulgaria shall have set to work in earnest on the Zaribrod-Sofia line. It is this line that causes most anxiety, owing to the unfriendly relations between Servia and Bulgaria, and because it is seen that the Bulgarians themselves have now an obvious interest in finishing the junction between Sofia and Philippopolis.

MESSRS. W. H. BARLOW AND SON, the engineers of the new Tay Viaduct, report to the directors of the North British Railway on the progress of these works as follows:—"Sixty-eight cylinder foundations, out of a total of seventy-three, have been sunk, leaving only five more to sink to complete foundations, and the testing of them is proceeding satisfactorily. The wrought iron shafts or superstructures of ten piers at the south end of the viaduct are erected in position, and at the first the whole of the span is complete, with its girders, flooring, and parapet. At the centre of the viaduct the girders for two of the 245ft. spans—which were built on the shore at Wormit—have been floated out and placed on their piers preparatory to lifting, and the erection of the wrought iron shafts of these three piers is in progress. At the north end twenty-five wrought iron shafts of piers are erected, and the girders, flooring, and parapets of twenty spans are completed. During the last two months the progress of the works has been very much interfered with by the weather, and on some days there has been a total stoppage of all the works; otherwise we consider the progress made during the last six months satisfactory. The construction of girders for the work is nearly finished, and the shafts or superstructures of piers are in a forward state. The viaduct is now ready to receive its permanent way for a length of 800 yards double line. We consider that the completion of the work may be looked for early in 1887, but the exact time is dependent on the weather and other contingencies which cannot be estimated with certainty. In order to be ready for the opening we have prepared the specification and drawings for the piece of railway required to connect the new viaduct with the existing railway on the south side."

NOTES AND MEMORANDA.

A STRIP one inch in width of the hemp canvas used by the Berthon Collapsible Boat Company will carry a load in tension of 730 lb. if the strip be cut in the direction of the length of the material, and of 570 when cut across the material.

THE report of Mr. William Crookes, F.R.S., Dr. William Odling, and Dr. C. Meymott Tidy, on the water supplied to London during February, says that the general character of the water did not differ appreciably, in respect to the small proportion of organic matter habitually present, from that of the supply furnished now for some months past. Thus the mean amount of organic carbon found in the Thames-derived supply for the month was ·172 part in 100,000 parts of the water, as against a mean amount of ·183 part in January, and of ·170 part in December, corresponding to about three-tenths of a grain of organic matter per gallon.

IN May last the *Brewers' Journal* suggested that the enormous quantites of carbonic acid evolved from our breweries and distilleries should be profitably utilised, and calculated that in our breweries alone 500 million pounds, or 25,000 million gallons, of carbonic acid are annually thrown off into the atmosphere as waste. The subject has engaged the attention of a Glasgow chemist, who, in a paper read before the Society of Chemical Industry, estimates the carbonic acid now being wasted in our distilleries as being of the annual value of £150,000. This might be used in the Mather-Thompson carbonic acid continuous system of bleaching, which we illustrate elsewhere.

AN extensive quarry, where the beautiful antique marbles were obtained, covering 2000 acres, has been recently discovered in the province of Oran, near the Mediterranean coast, in Algiers. The deposit has been obtained by an Italian who has constructed roads and begun operations. A contemporary says:—"The deposit contains giallo antico, breccia, and cipoline, besides black and white marble. These fine coloured stones can be laid on the wharf at Oran for about 4s. per cubic foot. The beautiful yellow marble, giallo antico, has, until this late re-discovery, been unknown, save by the fragments found in Roman ruins two or three years ago."

IN London last week 2697 births and 2285 deaths were registered. Allowing for increase of population, the births were 238 below, while the deaths were 472 above, the average numbers in the corresponding weeks of the last ten years. The annual death-rate per 1000 from all causes, which had been 25·0 and 26·9 in the two preceding weeks, further rose last week to 28·7, and exceeded the rate in any week since February, 1882. During the first ten weeks of the current quarter the death-rate averaged 24·4, and exceeded by 0·4 the mean rate in the corresponding periods of the ten years 1876-85. The killing effect of the long continued cold weather is thus shown, and may be safely taken at the greater part of the 472 above average death-rate.

SOME time since a remarkable paper on the micro-organisms of potable waters, by Dr. T. Leone, was published in an Italian scientific journal, in which it was asserted that carbonic acid acts as poison on most of the microbia. If, therefore, a beer becomes flat, that is, loses its proper proportion of carbonic acid, it is rendered especially susceptible to the attacks of the parasitic organisms of yeast, which begin to develope and multiply at an alarming rate as the carbonic acid diminishes. If this view be correct, carbon acid, the *Brewers' Guardian* remarks, must be the best beer preservative, and ought to be added to or forced into the beer as soon as the supply of this gas diminishes.

THE two lenses of an achromatic object glass are cemented together with Canada balsam, the volatile part of which passes away after a time, and it frequently happens that air or moisture, taking the place of this, gives an iridescent appearance to the glass and interferes with correct delineation. To remedy this fault it becomes necessary to separate and clean the two lenses and readjust them, cementing with Canada balsam as before. Hitherto it has been customary, in order to effect the separation, to apply heat, and, however carefully this may be done, it sometimes happens that a lens is thereby cracked. All risk of fracture may be avoided by placing the achromatic combination in a small quantity of benzole or naphtha—from coal tar—within a covered vessel, either of which hydrocarbons will, in a day or two, dissolve away or soften the hardened cement without heat. The same liquid will remove the last traces of resinous matter.

SPEAKING of the density of the sun, Professor Lockyer, in a recent lecture, said if we take water as our unit of density, the density of the sun is 1·444. If we take the density of the earth as 1, then the value is about 0 25—practically a quarter. These values have been determined by taking the volume of the sun as given by the diameter of the photosphere—860,000 miles. Now, we have had to concede 100,000 miles for the height of one atmosphere above the photosphere, and 1,000,000 miles for another, and it is not fair that those atmospheres should be left out of consideration. If we include these atmospheres, though we do not alter the mass, we alter the volume. If we put the same mass into a bigger volume, we naturally reduce the density. Now, if we take the atmosphere of the sun as extending to 100,000 miles above the photosphere, that will give us a radius of 530,000 miles, instead of 430,000 miles, and we shall, as nearly as may be, double the sun's volume. Therefore we shall have halved the density. Instead of being a quarter as dense as the earth, it will only be one-eighth as dense ; and, instead of being just denser than water, it will be a little over half the density of water. The gases of the centre may put on the appearance, if they do not put on all the physical properties of liquids ; but be this as it may, in any region that we can get at, unfortunately limited to something like 400,000 miles away from the centre, we are undoubtedly dealing with masses of gas." In giving the density of the earth what height of atmosphere would Professor Lockyer include ; if he takes enough, he can reduce our density to a fraction of the 5·5.

AT a recent meeting of the Birmingham Philosophical Society, a paper on resistance at surfaces of electrodes in electrolytic cells was read by Dr. G. Gore, F.R.S. The author shows conclusively that the phenomena discovered by him, and to which he applied the term "transfer resistance," are not due to polarisation, some kind of electro-motive force, or any other form of opposing difference of electric potential, because they still remain when those causes are entirely absent. He selected various cases of voltaic inversion, in which a pair of different metals in an exciting electrolyte produced no difference of electric potential and no voltaic current, and examined them for "resistance" and differences of "resistance" at the immersed surfaces of the two metals. He first tested them by a "bridge" method, and then by a "condenser" one, also described, and gives the results ; and in every case he found that the "resistance" still existed, and was different in amount at the two plates. In each case the plates were of equal sizes. He also took several cases in which a pair of plates of the same metal, but of different sizes, were immersed in an exciting electrolyte, and tested them similarly, and found abundant evidence of "resistance," different in amount at the two plates in each instance. He asks: "Is the phenomenon I have discovered really of the nature of ordinary electric conduction resistance? If it is its characters will agree with the most essential ones of that influence. It agrees in several important points with that resistance. First, it is not able to produce a current ; secondly, it is usually small with those liquids in which ordinary resistance is small ; and thirdly, it is considerably reduced in liquids by rise of temperature, it also, when overcome by current, evolves heat." He concludes by remarking that it performs an important part in the action of all voltaic batteries and eletrolytic cells, and calls attention to the circumstance that one important practical application of it has been made in the electro-metallurgical purification of copper on the large scale where a great saving has been effected by arranging the depositing vats in multiple series, and thus diminish the transfer resistance. It was in the year 1831 that the first attempt to discover this kind of resistance was made by Fechner.

MISCELLANEA.

MEDALS for long service and good conduct have been awarded to R. J. Crabb, stoker, of the Himalaya ; R. H. Huxley, leading stoker, of the Rupert ; G. Betteridge, engine-room artificer, of the Asia ; and J. H. Morgan, artificer, of the Vernon.

PONTEFRACT is much agitated concerning its water supply, and a long report by Mr. Geo. Hodson, C.E., with numerous analyses of water at present supplied and of proposed sources is being much discussed. He proposes a new supply from the Bunter beds not far from Pontefract.

THE first portion of the big contract for bricks needed by the Mersey Railway Company for the extension to New Brighton has been placed with a West Bromwich firm. The quantity given out is some 40,000 tons, mostly blue bricks, and the remaining 60,000 tons is for the present held over by the contractors. The firm which has taken the order is, it is understood, hoping to secure a reduction in railway rates to Birkenhead of perhaps 3s. per thousand.

SAMPLES of bevel pinions with beautifully clean, well formed teeth, have been sent us by Mr. Alexander Dick, of Cannon-street. They are 3in. in diameter, and are stamped out of a piece of 1·25 delta metal round bar at one blow and at a dull red heat. The tensile strength of this bar is 33·9 tons per square inch, the elastic limit 21·8 tons, total extension 21·6 per cent. The bevel wheels are apparently suitable for any engineering work without any subsequent work.

ON Tuesday afternoon, in the entrance channel to the Bute Docks, Cardiff, the steamer Rhyle, of and for Bute, with iron ore, from Bilbao, was in collision with the steamer International, of Newcastle, which had just left the Mount Stuart Dock. The latter steamer was cut right down to the light water-line, about 20ft. on the port side abaft the engine-room. She soon filled and sank aft. The Rhyle had her stem broken and bows stove in, but docked soon after the collision. Several of the crew on board both vessels had very narrow escapes.

THE War-office have recently entrusted to Messrs. Merryweather and Sons, of London, an order for the supply of a powerful double cylinder steam fire engine for the protection of the Birmingham Small-arms Factory, and similar to two engines of equal power constructed by that firm for the protection of the Royal Small-arms Factory at Enfield in 1874, but with all the latest improvements. These engines are capable of delivering two, three, four, or even six powerful jets simultaneously, and of forcing water through several thousand feet of hose in cases where the water supply is at a distance.

THE Cunard steamship Oregon was run into at the third compartment by an unknown schooner on the 14th inst., about eighteen miles off the Fire Island light, Long Island, and sank about one o'clock in the day in about twenty-two fathoms of water, all the passengers being safely put into vessels and landed at New York. She was thus about eight hours between the time of the alleged collision and going down, and one would have thought might have steamed into harbour, or at least shallow water. The noise of the collision is said to have been like the report of a cannon. Was there a collision or was it an explosion of some kind?

"SOME idea," says the *Bombay Gazette*, "of the energy with which the work in connection with the extension of the Prince's Dock is carried on may be formed from the fact that nearly ten thousand persons are constantly employed on the excavations, &c. The difficulties of the work are, of course, enormous, but they are gradually being overcome by perseverance and engineering skill. Considerable progress has already been made, and the future prospects of the scheme are most encouraging. The expenditure on the dock extension works during the ensuing year is estimated at 3,695,500 rupees. Government has agreed to guarantee the necessary loan, and negotiations are now proceeding.

REFERRING to Sir Frederick Abel's address on mining explosions, Mr. W. Galloway writes that Sir Frederick Abel has not fortified his statement by even one quotation from the writings of one of those workers "antecedent to and contemporaneous with" himself, who have taken the variable specific heat of air into account in drawing comparisons between experimental effects obtained in practically open apparatuses and the corresponding effects to be expected in a great explosion taking place in the practically closed space represented by the workings of a mine. Secondly, Mr. Galloway says he is entirely at a loss to know what are the "very obvious facts" which forbid the conclusion at which he has arrived, namely, that coal dust plays the principal part in most great explosions in mines. They have not yet been pointed out by any author.

AT a recent meeting of the Liverpool Engineering Society, a paper on "Brick and Masonry Arches" was read by Mr. A. Wharton Metcalfe. The object of the author was to contrast the empirical and theoretical modes employed in the design of arches, and by presenting certain tables derived from the general equation to the equilibrium curve to illustrate the great advantage of the latter mode. By means of these tables the construction of the true curve of an arch becomes an easy matter. The author also considered briefly the mechanical and graphical means for drawing the linear arch, and gave tables derived from actual examples prepared in the office, and calculated from the general equation to the linear arch. In dealing with such practical questions as the relative merits of brickwork and masonry in arches, some valuable information was given, derived from the practice and experience of Mr. Charles Richardson, the engineer to the Severn Tunnel.

IN view of the second reading of the Bill introduced by Lord Rayleigh to amend and extend the Electric Lighting Act, 1882, a report has been presented by the committee appointed to consider the matter at the instance of the President of the Board of Trade. The committee have arrived unanimously at the conclusion that the electric light companies should demand to be put simply in the same position as the gas companies are, both as regards their privileges and their obligations, inasmuch as they believe no satisfactory solution of the question of general electric lighting can be arrived at by amending the Act on the basis of a modified purchase option clause, and the conclusion itself is clear and intelligible, and will commend itself to the public by its fairness and simplicity. Electric light companies may safely undertake the business of general lighting under conditions entirely similar to those of the gas undertakings, and the committee have prepared the draft of a Bill, which Lord Rayleigh will present to Parliament. While unable to accept any purchase option clause, the committee think it quite right that all reasonable facilities should be given to local authorities to acquire electric lighting undertakings by agreement.

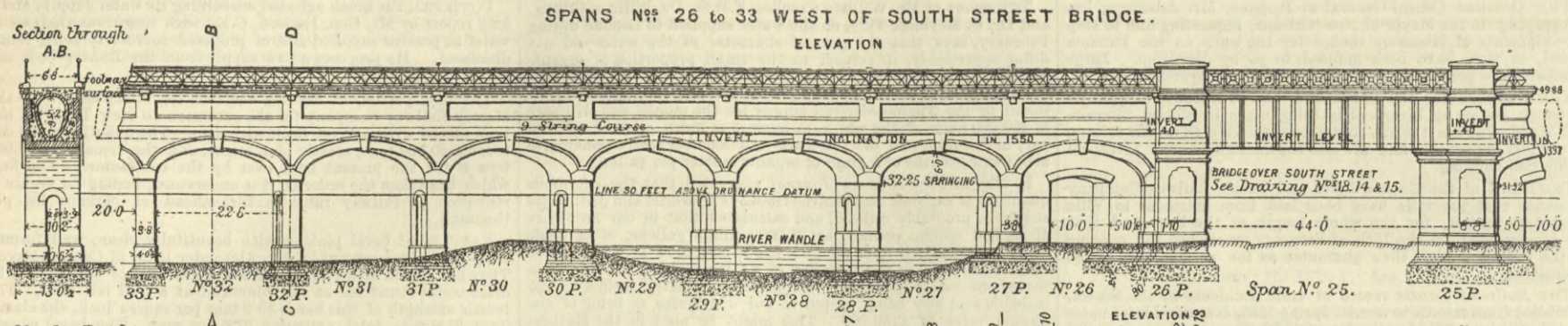
THE completed statistics of the steel and iron returns for 1885 give the exports of iron and steel as value £21,717,136, compared with £24,496,035 for 1884 and £28,590,216 for 1883. As compared with December, 1884, the exports of iron and steel for the month show a decrease of £191,199; for the year, as compared with 1884, the decrease is £2,778,899. Pig iron has been exported to the value of £2,090,091 in 1885, against £2,945,223 in 1884; for the month of December, £114,278, as compared with £115,490 for December, 1884. Bar, angle, and bolt iron, £1,621,702 for 1885, against £1,942,294 for 1884; for the month, £114,852, against £182,876 for December, 1884. Steel rails, £2,667,567 for 1885, against £2,893,019 for 1884; for the month, £138,753, against £186,774 for December, 1884. Railroad iron of all sorts, £3,896,563 for 1885, against £4,142,663 for 1884; for the month, £270,220, against £305,963 for December, 1884. Hoops, sheets, and plates, £3,288,509 for 1885, against £3,693,001 for 1884; for the month, £264,813, against £305,868 for December, 1884. Hardware and cutlery, £2,849,459 for 1885, against £3,142,711 for 1884; for the month, £246,893, against £239,780 for December, 1884. Steel, unwrought, £1,027,583 for 1885, against £1,127,481 for 1884; for the month, £92,987, against £84,385 for December, 1884. Steel and cutlery, though exhibiting a falling-off for the year, show an improvement in December.

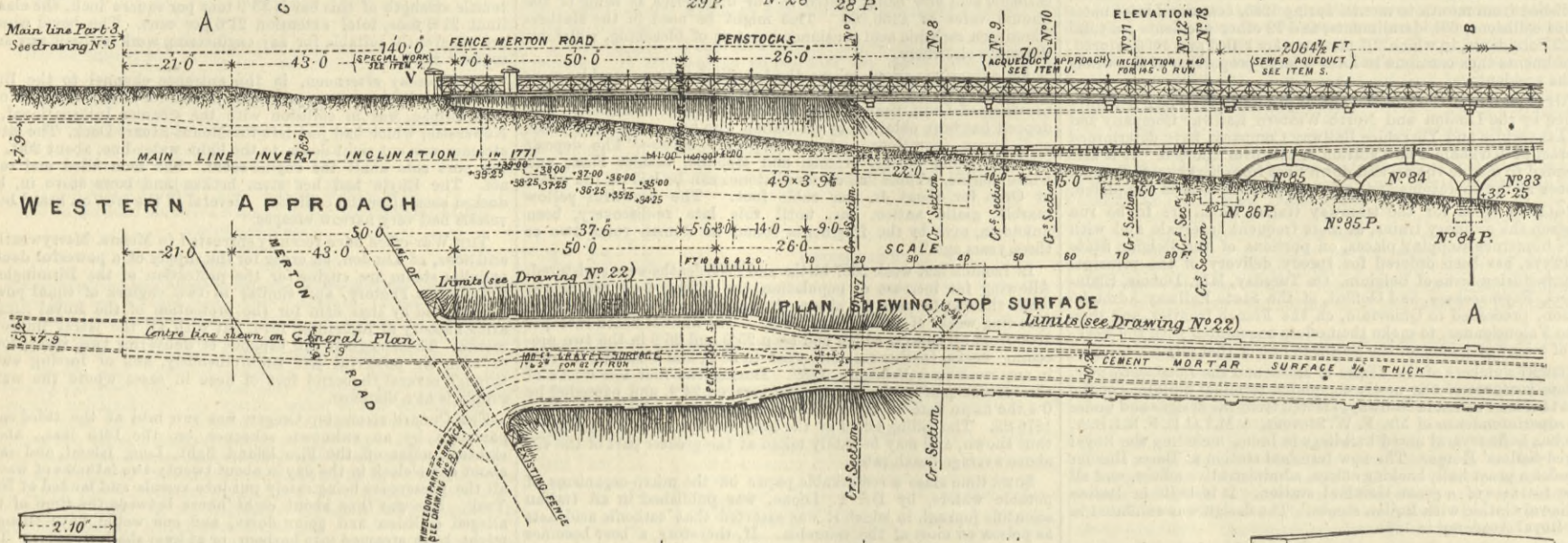
NEW SEWERS AND SEWAGE AQUEDUCT AT WANDSWORTH.

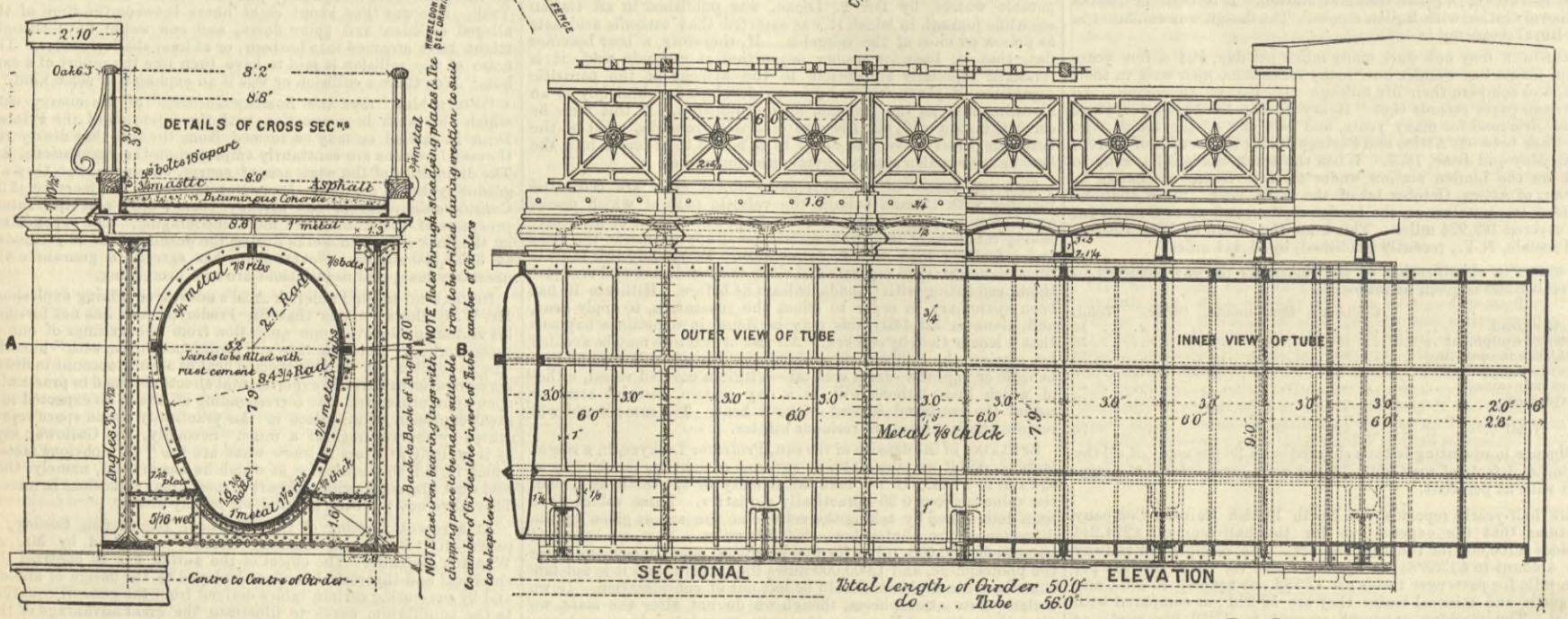
SIR J. W. BAZALGETTE, M.I.C.E., ENGINEER.

(For description see page 231.)

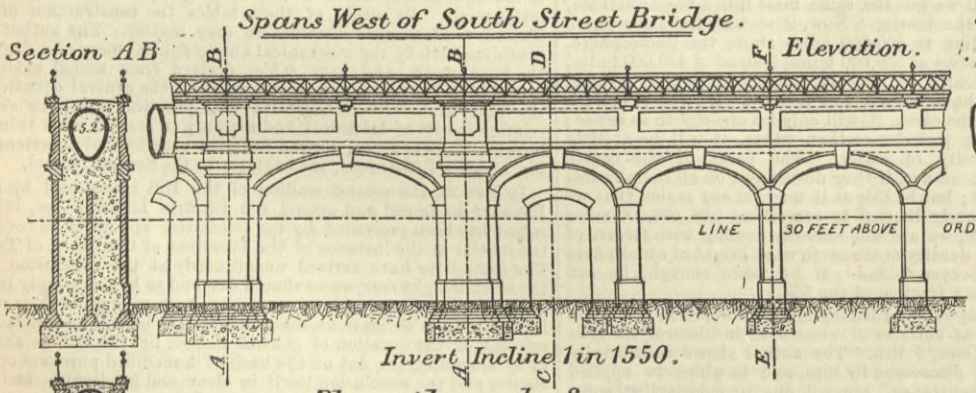
SPANS Nos 26 to 33 WEST OF SOUTH STREET BRIDGE.







Spans West of South Street Bridge.



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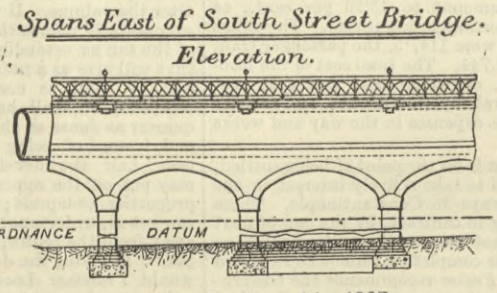
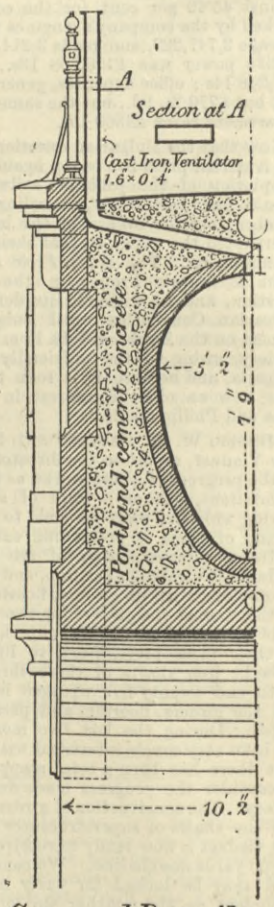
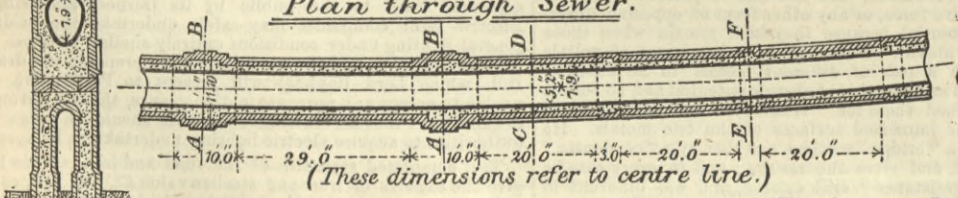
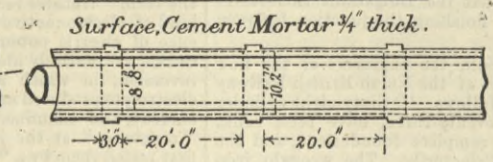




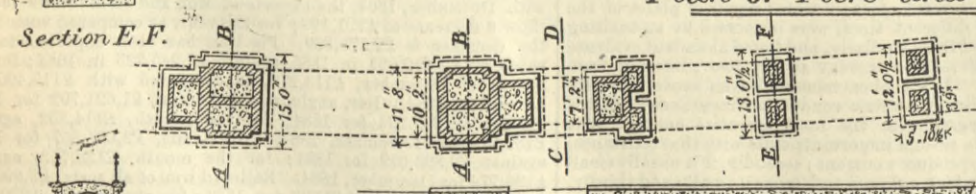
Plan through Sewer.



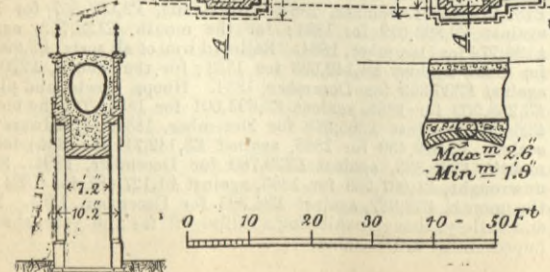
Plan at Surface of Footway.



Plan of Piers and Footings.

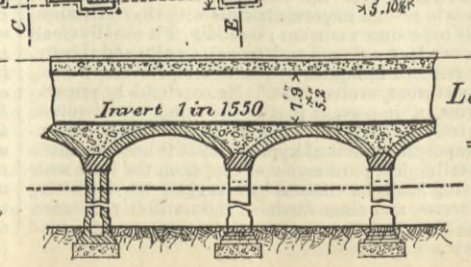


Section E.F.



Section C.D.

Longitudinal Section



General Details of Cross Section.

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*** *With this week's number is issued as a Supplement, a Conversion Table for French and English Measures—No. II., Areas. Every copy as issued by the Publisher contains this Supplement, and subscribers are requested to notify the fact should they not receive it.*

CONTENTS.

TO CORRESPONDENTS.

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

*** *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.*

S. M.—*Messrs. Salter and Co., Spring Works, West Bromwich, can supply what you want.*

H. T. J. (Pittsburgh).—(1) *There is no such book as you want in existence.* (2) *Royal Institution, Albemarle-street, London.*

H. K. (Tower Hotel, Liscard).—"*Marine Engineering,*" *by A. E. Seaton, of Charles Griffin and Co., Exeter-street, London.*

G. H. B. (Newhaven).—*Joy's valve gear has been repeatedly illustrated in* THE ENGINEER. *See pages* 68 *and* 73 *in our last volume.*

MID-AIR.—*If the mercury is boiled first in the tube, and precautions used to prevent the entrance of air, the vacuum will be practically perfect, save for a small quantity of mercury vapour. A better vacuum exists in the globes of incandescent lamps. The air is extracted from them by a Sprengel pump.*

RAILWAY SIGNALLING.

(To the Editor of The Engineer.)

SIR,—Could any of your readers inform me of the best work on railway signalling? SIGNAL.

London, March 17th.

MOULDING AND STAMPING SOAP TABLETS.

(To the Editor of The Engineer.)

SIR,—We require the address of any makers of machinery or moulds for moulding and stamping soap tablets. J. G. AND S.

Accrington, March 12th.

FILTER PRESSES FOR WHOLESALE CHEMISTS.

(To the Editor of The Engineer.)

SIR,—Will you kindly let me ask the address of an engineering firm who make filter presses for wholesale chemists, with frames 2ft. 6in. to 3ft.? J. R. D.

Cork, March 11th.

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

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

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS, 25, Great George-street, Westminster, S.W.—Tuesday, March 23rd, at 8 p.m.: Ordinary meeting. Three papers to be discussed, "The Economical Construction and Operation of Railways in Newly-developed Countries, or where Small Returns are Expected," by Messrs. R. Gordon, J. R. Mosse, and G. C. Cuningham, MM. Inst. C.E. Friday, March 26th, at 7.30 p.m.: Students' meeting. Paper to be read, "The Construction of the Hirnant Tunnel on the Line of Aqueduct of the Vyrnwy Waterworks for the Supply of Liverpool," by Mr. William Andrew Legg, Stud. Inst. C.E. Mr. James Mansergh, Member of Council, in the chair.

SOCIETY OF TELEGRAPH ENGINEERS AND ELECTRICIANS, 25, Great George-street, S.W.—Thursday, March 25th, at 8 p.m.: The following paper will be read, "Electric Lighting by Means of Low Resistance Incandescent Lamps."

KING'S COLLEGE ENGINEERING SOCIETY.—A general meeting will be held on Tuesday, March 23rd, at 4 p.m., when Mr. A. Collins will read a paper "On Sanitary Houses."

SOCIETY OF ARTS, John-street, Adelphi, London, W.C.—Monday, March 22nd, at 8 p.m.: Cantor Lectures. "Petroleum and its Products," by Mr. Boverton Redwood, F.I.C., F.C.S. Lecture III.—Manufacture of petroleum and shale products: naphtha, burning oil, lubricating oil, paraffine, methods of distillation and purification. Barrel and case making. Testing: flashing point, viscosity, lubricating power, melting point, &c. Tuesday, March 23rd, at 8 p.m.: Foreign and Colonial Section. "Canada and its National Highway," illustrated by lantern views, by Mr. Alexander Begg. Sir Charles Tupper, K.C.M.G., High Commissioner for the Dominion of Canada, will preside. Wednesday, March 24th, at 8 p.m.: Sixteenth ordinary meeting. "Domestic Electric Lighting," by Mr. W. Preece, F.R.S. Sir Frederick Abel, C.B., D.C.L., F.R.S., will preside. Thursday, March 25th, at 8 p.m.: Applied Chemistry and Physics Section. "Certain Appliances for the Utilisation of Refuse and Dust Fuels," by Mr. Walter G. McMillan, Demonstrator of Metallurgy at King's College, London.

DEATHS.

On Nov. 5th, 1885, at Fielding, New Zealand, Mr. EDWARD WRIGHT, C.E., of paralysis.

On the 12th inst., at Worthing, ALFRED BURGES, C.E., F.S.A.

On the 14th inst., at 1, Cromer Villas, East-end, Finchley, Mr. ROBERT DAVISON, M.I.C.E., aged 82 years. Friends are requested to accept this intimation.

THE ENGINEER.

MARCH 19, 1886.

THE LOSS OF THE OREGON.

THE foundering of the Cunard steamer Oregon—which occurred on Sunday last—about fifteen miles from the American coast, is an event calculated to somewhat shake the confidence of transatlantic voyagers in regard to the supposed immunity from danger enjoyed by the magnificent lines of steamers which run regularly between this country and the United States. There can be no doubt that the Atlantic passenger service has been conducted for very many years past in a manner which is most creditable to all concerned in the management of the principal steamship companies engaged therein. So few have been the accidents and so trifling their consequences, that statistics have been prepared with a view to proving that it is safer to cross the Atlantic in a Cunarder than to stay at home. Making all allowances for the fallacies contained in such calculations, it must still be admitted that the element of danger in Atlantic voyages on board these large and carefully navigated steamers has been reduced to a minimum. It is a most satisfactory fact in connection with this recent disaster, that it has not been attended with any loss of life so far as regards the Oregon herself; although, it is said, that the vessel which ran into her has been lost with all hands. The excellent record of the Cunard Company seems therefore to remain unbroken, and it may still boast of not losing a life confided to its care. It is, however, terrible to consider what might have been the consequences had the catastrophe occurred in bad weather, in the middle of the Atlantic, and with no assistance at hand, such as was afforded by the Fulda and a pilot boat. The contemplation of this contingency leads us to consider, with more than usual interest and anxiety, the circumstances attending the disaster and the lessons they point to in regard to the construction and internal arrangements of these vessels.

The Oregon was an iron screw steamer of 7375 tons gross register, built and engined in the year 1883 by the well-known firm of John Elder and Company, at Fairfield, Govan, for the Guion Line of Atlantic steamers running between Liverpool and New York. She was designed to beat the Alaska, which up to that time had made the quickest passages on record. Her dimensions, viz., 501ft. by 54·3ft. by 38·0ft., were such as to make her the fifth largest steamer in the world, and her indicated horse-power of rather more than 12,000 gave her upon her trial run a speed of 20 knots per hour. The subsequent performances of the Oregon have well maintained her reputation for swiftness, although faster passages have been made by some of her competitors. That she did, however, on one occasion steam from Liverpool to New York in 6 days 9 hours and 22 minutes sufficiently establishes her claim to be classed as one of the fastest Atlantic racers. She was, in fact, a successful vessel, and a creditable specimen of the naval architecture of the ninth decade of the century. But notwithstanding this fact, she has been ostensibly sunk by a comparatively small wooden schooner, and the lives of 638 passengers and a very numerous crew have been thereby seriously imperilled. Not long after she was built, the Oregon became the property of the Cunard Company, and it is as a Cunarder that she has been so ignobly sent to the bottom of the sea. The circumstances attending that disaster will no doubt be carefully investigated by her owners—who, it appears, have suffered very heavily thereby. They will also be the subject of other and, perhaps, official inquiry; for surely no maritime event can more properly be the subject of national concern than one in which so many lives as this vessel carried were placed in jeopardy.

The Oregon when the disaster occurred had nearly completed a voyage from Liverpool to New York, being at the time only a few miles from Fire Island. At about half-past four o'clock on Sunday morning, during fine, clear weather, a three-masted coasting schooner was, it is stated, suddenly discovered bearing down upon her port side. It is a noteworthy fact that no trace of the wreckage of this schooner has been found, and no schooner is known to be missing. In fact, the available evidence that any collision took place is extremely small, and at the other side of the Atlantic it has been plainly stated that a hole was knocked in the ship's side by an explosion of some kind. It is, indeed, very difficult to see how a small schooner could make a tremendous aperture in the side of such a ship as the Oregon. All this is, however, for the present matter of conjecture. It is alleged by the officers of the Oregon that the schooner did not show her lights until it was too late to avoid her; but it is difficult to understand how it could happen that in the light of the early morning such an object was not seen by the look-out men, if the statement regarding the lights is correct. Be this as it may, the schooner, we are told, struck the steamer at about midships, thereby making a hole in the port side which has been variously described at one time as 8ft. in diameter, and at another as large enough to drive a team of horses through. Whatever may have been the exact area of this hole, it seems by all accounts to have been a large one, and the water thereby admitted into the damaged compartment would be sufficient to fill it in a few minutes. Now nothing can be clearer than this fact—that if the filling of the one compartment into which water was admitted by this hole was sufficient to sink the Oregon, then she must have gone down almost at once. The Oregon had nine transverse watertight bulkheads, and if the ten compartments were all of equal size, the length of each would be about 50ft. As a fact, some were longer and others were shorter than this; but it was well understood when she was admitted to the Admiralty selected list for chartering as an armed cruiser or transport in time of war, that the bulkhead subdivision of the Oregon was satisfactory, and in accordance with the Admiralty requirements. It was only last year that the Oregon was taken up by the Government and armed as a cruiser—so that if any steamer in the mercantile marine was in a condition to suffer damage by the penetration of her side plating with comparative impunity, it must surely have been this vessel, which has now been sunk, it is stated, by a small schooner. As we have said, the accident took place at half-past four in the morning; an immense hole was made in the midship part of the vessel, and yet she remained afloat for eight hours afterwards. It is this remarkable circumstance above all others in connection with this case, that especially calls for inquiry. Whether there was care or otherwise in the navigation of the Oregon is, of course, also a proper subject for investigation; but it is one which is far subordinate in importance to the structural questions arising out of the disaster. That men entrusted with heavy responsibilities are sometimes negligent, and that they often commit errors of judgment, everybody knows, and when they do it is necessary for the good of society that retribution should follow. Whether anything of the kind occurred in this case we do not know, nor would it be right to offer any opinion thereon with the evidence at present available. But while man will always be fallible, it is at least possible to perfect the instruments committed to his keeping, and upon that account it is most important that the lessons taught by this disaster should be carefully studied with a view to avoiding in the future those errors of design and equipment which led to this vessel's foundering.

It is alleged that after the first collision between the schooner and the steamer there was a rebound, whereby further damage was done; but it does not appear that this second blow materially contributed to hasten the ultimate effects of the collision. From the fact that the stokehole fires were put out, it seems that the Oregon was struck in her machinery compartment, and if this was the case then the injury done to her was the greatest possible of the kind, for in large passenger steamers the machinery occupies the greatest subdivision of the vessel. Whichever compartment it was that was penetrated, the inrush of water was irresistible, and the space was quickly filled. If the loss of displacement due to this cause was sufficient to sink the Oregon, she would, as we have said, have sunk speedily. That it was not sufficient to sink her is evident from the fact that she remained afloat long after she was abandoned, and did not go down until a quarter to one p.m. How, then, did it happen that she foundered at all? That upwards of eight hours were occupied in the inflow of sufficient water to carry the Oregon to the bottom, points to a slow rate of ingress to other compartments than that which was penetrated. In other words, the transverse bulkheads were not watertight. Now, this want of water-tightness may have arisen in one or more ways, and it is to this point that we desire to call particular attention. Either the bounding bulkheads were not sufficiently strong to endure the pressure due to the compartment being filled to the height of the load-line in the deeply immersed condition of the vessel, or there were openings in it which should have been, but were not, closed directly the disaster occurred. It is alleged by the captain that all the water-tight doors were closed, and it is possible that such was the case. But the circumstances are strongly suggestive of either the partial closing of these doors, the opening of sluice valves, or the existence of apertures for the passage of ventilation or other pipes. If neither of these conditions existed, then the bulkheads must have given way. Certain it is that that water which should have been limited to a compartment that was not large enough to sink the vessel, found its way ultimately to others, until enough water was in the hold to sink her down to her ports and other openings. When this point of immersion was reached, the foundering quickly followed.

It is impossible to say what were the exact facts in this case, and it may be that the truth of the matter will never be fully determined. But the conditions of bulkhead watertightness and efficient subdivision of compartments which existed in the ill-fated Oregon are not

now subjects of such vital importance as those which are to be found in her surviving sisters. The great value to be derived from a discussion of the possibilities and probabilities in her case is found in the improvements which may thereby be suggested in the corresponding arrangements of other vessels built and building. A short time ago the construction of collision bulkheads was considered in the columns of this journal; and suggestions were then made in regard to the proper connection and stiffening of these bulkheads, which will apply with almost equal force to the transverse bulkheads throughout the whole of a steamer. The transverse bulkheads of vessels are not, as a rule, made strong enough to resist the pressure due to considerable heads of water. The curvature of a vessel's side contributes an element of stiffness, and the side plating is supported by girder-like frames spaced at intervals of about 2ft. In addition to these there are stringers — side keelsons and beams — to keep the plating at its work and give the necessary strength to the structure. But while the side and bottom plating may be from $\frac{3}{4}$in. to 1in. in thickness, the flat-surfaced transverse bulkhead is only about $\frac{7}{10}$in. thick, and its stiffeners consist of vertical angle irons spaced 30in. apart on one side, and horizontal angle irons spaced 48in. apart on the other. Stringers and beams there are none to support the transverse bulkhead, and, as a consequence, when the latter is called upon to fulfil its true functions, it is too often found wanting in ability to do so. If the efficiency of bulkheads was as habitually tried as that of bottom plating, there can be no doubt that we should have stronger and stiffer bulkheads; but because a bulkhead may never be called upon to do the duty for which it exists, it is to be feared that shipbuilders have been contented with making them less strong than they should be. If a bulkhead forms the end of a deep ballast tank it is stiffened with bulb plates and angle irons. Why then not always stiffen bulkheads in some such a way, considering that the time may come when the safety of the ship and all on board may depend upon their strength and stiffness?

But even were bulkheads always strong enough, it might still happen that sufficient care would not be taken in keeping watertight doors and sluice valves in good working order, and in training the members of the crew so that each man would know his proper post—whether it be to screw down a door or a sluice valve—when a collision occurs. In the case of the Oregon, it seems as if something happened very different to what was contemplated by those who designed and built her. The question before us is whether the same something may not occur again in another passenger steamer under less favourable circumstances. The case of H.M.S. Vanguard was very similar in some respects to that of the Oregon, for although the former vessel was badly rammed by the Iron Duke, she yet kept afloat one hour and forty minutes afterwards, thereby showing plainly that she was not sunk because she was rammed, but because a manhole door in a wing passage bulkhead was open. That is to say, although she was rammed and a compartment thereby filled with water, she would not have sunk had that manhole been properly shut, as it was intended to be by her designer. What was the particular opening in the Oregon, or whether there was an opening at all, will perhaps never be discovered. It is possible, and indeed likely, that the bulkheads gave way under the great head of water pressure. But whatever may have been at fault, the Oregon should not in our opinion have sunk, considerable as was the damage inflicted upon her.

THE ROYAL AGRICULTURAL SOCIETY.

Can it be said that the Royal Agricultural Society represents agricultural engineering? We think there can be but one answer to this question. It does not. All that the Society now does is to supply space to exhibitors at an exorbitant rental. Bearing in mind how much engineers add to the attractions of the annual shows, this is to say the least but scant justice. The whole policy of the Society is undoubtedly wrong, narrow-minded, and selfish in this respect; and it is matter for wonder that the agricultural engineers have so long submitted to the exactions of the Society, or rather of the majority of the governing council, without uttering a protest in very strong language. The Society annually gives away in prizes for stock thousands of pounds. Less than £100 is devoted to the improvement of machinery. We maintain that this is flatly opposed to the intentions of its founders, and we know that it is a policy strongly deprecated by a large number of its members. For what does the Society exist? Certainly not to provide comfortable and well-paid appointments for a number of officials. Its purpose is to develope, and encourage the development of, the art and science of agriculture in Great Britain. It was not founded, and it is not intended, to be only the great patron and developer of stock, sheep, and horse breeding. Its legitimate range is much wider than this. England is quite as much indebted for progress in agriculture to the mechanical engineer as it is to the stock-breeder. If we were without excellent ploughs, portable engines, threshing machines, reaping machines, and the whole host of mechanical appliances now found on every well-managed farm, what would be the position of Great Britain? All the excellence of our stock could not enable us to hold our own with other nations for a moment. Are tillage farms of so little account that a beggarly £100 is all that a great society can devote to them, while £3000 or £4000 can be spent in prizes for horses, cattle, sheep, and pigs? The thing is absurd on the face of it.

To what shall we look for the cause? It is to be found in the circumstance that while the majority of the council is not composed of engineers, but of men with whom stock breeding is a delight, the engineers forming the minority are men who, having won prizes years ago, are fully determined that the funds of the Society shall not be devoted to developing new inventions which may leave their prizes worthless. That there are exceptions in the governing body we admit with pleasure; but they are far too few to possess any weight or influence. The earnest protest of Mr. Jenkins, who ought to know as well as any man what is and what is not good for the Society, has fallen on cold and unwilling ears, and the show to be held this year at Norwich will more than ever be devoted to cattle, and less than ever to the fostering of invention. It is scarcely possible that the Royal Agricultural Society understands the full effect of its short-sighted policy. Let us try if in a few words we can indicate some of the injuries done.

For a great many years the English portable engine possessed a world-wide reputation. It was to be found in every civilised country. Competitor it had practically none. One reason was that foreign engineers did not believe that anything like finality had been reached. Every year, for many years, our improvements appeared on the Continent; and as the foreign purchaser was resolved to have nothing but the best, foreign makers refused to compete. It was not worth while to start on the manufacture of an engine this year which was certain to be superseded by something better from England next year. But it has at last dawned on the continental mind that we have reached the end of our resources, and that any portable engine built within the last six or seven years represents the best that England can do. So the foreigner has plucked up courage, and we have every reason to believe that a strong competition is in store for us in this direction. Will any unprejudiced reader turn to our impression for February 5th, and compare the portable engine which he will find therein illustrated with an English engine, and say if there is a wide dissimilarity. The design is one of which no English engineer need be ashamed. We have lying before us the circular of Messrs. Platz, Söhne, of Weinheim. This firm manufactures a portable engine so closely resembling one now made for some years by Messrs. Marshall and Co., of Gainsborough, that it is not easy to detect the difference. In one word, we have at last taught the foreigner how to build good engines, and he is going to build them. The foreign agents of our own firms know, if they would but confess it, that they are told to their faces that better portable engines can be had abroad than can be had from England. They are told that we are past improvement; that we can do no better than we have done. Have English engineers justified the assertion or not? A prominent member of the governing body of the Royal Agricultural Society, not long deceased, once told us that the steam engines sold by his firm were already too good for the price, and that he would certainly oppose any action on the part of the Royal Agricultural Society which would even tend to introduce any change which would render a departure from his own standard type necessary. This ostrich-like policy has done much harm, and will do more. Nor is it in engines alone that we are being beaten. The drill trade has almost died out. The foreigner makes for himself what suits his purpose better than our drills did. There has been no attempt at improvement in drills made in England for many years. Only this week we have had brought under our notice an American drill which is simply revolutionary, not so much in its principle as in the details of its construction. It is full of dainty devices for putting work together without hand labour of any kind—almost without the aid of a machine tool indeed. Assuming this to be only half as good as it looks, it is a distinct departure which, if it does nothing else, will permit the English machine to be fearfully undersold. Can it be denied that the energetic action taken years ago by the Royal Agricultural Society in the matter of reaping machinery helped the country enormously in beating off American competition? Can a single instance be cited in which the past influence of the Society when exerted in the development of machinery and implements has not been an unmixed good? We dare to say not one; and it is a noteworthy fact that the justice of the awards made by the Society's judges of implements have met with less criticism than the awards of any other judges whatever.

The question which we wish now to bring prominently before, at least enterprising agricultural firms, is this:—As the Royal Society refuses to do anything for the engineers, would it not be well that the engineers should decline to exhibit at the Royal shows, and should, on the contrary, strengthen, as far as possible, the hands of some other body, as, for example, the Bath and West of England? This latter society might very easily acquire sufficient prestige to give its prizes a very high value. Suppose, for example, that it announced that it would give gold medals for the best and most economical 10-horse power portable engine. There would be no lack of competitors on one condition, namely, that the tests were carried out with all modern refinements by a competent staff. The cost of the trial need not be considerable, provided care was taken that it did not cover too large a range. The publication of the results of such a trial, and the possession of a gold medal, a silver medal, or even an honourable mention, would prove of very great value to the lucky possessor. The value of the prizes given by the Royal Agricultural Society did not depend on the position of the Society, but on the experience, care, and skill with which its trials were carried out. The fact that such men as Bramwell, Cowper, Anderson, and Rich conducted them was sufficient to impart a remarkable worth to them. A medal awarded by such judges was more valuable and more valued than any other medal that could be won at home or abroad. But there was nothing about the conditions that cannot be followed or adopted by other bodies. We have heard it argued that medals and awards are no good, that they do not help trade, and possess no real value. The men who spoke thus either possessed no trophies, or did not themselves half believe what they said; and we have little doubt but that if medals were to be had again for the winning, they would compete just as they have done before.

Whether any action be or be not taken in the direction we have indicated, we would earnestly ask engineers whether it is really to their advantage to go on exhibiting at the Royal Agricultural Society Shows? They are admitted to the yard, so to speak, on sufferance. They meet with no particular attention or civility. They incur tremendous expenses. Do they reap any adequate return? There can be but one answer—they do not. If all firms would follow the excellent example set by one or two, the Royal Agricultural Society would be taught a lesson which it richly deserves; and the hands of those who wish to see it resume the discharge of all its legitimate functions would be strengthened. If it could be argued that the engineers never did anything for the Society, the Society might have grounds for refusing to spend money on the engineers, although we entirely dispute that such a policy can be justified at all. But what are the facts? We quote from a very clever address delivered before the Farmers' Club, Salisbury-square, on the 1st instant, by Mr. McLaren, of Leeds:—"I have taken," said he "the trouble to look through the *Royal Agricultural Society's Journal* reports and cash accounts, and I find that for the ten years beginning with the Taunton Show in 1875, and ending with the Shrewsbury Show in 1884, the implement exhibitors have contributed, under the heading of entry fees, payment for shedding, and description of their entries in the catalogue, the sum of £47,139, while the total contributions of the exhibitors of stock have only amounted to £6498. In this period the amount of money awarded in prizes to implements of all sorts amounted to £697, and the cost of trials and judges' expenses to £2925, or £3622 in all, including the enormous cost of the stack-fan trials at Reading. On the other hand, the sum divided amongst exhibitors of live stock, including expenses of judges, amounted to £61,979. Of this sum four exhibitors of stock, Lord Ellesmere, Mr. Hutchinson, Mr. Farthing, and Lord Falmouth have drawn £3920 in prize money for stock alone, or more than five times the amount of money divided amongst all the implement exhibitors put together. The amount offered in prizes for the Norwich Show this year is divided as follows:—For stock nearly £5600 and for implements £70—with the usual offer of medals to which I have referred. Now, I respectfully submit that a great deal of the money thus given away in stock prizes is simply wasted, and that the 'Royal' could have rendered a far greater service to agriculture by a more judicious expenditure of these enormous sums of money. If a silver medal worth 7s. 6d. at the outside, be considered a sufficient encouragement for an engineer to spend years of study, and risk large sums of money in perfecting labour-saving machinery, surely the same inducement would suffice to encourage an aristocratic horse or pig-breeder. The grand object of all is the same. The horse and pig-breeder command better prices for their prize wares, just as the engineer does for his, in virtue of the award itself, and quite apart from its intrinsic value."

It is impossible, we think, to put the facts in a clearer light. If engineers continue to submit to the treatment which they have endured, they will manifest less wisdom than we give them credit for.

ENGINEERING AT CAMBRIDGE UNIVERSITY.

For some years past the authorities of Cambridge University have established a school for the study of engineering. Every effort has been made by them, as well as by the distinguished Professor who presides over that branch of the University curriculum, to impart to such a study a practical character. Workshops have been erected and machinery has been provided for the training of students, and so large a measure of success has attended the effort that an endeavour is now being made to secure the grant by the senate of a Tripos examination in engineering. If this be accorded, it is held that, ultimately, students passing that examination will—to quote the words of a recent writer on the subject—"obtain the best engineering certificate in the world."

Now we cannot but favourably regard any effort in the direction of securing for our profession a distinct recognition of its scientific position. We may be sure, besides, that young men who have availed themselves of the tuition afforded at Cambridge in such a degree as to pass a Tripos examination, with its assuredly high standard, will be thoroughly well-grounded in that knowledge of all the branches of science which is necessary to make a competent engineer. But having secured that position, it may well be asked by those whose experience in practical work has been life-long, how far a successful student has qualified himself to follow in their footsteps? The knowledge which constitutes the groundwork of an engineering education does not and cannot constitute by itself an engineer. Much more has to be acquired before anyone responsible for engineering work would depute any part of that responsibility to another. We well recollect the governor of the Royal Military Academy at Woolwich—Sir Lintorn Simmons — addressing the cadets who had been successful in obtaining commissions in the Royal Engineers in words to the following effect:—"You will, gentlemen, if you think you leave this Academy as engineers, fall into a very great and dangerous mistake. Your education in that capacity is really only about to begin, and it will occupy you your lives." Such a warning may well be addressed to parents or friends who believe that their charges who may pass the proposed Tripos examination will be fitted to secure at once adequately remunerative employment. It should be remembered that a young man who has so qualified himself is scarcely likely, owing to the rules as to age which govern admission to our Universities, to be under twenty-two years old. Under the system of pupilage which has hitherto supplied the ranks of our profession, a young man at that time of life ought to have become possessed of a considerable amount of practical experience. He is pretty sure, if he has proved himself to be worth anything, to have had delegated to him during his articles some partial charge of practical work. At any rate, he must have had opportunities of seeing the theory he has studied in the office carried into practical effect. The oft-quoted saying that practice is worth far more than theory does not always hold good; for without training in the latter the former is often erroneous. But where the two are combined, where the young student takes the design he has assisted in preparing in the office and bears part in putting it into practce, the two elements of study are combined in such a way as to

surpass any other method of teaching. Such an advantage, we hold, cannot be secured in any of the schools with which we are acquainted. As regards mechanical engineering, we admit a certain amount of practical detail may be learned in them; but the resources of such schools, even in that branch of the profession, must always be limited—very limited—as compared with those available in the workshops of our great firms. As regards civil engineering, the training to be given can be but theoretical alone; and far more than this goes to make up the qualifications of a man competent to carry out large works. The management of labour; its proper apportionment, and the art of at once obeying and yet of enforcing discipline in others is only, we believe, to be acquired by being early placed in a position of association with large masses of labour.

We trust our remarks will not be misunderstood. We cordially welcome and appreciate the efforts which have been made to establish schools of engineering. They have effected, and yet must effect, much good; but it has chanced to us to come into contact with young men just issued from them who conceive that they have been fitted for the most responsible positions, and who have had sad reason to learn that, when they seek a market for their services, they are "bidden to take the lowest place," and are held to be only at the commencement of their real scholarship. It is well that this fact should receive recognition. Few of our more eminent engineers attach much value to the certificate of these engineering schools when they have to fill up vacancies among their staffs. They value more highly by far testimonials showing acquaintance for a few years with real work. In these days of higher education there are few lads who do not acquire the rudiments of mathematics before they quit school life, and it must be an exceptionally dull one who does not, during a term of five years or seven years' pupilage with an experienced engineer, improve his knowledge up to the fullest standard required. What chance of obtaining employment does a young man of twenty-two, just finishing only his theoretical education, stand with another who, by the time he has reached that age, has for several years combined his theory with its practical application? A Tripos examination certificate is a good thing, a thing certainly to be desired; but we doubt much if it will prove that the ranks of our profession will in the future be filled by men who have obtained it, and who have, perhaps, exhausted much youth, strength, and valuable time in the effort to do so.

ENGINEERING PROGRESS IN ITALY.

IN 1883 a Commission was appointed by the Italian Government for the purpose of ascertaining the state of engineering industry in the country. An official report which has lately appeared says that, although undoubted progress has been made of late years, Italian contractors are not in a position to produce those specialities which Italy receives from English, French, and German establishments. A large portion of the national requirements would seem, however, to be supplied by domestic industry, the copying of English models in torpedo boats, &c., being referred to as a marked success. The general tenor of the recommendations of the Commission is that while the imitation of foreign machines, and the construction of relatively simple original models can safely be entrusted to Italian houses, the exigencies of the naval service require in the national interest that the larger and more complicated machinery should be imported. A competition was instituted—in which seven firms took part—for an engine of 6000 indicated horse-power for a cargo ship. The firms competing were:—G. Ansaldo and Co., Sampierdarena; Pietrarsa and Granili, Guppy and Co., Pattison and Co., Naples; Fratelli Orlando, Leghorn; N. Odero, Sestroponente; and the Fonderia Oretea, Palermo. Five of the seven designs were selected for further consideration, and that of Fratelli Orlando was finally selected as fully satisfying the conditions imposed. One cause of the relatively slow progress of Italy in this direction has been the absence of continuous occupation, and the Commission—according to the *Eisen Zeitung*—attributes to the division hitherto made amongst six or seven establishments of the work done in Italy, the backwardness of that country as compared with England, France and Germany. Hence, with a view to concentrate the Government work as far as possible, and stimulate the leading firms to more efficient organisation, the Commission has proposed to confine the orders to one or two establishments, in order to see whether greater success would thereby be attained than by the existing system. In connection with this subject the new ironworks at Terni deserve mention. The attempt is being made at this establishment to produce, with Italian fuel and labour, the iron and steel required for national military, naval, and railway purposes. The proposal made in 1878 to enter into a contract for this purpose with the Elba Mining Company was rejected by the Italian Legislature; but the Commission already referred to has now succeeded in getting the trial made at Terni, where a gun factory already existed, which had been founded in 1872 by Signor Ricotti, the Minister of War. The new enterprise has been placed under the direction of Commendatore Vincenzo Breda, who is satisfied that by using the water-power of the Velono as well as the cheap Italian fuel, and a perfect system of manufacture, he can produce a great part of the armour-plates, guns, axles, rails, &c., now imported, if the contract for armour-plates is guaranteed to him for three years. Last November the works employed 900 men. The pipes for the utilisation of the water-power are about 20,000ft. in length, and a pressure up to twenty atmospheres can be obtained by this means. A motive force of 5000 to 6000-horse power is thus developed, and can, without much difficulty, be increased to 10,000-horse power. Part of the water-power is used for the machines, ventilators, cranes, &c., and another portion for the preparation of compressed air, which is used in place of steam.

SHIPBUILDING IN MINIATURE.

THE forthcoming Maritime Exhibition at Liverpool, the International at Edinburgh, and the Indian and Colonial in the metropolis, at all of which exhibits illustrative of shipbuilding and marine engineering will form a conspicuous feature, are calling into exercise a considerable amount of activity in the model-making department of Clyde shipyards and engine shops at the present time. Messrs. Elder and Co., J. and G. Thomson, D. and W. Henderson, the London and Glasgow Company, Messrs. Napier and Sons, Denny and Brothers, and Caird and Company are amongst the well-known firms who are preparing small-scale presentments of their crack steamships for one or other of these exhibitions. At the Colonial the committee in charge of the naval architecture section are rejecting all models which are not full-rigged and in glass cases. The display will thus be more imposing, and of greater artistic as well as professional interest than the usual plethoric array of half-block wall models. The committee are also compiling full technical particulars of the various ships from which models are shown, and this will be inserted in a systematic form in the catalogue. An exceptionally noteworthy example of the model-maker's art will find a place in the Edinburgh Exhibition, of which some details may be interesting. This is an elaborate sectional model, constructed not of the usual wood block but of thin sheet iron, and represents an internal view of a large vessel belonging to the British India Steam Navigation Company. The vessel, which is 348ft. by 42ft. by 29ft., is represented as if shorn completely up the mid-line from stem to stern, and revealing all the internal work both with respect to structure and outfit. The model, which is on a ½in. scale, or $\frac{1}{24}$th the actual size, is the work of mechanics attached to the Science and Art Museum in Edinburgh, and has been several years under way. It is constructed in a nanner which corresponds exactly, as regards the arrangement of the structural parts, to the construction of the actual vessel, except that the parts, which consist of very thin sheet iron, are bound with solder instead of rivets. Thus, the deck-plating, shell-plating, and framework of hull are represented in all the detail of out-and-in strakes of plating, butt straps, main and reverse frame angles, beam angles, &c.; and inside of these, just as in the actual vessel, are the wood ceiling and sparring, pillars, masts, deck houses, deck fittings, state-room framing, side lights, &c. The whole is rendered with marvellous fidelity, and the impression of realism and fulness is further enforced by the presence of the propelling machinery, engines, boilers, steam pipes, shafting, propeller, and smaller details, much of the work being shown in section, and all proportionate. All the work, except a few items of deck machinery, such as steam winches and windlasses, has been done in the workshop attached to the museum, from sketches supplied by builders of the original vessel, and it is an eloquent testimony to the intelligence, neat-handedness, and painstaking skill of the museum mechanics.

NORTHUMBERLAND COAL TRADE.

IN a speech delivered by Mr. C. M. Palmer, M.P., on trade topics, there is a reference to the position of the Northumberland coal trade which is very suggestive, and at the present time of considerable importance. Mr. Palmer states that the "trade had been carried on by some of the largest coalowners for the last ten years without a shilling of profit—nay, at a loss." He then went on to give some indication of the causes—high normal rates of wages, high royalties, wayleaves, &c.; and he drew not only a gloomy picture of the future of the Northumberland coal trade, but he painted the present as extremely black. In the coal field in question, the rate of wages is determined by the selling price of coal, through a sliding scale arrangement which dates back for a considerable period. There is, therefore, some relief to the coalowner in this part of the cost of production as the rate at which the coal is sold falls on the average. But the royalty rents, the wayleaves, and other such charges have been unaltered, and this is one of the chief grievances of the coal trade of the North; and we may add that there are other points which are a little more under the control of the coal-owners—such items in the cost of production and shipment as the dock and river dues. It is manifestly unfair to expect that the coalowner should bear the whole burden of the dulness of trade. That burden would be less if it were distributed over a larger area, and if the owner of the royalties, the carriers, and the dock owners shared with the coalowner and the miner the burden which low prices bring; and there is another serious matter, that of the pressure of the local rates, which has increased, and is still very rapidly increasing. If the coalowners of the North would make a combined effort to reduce the whole of the charges that press upon the cost of producing coal, they would be enabled—possibly after some slight stoppage of pits—to sensibly lessen the price, and that is what is needed to give relief to the coal trade, not only in the northern county named, but throughout the producing districts of the United Kingdom. Wages will have to bear its share of the results of the dulness, and Mr. Palmer seems to think, and not unnaturally, that fuller employment at a slightly less wage will be better for all parties. He instanced very large mines in Northumberland, where the men were not working more than two days a week, and that in part to maintain a high standard rate of wages; and he also instanced the case of a concern where the lessors of the mines received £40,000 yearly. It is quite evident that if the workman is to have his wages reduced to lessen the strain on the trade, the owner of the royalties may be fairly called upon to suffer some slight reduction also. Mr. Palmer's speech will have a good result if it direct attention to other burdens of production than wages.

THE RAILWAY TRADERS AND MR. MUNDELLA'S BILL.

THE railway and canal traders have not lost any time in turning their attention to the Bill which has been brought forward by Mr. Mundella. The reception which the measure has met with at their hands has not been wholly cordial. At this we are not surprised. It would have been remarkable if a measure of so wide a character had, upon its first appearance, met the demands of the traders from every standpoint. Yet we would, bespeak for the new Government attempt at legislation upon this vexed subject an unbiassed consideration. Traders must bear in mind the forces which the Board of Trade have opposed to them, and further, that the department has to guard against class legislation. The chief points to which the traders—as represented by their London association, which has grown out of Lord Henniker's late committee—take exception, are the provisions which they contend practically legalise preferential rates in favour of foreign manufactures, which allow of appeal from the decisions of the Railway Commissioners, and which deal with the question of canal traffic. Beyond doubt the Bill is inadequate upon the subject of water carriage. The Board of Trade evidently scarcely realise the importance of this side of the matter, and the member for West Wolverhampton correctly interpreted manufacturers' feelings concerning this part of the Government proposals when, so soon as Mr. Mundella had sat down, he expressed disappointment with them. If manufacturing and commercial men are wise, however, they will not be too fast at quarreling with the settlement which is now offered them. They would do well to remember that, after opposing Mr. Chamberlain's late measure, they had before the last election to return to the junior member for Birmingham, and ask him to pilot fresh legislation. Wisdom will consist in manifesting a spirit of conciliation towards the new Bill.

SANITARY INSTITUTE OF GREAT BRITAIN.—The Autumn Congress and Health Exhibition of this institute will be held in the City of York in September next.

THE PROGRESS OF THE IRON, METAL, AND COAL INDUSTRIES OF RUSSIA.

SINCE the year 1820, when a revolution took place in the iron industry of Russia, it has made the most remarkable progress; but, nevertheless, the production has been unable to keep pace with the consumption, although the imports of iron and steel have also rapidly increased. It is, however, most likely that within the next few years the latter will decrease vastly, as the Russian Government are doing their utmost towards this end by steadily raising all duties, and by the circumstance that important new lines of railway will then have been finished and waterways canalised, whereby the internal riches of iron and coal will be at the country's direct disposal.

The first furnaces erected in Russia were those in the provinces of Ural and Olonetz, opened in 1631-32, the work here being carried out under an imperial ukase, which was revoked in 1782. First, in 1806, the Russian Chamber of Mines was established. Until about the year 1820, most of the bar iron produced in Russia was exported chiefly to England. The latter trade must, however, now be said to have ceased almost entirely; but some is still exported to Central Asia and further East. In 1822 the exports of bar iron amounted to 22,000 tons, but in 1840 only to 14,000 tons, and at present it is only half of that amount. The increase in the iron production of Russia in every ten years since 1822 has been as follows:—

	Pig iron. Tons.	Bar iron. Tons.
1822	152,100	—
1830	183,000	—
1840	180,000	83,000
1850	227,700	150,000
1860	297,900	183,700
1870	360,000	251,500
1880	456,000	320,000

The quantities of pig iron produced, as compared with those imported, were as follows:—

	Production. Tons.	Imports. Tons.
1860	297,200	9,100
1870	360,000	35,700
1880	456,000	256,000

The manufacture of finished iron and steel goods in Russia has progressed greatly during the last twenty-five years, some being now even exported, for instance, to Central Asia. That this is the case is doubtless due to the heavy duties which have been imposed on all foreign goods, enabling the Russian manufacturers at present to deliver such articles at a price considerably below that demanded from abroad. In consequence the import of the same is now very limited.

The manufacture of machinery in Russia may be said to date from 1860, when the first railway engines were turned out; but already in 1872, at the Moscow Exhibition, the out-turn had advanced to two hundred and fifty engines per annum, and at the time of the Exhibition held at that place two years ago, more engines could be turned out in the empire than could possibly be required. The manufacture of other kinds of machinery, as for instance saw-mill plants, wood-pulp makers, and agricultural machinery, implements, &c., has greatly advanced during the last twenty-five years in consequence of the severe protection, and Russian statesmen confidently maintain that the day is not far distant when all such articles required will be turned out at home. At present most of them are taken from Sweden, some from Germany, but hardly any from this country compared with twenty years ago.

Although great strides have been made during the last ten years, the Russian shipbuilding industry is still in a backward state, and this in spite of the duties on vessels built abroad being constantly increased. Nearly every steamer added to the Russian mercantile marine is either purchased or built abroad, some of the Swedish yards, for instance, having for the last five years been busily employed with Russian orders, which have lately also found their way to Denmark, and even Norway. To some extent these remarks may also be said to apply to the Russian Navy, but several large ironclads are now building in the Baltic and the Black Sea.

With regard to the production and manufacture of other metals than iron and steel in Russia, it may be mentioned that in 1880 there were 336 such works in operation, the manufacture varying in nature, employing 142,000 labourers, and turning out goods to the value of nearly £700,000; thirty-one copper works, turning out about 10,000 tons of copper; and 210 works for the manufacture of copper and bronze articles bell-casting, &c., with 5000 labourers, and a production valued at about £50,000.

There is, however, hardly any Russian industry which has made such gigantic strides of late years as the coal trade, in spite of the circumstance that at present only one deposit is worked on any great scale, viz, that of Donetz. Besides this deposit there are coals in the Caucasus, the Ural Mountains, and some other places, as well as in Siberia.

Since 1840 the out-turn has been as follows:—1840, 15,000 tons; 1850, 52,000 tons; 1860, 131,200 tons; 1870, 683,260 tons; 1875, 1,667,400 tons; 1880, 2,920,000 tons. It is estimated that the Donetz deposit alone is capable of supplying European Russia with the necessary amount of fuel if fully worked.

SEWERS IN CLAPHAM, BATTERSEA, WANDSWORTH, AND PUTNEY.

ON page 228 we now give further illustrations of the sewage aqueduct in course of completion by the Metropolitan Board of Works for the conveyance of sewage of Wandsworth, Putney, and districts. Further engravings will appear with description in another impression.

TENDERS.

OXFORD.

FOR the supply and erection of iron Gothic roof, columns and galleries, &c., for the Anthropological Museum, Oxford.

Gardner, Anderson, and Clarke, London—accepted.. £1047 0 0

SILLOTH.

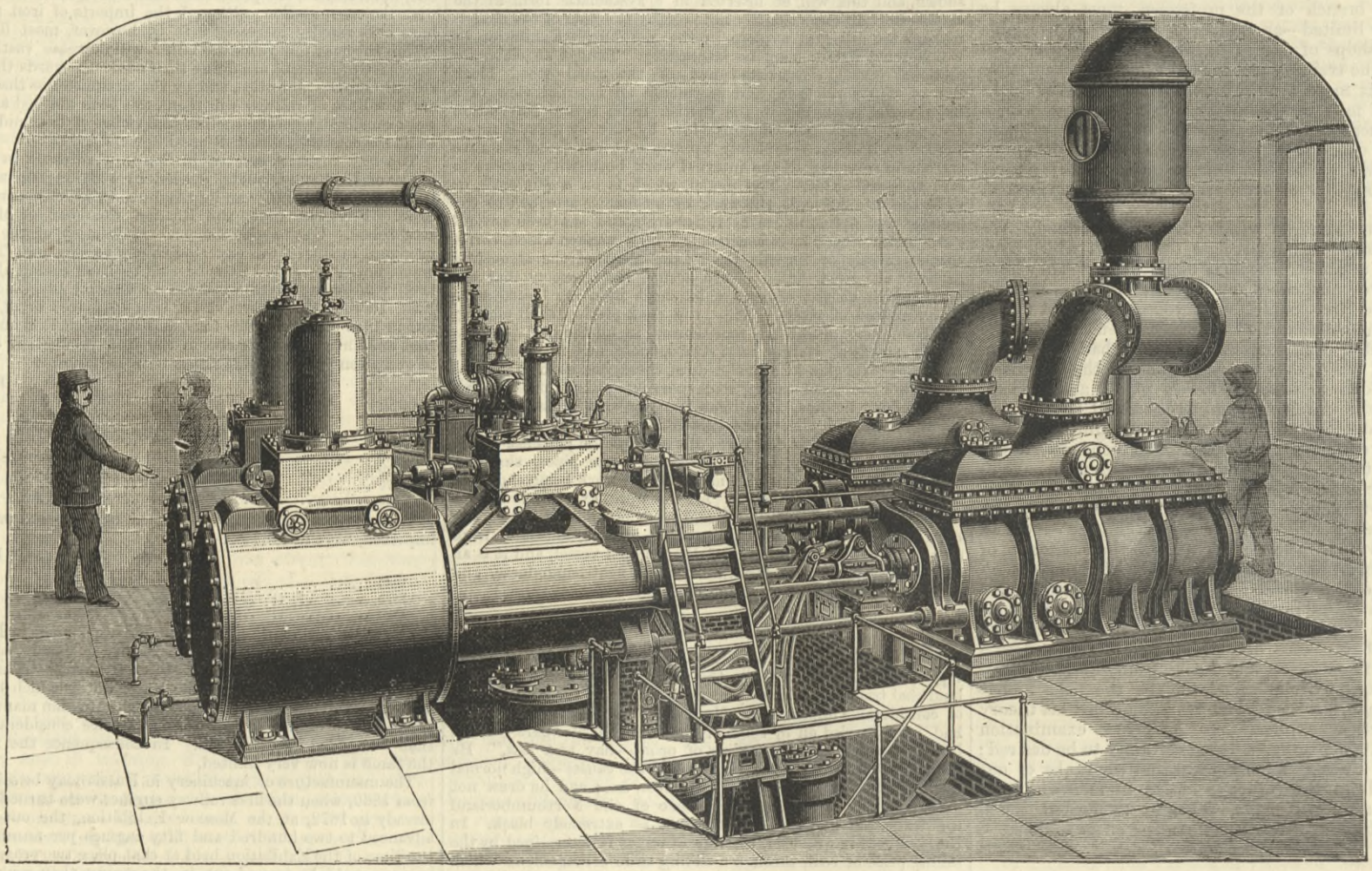
For the supply and erection of the whole of the cast iron columns and other cast iron work for new grain warehouse for the North British Railway Company.

Gardner, Anderson, and Clarke, London—accepted.. £1006 0 0

EXHIBITION OF BAROMETERS.—The Meteorological Society held on Tuesday night an exhibition of barometers at the Institution of Civil Engineers. A paper was read by the president, Mr. Ellis, of Greenwich Observatory, in which the history of the barometer from the time of Torricelli, in 1643, to the present day was treated. The exhibits consisted of specimens of nearly every kind of instrument which has been invented, from the merest glass tube fitted with mercury and inverted in a cistern of mercury to diagrams of the King's self-registering barometer and the photographic registering barometer, parts of the—Jordan's—glycerine barometer, and the numerous self-recording barographs and aneroids which have been brought out during the past few years.

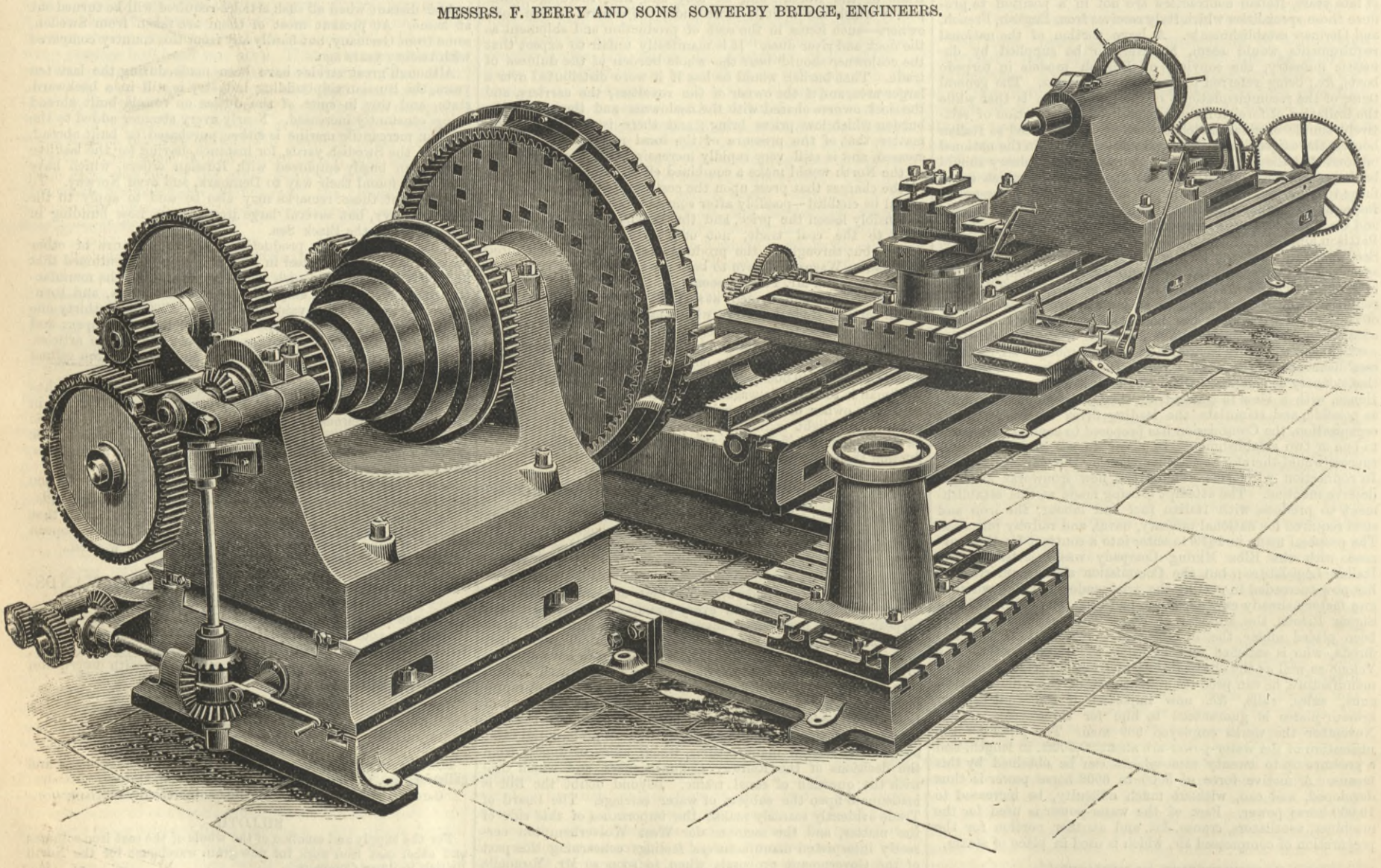
THE WORTHINGTON PUMPING ENGINE.

MESSRS. SIMPSON AND CO., PIMLICO., ENGINEERS.



LARGE BREAK LATHE FOR PORTSMOUTH DOCKYARD.

MESSRS. F. BERRY AND SONS SOWERBY BRIDGE, ENGINEERS.



LARGE BRAKE LATHE FOR PORTSMOUTH DOCKYARD.

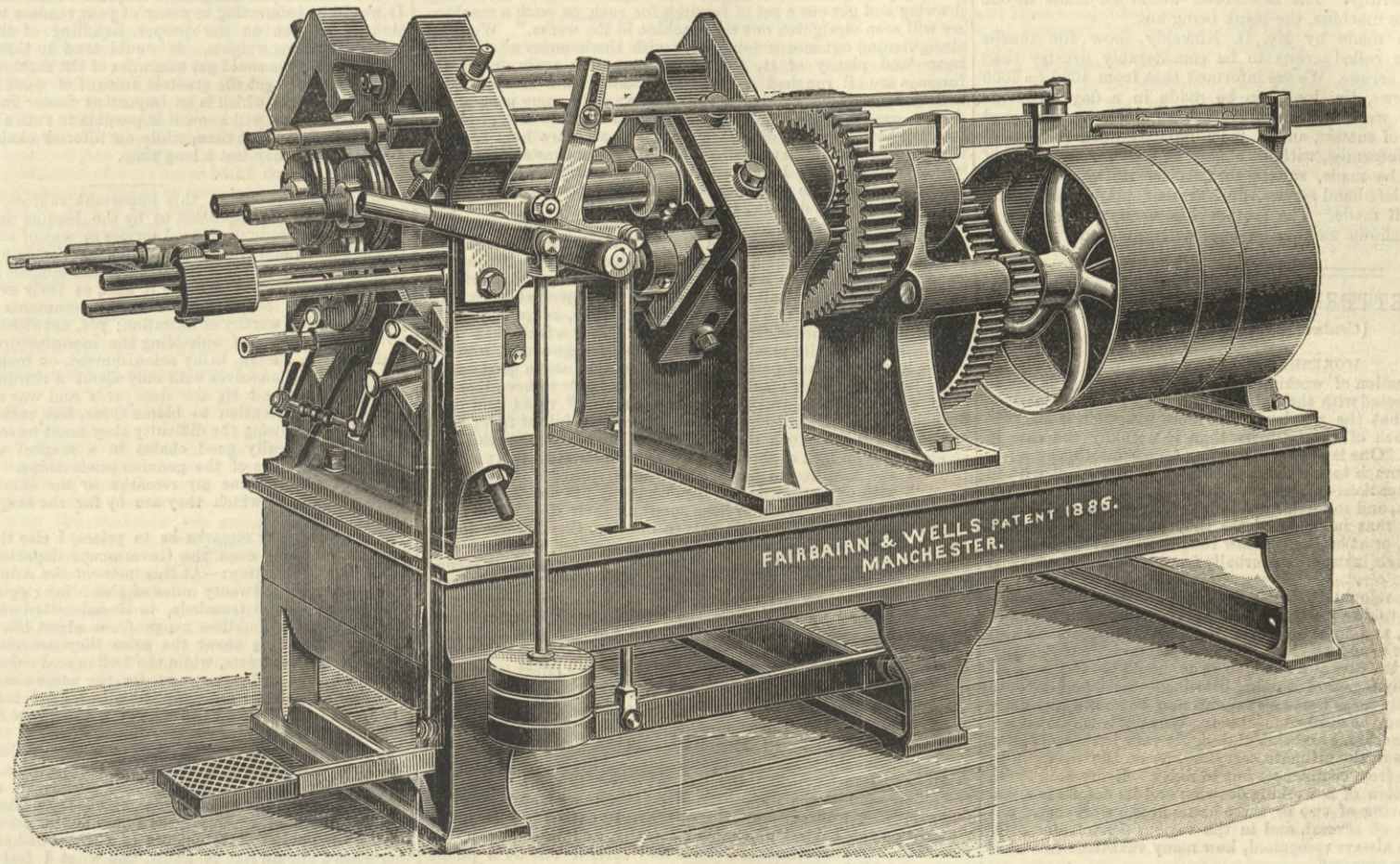
We illustrate above a very fine treble-geared, self-acting, sliding, surfacing, and screw-cutting brake lathe, constructed by Messrs. Berry and Sons, of Sowerby Bridge, Yorkshire, for Portsmouth Dockyard. The headstocks are 3ft. 6in. centres, with a brake to admit 12ft. diameter, and to open out 4ft. long from the front of the face-plate. The massive sliding bed is 27ft. long, and 5ft. broad across the face, and 18in. deep. The under bed is 12in. deep, with bolt slots. The fast headstock is fitted with a steel spindle front neck 12in. diameter and 15in. long. The back neck is 9in. diameter, and 10½in. long, running in parallel bearings of hard gun-metal. The gearing is very powerful. The large cone pulley has five speeds each 6in. wide. The loose headstock has a spindle 7½in. diameter. This headstock is movable longitudinally on the bed by a rack-and-pinion motion. The saddle is fitted with a compound slide rest, self-acting for sliding, surfacing, and screw-cutting, and with a rack and pinion motion for hand traverse. There is a guide screw for screw-cutting, a backshaft for sliding, and a full set of change wheels. The face-plate is 6ft. 9in. diameter, and fitted with four chucking jaws. There is a strong pillar to fix on the bed-plate in front of the brake, on which is placed the compound slide rest when turning large diameters in the brake. The lathe is provided with top-driving apparatus, screw keys, &c., complete. The total weight is 45 tons.

THE WORTHINGTON PUMPING ENGINE.

A few years ago we illustrated and described the smaller type of the direct-acting steam pumps made by H. R. Worthington, of New York. Since then the favourable opinion we expressed of these pumps has been verified, and there is no direct-acting pump so widely used in America as this one. The larger forms of this pump, as made for waterworks, is in use in more than 40 per cent. of all the waterworks in America; and the economy with which it works, as described by our Special Commissioner to the Philadelphia Exhibition,* has attracted so much attention, that Messrs. Simpson and Co., the eminent pumping engine

* The Engineer, 24th November, 1876.

FAIRBAIRN AND WELL'S SCREW FORGING MACHINE.



builders of Pimlico, have made arrangements for its manufacture in this country. After making a special visit to America for inspecting and testing these pumps, they are thoroughly satisfied of the efficiency of the means by which a considerable range of expansion is made possible in a direct-acting engine, and Messrs. Simpson are prepared to guarantee as high an economical efficiency from these pumping engines, such as that above illustrated, as with the rotative or Cornish engines, for which they hold so high and well-known a reputation. At present we are not in a position to describe the equalising device by which difference of steam pressure through the stroke is approximately eliminated on the pump piston or plunger; but it appears to be perfectly satisfactory to the Pimlico firm. In the circular letter by which they announce their agreement with the Worthington Pumping-Engine Company, Messrs. Simpson and Co. give a list of 288 water works supplied with these pumping engines, and a *brochure* published by Mr. Worthington shows how very various are the conditions under which the engines are working. They are also used for pumping oil from the wells to seaboard; and in one instance—the New York Pipe Line—the oil is pumped by them through 300 miles of pipe, passing over country varying in height to 1000ft. above the pumping station, and against a pressure varying, according to the speed of pumping, from 900lb. to 1500lb. per square inch, the normal pressure due to friction and head being 900lb. per square inch, and the quantity pumped 28,000 barrels per day.

In waterworks these engines, erected since 1872, aggregate a contract pumping capacity of about one thousand millions of gallons per day. In an early impression we hope to give details of one of these engines, with indicator diagrams, showing the action of the steam and the equalising or compensating device.

SCREW FORGING MACHINE.

The accompanying engraving illustrates a very ingenious machine for rolling or forging wrought iron and steel screws. It has been designed and is made by Messrs. Fairbairn and Wells, of Hardman-street, Deans Gate, Manchester. Several years have been occupied in perfecting the machines and the process of rolling large screws hot, and small screws cold, and several of them have now been at work for about nine months in the works of the New Russia Company, of Queen Victoria-street. The machine we illustrate is for making large screws, and is fitted with three rollers, the screws being rolled hot. Screws below ½in. in diameter are made with four rollers, and are rolled cold.

The advantages of screw rolling as compared with screw cutting, for very many of the purposes to which they are applied, are sufficient to make an effective machine of great importance. The material which is wasted in cutting a screw in the ordinary way is utilised, and the screw blanks may be considerably shorter in consequence, effecting a saving in some screws—such as coach screws—of over 30 per cent. The threads are, moreover, much stronger when rolled than when cut out. The engravings we publish of the sections of screws are facsimiles of screws rolled by these machines, all of which are perfectly made.

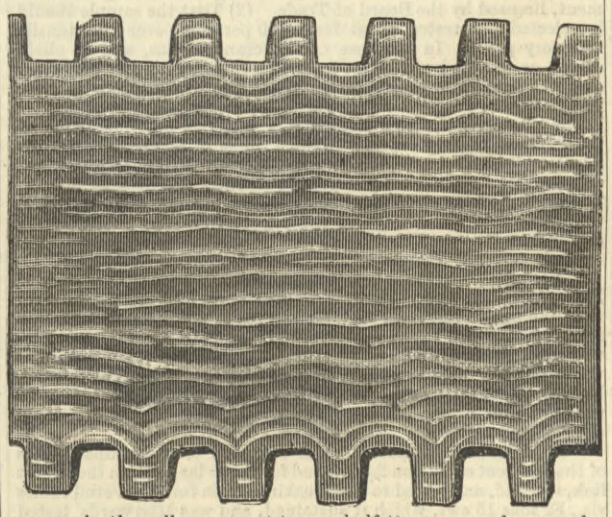
The manufacture of screws by rolling has been the subject of a number of patents—the first of those of Messrs. Fairbairn and Wells being dated 1871—and the machines employed may be divided into two kinds. We may very briefly describe these two classes of machines, in order to make the description of the machine under consideration more intelligible. The first kind has usually three rollers of equal diameter revolving in the same direction and at the same speed. Grooves are cut in the peripheries of the rollers of the same pitch and angle as the threads on the bolt blanks to be screwed. The rollers are placed in the form of a trigon parallel to one another, and while revolving are made to open to receive the bolt blank, and then close on it under great pressure. The blank revolving between the rollers receives from the grooves the impression of a thread, but as it simply revolves without longitudinal motion, the thread is raised half its depth above the size of the iron, and the other half sunk into the body of the bolt. Any inequality in the sizes of iron from which the blanks are made makes a corresponding difference in the screws. This machine is, therefore, useless as regards accuracy in fitting nuts.

The second class of machine is entirely different. It can have only two rollers with plain straight grooves cut on the peripheries. The axes of the rollers are then set in the machine to give a twist to the rollers, which brings the straight grooves to the angle of thread desired, as indicated in Fig. 2. The blank revolving between the rollers receives the impression of the thread, but for every revolution it makes on its axis it moves out or in one thread, or rather the distance between two threads. This machine also raises the thread, so that it is larger than the blank, a result of insufficient rolling or work. Thus, in making a 1in. screw with eight threads per inch, and say 2in. long, the blank would only make sixteen revolutions.

The first machine, made by Messrs. Fairbairn and Wells, had two plates grooved and sliding in opposite directions, the blank being pressed between them. It was, however, soon found that a screw made between two surfaces while hot is very liable to become hollow or spongy in the centre. After a great many experiments three rollers were adopted, but for the purpose of explanation we must describe the machine with two rollers.

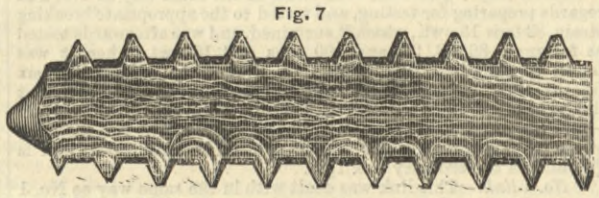
If, instead of plain concentric grooves, as shown at Fig. 2,

Fig. 6



grooves in the rollers are cut to one-half the true angle or angle of the screw thread, the angle or twist of the rollers must then be reduced, as where the angle of the grooves is increased a corresponding reduction in the angle or twist of the axes of the rollers must be made. For instance if we suppose the angle of Whitworth threads is 12 deg., and it is desired to give the blank,

Fig. 7

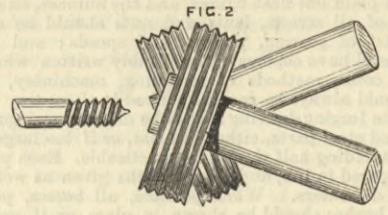


say, eight revolutions in moving between two threads, then Mr. Fairbairn makes the angle of the grooves on the roller, say, 10·5 deg., and sets the roller's axes to an angle of 1·5 deg.—*i.e.*, 10·5 + 1·5 = 12 deg. In order to produce a right-hand screw, the rollers are cut left-handed. The method used by Mr. Fairbairn is thus described by him:—"Suppose a set of rollers is used 4in. in diameter and, say, ¼in. in pitch of thread, on 1in. coach screw, then $\frac{4\text{in.}}{1\text{in.}} = 4$ revolutions of iron for 1 of rollers, and 4 × ¼in. = 1in. total and true pitch for cutting grooves on rollers. But we want the screw blank to make four revolutions while moving between two threads. Fig. 3 is a diagram of the true pitch with four threads, and axes parallel. Then the line 2—5 becomes the basis, and instead of four threads we get three, and the total pitch becomes ¾in. instead of 1in., the other ¼in. being supplied from the twist of rollers. Generally, the less the twist of rollers the less the longitudinal motion and better finish given to the screws.

The principal objection to this machine is that the rollers are necessarily small, and so when making from 4000 to 5000 screws per day, one after another, the wear and tear must be great. The size adopted for the rollers is six times the smallest diameter of the screw at the bottom of thread. Thus for ⅝in. coach screw, the largest possible size would be—diameter of screw at bottom of thread $\frac{5}{10}$in. full, and $\frac{5}{16}$in. × 6 = $\frac{30}{16}$ = $1\frac{7}{8}$in. diameter of roller. This is small, although a set of 3in. rollers has been working eighteen months without change.

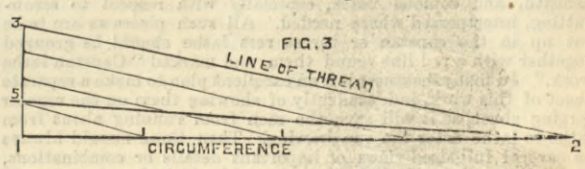
To obviate these disadvantages the four-roller machine has been made, in which larger rollers for any purpose and of one

FIG. 2



size can be used and run always in one direction, *i.e.*, no reversing of the machine. He obtains longitudinal motion of the screw with two of the rollers paralleled, and two smaller ones, with just as much of twist as will make up for the difference of angles due to two rollers of unequal size having the same number of grooves and cut to the same total pitch; for instance, *a* to 3 = circumference of small roll, and *a* to 4 of large roller. The difference in these circumferences is equal to one revolution of a

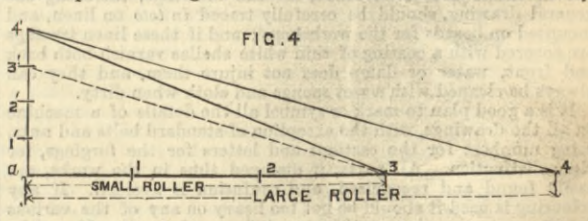
FIG. 3



blank screw. The twist or reduction of angle on the small roller removes the line to 3^1 3, which makes the same angle as the large one, or 4^1 4.

The two large rollers then are parallel, while the small rollers are brought to the same angle of grooves. They make the same number of revolutions in the same time. By the twist on the smaller rollers greater resistance to slipping is obtained, and the blank slips on the larger rollers which thus becomes so far a nut,

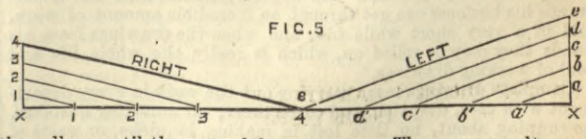
FIG. 4



causing the blank to screw itself out from the machine. Apparently the three and four-roller machines produce longitudinal motion by different means, but when examined closely the methods are similar.

In making left-hand screws on the three-roller machine, the obvious rule is to reverse the operation by cutting three grooves the opposite angle and then twisting or increasing the angle of

FIG. 5



the rollers until they equal four grooves. The same result may be obtained with the axes of the rollers in the same position for both in this way. For right-hand screws three grooves are cut and their effect increased to four by the twist of the axes. In the same way, for left-hand screws, five grooves are cut on the rollers, and their effect as regards direction obtained by reducing them. The diagram, Fig. 5, illustrates the right-hand screw with three groove, 1 to 4 become—*x* to 4, and for left-hand on the same axes with the rollers cut to five grooves—*x* to *e* becomes *a* to *e*.

Mr. Fairbairn proposes rolling fish bolts with right and left-

hand grooves on the same rollers, say, $\frac{3}{4}$in. right-hand, and $\frac{1}{16}$in. left-hand on the point of the bolt to act as a locking nut, and from the experience he has had he sees nothing very difficult in doing it successfully. The two screws would be made at one operation of the machine, the blank being hot.

Experiments made by Mr. D. Kirkaldy show the tensile strength of the rolled screws to be considerably greater than that of the cut screws. We are informed that from 4000 to 5000 $\frac{3}{4}$in. coach screws, 4in. long, can be made in a day with one machine. The wear of the rollers is very small as compared with the wear of cutters, and a machine may work for several weeks, we are informed, without change of rollers. Threads of any form may be made, square threads for railway couplings with right and left-hand screws, and armour plate bolts being exceedingly well made. The section Fig. 6 shows one of this kind. Fig. 7 shows smaller screws with different forms of threads.

LETTERS TO THE EDITOR.

(*Continued from page* 226.)

WORKSHOP DRAWINGS.

Sir,—The question of working and workshop drawings is one so intimately connected with the welfare of any and every engineering establishment, that the wonder is that more attention is not paid to this vital branch of the business than is actually the case in many instances. One is always stumbling across intelligent workmen who have much to say about the drawings they meet with in their various situations—either how good, bad, or indifferent they have found them, and so forth—and it is astonishing to find in this enlightened age that in many places they have had no drawings put before them, or at best only a few rough sketches to work to, and taking all their instructions verbally from foremen or managers in such cases.

There can be no doubt that the first step taken in any undertaking has more to do with the success of it than any amount of succeeding steps, and in the case of a complicated machine this must be apparent to any who have given the matter serious thought. The first step in the case of a machine is, or should be, the preparation of a design by means of working drawings—these laid down to a scale sufficiently large that every detail may be shown distinctly and in its place on the finished machine. When this is carried out by a practical mechanic and skilful designer very little trouble, if any at all, occurs in the ultimate carrying out of the machine in its various stages from commencement to finish. Every hour spent upon the completion of a working drawing and its details is a distinct gain and saving of two or three hours in the workshops, not of one man, but of several, and in the various departments. If this one fact was always recognised, how many vexatious mistakes would never have occurred.

A set of working drawings should consist of an absolutely complete general drawing of the machine about to be constructed, drawn, if possible, 3in. to a foot, and should comprise as many general views as will enable the leading hands to see every detail of the machine in its correct position on the machine when finished. He can thus grasp the idea of the whole job, and lay out his work to the best advantage. On this general drawing also should be as many views of intricate or small details as can be separated out from the general views without crowding. Every dimension should be put on in plain but neat figures, and the number, size, diameter, and length of all screws, bolts, and nuts should be on. Also a tabulated list of gearing, pulleys, and speeds; and lastly, the drawing should have copious notes, legibly written where needed, relative to cores, methods of moulding, machinery, &c. This drawing should always be carefully inked in.

A complete forging drawing should be made, showing all wrought iron or forged steel parts, either full size, or if too large, half size, but always avoiding half size where practicable. Each piece should be clearly figured in ink, and total lengths given as well as detail lengths and diameters. When possible, all bosses, pulley hubs, journals, or bushes should be shown in place, or if not shown, a note indicating them should be placed where they occur. All keys, screws, feathers, tapers, or nuts, should be distinctly shown, and dimensioned when not of standard sizes. A cutting-off list should be tabulated in the right or left-hand lower corner of each sheet of forgings, giving diameters and lengths of each piece in the rough bar, a column being reserved for remarks, such as collaring, jumping-up, &c. Each piece should bear a distinctive symbol, and its corresponding piece in the cutting-off list should bear the same symbol. All the forgings should have their names legibly written beneath, and copious notes, especially with respect to screw-cutting, interspersed where needed. All such pieces as are to be cut up in the capstan or turret rest lathe should be grouped together with a red line round them, and marked "Capstan lathe work." In many instances it is an excellent plan to make a separate sheet of this work, independently of showing them on the regular forging sheet, as it will save the men from running about from lathe to lathe after the one drawing. Then there should always be several full-sized views of important details or combinations, especially motions of all kinds, a note of which drawings should appear on the general drawing. These full-sized views, if carefully made and worked out and properly figured, and notes made of all teeth of gears, &c., on them, will save more of the firm's money than can be appreciated except by those who have been fortunate enough to use them. The whole set of drawings should absolutely correspond in every particular with respect to figures, sizes, diameters, and length of bolts and nuts, gears, pulleys, and notes, and should be carefully checked to this end. If many of the machines are to be made, all the drawings, including the general drawing, should be carefully traced *in toto* on linen, and mounted on boards for the workshops; and if these linen tracings are covered with a coating of thin white shellac varnish both back and front, water or damp does not injure them, and they can always be cleaned with a wet sponge and cloth when dirty.

It is a good plan to mark or symbol all the details of a machine on all the drawings, with the exception of standard bolts and nuts, using numbers for the castings and letters for the forgings, for clear distinction. All parts, if stamped thus in the works, are easily found and recognised, and confusion is avoided. If any colouring is used it should be not too heavy on any of the various details—not excepting sections—and flat surfaces should not be coloured generally. A faint line of colour around the edges of the general views on the complete general tracing and drawing brings the views out with much distinctness; but it is well to leave off all flat washes on full-sized work, only tinting round pieces and sections, and these not too heavily.

It may seem that to follow out this system of preparing working drawings involves a large amount of labour and time; but in reality such is not the case. An expert practical man who understands his business can get through an incredible amount of work, and in a very short while too; and when the drawings leave his hands they may be relied on, which is really the whole life and soul of working drawings.

Complete drawings mean carrying out the work in every department with ease, despatch, and correctness; no annoying mistakes, no running about, no time lost in making inquiries, or waste of material, and no excuse for blunders, and a smoothness of working from beginning to end of a job. On the other hand, unfinished general drawings, and incomplete or obscure detail drawings, mean mistakes in every department and at every turn, uncertainty of doing the work, men running about making trivial and foolish inquiries of their foremen and managers, fouling of motion parts, resulting in numerous visits to both scrap heaps, which means new or altered patterns and forgings and new castings, all to be again machined, discussed, and wrangled over, and with a certainty in the end of no two machines being alike. All this means loss—loss of credit to the draughtsmen, foremen, and leading hands, loss of temper with all of them in turn, and loss of money to the principals, and not forgetting loss of time to customers waiting for their machines and loss of these customers' future orders.

Many principals and managers will say, "Just give me a rough drawing and get out a set of forgings for such or such a machine, we will soon straighten out the machine in the works." Well, the straightening out means doing a lot with the hammer at the scrap heap—and plenty of it, too, sometimes. Or again, after the forgings are all roughed out and the castings are mostly in, the manager insists on making a radical change in some part of the design—result, chaos; drawings to alter, patterns to alter, forgings to scrap heap, castings ditto, when perhaps an extra hour spent at the drawings would have avoided all this loss of time and material, which is all money. It is these ruinous alterations which take off the profit, and make machines come out bad in cost estimates.

With respect to drawing staff, it is much to be regretted that we have so few really good practical engineers in our drawing-offices; such is, however, the fact. What becomes of all the pupils, especially the really many intelligent and well-educated youths who enter the business, and who have a good workshop training? They cannot all be partners or managers at once. Do they leave the business when out of their time, or go abroad, or die, or what becomes of them as a whole? It is a fact that there is a dearth of really practical mechanical draughtsmen, who are quick, intelligent, and painstaking. Those that are in good berths keep them, and their employers do all they know to keep them in their offices. There are plenty of "geniuses," rapid and neat draughtsmen truly, but unpractical. These are full of fads; their work requires too much overhauling and re-scheming; they are spoiled through lack of thoroughness and practical tuition; always restless, and wanting to begin half-a-dozen jobs before they are through with one—they do not pay, certainly not one in ten does. Then there are the men who have spent all their time in drawing-offices, from ink-rubbing office lads to the time they become junior hands. Some of these develope into good men, but they take a lot of developing too, and too often degenerate into tracers or second and third-rate draughtsmen. There are abundance of these; scores answer every advertisement. They do their best most of them, but they never become the useful men they should be. First-class practical men are in demand, not theorists, but men whose work reaches the intelligence of the most thick-headed workmen; young and energetic, and whose every effort is given to raise the standard of their employer's work. R. G. H.

Manchester, March 16th.

GOOD AND BAD CHAINS.

Sir,—This subject having recently appeared in the correspondence columns of The Engineer, the purport of which was a caution to the public against the imposition of certain manufacturers, using and supplying iron of an inferior quality, I venture to offer a few remarks on the subject of chains generally, and to send you the results of a few experiments I have had carried out at a public testing establishment, also a photograph of the specimens experimented upon.

The necessity of securing iron of the best quality for the manufacture of every description of crane chains and chain cables, is so patent to anyone conversant with their use, and for the preservation of life and property, that any further remarks from me on that point would be superfluous. There are, however, in my opinion other equally important points to be noticed by all parties concerned both in the use and manufacture of chains, which I fear are in too many instances lost sight of, viz., the neglected malformation of links; secondly, the injurious effect of welding. The former I fear is left too much to the discretion of the chain maker, and the latter is a fact admitted by all authorities, and demonstrated by testing, viz., that it is a practical impossibility to weld chains, either on the end or the side, and retain the same quality of material at the part welded as that in the other portion of the link. That being so, it follows that the very best of iron is so deteriorated at the welded part that the strength of the chain is reduced in proportion, and I would recommend all users of crane, sling and mooring chains, or indeed any kind of chains, when purchasing to specify (1) That the chains be tested at a public testing establishment, licensed by the Board of Trade. (2) That the sample should be selected and tested to at least 150 per cent. over the tensile statutory proof. In the case of the crane chains, and in chain cables, or studded chains, at least 60 per cent. to 100 per cent. over the Admiralty tensile test. With these precautions inferior iron for chain purposes would never find its way into use.

The photograph accompanying this letter is an illustration of the result of testing ordinary welded links of the best best cable iron studded and unstudded, in conjunction with a patent weldless and studless link made by a process recently patented by myself. The centre link in each specimen represents the patent link, and the annexed is an extract of the report from the public testing establishment.

"*Extract of Test Master's Report.*

"*No.* 1 *link.*—This link was attached to two ordinary welded links of the best best cable iron without studs and five sizes larger than the patent link, and sustained the appropriate breaking strain for $1\frac{1}{8}$ unstudded chain cables, viz., 78 tons 16 cwt; it was afterwards tested to 96 tons, when one of the ordinary links parted at the weld, leaving the patent link in position slightly fractured, having sustained without parting an over proof strain of about 22 per cent.; the elongation upon the patent link is $\frac{3}{4}$in., and upon the ordinary also $\frac{3}{4}$in.

"*No.* 2 *link.*—This link was also attached to two ordinary links of the best best cable iron $2\frac{1}{16}$in., and four sizes larger than the patent link, studded, and tested to the breaking strain for $1\frac{1}{8}$in. stud cables viz., 82 tons 15 cwt, which it sustained, and was afterwards tested as follows:—102, 104, 108, 112, 116, 120, and 124 tons, at which proof the welded link parted, leaving the patent link in position much fractured at a defective part. The elongation upon the patent link is $1\frac{3}{8}$in. and on the ordinary link $1\frac{1}{4}$in., thus showing the patent link sustained without parting about 50 per cent. above the required proof for studded chain cables.

"*No.* 3 *link.*—This link was dealt in the same way as No. 2 as regards preparing for testing, and tested to the appropriate breaking strain, 82 tons 15 cwt., which it sustained, and was afterwards tested as follows:—86, 92, 96, and 100 tons and 16 cwt., when it was found on examination that one of the ordinary links had six fractures in it and the patent link had one, thus showing the patent link to have sustained without parting—but showing a small fracture—an over proof strain of about 22 per cent. above the breaking strain for $1\frac{1}{8}$in. stud cables; the elongation on this patent link is $\frac{3}{4}$in. and on the ordinary link $1\frac{1}{8}$in.

"*No.* 4 *link.*—This link was dealt with in the same way as No. 1 as regards preparing for testing, viz., two unstudded $2\frac{7}{16}$in. links attached, being five sizes larger than the patent link, and was tested as follows:—96, 100, 105, 110, 115, 120, 125, 130, and 135 tons. At this proof the links were examined and small fractures were found in the ordinary and also the patent link; the links are so thoroughly rigid and locked together, owing to the enormous strain they have sustained, viz., about 71 per cent. over the required proof for $1\frac{1}{8}$in. unstudded cables, that I am unable to ascertain any further injury to the specimen than that described above. The elongation on this patent link is $1\frac{3}{8}$in., and on the ordinary link $1\frac{5}{8}$in.

"February 22nd, 1886."

The advantages my patent professes to possess over chain cables at present in use are as follows: (1) to avoid welding; (2) to secure true geometrical form of link; (3) to discard the use of cast iron studs; (4) to increase the strength of cables when in use in tensile, transverse, or compound strains to which they are subjected at sea.

The Lawe, South Shields, W. Penman.
March 12th.

Sir,—Your leading article on "Good and Bad Chains" in The Engineer of January 22nd, 1886, has drawn forth a large amount of information from chain makers interested in the matter. But there is another side of this question that will bear speaking on, viz., the proper working, examination, and care of chains on hand, steam, and hydraulic cranes, lifts, hoists, &c. To our large dock companies and extensive factory owners this is an important point, where the safety of many lives depend on the condition of chains. It would be interesting to many of your readers to have an expression of opinion on the proper handling of chains working in machines lifting weights. It would tend to throw some light on the matter if we could get examples of the methods adopted where largely used, to get the greatest amount of work done with safety to life and limb, which is an important factor in the case. Your practical readers will know it is possible to ruin a chain of the very best make in a short time, while an inferior chain by proper care and attention may last a long time. Clyde.

London, March 12th.

Sir,—Your leader on this important subject, and the way in which it has been responded to by the leading makers of branded chains, has already done good service by way of enabling consumers to know how, and from whom, they may obtain good and trustworthy chains; and it is to be hoped the officials at our Admiralty may see their way to profit by it also, as their example in matters of this kind is looked to by other Governments and the general public as being worthy of imitation; yet, notwithstanding the great power they possess of upholding the manufacture of chains of a high quality, I learn, to my astonishment, on making inquiry, that they content themselves with only about a third-rate quality with which to equip and rig our dockyards and war ships. It is not, however, my intention to blame them, but rather to sympathise with them, knowing the difficulty they must have to contend with in obtaining really good chains in a market overflowing with spurious imitations of the genuine productions. For the sake of brevity I now confine my remarks to the short-link crane and rigging chains, of which they are by far the largest consumers in this country.

Apropos of your remarks as to prices, I cite the following, just to show you how even the Government departments themselves differ on this question:—At this moment the Admiralty is inviting tenders for about twenty miles of short-link rigging chains for the use of our splendid ironclads, to be submitted on the 19th inst., and which will doubtless range from about 13s. to 14s. per cwt. for $\frac{1}{2}$in., that being about the price they are now paying under their present contracts, while the Indian and colonial departments pay from 18s. to 19s. per cwt. for the same size, with the result that while the latter are supplied with a good fair quality for the price, the former is contented with a third-rate quality to rig our first-class ships.

In a letter which you published upon this subject last week and the week before, Messrs. Joseph Wright and Co., of Tipton, give the price of their "A1 special best best J. W. and C." branded chain at 23s. 6d. per cwt. for $\frac{1}{2}$in., and Messrs. Parkes and Co. say the cost price of their special brand is 21s. per cwt. Now, Sir, having the published statements of these well-known firms before me, what I should like to know, and what I feel sure the general public would like to know, is why it is that our own costly ships and dockyards should be supplied with chains 30 per cent. lower in quality than those used by our Indian and colonial departments? and further, how comes it that private firms can afford to purchase the very best branded chains for their ships, cranes, and collieries at 23s. 6d. per cwt. while our own Government is satisfied with a third-rate quality at about 13s. or 14s. per cwt. for the same size?

Sumner-road, Edgbaston, March 16th. J. Barnes.

CURTIN'S TUBES.

Sir,—I dare say other readers of your valuable paper as well as myself would very much like to know how Mr. Curtin intends to renew one of his tubes in the vertical boiler, without taking out the furnace; or allowing he can work a tube in from the bottom of the furnace, how will he rivet it? and in a Lancashire boiler how will he rivet the bottom of tubes, raked from centre of boiler to shell? I may perhaps inform Mr. Curtin that we have made several vertical boilers with crowns stamped to take the uptake. I think the old Galloway flanged tube the best for all purposes. Perhaps Mr. Curtin will consider the cost of cutting out and putting in a Galloway tube and also one of his patent. H. B. Buckland.

Tyne Boiler Works Company, Low Walker,
Tyne, March 17th.

LAUNCHES AND TRIAL TRIPS.

The Olaf Kyrre, built by Messrs. Martens, Olsen, and Co., of Burgen, Norway, was launched on the 8th ult. Her dimensions are as follows:—Length over all, 206ft.; extreme breadth, 29ft.; depth of hold, 14ft. 10½in. She has a hurricane deck over all, and will be fitted out in a modern way, being intended for the tourist traffic on the North Cape. Her engines, also built by the same firm, are triple expansion, the first of this kind built in Norway. She is to be lighted by electricity, this being unique in Norway.

On the 3rd inst. the s.s. Frampton, built and engined by Earles' Shipbuilding and Engineering Company for the Boston Deep Sea Fishing and Ice Company, was taken on her trial trip. The following are the particulars of the vessel:—Length, B.P., 85ft. by 19ft. 9in. beam by 10ft. depth of hold, with flush deck aft and small raised forecastle forward. She is built to class 90 A 1 at Lloyd's, and has accommodation for captain and officers aft and for crew in forecastle, the whole of the remaining space clear of engine and boiler being fitted for the storage of ice and fish. She is ketch rigged with pole masts, and is fitted with a steam winch of Earles' special design and make for working the trawl gear. Her engines are inverted direct-acting, with cylinders 12in. and 22in. diameter by 20in. stroke, and are supplied with steam of 90 lb. pressure from a steel boiler fitted with one of Fox's patent corrugated furnaces. The engines worked most satisfactorily during the trip, giving a speed of upwards of 9½ knots per hour, the indicated horse-power being 170 and the revolutions 160 when working at full speed.

On Thursday, the 11th inst., Messrs. Earles' Shipbuilding and Engineering Company launched from their yard at Hull the iron screw steamer Pera, which has been built for Messrs. Bailey and Leetham, of Hull, for general cargo purposes. The dimensions are: Length, 310ft.; breadth, 37ft.; depth of hold, 20ft. She is built to Lloyd's highest class, with additional strength in the shape of steel for the upper works, where great longitudinal strength is needed. Provision is made for water ballast in double bottom all fore and aft, framed on the longitudinal system. The vessel has a raised quarter-deck, bridge, and turtle back forecastle, with accommodation for the captain and a few passengers in the poop. The officers' quarters are under the bridge, and the crew are berthed in the forecastle. The deck arrangements are designed with a view to the rapid loading and discharging of cargo, powerful steam winches being provided to facilitate this. The rudder is of cast steel, by Messrs. Jessops, and connected to steam steering gear amidships. The ship is schooner rigged, with two pole masts. Her engines will be 200-horse power nominal, the cylinders 34in. by 64in. by 39in. stroke, which will be supplied with steam at 95 lb. pressure from two boilers. The engines and boilers are being constructed by Messrs. Bailey and Leetham, at their Humber Ironworks, and will be fitted on board by the builders.

The Union Steamship Company's new mail steamer African, built by Messrs. Raylton Dixon and Co., of Middlesbrough, was successfully launched from the shipbuilding yard of that firm. The African is intended for employment in the Union Company's intercolonial mail service between Cape Town and Natal, and her leading dimensions are: Length over all, 253ft.; breadth, 33ft.; depth, 24ft. 7in.; and her gross tonnage will be about 1300 tons. The hull of the vessel is constructed of steel, but all the plates, scantlings, &c., are of the same dimensions as those required by Lloyd's rule for an iron vessel of similar dimensions. The ship has been built under Lloyd's special survey, and meets all the requirements necessary for the 100 A1 class. The African has four watertight bulkheads, and will be fitted with three steam winches and Bow and McLachlan's steam steering gear, and in view of her being

employed on the coast of South Africa, where bad weather is frequently experienced, cables and anchors of special strength will be supplied. The engines and boilers have been constructed by Messrs. T. Richardson and Sons, Hartlepool, and are of the three-cylinder triple-expansion type, to develope 1000 indicated horse-power. The diameters of the cylinders are 19½in., 34in., and 54in., with a stroke of 36in. The crank and screw shafting are of steel, made on the Siemens-Martin principle, and of extra strength. The propeller is fitted with steel blades. The boilers are constructed of steel, will work up to a pressure of 150 lb., and have been fitted with Wyllie's patent artificial draught, as well as with all modern improvements. It is anticipated that the adoption of the type of three-crank engine will give the greatest satisfaction, both in regard to smoothness of working and consequent increased comfort to passengers, and in regard to decreased consumption of fuel. The ship's speed, with a full cargo and coal supply, is guaranteed to be not less than 12 knots. The African will be fitted up in a luxurious manner for about 112 passengers, wire-wove mattresses and patent lavatories being used throughout the ship, and she will be despatched to take up her station within the next few months.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, March 6th.

THIS city has been agitated for the past few days by serious labour complications, and yesterday the entire surface roads of the city were "tied up" by the employés in order to force concessions which have been denied for a week or two. The managers are fighting the question of control as well as shorter hours and higher pay. Numerous strikes are reported all over the United States, and as a rule the workmen are gaining their point, increasing their pay and securing promises of shorter hours. The eight-hour movement threatens to be successful in all branches. In the building trades the reduction is promptly conceded, and in most cases ten-hour pay will continue. The general executive committee of the Knights of Labour has been in almost constant session for three weeks, and have work on hand that will keep them engaged for several weeks to come. They are settling strikes in nearly all cases in favour of their comrades, and are, therefore, gaining in popularity among their fellows, as well as securing the esteem of liberal-minded employers. In trade matters there is very little new. The politicians and manufacturers are quarrelling over tariff duties at Washington. There will be no reduction; at least the Protectionists do not apprehend any. Importers of iron and steel are anticipating considerable improvement in import orders. They have a great many orders for material, which are made on the supposition that material of all kinds will still further advance. The blast furnaces are pretty well sold up, as also are the steel rail mills, Bessemer furnaces, skelp mills, sheet mills, and some others, and should any extra demand be presented, it will be necessary, it is thought, to increase importation. Prices are everywhere firm, and brokers talk in a very hopeful frame of mind. The building trades are crowded, and at no time in the history of the country has there been as much activity and preparation for building in houses, shops, and factories. The activity is not confined to New York alone, but extends to all larger cities and to many smaller cities throughout the interior. The railroad matters have not been adjusted, but two weeks, it is said, will bring a great deal of uncertainty within the realms of certainty. The Pennsylvania Company offers to compromise with the Baltimore and Ohio in reference to its New York terminus if it will agree to postpone the construction of its road five years.

LONDON WATER SUPPLY.—In his report on the London water supply during February, Dr. Frankland reports that the Thames water sent out by the Chelsea, West Middlesex, Southwark, Grand Junction, and Lambeth companies, contained in every case less organic matter than was present in the January samples, the improvement being least conspicuous in the case of the Chelsea and West Middlesex companies. In none of the samples was the organic matter excessive for this season of the year. All the samples were clear and bright. Of the water drawn from the Lea, that supplied by the New River Company contained less, and that by the East London Company more organic matter than any of the other river waters. Both samples were clear and bright. The Colne Valley Company, by softening the supply with lime, thereby rendered it well fitted for washing and all other domestic uses. Seen through a stratum 2ft. deep, the waters presented the following appearances:—Kent, Colne Valley, and Tottenham, clear and colourless; New River, clear, and nearly colourless; Southwark, Grand Junction, Lambeth, and East London, clear and very pale yellow; Chelsea and West Middlesex, clear and pale yellow.

BELGIAN ENGINEERS AND METAL SLEEPERS.—Excepting the Government Engineer of Mines and Ponts et Chaussées, by far the most important body of engineers in Belgium has hitherto been the Société des Ingénieurs sortis de l'Ecole des Mines de Liége, with its branches in the four principal cities of the kingdom. But, from the nature of its constitution, like that of the Association des Anciens Elèves des Ecoles des Arts et Manufactures of France, no engineer, whatever eminence he may attain, can become a member of the Liége Society unless he happen to have been educated at the excellent mining school of that city. It was, therefore, thought advisable to found a new and central association of Belgian engineers, under the title of Société Belge des Ingénieurs et des Industriels, in connection with the Brussels Metal Bourse, and having its headquarters in the fine Palais de la Bourse, Brussels, which was built by an English company. This body began its active work with the present year by organising a series of lectures on the capabilities of the new Congo Free State, with proposed means of communication, and has now arranged an Exhibition of Metal Sleepers, the opening of which last Thursday was announced in our last issue. The president of the society is M. F. Wellens, Inspector-General of Ponts et Chaussées; the vice-presidents, M. C. de Burlet and M. V. Despret; and the secretaries, MM. Flamache and Ch. Legrand, while the organisation of the exhibition has been confided to a committee, of which M. Rombaut, Government Commissioner for the Antwerp and Amsterdam Exhibitions, is president. What is most noticeable about this exhibition, at which upwards of fifty systems of metal permanent way are represented, is the admirable order of its arrangement and the facilities afforded for examination of the exhibits. There is none of the vexatious "Please do not touch;" but, on the contrary, spanners are provided where necessary for unscrewing bolts. The sleepers, including some that have been in actual use for a certain number of years, models and fastenings are arranged on tables, round which there is free passage, while the drawings are attached to frames between each table. At present it is arranged that the Exhibition shall remain open for a month; but it is possible that its duration may be extended, if there should be any considerable accession of exhibits or the existence of the Exhibition becoming more widely known. Already the initiative has been followed by the French Comité des Forges and the Société des Industries Français, who proposed, at the close of the Brussels Exhibition, to hold another in the Pavilion of the City of Paris, near the Palais de l'Industrie in the Champs Elysées, where the absence of a floor will permit of actual trials with sleepers, and of demonstrations of packing ballast. A series of lectures, to be followed by discussions, is arranged at the Brussels Bourse for Friday evenings, the inaugural lecture last Friday, by M. Flamache, engineer of the Belgian State Railway and Professor of Railway Working at the Ghent University, having appropriately traced the history of metal sleepers from the early experiments with bowl chairs to the International Railway Congress held at Brussels last year.

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

(*From our own Correspondent.*)

A NEW feature has been introduced into the trade outlook this week by the circumstance that the ironworkers have determined to avail themselves of the provisions of Alderman Avery's award of last January, and give notice for an advance in wages in the middle of April, when the present arrangement expires. The market is not, however, much concerned, since it regards such a movement at the present time as hardly better than absurd.

The operative secretary of the Wages Board has been giving somewhat singular advice to the ironworkers. This week he publicly expressed the opinion that things were going from bad to worse, and that he was half-inclined to think that a general stand on the part of the ironworkers from Scotland to South Wales for a period of two months would tend very much to purify the social and commercial atmosphere. He could give the names of works at which the men had not worked a day and a-half per week during the last six months. This same leader is, however, continuing his efforts for the establishment of a sliding scale. He has long been convinced that a self-acting scale is by far the best means of regulating wages, and that all classes of iron, and not bars merely, should be taken into consideration. He, however, has now raised the minimum of 7s. 6d. per ton for puddling, which has been previously specified, to 8s. per ton, and the price to be regulated 1s. above the selling price of iron.

The men engaged at Messrs. Johnson's Ridgacre Ironworks have received notice to terminate engagements. It is stated that the works are to be closed, but the notice will not affect the other works of the firm.

What is construed as being an attempt to carry out in this part of the kingdom the decision come to by the Lancashire engineers to reduce wages 10 per cent. has brought about a dispute at the engineering shops at Oakengate, Shropshire, and the Lilleshall Iron and Steel Company. Notice for a 10 per cent. reduction has been served, but the hands have refused to consent to any drop, and the notice having expired the proprietors have for the present closed the works.

The bulk of the men are connected with the Amalgamated Engineers' Association, and are receiving 15s. per week per man, while non-society men are, it is said, receiving 7s. 6d. per week. The Earl of Granville, who is the managing director of the works, and the chief proprietor, has paid a visit to the establishment from London, but it does not yet appear that his lordship's presence has been able to suggest a settlement.

Business in finished iron keeps restricted. Ironmasters are earnestly anticipating an appearance of spring weather, which would have the effect of benefiting the home demand. The uncertainties of the political situation are too unfavourable to trade.

A few more specifications for the best descriptions of the finished material for export have lately been received, but in the sheet trade the volume of business is considerably less than it was a year ago. Marked bars are still quoted at £7 10s. and £8 2s. 6d., according to brand; unmarked bars are purchaseable at £5 down to £4 17s. 6d. as a minimum; and sheets range in value from £6 5s. upwards, though some consumers are buying at £6. On the whole, the sheet makers and the manufacturers of girders and bridgework appear to be best employed; but even among these firms only half production, and in some cases less than half production is the order of the day.

The present prices of the Pelsall Coal and Iron Company, Limited, are as here:—P.C. bars, £5 5s.; P.C. hoops, £5 10s.; crown bars, £6; crown hoops, £6 5s.; crown sheets, £6 15s.; charcoal sheets, £13 15s.; hinge strip, £6 5s.; gas strip, £5 5s.; nail strip (24in. wide to 13 g.), £5 5s.

German competition keeps the wire-rod trade very quiet. Export sizes Nos. 0 to 6 of rolled rods are quoted by Shropshire firms on the basis of £6 per ton, f.o.b., Liverpool, while smaller sizes run down to £4 and less. Drawn rods Nos. 7 to 8 are quoted £7, Liverpool.

In some quarters in the pig-iron trade a further restriction of output is talked of, the reduced prices quoted for importations from other districts placing local smelters at a disadvantage. The further business reported is for comparatively small parcels. Hot-blast mine pigs are quoted from 55s. to 54s. 6d. per ton, according to number; part mine, 45s. to 40s. per ton; common iron, 35s. to 30s. per ton. Northampton pigs are 36s. 6d. easy at railway stations, and Derbyshires 6d. to 9d. per ton more.

Welsh scrap iron, composed mainly of sheet shearings, is quoted by sellers at 48s. per ton, but buyers are attempting to secure supplies at 45s.

Engineers of established reputation engaged in heavy roll and wheel manufacture are experiencing a steady, though quiet, demand. Orders are received not only from ironworks and other heavy machinery users at home, but from buyers in Belgium, France, Germany, Spain, Italy, and other Continental countries. Messrs. Thomas Perry and Son, Highfield Engineering Works, Bilston, have just accomplished another addition to their former triumphs as chilled roll makers. They have cast a chilled roll over 13ft. on the barrel, of 28½in. diameter, and weighing 14 or 15 tons. The roll has a chill of ¾in., and has been despatched to the North to be used in imparting the high polish which appears upon the best goods of the linoleum manufactures. This makes the third roll of almost exactly similar size and weight which Messrs. Perry have cast for the same manufacturers. Messrs. Perry are the only firm in Europe or in America whom the Northern manufacturers could induce to undertake this special work, all others, when appealed to, declining to venture the attempt.

A heavy business in railway wheels and axles on export account continues to be done by the Patent Shaft and Axletree Company, Wednesbury. India, South America, Australia, North America, and other distant markets, are all understood to be good customers.

Mr. Alfred Hickman, M.P., iron and steel-master, who has lately figured in the House of Commons on the railway rates question, read an important paper on "Railway Rates" before the Institute of Iron and Steel Works Managers, at Dudley, on Saturday. He dwelt on the merits of the Bill introduced by Mr. Mundella, and pointed out some essential omissions. However complete the Bill might be, it would not fulfil all the requirements of traders, and the only remedy to which they could confidently look was in the improvement of the waterways. By this means goods could be conveyed to the Severn ports from South Staffordshire at half their present cost, and the freightage to London would be reduced to 7s. per ton, including collection, instead of as now 15s. per ton. Mr. Benjamin Hingley, M.P., ironmaster, expresses the strong hope that manufacturers and other traders in this district will have the money ready for the projected improvement of the waterways.

The strike of the socket and fittings makers in the Wednesbury wrought iron tube trade continues, and is now extending to the largest works which were not previously directly engaged in the dispute.

The largest gasholders which have hitherto been put up are those which have just been erected by the Birmingham Corporation. The two new gasometers have each a capacity of 6,250,000 cubic feet, being 240ft. in diameter, and standing when filled with gas 170ft. high. They are suspended over tanks 51ft. deep. The gasometers are supported by standards and latticework of iron. These gasholders will be somewhat eclipsed by a gasometer which is being erected for the South Metropolitan Gas Company, and which is to be made in four lifts, as compared with three at Birmingham. The new retort-house of the Birmingham gasworks is a fine building, 487ft. in length and 210ft. in breadth. With the full number of retorts in position, there will be 1512 mouthpieces. These are fed by three systems, namely, those of Klönne, Dr. Siemens, and Mr. Charles Hunt, the engineer of the works. The new purifying house is about 200 yards long. These and other appliances make up modern additions which have entailed a cost of about a quarter of a million sterling. The contractors for the gasholders are Messrs. Cutler and Sons, of London, and Messrs. Aird and Sons have constructed the tanks. The principal ironwork has been supplied by the Patent Shaft and Axle Company and by the Horseley Company.

The accounts of the Guardians of the Birmingham Gun-barrel Proof-house for the past year show that the receipts amounted to £6015 and the expenditure to £6308, leaving a balance of loss of £292. Last year, before the reduction of the charges, the receipts were £8212, on which there was a profit of £1505.

The annual spring Speedwell Cycle Show, which has been held in Birmingham this week, marks an epoch in the cycle trade. In the large number of machines which were there exhibited was seen the consummation of a development in this branch of the light machine trades which has been almost phenomenal. A striking instance of this was the varied exhibition of Messrs. Humber and Co., who had on view machines of all types and sizes, ranging from the "Humber safety" to the swiftest racer. Among other prominent exhibitors were the Coventry Machinist Company, the Caroche Tricycle Company, the Coventry Cycle Company, and several Wolverhampton firms.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—The close of the first quarter of the year is rapidly approaching, and there is still no sign of any improvement in the iron trade of this district. Certainly not within the last thirty or forty years has trade been in a more depressed or despondent condition than during the past three months, and the outlook continues quite as discouraging as ever. The weight of new work coming into the hands of users of iron, or even in prospect, continues so small that actual requirements are kept down to the most limited possible dimensions, and as consumers can see no sign of any likely upward movement in the market, at least for the present, excessively low as prices are, they offer practically no inducement for buying beyond bare hand-to-mouth requirements. It is, however, not only the scarcity of new orders of any weight giving out that is making itself felt; in not a few instances consumers have been unable even to take the iron already bought, and sellers complain almost as much of suspended deliveries on old contracts, which in many cases should have long since run off, as of the absence of new contracts being placed out. The position of the pig iron trade, so far as this district is concerned, could scarcely be worse; of what may be termed purely Lancashire brands of common pig iron, the production has now been reduced to so low a point that local iron has ceased to be an element of any importance in the market, whilst as regards district irons, which are chiefly represented by the Lincolnshire brands, not one-half of the furnaces are in blast, and even for this restricted production it is so difficult to find an outlet that iron is pressed for sale here at lower prices than have ever before been known. The position of the finished iron trade is equally as bad; several of the works in the Wigan district have been closed entirely for a considerable time past, and in the Warrington district, which is the centre of the largest production in Lancashire, forges are not working up to more than half their output, even at prices which have been cut down to below the actual cost of production.

At the Manchester iron market on Tuesday extreme slackness in demand throughout all departments was again the general complaint. For pig iron there was very little inquiry, and I could hear of no transactions of any weight being effected. Prices were not quotably any lower than last week, but the general tone of the market continues weak. For Lancashire pig iron makers hold to 37s. 6d. and 38s., less 2½, as their lowest quoted rates for delivery equal to Manchester, but with the present very limited make these are little more than nominal prices, and they are so much undersold by district brands, that except for very small sales to customers in the immediate neighbourhood of the furnaces, local makers are practically out of the market. Lincolnshire iron continues to be offered at extremely low prices, and some brands can be bought ready for delivery equal to Manchester at about 36s. 6d. to 37s. per ton, less 2½. For outside brands prices remain nominally pretty much the same as last week, but there is really little or nothing being done here either in Scotch or Middlesbrough iron.

Hematites still meet with only the most restricted inquiry, and prices if anything are weaker, good ordinary brands of No. 5 foundry not averaging more than about 51s. 6d., less 2½ per cent., delivered into this district. The threatened break up of the Steel Rail Makers' Association has a disturbing effect upon business; buyers have no orders of any weight to give out except for forward delivery, and makers are disinclined to sell at present rates except for immediate delivery.

In the finished iron trades there is still only a very slow hand-to-mouth business doing, and this only at the lowest possible prices on the basis of £5 to £5 2s. 6d. for bars delivered into the Manchester district, the minimum quotation representing the average price that makers are open to take for prompt specification.

The condition of the engineering trades of this district remains practically unchanged. Locomotive builders in some instances have still sufficient work in hand to keep them about fully employed, tool makers are generally moderately off for work, and there are rumours that there is work coming out in the stationary engine building trade, but it has not yet shown itself in the shops; as a rule, however, there is an absence of new orders of any weight in prospect. The men in this district, although they have accepted the reduction in wages, are persisting in the determination not to work overtime at the reduced rates, and this has become a difficulty at one or two works which are under pressure to complete orders in hand. The returns of the various Trades Union societies connected with the engineering branches of industry show no improvement in the condition of employment. There is a continued steady increase in the numbers coming upon the books of their respective societies for out-of-work support, which in some of the leading societies now amount to an unusually large percentage. The Amalgamated Society of Engineers has now 10 per cent. of its members in receipt of out-of-work support. The percentage is about the same in the Moulders' Society, and the Steam Engine Makers' Society has 6 per cent. of its members in actual receipt of out-of-work donation benefit. As regards trade, general slackness continues to be the report from the districts in the leading industrial centres throughout the country. The engineering works in the London district appear, however, to be better employed than elsewhere, and from some of the shipbuilding centres a slight improvement is reported.

At the monthly meeting of the Manchester Joule Club, on Wednesday last, several interesting communications were brought before the members. The chairman, Mr. Allott, gave a description of the length of line constructed by the Lancashire and Yorkshire Company between Pendleton and Hindley, and with the aid of drawings indicated the amount of cutting which had been necessary, and some of the difficulties which had been encountered in carrying out the work, notably the underpinning of the Maypole Hotel, which necessitated the removal of the wines and spirits to a distant part of the building, owing to the vibration of the passing trains. This was followed by a paper on pressure gauges, by Mr. Budenberg, after which Mr. Bollé read a paper on liquid fuels, showing how they were used on the Caspian and Black Sea Russian steamers, the petroleum being split up into sprays by the injection of steam, so as to guarantee perfect combustion. It was claimed that with the liquid fuel a double efficiency was secured as compared with coal, or, in other words, that 18 lb. of water would be evaporated with 1 lb. of petroleum, as against an evaporation of 9 lb. of water with 1 lb. of coal; but as Mr. Bollé was unable to substantiate these results by actual experiments, they were, in the discussion that followed, considered as open to some doubt.

The development of improvements in gas-lighting seems to more than keep pace with the progress made by electricity as a competing system of lighting. One of the latest improvements I have seen in this direction is a new lamp on the regenerative principle recently introduced by Messrs. H. Fourness and Co., of Manchester, which, though designed more particularly for private and public buildings, would certainly seem a very effective means of lighting railway stations and outside spaces, the difficulty in the latter case being overcome by enclosing the lamp in an independent glass shield to protect it from wind and storms. The lamp was first introduced last year, but it has since been gradually improved. The main feature is a regenerative chamber placed immediately above the gas flame; this chamber consists of a series of vertical tubes, through the centre of which passes the chimney. Through these tubes the outside air or oxygen is conveyed to the flame, the air in its passage through the tubes being heated by the products of combustion escaping up the chimney. The air entering the globe in a heated state creates a vacuum, and when it reaches the efflux of the gas, spreads the flame out into an incandescent disc light of very high illuminating power. By the special arrangement of the lamp there is neither smoke nor smell from the combustion of the gas, and by recent improvements the lamp is made entirely self contained, both as to controlling the light and the supply of oxygen according to the quality of the gas which is being consumed, and it can be lit from through a small slide from the bottom of the lamp without opening the glass. The light is thrown vertically from the lamp by means of a reflector immediately above the flame, and it is claimed that with the same consumption of gas five times the illuminating power is secured as with the ordinary lamp.

The continued exceptionally severe weather still keeps up a brisk demand for house-fire coals at full rates, but the activity in the coal trade does not extend to other classes of fuel. Common round coals meet with only the very slowest sale either for steam or forge purposes; in fact, for ironworks purposes there is a continued decreasing demand, which is throwing such large quantities of forge coal on the market that this class of fuel is a complete drug. Engine fuel meets with a fair sale for mill purposes, but the salt and chemical works are only taking very restricted quantities, and common slack is plentiful. At the pit mouth prices remain at about 9s. for best coals, 7s. 6d. good second qualities, 6s. common house coal, 5s. to 5s. 6d. steam and forge coals, 4s. to 4s. 6d. burgy, 3s. to 3s. 6d. good ordinary slack, with some best sorts fetching 3s. 9d. to 4s. per ton.

Shipping is only dull, and steam coals delivered at the high-level, Liverpool, or the Garston Docks, can be got at about 7s. per ton.

Barrow.—There is practically no change to note in the demand for hematite qualities of pig iron. The market is exceptionally quiet, and buyers not only have very few wants, but they are not disposed to enter into contracts for forward deliveries at present. Prices certainly show a disposition in the direction of a decline, although mixed parcels of Bessemer are still quoted at 43s. per ton net at makers' works for prompt delivery. Some quotations have, however, lately been given from the northern part of this district at 41s. per ton net at works for hematite of the lower standards of quality. Stocks are much smaller than they have been; but makers some time ago entered into delivery engagements with consumers which practically furnish them with employment at the present moment. Steel makers are selling very little steel in the shape of railway material, and it is still a fact that orders which it is known are soon to be placed are being held back in view of the collapse of the Steel Rail Makers' Association. Ten shillings per ton reduction has been noted on tin bars, and the demand, which was brisk before this decline in prices, may be expected to be still brisker. The only other department of the steel trade which is busy is that in which ships' steel and boiler steel is being produced. The mills are busy, and are likely to be even more so, while extensions are being made to increase the production. There is still a very quiet demand for iron ore, but prices are steady. Coal and coke in slow consumption. Engineers well employed in the marine department only.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

Though as yet there are fewer indications of improved trade than one could wish to see, I find confidence pretty freely expressed that we are on the eve of better times. In the heavy industries there has been of late no lack of work, in connection with railway material both on home and foreign account, marine forgings and castings, armour-plates, gun-forgings, and similar material. Firms engaged in these specialities are fully employed. Several markets, too—notably the United States, where an improvement is always regarded as a particularly good sign—are sending better orders in cutlery and steel. The call for high-class crucible steel for the States during February was twice as great as that for the corresponding period of 1885. In cutlery there was also a decided improvement. The home markets do not show any great change either way. Files, saws, and edge tools continue in limited request. A large number of hands is unemployed in these departments, and at one extensive establishment will continue idle till they concede 15 per cent. reduction, which the employers declare absolutely necessary to enable them to meet German competition. Now-a-days the Germans, not content with supplying their own requirements and pushing briskly into the colonial and foreign markets, are making themselves rivals in our industrial centres, mainly through the remarkably low prices at which they put their goods on the market.

The Town Council is to hold a special meeting in regard to the charges of fraudulent trading against Sheffield merchants and manufacturers in regard to the alleged false marking of goods. It is difficult to see what the Town Council can do in the absence of specific evidence against local manufacturers; and this the accusers, having a wholesome dread of the law of libel, refuse to furnish. The great evil is in Germany, where tons upon tons of cutlery, tools, and other wares are stamped with the word "Sheffield" and Sheffield trade-marks, or imitations of them, and sent direct to the various markets of the world. Occasionally these goods are coolly sent to England to be transhipped in British bottoms, so as to make the imposture more complete. It is while this nefarious process is going on that the Customs' officers occasionally pounce upon the pirates and seize the goods. Messrs. Joseph Rodgers and Sons, our celebrated cutlery firm, have had enormous quantities of German productions marked with their name and trademarks seized in the Thames and publicly burned on Tower-hill. To strike at the origin of the evil has been the constant aim of the Cutlers' Company, and they are at last, after many rebuffs from the Government which would have daunted a less determined body, within measurable distance of success. A deputation, representing the Cutlers' Company and the Chamber of Commerce, waited upon the President of the Board of Trade last week, to urge him not only to appoint a British delegate to attend the Industrial Property Convention next month at Rome, but to secure that that delegate shall be instructed to support their request in the interests of honest trading. It has been already decided by the Convention that the marking of "Sheffield" with the name of a maker on a blade not made in Sheffield is fraudulent, but that the mere marking of "Sheffield" by itself is not fraudulent. The Sheffield representatives will insist that the marking of "Sheffield" or the name of any other town on a blade where it is not made is deception, and ought to be declared fraudulent, whether the name of a maker is stamped on it or not. If this point can be obtained, the German pirates will be rooted out, and the home imitators, if there are any, can be promptly crushed. But it is little use lopping off the branches so long as the root remains untouched.

Messrs. Watson, Moorwood, and Co., of the Harleston Ironworks, Sheffield, are at present engaged upon several exceptionally large cooking stoves for her Majesty's Navy. Two or three now in course of construction will cook for some 1400 to 1500 men. This firm have obtained the contract for the cooking apparatus for the Navy, which extends for five years. It has previously gone to Glasgow. Two large shops have been erected with a view to the work to be done under the contract.

Messrs. A. J. Acaster and Co., engineers, Princess Works, Sheffield, have just supplied to the Mint, Birmingham, two 40-horse power inverted cylinder engines with double-throw cranks, on one base, fitted with fly-wheel and other accessories. This firm is engaged on a considerable quantity of work required in the construction of the Manchester Ship Canal.

THE NORTH OF ENGLAND.

(From our own Correspondent.)

There was but a moderate attendance at the Cleveland iron market held in Middlesbrough on Tuesday last. Although a dull and despondent feeling prevailed, it cannot be said that things were worse than they were a week ago. No arrangement has yet been arrived at for reducing the output, and consumers hesitate to buy more than they want for immediate use, whilst stocks are increasing at their present rate. Merchants are asking 30s. per ton for No. 3 g.m.b., for prompt delivery. Some who are compelled to realise even at a sacrifice, have taken 29s. 10½d. per ton, but the sales made at that price are few in number, and not for large quantities. For delivery to the end of June, merchants are quoting 30s. 3d. to 30s. 6d. per ton. Makers' quotations are about 6d. per ton higher. The demand for forge iron has not improved; on the contrary, the price has fallen to 29s. per ton.

As regards warrants, buyers are offering 29s. 9d. per ton, but sellers ask 3d. to 6d. more, and few sales are made.

The stock of Cleveland pig iron in Messrs. Connal and Co.'s Middlesbrough store increased no less than 6780 tons during the week ending Monday last. The total stock on that day was 199,530 tons. On March 17th last year the total quantity held by them was only 50,832 tons.

Shipments of pig iron are proceeding very slowly. Only 25,110 tons had been shipped up to Monday last, that being about 5000 tons less than during the corresponding portion of last month.

There is but little doing in the finished iron trade. It is to be hoped that the demand will improve when the shipyards are again fully at work; for the present the weather is impeding all outdoor operations. Prices are unaltered.

The strike of platers' helpers at Messrs. Raylton Dixon and Co.'s shipyard was amicably arranged on the 10th inst., and work was resumed on the 11th. The strike arose on account of a threatened reduction in their wages of 1s. per week. The platers abated their claim to 9d. so long as only three-quarters time is worked, the helpers agreeing to the full shilling reduction so soon as they are again working full time.

There are now over 900 able-bodied paupers engaged in the stone yards at Middlesbrough.

Between 200 and 300 foundry-men in the employment of Messrs. Cochrane, Grove, and Co., at Middlesbrough, recommenced work at a reduction of 7½ per cent. on Monday last. The notice to this effect only expired on Saturday.

At a meeting of the River Tyne Commissioners held on Thursday, the 11th inst., it was announced that 130 steamers and 25 sailing vessels, of a total capacity of 177,968 tons, were now laid up on the river Tyne, owing to the depression in trade. The number of seamen thrown out of employment thereby is estimated at 3000.

Messrs. Hawks, Crawshay and Co., of Gateshead, have recently, entered two heavy contracts. The larger of the two is for about 4000 tons of iron and steel bridge work for the Indian Government. The smaller one is for an iron pier estimated, however, to contain 1000 tons.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

There has been a somewhat firmer feeling in the iron market this week, attributed to a scarcity of warrants. Several makers have also been holding for slightly higher prices, and it is understood that the prospects of business with the United States are a little more hopeful. The current shipments are, however, small, those of the past week amounting to 6009 tons, as compared with 6675 in the preceding week, and 8879 in the corresponding week of 1885. A furnace has been put out at the Langloan Ironworks, but one has been relighted at Gartsherrie and another at Glengarnock, the total now in operation being ninety-five, as compared with ninety-two at the same date last year. In the course of the week upwards of 5000 tons of pigs have been added to the stock in Messrs. Connal and Co.'s Glasgow stores.

Business was done in the warrant market on Friday at 37s. 11½d. to 38s. 1½d. cash. On Monday transactions occurred at 38s. 2d. Tuesday's market was stronger, with business up to 38s. 5d. cash, closing with buyers at 38s. 3d. On Wednesday transactions occurred at 38s. 2½d. to 38s. 1½d. cash. To-day—Thursday—business took place at 38s. 4½d. to 38s. 5d., closing at 38s. 4d. cash.

The current values of makers' pigs are as follows:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 43s.; No. 3, 41s.; Coltness, 47s. and 43s.; Langloan, 44s. 6d. and 42s.; Summerlee, 47s. and 42s.; Calder, 47s. and 41s.; Carnbroe, 43s. and 40s. 6d.; Clyde, 43s. and 40s. 6d.; Monkland, 39s. and 36s.; Quarter, 38s. 6d. and 35s. 6d.; Govan, at Broomielaw, 39s. and 36s.; Shotts, at Leith, 45s. and 44s. 6d.; Carron, at Grangemouth, 48s. 6d. and 45s. 6d.; Kinneil, at Bo'ness, 43s. and 42s. 6d.; Glengarnock, at Ardrossan, 43s. 6d. and 40s. 6d.; Eglinton, 39s. and 36s.; Dalmellington, 41s. 6d. and 38s. 6d.

An important meeting of members of the iron and steel trades of Scotland was held in Glasgow on Tuesday, under the presidency of Lord Provost M'Onie, for the purpose of considering the present unsatisfactory position in which iron and steel manufacturers generally are placed in consequence of the high duties imposed on British goods imported into Spain. Mr. Andrew Stewart—of Andrew and James Stewart—submitted the following statement:

Duties Charged on British Produce Entering Spain, as compared with other European Countries.

Duties.	British.	French, Belgian, German.	Difference per 1000 kilos. = 2206 lb.	Difference expressed in percentage.
	£ s. d.	£ s. d.	£ s. d.	per cent.
Pig iron	0 19 3	0 15 5	0 3 10	25
Iron bars .. }	5 0 0	3 6 7	1 13 5	50
Iron plates .. }				
Iron sheets .. }	3 9 2	2 11 6	0 17 8	34
Steel sheets .. }				
Steel plates .. }	5 0 0	3 6 6	1 13 6	50
Steel bars .. }				
Steel rails	3 1 6	1 14 10	1 6 8	76
Iron tubes	5 0 0	3 5 4	1 14 8	53
Cast iron pipes ..	1 16 2	1 6 11	0 9 3	34

Mr. Stewart said that there were even greater anomalies in other classes of goods than that mentioned above. It appeared that our treaty with Spain lapsed about five years ago, but its terms were allowed to go on for another year, when a treaty was made between this country and Spain, in which the duties that were lowered to France and other countries were allowed to stand at the old figure to Great Britain. The result was that the Spanish business in this country had shrunk almost to nothing. He suggested that a committee be appointed to draw up a memorial to the Foreign Secretary on the subject. The chairman said it was a fact that Great Britain and her Colonies recived 66 per cent. of all the exports from Spain. In reply to Mr. Bost, Mr. Stewart said Mr. Gladstone had caused the duties on wines to be charged by the degree of alcoholic strength, which came heavier on wines received here from Spain than on those from France. The following were appointed to draw up a memorial to Lord Rosebery on the subject:—Messrs. Paul, Laidlaw, James Neilson (Mossend Company), Archibald M'Lellan (Steel Company of Scotland), Cowan (Carron Company), Bost, and J. R. Cassels (Glasgow Iron Company).

The malleable ironworks of Lanarkshire are now reported to be ill-supplied with orders. But for certain contracts of old date, which are in most cases nearing completion, it is understood that the business would ere this have been in a very depressed condition.

Messrs. Laidlaw and Son, of Glasgow, have obtained an order for 3200 tons of cast iron water pipes for Sydney, New South Wales.

In the past week the shipments of iron and steel manufactured goods from the Clyde embraced locomotives to the value of £27,470 for Calcutta; ditto, £7750 for Queensland; machinery, £3422; sewing machines, £4070; steel goods, £9420; and general iron manufactures, £20,100.

The shipping department of the coal trade has been slightly more active in the past week. From Glasgow the shipments amounted to 21,856 tons; Greenock, 1752; Ayr, 7805; Irvine 2000; Troon, 8328; Leith, 5100; Grangemouth, 4461; Bo'ness, 295 tons. The prices of all sorts of coals are nominally unchanged, but in reality in not a few cases in favour of buyers. Although the colliers of Fife are only getting from three to four days' employment a week, stocks are still reported to be accumulating.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

I am not surprised that the Rhymney Railway directorate have decided to abandon their Bill. In the face of existing depression a project that, however feasible, would require five years to complete, was not of the most hopeful character, especially as the shareholders were dead against it. I still hold to the belief that the virgin coal track sought to be developed by this Bill must some day enlist the energies and capital of our best men; but at a time like the present, when well-developed collieries are doing so little, and the best coal is as good as given away, it is better to pause.

The rumour that operations are to be suspended at Ynysbwl has been denied, and it is well that things are not quite so bad, as this would have meant ruin to large numbers.

There is not the slightest improvement in the coal trade. In fact, it seems to be getting worse, for while Cardiff continues as depressed as ever, things are represented as flagging at other ports. Swansea, for instance, has been pretty brisk up to a late period; but last week slackness prevailed, the east winds preventing tonnage from coming in. Consequent upon the falling-off in the output of steam coal, prices for small steam have advanced, and the ruling figure is now 5s. per ton. Pitwood is still on the decline. Last week offers at 14s. 6d. were only feebly accepted.

In the manufactured iron trade only a small hand-to-mouth kind of business is being done. Some of our principal ironmasters are occupied with a few home railway orders, such as for the Barry Docks, and small colonial requirements. The most important and almost the only consignment of the week so far has been 500 tons to San Francisco.

Welsh makers are doing their best to win the confidence of tin-plate makers, both as regards the article and the price, though Barrow often competes successfully, and imports to Swansea are not unfrequent. The tin-plate industry seems forging ahead of the rail trade. Last week 53,000 boxes were sent away from Swansea, principally for New York and France.

Hopes are entertained that the proposed reduction in the American tariff will tell favourably. The reduction in tin-plate bars has not told well, but its action is not yet thoroughly well worked out. Buyers held back at once, thinking it a prelude to a fall in the price of tin plate, and a few weak holders gave way to the extent of 3d.; but firmness has been resumed and prices seem to be stiffening.

Coke plates are quoted from 13s. 9d. to 14s. 3d.; Bessemers, 14s. to 14s. 6d.; and Siemens command fully 3d. more. A reduction of wages to forgemen is talked about, and will very likely be enforced. The extent is doubtful, but is not likely to be under 7½ per cent.

170,000 boxes now represent the stock at Swansea. The Monmouthshire trade remains tolerably buoyant, and returns all round show that March totals will compare favourably with those of previous months. Ternes are getting into good demand, I see, but charcoal plates, which used to be a speciality at Pentyrch Works, near Cardiff, are not buoyant.

A few days ago the last coping stones were placed on the new Roath Dock, and this great enterprise, which was began in 1833, is brought to a successful completion. The contractors—T. Nelson and Co., of Carlisle—will now dispose of their plant, and in a short time the finishing details, hanging gates, &c., will be completed. These are being made by Armstrong at Newcastle. The new dock will be a vast addition to the import and export facilities of Cardiff, and it is to be hoped that with its opening another prosperous spurt may take place in the coal trade.

A new timber pond that will cover about eight acres of ground is to be formed at Cardiff by the Marquis of Bute's management, and will be commenced forthwith. The site is on the Glamorganshire Canal.

I hear that the Mines' Commission have completed their great task, and upon it the new legislation for collieries will be floated.

Protection of Wooden Piers from Fire. — Timber necessarily entering to a very large extent into the construction of piers for shipping, it follows that these structures are very liable to be damaged by fire, and several instances of this have occurred in recent years. Queenborough Pier, forming one of the termini of the continental steamboat service of the London, Chatham, and Dover Railway, in this manner was totally destroyed by fire three years ago. Upon its re-erection in August last, arrangements were made with Messrs. Shand, Mason, and Co., to supply one of their fixed steam fire-engines, for the protection of the pier and offices. The engine, necessarily a powerful one, is of the horizontal construction, placed with the boiler in a wrought iron framing, also forming an ashpan, and is placed in an engine-house on shore, so as to be itself out of danger from fire. The necessary cast iron suction pipe is conveyed to deep water, a distance of 400ft., and a fire main service is fitted along the whole length of the pier, branching into the various sheds and buildings, with hydrants at the required intervals. The hose is of leather, and this with the necessary implements, is arranged on two hose carriages, so as to be ready for instant use. The fire in the boiler is kept ready laid, and, being on Shand, Mason, and Co.'s quick-steaming system, the engine can be got to work and discharging a powerful jet in a few minutes from lighting the fire. In order to test the efficiency of this apparatus, which has just been completed, a series of interesting experiments took place on Thursday last in the presence of Mr. W. Wills, Mr. G. Roche, engineers, and other officials of the company. Mr. Hedgman represented the constructors. The boiler was charged with water at the existing temperature, and in nine minutes ten seconds from lighting the fire the engine was started with steam of 100 lb. to the square inch, the water issuing from the jet in fifteen seconds after starting, notwithstanding the great length of suction pipe and depth of the water to be raised. Various jets were used with varying results, the water reaching the horizontal distance of 225ft. from the jet pipe with the vertical height of about 150ft. against the wind. In one of the tests five jets were used simultaneously from as many hydrants, showing that in case of fire a complete mastery would be obtained over it.

NEW COMPANIES.

THE following companies have just been registered:—

Nordenfelt Guns and Ammunition Company, Limited.

This company proposes to take over the business of manufacturer and dealer in machine and other guns and ammunition, carried on by Thorsten Nordenfelt—the founder of the company—in London, Stockholm, and elsewhere. It was registered on the 5th inst. with a capital of £300,000, in £1 shares. The subscribers are:—

	Shares.
A. S. Statham, 8, Salisbury-road, Dalston, accountant	1
W. Heald, 40, Balham-grove, S.W.	1
Henry Cooke, 29, New Broad-street	1
H. Sparshall, 15, Finborough-road, S.W., solicitor	1
T. Nordenfelt, C.E., 53, Parliament-street	1
W. Westlake, 40, Nottingham-place, accountant	1
T. Heckels, 9, King's-road, Peckham, clerk	1

The number of directors is not to be less than three nor more than seven; qualification, 500 shares; the first are Sir Astley Cooper, General Sir Donald Stewart, Bart., Messrs. C. E. Barnett, and T. Nordenfelt, the latter being appointed managing director. The remuneration of the board will be £1500 per annum.

Ticehurst, Tolley, and Co., Limited.

This company was registered on the 3rd inst. with a capital of £10,000, in £5 shares, to take over the engineering and manufacturing business carried on by Messrs. B. T. Moore, F. W. Ticehurst, and Henry Tolley, at 77, Colmore-row, and 65 and 66, Wenman-street, Birmingham. The subscribers are:—

	Shares.
A. R. Johnson, 14, Pakenham-road, Birmingham	1
A. Hirst, 110, Upper Mary-street, Birmingham	1
J. S. Rhodes, 10, Newhall-street, Birmingham, chartered accountant	1
F. W. Ticehurst, 77, Colmore-row, Birmingham	1
G. W. Dalley, 26, Beaufort-road, Birmingham, clerk	1
Henry Tolley, 65, Marian-street, Birmingham, gunmaker	1
L. H. Elkington, 10, Newhall-street, Birmingham, chartered accountant	1

Registered without special articles.

Wolfenden and Son, Limited.

This is the conversion to a company of the business of cotton spinners carried on by James Rawsthorne Wolfenden and Henry Wolfenden, of Bolton, Lancaster. It was registered on the 9th inst. with a capital of £200,000, divided into 4000 (£5 per cent.) preference and 16,000 ordinary shares of £10 each. The subscribers are:—

	Shares.
*J. R. Wolfenden, Bolton, cotton spinner	1
*Henry Wolfenden, Birkdale, cotton spinner	1
C. E. Wolfenden, Bolton, spinst r	1
M. E. Wolfenden, Bolton, spinster	1
S. J. Wolfenden, Bolton, spinster	1
L. H. Hind, Lytham, married woman	1
C. K. Dalton, Bolton, cashier	1

The number of directors is not to be more than five; qualification, 100 shares; the first two subscribers are appointed directors.

St. George Gold Mining Company, Limited.

Upon terms of an agreement of 30th December, this company proposes to purchase from W. C. Martin, of 63, Gellatly-street, Dundee, certain mineral property situate at Nacoochee (Indian Gold Valley), in White County, Georgia, U.S.A. It was registered on the 6th inst. with a capital of £60,000, in £1 shares. The consideration is £50,000, whereof £25,000 is payable in fully-paid deferred shares, and £20,000 in fully-paid ordinary shares. The subscribers are:—

	Shares.
Hy. Green, 70, Lansdown-road, Clapham-road, surgeon	1
John Martin, 58, Lombard-street, merchant	1
Joseph Price, 101, Leadenhall-street, accountant	1
M. F. Dormer, 15, Fernlea-road, Balham, insurance agent	1
C. C. Baker, 4, Austinfriars, clerk	1
J. W. R. Young, 28, Alma-road, Canonbury, clerk	1
W. H. Foy, 58, Union-road, Clapham, accountant	1

The number of directors is not to be less than three nor more than seven; the subscribers are the first; qualification, 200 shares; remuneration, £105 per annum to each director. Mr. J. Martin is appointed managing director for three years at a salary of £300 per annum, with a bonus when 10 per cent. dividend is paid. When travelling or residing at the mines, Mr. Martin's salary will be £50 per month, such sum to include expenses.

Stanley Paper Fibre Company, Limited.

This company was registered on the 8th inst. with a capital of £3000, in £1 shares, to acquire from John Charles William Stanley, the British and other patents, granted for an invention for improvements in the preparation of material suitable for being made into paper, and for other purposes, and in apparatus therefor. The subscribers are:—

	Shares.
J. C. Stanley, 41, Barnsdale-road, N.	1
A. G. Witherby, 117A, Earl's-court-road	1
O. A. Fry, 4, Hare-court, Temple, barrister	1
A. T. Alac Conkey, West Derby, Liverpool	1
P. F. G. Lord, 26, Lee Park, S.E.	1
H. Hendicks, 60, Warwick-road, W.	1
Wyatt Smith, Newland, Sherborne	1

Registered without special articles.

Birmingham Central Buildings Company, Limited.

This company proposes to acquire a lease of a piece of land situate in Corporation-street, Birmingham, and to construct buildings thereon. It was registered on the 9th inst. with a capital of £10,000, in £5 shares. The subscribers are:—

	Shares.
S. Wilkinson, Alvechurch, Worcester	10
E. Collins, King's Head, Birmingham	10
T. Chatwin, Edgbaston, engineer	10
H. Draysey, Edgbaston, traveller	10
Henry Jones, F.C.A., Edgbaston	10
W. D. Wilkinson, Moseley, manufacturer	10
W. Shakeshaft, Coventry	10

The number of directors is not to be less than four nor more than seven; qualification, 20 shares; the subscribers are to appoint the first; remunetion, £100 per annum after providing for 5 per cent. dividend, and such additional amount as the company in general meeting may determine.

Brier and Son, Limited.

This is the conversion to a company of the business of Brier and Son, of the Manor-lane Oil and Size Works, Gally Wall-road, Bermondsey. It was registered on the 6th inst. with a capital of £50,000, divided into 4000 preference and 1000 deferred shares of £10 each. An agreement of the 10th ult. regulates the purchase, the consideration being £18,000, payable £5500 in cash, £2500 in 5 per cent. debentures, and the residue in fully-paid shares. The subscribers are:—

	Shares.
G. Milner, 59, Mark-lane, merchant	50
A. G. Beck, Market-street, Bermondsey, merchant	50
M. Cahill, 193, Long-lane, S.E., fellmonger	50
J. A. Smith, 22, St. Mary-road, Peckham, merchant	25
C. H. S. Ward, 10, Villa-road, Brixton	25
F. R. M. Pothecary, Market-street, Bermondsey, leather and hide factor	25
T. E Webb, Perry House, Peckham-road, surgeon	10

The number of directors is not to be less than three nor more than six; qualification, 25 shares; the subscribers are to appoint the first; remuneration—chairman, £100 per annum; and each director, £50 per annum.

Brighton Palace Hotel Company, Limited.

This company was registered on the 8th inst. with a capital of £200,000, in £10 shares, to carry on business as hotel, restaurant, and tavern keepers. The subscribers are:—

	Shares.
A. G. J. Ponsonby, J.P., 9, Princes-gardens	1
P. Dashwood, Godstone	1
A. Parks Smith, 18, Selborne-road, West Brighton	1
James Rudd, Albion Hotel, Eastbourne, hotel keeper	1
T. Mutton, 84, King's-road, Brighton, hatter	1
C. Mutton, 44, Russell-square, Brighton	1
J. Anscombe, 116, Queen's-road, Brighton, builder	1

The number of directors is not to be less than three nor more than seven; qualification, 25 shares; the subscribers are to appoint the first; remuneration, £1000 per annum.

Brooke, Simpson, and Spiller, Limited.

This is a proposed conversion to a company of the business of aniline dye manufacturers, merchants, and drysalters, carried on by Messrs. Brooke, Simpson, and Spiller, at the Atlas Works, Hackney Wick, with branch depôts at Manchester, Bradford, and Huddersfield. It was registered on the 9th inst. with a capital of £150,000, in £5 shares. The promoters, who are responsible for £5 each, are:—

	Shares.
Wm. Shaw, Worple-road, Wimbledon, stock and share dealer	1
J. Goff Spencer, Sutton, Surrey, stockbroker	1
W. Moore Sherriff, 53, Gresham-street, solicitor	1
E. R. Morris, 60, Amherst Park, Stamford-hill, stationer	1
D. A. Nicole, 8, Willimas-terrace, Chiswick, clerk	1
G. T. Smith, 9, Westbourne-terrace, Chiswick, clerk	1
Captain Leith Bonhôte, Junior United Service Club	1

The number of directors is not to be less than four nor more than eight; qualification, 100 shares; the first are Messrs. Edward Mucklow, R. J. Friswell, and H. D. Wynter. Mr. Arthur Brooke is appointed managing director for five years at a salary of £800 per annum, and a further sum equal to £5 per cent. on the event of net profits up to £10,000, and £7½ per cent. on the excess of profits if over £10,000.

Calcorion Decorative Company, Limited

This company proposes to acquire and work a patented invention of Marlborough Conrath for wall and general decoration. It was registered on the 4th ult. with a capital of £25,000, in £50 shares. The subscribers are:—

	Shares.
*J. Livesey, 105, Pall-mall	1
*C. G. Hyde, 1, Temple-gardens	1
*M. Conrath, 15, North Audley-street	1
J. Ford, 50, Park-road, Southport	1
R. R. Dobell, 110, Cannon-street	1
J. C. Bunten, 28, Prince's-gate, S.W.	1
Henry Carter, 115, Victoria-street, S.W.	1

The number of directors is not to be less than two nor more than five; first are the subscribers denoted by an asterisk; remuneration, £100 per annum to each director, with £50 additional for the chairman, if any. Qualification for subsequent directors, five shares (other than deferred shares).

Dexter, Colorado, Gold Mining Company, Limited.

Upon terms of an agreement of the 1st inst. between George Pulling Armstrong and Leonard Beauchamp Northcote, this company proposes to acquire interests in freehold land and mineral properties known as the Dexter Lode, situate in Gilpin County, Colorado, U.S.A. It was registered on the 6th inst. with a capital of £75,000, in £1 shares, with the following as first subscribers:—

	Shares.
B. W. Pycock, 110, Cannon-street	1
A. B. Isaac, 8, Garlinge-road, West Hampstead	1
F. H. Relph, 101, Leadenhall-street, merchant	1
P. O Margetson, Glenfell, Clapham Park	1
W. C. Spurr, 34, Brownswood-road, N., engineer	1
S. Fedden, 3, Avonmore-road, West Kensington	1
F. A. Groom, 101, Leadenhall-street	1

The number of directors is not to be less than three nor more than nine; qualification, 100 shares; the subscribers are to appoint the first and act *ad interim*; remuneration, £100 per annum to each director, with an additional £100 for the chairman, and also 5 per cent. of the divisible profits. The purchase consideration is £10,000 in cash, and £25,000 in fully-paid shares.

Henry Crouch, Limited.

This company was registered on the 6th inst. with a capital of £5000, in £1 shares, to take over the business of microscope and scientific instrument manufacturer, formerly carried on by Pearce Henry Crouch, and now by John Ashley, at the Optical Works, 66, Barbican, E.C. The subscribers are:—

	Shares.
A. Barrett, Surbiton, Surrey	1
W. Barrett, Brentwood, Essex	1
H. Syndon, 1, Queen's-road Studios, St. John's-wood, artist	1
John Ashley, Staines, banker	1
C. A. Barrett, 43, Beech-street, Barbican, brass and iron founder	1
D. Pearman, 11, Idol-lane, tea dealer	1
H. Fowler, 1, Copthall-chambers, stockbroker	1

Registered without special articles.

Henry Gardner and Co., Limited.

This is the conversion to a company of the business of Henry Gardner, of 59 and 61, Bridgewater-street, and 56, 58, and 60, Watkinson-street, Liverpool, manufacturer of lead encased block tin pipe, &c. It was registered on the 5th inst. with a capital of £5000, in £5 shares. The subscribers are:—

	Shares.
*L. Hughes, jun., 79, Tithebarn-street, Liverpool, metal merchant	1
R. H. Perrin, 79, Tithebarn-street, Liverpool, metal merchant	1
*J. D. Martin, 6, York-buildings, Liverpool, ship-broker	1
*Henry Gardner, 59, Bridgewater-street, Liverpool, lead manufacturer	1
G. Readdy, 13, Harrington-street, Liverpool, accountant	1
C. A. G. Wynne, West Derby, Liverpool, book-keeper	1
G. McSorley, 100, Walton Village, Liverpool, book-keeper	1

The subscribers denoted by an asterisk are the first directors.

PRODUCTION OF LIME IN THE UNITED STATES.—There were 37,000,000 barrels (of 200 lb.) made in 1884, the average value per barrel at the kilns being not over 50c., or 18,500,000 dols. The production was about 5,900,000 barrels greater than in 1883, but owing to the fall in price the total value was about 700,000 dols. less.

THE DEATH IS ANNOUNCED OF MR. ALEXANDER JACK, Lorne-terrace, Liverpool. Deceased was for many years the head of the firm of J. Jack and Co., Victoria Engine Works, Sandon Dock. Mr. Alexander Jack was afterwards the sole partner in that concern, and also carried on business as a shipbuilder at Seacombe.

BROWN X PRISMATIC GUNPOWDER.—This gunpowder, which has given such excellent results for heavy ordnance, is being manufactured for the Government by Messrs. Curtis and Harvey under the patent of Mr. C. W. Curtis, and a quantity has been accepted, having passed the Government test with the following successful results:—Initial velocity of projectile 1944ft., mean pressure on the test crushers 15·4 tons, maximum pressure on one of the crushers 15·5 tons. The Government specifies a velocity of 1940, minimum velocity 1900, also mean pressure on crushers not to exceed 16 tons, and pressure on any one crusher not to exceed 16½ tons.

KING'S COLLEGE ENGINEERING SOCIETY.—At a general meeting held on the 2nd inst., Mr. Brydges read a paper on "Gas Engines." The author commenced by enumerating some of the theoretical considerations involved in gas engines, mentioning *inter alia* that Carnot's principle applied as much to them as to all other heat engines. He divided gas engines into three classes, hot air, those using a mixture of coal gas and air, and those using a similar mixture compressed. It was also explained that the amount of this compression was varied in different engines according to the average temperature in the cylinder. The reader next deduced the theoretical quantity of gas required per horse-power per hour by the different classes of engines, and gave some figures showing what was actually consumed. The advantages and uses of indicator diagrams in detecting faults were dwelt on, and the main sources of loss of heat were also pointed out. The regenerative principle was stated not to have been yet applied to gas engines with success. A historical review followed. The early forms, Hugon, Lenoir, Otto, and Langen, were described. Mr. Brydges then passed on to the details of the Otto, Tangye, Stockport, Glasgow, Clerk, and Atkinson's differential engines, and of the non-compressing type of the Bischof, Syrinx, and Universal. The great advantage claimed for gas engines by the author was that they supplied an economical substitute for small wasteful steam engines. At a general meeting held on Tuesday, the 9th inst., Mr. F. M. Long read a paper on "Submarine Vessels." The paper began with a description of the earliest form of submarine boat, which was constructed by Bushnell in 1775, explaining the means used to submerge and propel it, and also the mode of attacking a hostile vessel by attaching a magazine to its bottom to be fired by clockwork. The author next spoke of Fulton's submarine boat, which was an improvement on the last mentioned. Mr. Long then briefly discussed several other subsequent boats, after which he passed on to describe in detail two of recent date, the Goubet and the Nordenfelt, which were both illustrated by diagrams. After glancing generally at the former, he considered the special arrangements adopted for preserving stability, propelling, steering, and ventilating. The boat is propelled by an ordinary screw driven by an electro-motor, capable of being turned in a horizontal plane, so that steering is accomplished without a rudder. The method of using the torpedo was also explained. A description of the Nordenfelt boat followed. In this case the motive power is derived from highly heated water stored in a boiler and two large tanks. This water is heated while the vessel is at the surface. When it descends the stokehold is closed and the funnel securely covered over, so that all communication is cut off between the furnace and the external air. To sink the boat vertical propeller screws are used. The stability is insured by longitudinal rudders. In concluding the author maintained that vessels of this type were well suited for harbour defence, though not for engagements on the open sea. A lively discussion followed, after which the meeting terminated.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

Applications for Letters Patent.

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

9th March, 1886.

3265. REGULATING, &c., CLOCKS, G. W. Millard and J. H. Clarke, London.
3266. FUEL SUPPORTS for STEAM BOILER FURNACES, H. Callas, London.
3267. RUBBER CORNER CAPS for PORTMANTEAUS and TRUNKS, E. Hones, London.
3268. RAT and MOUSE TRAP, W. Eade, West Brighton.
3269. STRETCHING or STRAINING PAPER, W. T. Morgan and R. L. Kidd, Richmond.
3270. INJECTORS, C. S. Madan, Manchester.
3271. WIRE BRUSHES, G. F. Rigby, Sheffield.
3272. CONTINUOUS MOTION HANDLE for SCREW-DRIVERS, &c., C. H. M. Wharton, Manchester.
3273. SOLES of BOOTS, &c., J. Willis and E. K. Heaps, Sheffield.
3274 HAMILTON'S NAIL SCREWS, F. T. S. Hamilton, Egremont.
3275. CORRUGATED COAL SCOOP, E. Wharington, Wolverhampton.
3276. UNIVERSAL DOUBLE FEEDER, &c., E. Wharington, Wolverhampton.
3277. RAILS for METALLIC BEDSTEADS, J. and H. J. Brookes, and H. Garner, Cape Works, near Birmingham.
3278. HAND or DUST BRUSHES, J. Worthington, Blackpool.
3279 BOBBINS and SPOOLS for CAP and RING SPINNING, &c., FRAMES, J. DIXON and SONS and J. Lee, Bradford.
3280. COMBINED PIPE CASE and MATCH-BOX, F. J. Kelly, Dublin.
3281. MUSICAL NOTATION, E. Plummer, Nottingham.
3282. RIBBED PILE FABRICS, O. Drey, Manchester.
3283. MACHINES for MAKING SAWS, S. E. Mower and T. Fowler, France.
3284. MACHINES for POINTING DRILLS, J. Y. Johnson.—(*J. S. Bancroft, United States.*)
3285. WINDOWS, W. Howie and R. Henderson, Glasgow.
3286. RAILWAY WAGON, &c., COUPLING, H. Chancellor, London.
3287. SMOKE-CONSUMING FURNACES, W. R. M. Thomson.—(*O Coldeve, Germany*)
3288. FASTENING INDIA-RUBBER TIRES to BICYCLE and TRICYCLE WHEELS, R. Taylor, Glasgow.
3289. STEAM and HYDRAULIC HOSE PIPE, J. Walker, Manchester.
3290. DRAWING BOARDS, &c., B. K. Webber, Sheffield.
3291. STOPPING ENGINES, J. Fothergill, Birmingham
3292. EXTRACTING FISH-HOOKS from FISH, E. H. G. Brewster, London.
3293. EXTRACTING ANTIMONY from ORES, T. C. Huntington and M. Chiapponi, London.
3294. VELOCIPEDES, P. L. C. F. Renouf and I. W. Boothroyd, London.
3295. SOUND-BOARD of PIANOFORTES, &c., J. Brown, London.
3296. AUTOMATIC SELF-FITTING PLUG for GAS, &c., COCKS, J. H. Smith, London.
3297. KNITTING MACHINES, P. Haddan.—(*A. Wedermann and B. Endler, Austria.*)
3298. SUPERSATURATION of DEFINITE or STANDARD MIXTURES of WINES or SPIRITS with SPRING WATER, &c., H. R. and C. G. Matthews, London.
3299. AIR GUNS, A. J. Boult.—(*G. P. Gunn, United States.*)
3300. UTILISING BINARY LIQUIDS, J. H. Campbell, London.
3301. LOCKING DEVICE for HAMPERS, &c., T. S. Barrows, London.
3302. MONOCYCLES, Z. J. and C. Francis, and F. D. Barrett, London.
3303. SUPPORTING TREES, &c., H. C. Frettingham London.
3304. BREECH-LOADING FIRE-ARMS, C. G. Harston, London.
3305. STEAM ENGINES, G. W. Price, Baltimore.
3306. SHOE-MAKERS' LASTS, A J. Boult.—(*L. Arlaud France.*)
3307. SPEAKING TUBES, F. E. Pontifex, London.
3308. ATTACHING WINDOW-BLINDS to ROLLERS, A. and H. A. K. Davis, East Dulwich.
3309. ATTACHING DOOR KNOBS to SPINDLES, G. G. Potter, London.
3310. HEATING APPARATUS or STOVE, T. H. P. Dennis, London.
3311. TEACHING PERSONS to READ, G. J. Darrschmidt, London.
3312. KNITTED or WOVEN GARMENTS, F. Kob, London.
3313. EXPLOSIVES, E. and A. Luck, London.
3314. FILLING and TESTING BOILERS, J. Jackson, London.
3315. UTENSIL for HEATING WATER, H. A. Galliers and F. Klaerr, London.
3316. HEATING WATER by GAS, H. A. Galliers and F. Klaerr, London.
3317. ADMINISTERING a VAPOUR BATH, D. M. McIntosh, London.
3318. BENDING TIMBER for BOATS, O. Imray.—(*J. A. Dower, Honolulu.*)
3319. FIRE-TUBES, R. F. M. Müller, London.
3320. SECURING LIDS to the MOUTHPIECES of GAS RETORTS, H. H. Salomons, London.
3321. MEDICAL and SURGICAL DRESSING, R. Park and Sir S. J. Blane, London.
3322. PRODUCING CHLORINE, &c., B. J. B Mills.—(*The Verein für Chemische Industrie, Germany.*)
3323. ELECTRIC FLASH-SIGNALLING APPARATUS, E. S. Bruce, London.
3324. PHOTOGRAPHIC CAMERAS, C. Sands and J. J. Hunter, London.
3325. INDICATOR and LOCK for the SHUTTERS of PHOTOGRAPHIC DARK SLIDES, F. Hazeldine, London
3326. DISTILLING WATER, A. M. Clark.—(*P. Oriolle, France*)
3327. BOX for PACKING LIGHT ARTICLES, S. W. Abbott, London.
3328. TOOL for OPENING OYSTERS, A. M. Clark.—(*B. Andrieu, France.*)
3329 CORRUGATED FURNACES and FLUES, S. Fox, London.
3330. KEELS of SHIPS, E. F. Wailes, London.
3331. DRAW-OFF and SAFETY VALVE COCK, F. S. Morris and E. Field, London.
3332. MUSIC STOOLS, E. Parr, London.
3333. MACHINES for WINDING YARN, J. H. Woodward, London.
3334. ELECTRIC ARC LAMPS, R. H. Courtenay, London.
3335. APPLIANCE for PREVENTING OVERHEAD BROKEN TELEGRAPH WIRES from FALLING, J. M. Baker and H. E. Pollard, London.
3336. WINDOW FASTENER, H. Kingsbury and A. E. Puzey, London.
3337. CONSTRUCTION of RAIL SECTIONS for RAILWAYS, G. Pooley and E. Thompson, London.
3338. APPARATUS for COLLECTING SMOKE from LAMPS, J. Stott, London.
3339. RAISING SUNKEN VESSELS, W. A. Barlow.—(*M. Möller, Prussia.*)
3340. ELECTRIC ARC LAMPS, W. H. Trentham, London.
3341. INDEX for LETTER-BOOKS, H. H. Lake. (*R. Spurgin, United States.*)
3342. HEATING the FEED-WATER of STEAM BOILERS, H. H. Lake.—(*F. Shickle, United States.*)
3343. MATCHES, G. E. Norris and W. E. Hagan, London.
3344. COMBINED DOOR MAT and SCRAPER, Messrs. Lorris and Co., London.
3345. PAPERING NEEDLES, H. Thomas, London.
3346. ALLOYS of ZINC, F. W. Martino, London.
3347. SAFETY APPLIANCE for MINE CAGES, W. Castendyck, London.
3348. FOOD and WATER TROUGHS for POULTRY, W. Harden, London.

10*th March*, 1886.

3349. Apparatus for Actuating Figures Used in Roundabouts, A. Waddington, Leeds.
3350. Easels, M. Browne, Leicester.
3351. Ring Spinning and Doubling Frames, A. H. Dixon and W. J. Gradwell, Manchester.
3352. Silos, H. Lander, Mere.
3353. Portable Parallel Vice, J. Evans, sen., Sheffield.
3354. Levers for Sash Fasteners, C. Price, Wolverhampton.
3355. Nails for Upholstering Purposes, J. Hewitt, Birkenhead.
3356. Cork Drawer, W. W. Schofield, Birmingham.
3357. Knives, W. F. Stanley, South Norwood.
3358. Blow-pipes, A. Lovekin, Birmingham.
3359. Shuttles of Looms for Weaving, J. Booth, Halifax.
3360. Electric Alarm Clock, J. Warmisham, Manchester.
3361. Dressing and Beaming Yarns, W. Robertson and J. G. Orchar, Glasgow.
3362. Fastening Down Tarpaulin on Ships' Hatches, W. Hewitt and T. Dineen, Leeds.
3363. Locking Nuts on Bolts, J. Roberts, Cumberland.
3364. Breech-loading Small-arms, T. Woodward, Birmingham.
3365. Bosses for Pullies, &c., G. Tolson, Dewsbury.
3366. Plans, &c., T. P. Johnstone, Carnbee.
3367. Combination Slate and Drawing-board, R. H. Shanks, Newcastle-on-Tyne.
3368. Safety Lamps for Mines, M. Settle, Manchester.
3369. Embossed, &c., Tiles, J. D. Denny, North Wales.
3370. Bicycles, R. P. Scott, Baltimore.
3371. Solitaires, Studs, &c., J. Sadler, London.
3372. Bicycle Saddles, G. Barker.—(*J. Payne, California.*)
3373. Extinguishing Burners of Street and other Lamps, J. W. Buckley, Liverpool.
3374. Manufacture of Acetic and other Acids, J. Whittle, London.
3375. Gimlets, &c., W. Lund, London.
3376. Moulding Flanged Pipes, F. Witte, Halifax.
3377. Device for Stretching Trousers, &c., E. Parr, London.
3378. Substitute for Water in Gas Meters, E. Edwards.—(*C. Pottier, France.*)
3379. Manufacture of Tin and Terne Plates, &c., J. H. Thomas, London.
3380. Machinery for the Manufacture of Plates and Bars of Steel, &c., W. E. Gedge.—(*C. M. Pielsticker, Russia.*)
3381. Umbrellas, R. Thorne, London.
3382. Slubbing, &c., Frames for Fibrous Materials, W. Tatham, Manchester.
3383. Screw-tapping, &c., W. A. Pearn, Manchester.
3384. Bevelling and Planing Machines, H. A. Singrun, Glasgow.
3385. Coiled Springs and Fittings, J. H. Weston, London.
3386. Lamps, A. J. Boult.—(*J. A. Kumberg, Russia.*)
3387. Securing Trees, &c., to Stakes, &c., W. Bardill, London.
3388. Fireplaces, H. Dempewulf, London.
3389. Sheet Iron, I. E. Craig, London.
3390. Float or Bell for Gas Regulators, J. Stott, London.
3391. Fire-bricks, &c., S. J. Payne, Romford.
3392. Bending the Edges of Metal Plates, W. L. Wise.—(*J. R. Cummings, United States.*)
3393. Annealing Apparatus, J. Lysaght and J. Lysaght, Limited, London.
3394. Photographic Apparatus, G. F. Redfern.—(*C. V. Labargé, France.*)
3395. Machine and other Guns, W. A'C. G. Birkin, London.
3396. Carriage Door Fittings, J. Edwards, London.
3397. Tricycles, H. Bligh, London.
3398. Regulating the Temperature of Incubators, &c., A. J. Tyler, London.
3399. Gunpowder, C. W. Curtis and W. J. Brown, London.
3400. Breech-loading Break-down Sporting Guns and Rifles, G. Jeffries, London.
3401. Grinding Card Flats of Carding Engines, J. Bullough, Halifax.
3402. Gas-motor Engine, J. Fielding, London.
3403. Attaching Handles to Brooms, W. A. Pearn, London.
3404. Presses for the Manufacture of Covered Buttons, J. R. Green, London.
3405. Locomotive Engines, E. Perrett, London.
3406. Carbonate of Sodium, E. F. Trachsel, London.
3407. Dyes, J. Y. Johnson.—(*The Farbenfabriken vorm. Friedrich Bayer and Co, Germany.*)

11*th March*, 1886.

3408. Spring Latches for Sleeve Links, &c., J. Cheshire, Birmingham.
3409. Self-acting Pump, R. Wortley, Oldham.
3410. Tricycles, &c., O. R. Barnicott, Cambridge.
3411. Stands for Cameras, J. E. Thornton, Manchester.
3412. Copying Writings, &c., W. Gibbs, Halifax.
3413. Hardening Cast Steel Teeth used in Silk Combs, L. E. and G. F. Priestley, Halifax.
3414. Producing Fancy Yarn, J. A. Greenwood, Bradford.
3415. Ring and Cap Finishing and Roving Boxes, J. Dawson, Bradford.
3416. Cast Metal Door and Frame, W. Barraclough, Glasgow.
3417. Delivery of Cigarettes, &c., on Prepayment of the Requisite Coin, F. C. Lynde and J. Lees, Manchester.
3418. Protecting Wires used for Conducting Electric Currents, M. Settle, Manchester.
3419. Enamel, &c., Kilns for Pottery Ware, W. and H. Cartledge, Liverpool.
3420. Basic Bricks, G. A. Jarvis, Salop.
3421. Basic Bricks, G. A. Jarvis, Salop.
3422. Rotary Engines, T. Lambert, London.
3423. Bolts for Securing Nuts, B. F. Cocker, London.
3424. Laying Pavements of Wood, &c., M. Macleod, London.
3425. Facilitating the Reading of Dial Scales, &c., H. S. S. Watkin, Woolwich.
3426. Ice Gripper, H. Hobson and W. W. Slack, Sheffield.
3427. Flats of Carding Engines, G. and E. Ashworth, Manchester.
3428. Music Stand, A. C. Burdett.—(*H. Durand, New Zealand.*)
3429. Stands for Wines and Spirits, &c., V. Tyzack, Sheffield.
3430. Portable Paper Stretcher, T. R. Johnston, Edinburgh.
3431. Bung-holder, E. Richardson, Kendal.
3432. Boring Machines for Rock, &c., G. W. Elliott, Sheffield.
3433. Address and Way-bill Box for Vans, T. Elcome, Margate.
3434. Attaching Candles in Lamps, W. Whiston, Birmingham.
3435. Registering Flow of Fluids, T. Thorpe, Whitefield, and T. G. Marsh, Manchester.
3436. Rearing and Nursing Infants, &c., W. Hillier, Nailsworth.
3437. Forcing Liquid, A. N. Porteous and R. L. Urquhart, Glasgow.
3438. Sorting Granular Materials, J. Y. Johnson.—(*J. B. F. Trolliet, France.*)
3439. Lathe Carrier, F. H. Butter, Plumstead.
3440. Safety Stirrup, J. Cope, London.
3441. Strings, Bands, and Belts, F. Vornberger, London.
3442. Refining Fluids, G. H. Moore, Liverpool.
3443. Boomerang Toy, W. P. Thompson.—(*F. F. Bourdil, France.*)
3444. Cardboard Boxes, &c., W. P. Thompson.—(*J. Geiger, Germany.*)
3445. Wheel Rim Cleaner for Tricycles, &c., R. G. Owen, London.
3446. Flexible Mud-guard Tip for Tricycles, &c., R. G. Owen, London.
3447. Maintaining Vessels upon a Given Course, J. H. Thomson, London.
3448. Shot Firing and Blasting in Mines, F. Brain, London.
3449. Tiles for Roofing, C. E. Davis, London.
3450. Unrolling, &c., Textile Fabrics, F. W. Ulrich and J. Joyce, London.
3451. Automatic Sale and Delivery of Cigarettes, &c., A. T. Chamberlain, London.
3452. Window Sashes and Frames, J. and F. Loughran, Glasgow.
3453. Tools for Screw-cutting, J. Norman, Glasgow.
3454. Establishing a Flow through Syphons, E. de Pass.—(*E. Aimond, France.*)
3455. Combined Bottles and Brushes for Gum, &c., P. Lawrence, London.
3456. Name and Number Plate or Label, H. E. Brittin, London.
3457. Furnaces, W. D. Allen, London.
3458. Joining Glass, J. Plenty, Wincanton.
3459. Glazed Structures and Skylights, J. Plenty, Wincanton.
3460. Winnowing Machines, T. H. and T. Smith, Iver.
3461. Anchors, J. F. Hall and J. Verity, London.
3462. Pulverising Machines, S. Collier, London.
3463. Uniting, &c., the Ends of Railway Rails, J. Howard and E. T. Bousfield, London.
3464. Navigable Vessels, &c., J. R. Thomson and J. H. Biles, Glasgow.
3465. Carriage Brake Blocks, J. Gardner, Glasgow.
3466. Preparing Emulsions of Oils, &c., A. Blackie, London.
3467. Destroying Insects, &c , A. Clemm, London.
3468. Sifting Apparatus, G. Kapler, London.
3469. Venting Apparatus, &c., G. F. Redfern.—(*P. Prat, France.*)
3470. Detecting Chemicals in Wine, Spirit, &c., E. Edwards.—(*P. Clair and J. B. Socard, France.*)
3471. Stays, F. E. H. Clark, London.
3472. Making Paper Stock, J. D. Tompkins, United States.
3473. Gas Engines, C. Davy, London.
3474. Sight Drop Lubricators, R. E. B. Crompton and W. A. Kyle, London.
3475. Dynamo-electric Machines, R. E. B. Crompton, London.
3476. Galvanic Batteries, A. Schanschieff and G. R. Fludder, London.
3477. Depositing Apparatus, W. H. Punchard.—(*W. C. Punchard, South America.*)
3478. Depositing Apparatus, W. H. Punchard.—(*W. C. Punchard, South America.*)

12*th March*, 1886.

3479. Stud and Solitaire, T. E. Rennie, Sheffield.
3480. Pneumatic Door Springs and Checks, G. F. Newman, Birmingham.
3481. Locks and Latches, H. T. Owens, Birmingham.
3482. Manufacturing Cards used in Preparing Fibrous Materials, C. Moseley, Manchester.
3483. Finishing Stockinette Fabrics, G. Lendrum and D. F. Cocks, Huddersfield.
3484. Sock for Boots and Shoes, T. Barker, Halifax.
3485. Frog Pad and Protector for Animals, R. Revell, Leicester.
3486. Reeling Skeins of Thread, &c., T. Coleby, Manchester.
3487. Ball Centre Heads for Bicycles, S. Goodby, Wolverhampton.
3488. Straightening Trouser Legs, &c., J. J. Bennett, Southampton.
3489. Rivetting Chains, Belts, &c., W. Birch, Manchester.
3490. Christmas, &c., Cards, M. Krause.—(*M. Krause, Germany.*)
3491. Velocipedes, F. Taylor, London.
3492. Solid Firebrick Backs for Grates, &c., F. Moore and W. J. Fieldhouse, Birmingham.
3493. Producing Flour from Wheat, &c., R. S. MacAdam and J. Byrne, Limerick.
3494. Preserving Animal and Vegetable Substances, A. T. Wedelin, London.
3495. Treating Hydrocarbon Oils, &c., L. M. Becker, London.
3496. Knitted Fabrics, J. Tebbutt, London.
3497. Rudder Attachment, J. D. Hickman, London.
3498. Casting Metal in Chill Moulds, E. Fox, London.
3499. Small-sized Switches for Electric Lighting, G. Lowdon, Dundee.
3500. Cigarette Making Machines, G. H. Smith, London.
3501. Keyless Watches, J. Phillips, Birmingham.
3502. Lids of Tea and Coffee Pots, A. Hopkinson, London.
3503. Railway Wagon Couplings, F., J. K., F. jun., and B. G. F. Golightly, London.
3504. Sinking Shafts, Constructing Foundations, &c., F. H. Poetsch, London.
3505. Temporary Tubbing, &c., F. H. Poetsch, London.
3506. Railway and Tramway Passenger Carriages, G. C. Rice, London.
3507. Clutch, C. S. Scott, Cadiz.
3508. Electric Light Fittings, R. E. B. Crompton and W. A. Kyle, London.
3509. Wire Strainer, F. B. W. Malet, London.
3510. Planing Metals on the Lathe, W. Balck, London.
3511. Tanning Skins, J. S. Billwiller, London.
3512. Lubricant, E. J. Digby, London.
3513. Steam Boiled and Iron Varnish, E. J. Digby, London.
3514. Goldsmith's and Polishing Powders, E. J. Digby, London.
3515. Drainage Pavings, A. J. Ward, London.
3516. Holders for Incandescent Electric Lamps, A. Swan, London.
3517. Mirrors, J. J. Hooker, Stockton-on-Tees.
3518. Lubricating Composition, B. J. Hicks and J. Kirkwood, London.
3519. Stoppers, &c., for Receptacles, L. Rogers, London.
3520. Locks, &c., F. J. Biggs, London.
3521. Bakers' and Confectioners' Ovens, W. S. Allcock, London.
3522. Gas Engines, J. Atkinson, London.
3523. Compasses, E. Edwards.—(*P. Claire and J. B. Socard, France.*)
3524. Direct-acting Pumping Engines, A. Boyd, London.
3525. Stones for Grinding, &c., G. McPherson, jun., Glasgow.
3526. Sewing Machines, A. McCaul, Glasgow.
3527. Fire-extinguishing Apparatus, K. McLennan, London.
3528. Fish-hooks, W. A Adams, London.
3529. Wagons, A. S. Hill, London.
3530. Lamp Glasses, A. J. Boult.—(*F. W. Rosenow, Germany.*)
3531. Ornamenting Tin-plate, Lady F. L. C. Eden, London.
3532. Regulating the Flow, &c., of Size, J. Hibbert, Halifax.
3533. Couplings for Carriages, J. Briggs and J. Jenkin, Halifax.
3534. Hoods of Carriages, F. Davis & E. G. Benford, London.
3535. Acoustic Telephones, H. G. Ellery and J. T. Gent, London.
3536. Holder for Lawn-tennis Rackets, G. F. Twist, London.
3537. Spiked Drums, J. H. Vavasseur, London.
3538. Permanent Way of Railways, A. T. G. Brown, London, and J. Mackenzie, Middlesbrough.
3539. Making Biscuits, E. Carr, London.
3540. Electric Fuse, A. M. Clark.—(*La Société Scola et Ruggieri, France.*)
3541. Pinch-bars, H. H. Lake.—(*M. A. Sheldon, United States.*)
3542. Producing Letters on Wood, C. A. O. Tempel, London.
3543. Breech-loading Rifles, A. Chuchu, London.

13*th March*, 1886.

3544. Hanging Window-sashes, J. and J. Mason, London.
3545. Moving Switches on Tramways, H. B. Pearce, Glasgow.
3546. Match-box, L. Binst, London.
3547. Fire-grates, G. G. Brodie and J. D. Prior, Aston.
3548. Regulators for Fluid Motors, J. A. McMullen, Hertford.
3549. Chisels, S. Warburton, Burly.
3550. Fastening Leather to Woven Belting, J. Bromhall, Glossop.
3551. Drawing Oils, &c., D. Lane, Bradford.
3552. Separating Amines, J. B. Cohen, Manchester.
3553. Colouring Jewellery, A. Martin, Birmingham.
3554. Dynamo-electric Machines, W. Hartnell, Leeds.
3555. Treating Wool, A. B. O'Connor and J. H. Wilson, London.
3556. Making Sugar by Electrolysis, E. Fahrig, Manchester.
3557. Detecting Fraudulent Transfer of Railway Tickets, J. Crompton, Farnworth.
3558. Textile Driving Bands or Belts, I. Jackson, Manchester.
3559. Coupling, &c., Railway Carriages, E. J. Adams, London.
3560. Gullies and Drain Traps, J. W. Dyson, Newcastle-on-Tyne.
3561. Knife for Cork-cutting Machines, J. F. Russell, London.
3562. Felt Carpets, W. and R. J. C. Mitchell, Manchester.
3563. Ball Castor, J. E. Beanland and W. Sutcliffe, Halifax.
3564. Friction Clutches, W. H. and F. C. W. Latham, Bolton.
3565. Tissue Copying Process, T. Thorpe, Whitefield.
3566. Wrapper for Protecting Goods, E. Sherring, Manchester.
3567. Testing Heat of Kilns, T. Stanway and S. Spencer, Longport.
3568. Cables, A. Vogt, London.
3569. Constructing Wall Bonds, &c., J. Dyson, Wakefield.
3570. Mouthpieces for Speaking Tubes, J. B. Clayton, London.
3571. Signboards, &c., F. McIlvenna and W. Thompson, Liverpool.
3572. Enamelling Material, W. P. Thompson.—(*J. A. Pond, New Zealand.*)
3573. Letter Files, J. S. Remer, Liverpool.
3574. Registering, &c., Liquids, G. Broadhead, London.
3575. Controlling Supply of Liquids, W. Davies, London.
3576. Music Rest, J. G. Stephens, Glasgow.
3577. Depolarising Electric Batteries, A. C. Henderson.—(*E. Bazin, France.*)
3578. Gunpowder, A. H Burford, London.
3579. Cutting Indices in Books, &c., P. Lawrence, London.
3580. Execution of Criminals, J. J. de Z Marshall, London.
3581. Artificial Fuel, J. A. Yeadon and R. Middleton, Leeds.
3582. Drying Coal, &c., J. A. Yeadon and R. Middleton, Leeds.
3583. Frames of Carriage Windows, A. Lehmann and S. H. Fitch, London.
3584. Consuming Smoke in Boilers, &c., H. McDowell, London.
3585. Operating Valves of Hydrocarbon Engines, &c., J. J. R. Humes, London.
3586. Watering-cans, R. Foster, Birmingham.
3587. Vibrating Electric Motors, A. L. Parcelle, London.—11*th August*, 1885.
3588. Railway, &c., Brakes, W. H. Beck.—(*C. J. Biraud, France.*)
3589. Gravity Drag, J. T. Graham, London.
3590. Ventilating Close Carriages, J. T. Graham, London.
3591. Opening Internally Stoppered Bottles, J. Richardson, London.
3592. Illuminant Appliances for Burners, O. Imray.—(*C. A. von Welsbach, Austria.*)
3593. Gunpowder, O. Bowen, A. S. Tomkins, and J. Cobeldick, London.
3594. Glass Hydrometers, S. A. and A. J. Calderara, London.
3595. Motive Power Obtained by Springs, B. M. Plumb.—(*H. E. Marchand, United States.*)
3596. Transport System, H. M. Stanley and H. S. Wellcome, London.
3597. Water-closets, J. Lawson, London.
3598. Electrical Switches, H. W. Edlin, London.
3599. Securing Spokes to Rims of Velocipedes, W. Bown, London.
3600. Pads used in Shoeing Horses, L. Vincent, London.
3601. Parts of the Permanent Way of Railways, J. H. Tozer and W. Tozer, London.
3602. Railway Carriage Lamps, J. N. Flatau, W. Flatau, and A. D. Turner, London.
3603. Freshening Beer, H. H. Lake.—(*J. W. Noll, Germany.*)
3604. Safety Friction Clutches, A. Brown, London.
3605. Controlling Electric Currents, J. Y. Johnson.—(*E. A. G. Street and A. L. W. Desruelles, France.*)
3606. Folding Carriages for Invalids, &c., J. Y. Johnson.—(*V. Dougny, France.*)

15*th March*, 1886.

3607. Hot-water Circulating Boilers, &c., T. Wood, Stapleton.
3608. Therming Wood, T. Purves, Newcastle-on-Tyne.
3609. Vacuum Pans, J. D. Scott and A. Scott, Glasgow.
3610. Moving Doors or Valves, J. A. McIlroy, Glasgow.
3611. Steps of Vehicles, T. Woodhead, Bradford.
3612. Plug Valves, J. S. Barraclough and J. W. Schofield, Halifax.
3613. Sash Fasteners, H. Hawkins, Birmingham.
3614. Wicket-keeping Gauntlet, A. Shaw and A. Shrewsbury, Nottingham.
3615. Striker for Locks, &c., C. Fellows, Wolverhampton.
3616. Medicinal Compound, E. C. Hodgson, Dublin.
3617. Taps, C. A. Tew, Smethwick.
3618. Driving the Tubes of Ring Spinning Frames, S. Naylor and Co. and J. Redman, Bradford.
3619. Applying Ball Bearings to Washing Machines, R. Moore, Silsden.
3620. Safety Slide for Mangle Boards, R. Moore, W. H. Murton, and W. S. Varley, Keighley.
3621. Antifriction Metal Liners for Bearings, C. Billington and J. Newton, Longport.
3622. Heel Tips for Boots and Shoes, F. W. Rosser, Birmingham.
3623. Gas Regulators, J. F. Simmance and C. R. Bellamy, Liscard.
3624. Shafts of Picks or other Tools, A. E. Stayner, near Sheffield.
3625. Barometers, S. A. de Normanville, London.
3626. Water-closets, Urinals, &c., W. Berridge, Windsor.
3627. Lamp Frames, B. W. Russell and T. Huxley, London.
3628. Sugar Blocks, H. E. J. Selwig and B. C. A. C. Lange, Liverpool.
3629. Furnaces of Steam Boilers, &c., T. Mudd, Liverpool.
3630. Dummy Points for Tramways, A. Dickenson, Birmingham.
3631. Pea-shelling Machines, L. Thies, London.
3632. Glowing Powder, L. A. Groth.—(*C. Beckstein, Germany.*)
3633. Horseshoes, W. Body, Ashford.

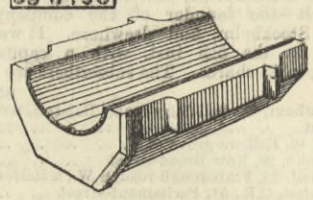
SELECTED AMERICAN PATENTS.

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

334,490. Journal-box, *Robert W. Traylor, Richmond, Va.*—*Filed December 21st*, 1885.

Claim.—In a journal or bearing, the combination of the brass bearing with a lead covering upon its bearing surface and welded thereto, and with a Babbit cover

334,490

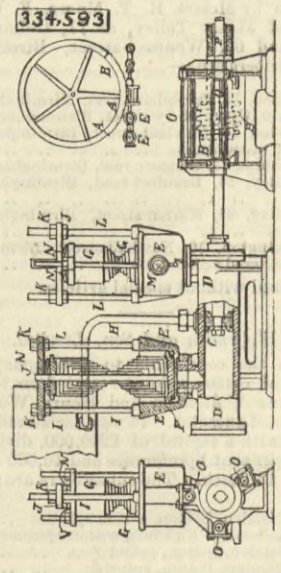


ing or surface upon the lead covering and welded therero, the three metals being thus welded together substantially as set forth.

334,593. Steam Steering Gear for Vessels, *A. J. Maginnis, Liverpool, England.*—*Filed November 23rd*, 1885.

Claim.—(1) The combination of the worm, which can move endwise and also be rotated, the toothed arc into which the worm gears, and which is attached to the quadrant or tiller of a rudder, and spring or buffer mechanism, which allows the worm to move endwise whenever excessive strain comes on the rudder and brings it back to its normal position as soon as the excessive strain is relieved, substantially as described. (2) The combination of the toothed arc

334,593

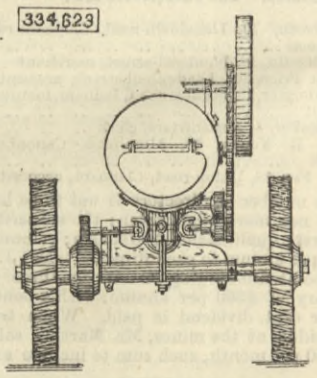


attached to the quadrant or tiller of a rudder, the worm gearing therewith, and also capable of endwise movement, the piston on the axis of worm working in a control cylinder filled with liquid, and the regulating cylinder at each end of control cylinder fitted with a piston pressed inward by a powerful spring, substantially as described. (3) The combination of the toothed arc A, the worm B, the roller bearing O, for supporting the worm, the piston C on the axis of the worm, the cylinder D, with opening H at its centre for supply of liquid, and the cylinders E, fitted with pistons F, pressed inward by springs G, substantially as described.

334,623. Traction Engine, *Loyal C. Taber, Danforth, assignor to Wood, Taber, and Morse, Eaton, N.Y.*—*Filed October 19th*, 1885.

Claim.—In a traction engine, the combination, with the four carrying wheels and their axles, of two compensating gears, one on each axle, an oscillatory countershaft supported at its oscillatory end in a

334,623

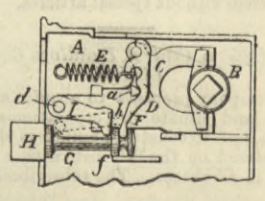


bearing mounted on the forward or steering axle, and a train of gears extending from the driving shaft to the two compensating gears, all combined to transmit to all the carrying wheels propelling power responding to the various speeds of motion required of the several wheels in travelling around curves, substantially as set forth.

334,815. Reversible Latch, *William E. Sparks New Haven, Conn.*—*Filed October 5th*, 1885.

Claim.—(1) In a knob-latch, the combination of the hub B, the slide C, the lever D, hung upon said slide, latch-bolt H, with which said lever engages, and a spring E, with the dog I, hung within the case so as to swing free by its own gravity in a vertical plane and adapted to engage the latch-bolt when in an upright position or be released therefrom by its own

334,815



gravity when the case is inverted, substantially as described. (2) The combination of the hub B, the slide C, the lever D, hung upon said slide, the spring E, the latch-bolt engaged with said lever, and a dog I, hung to said slide so as to swing freely by its own gravity in a vertical plane, and adapted to engage the bolt when the case is in an upright position or turn therefrom by its own gravity when the case is inverted, substantially as and for the purpose described.

CONVERSION TABLES FOR PRE

SQUARE METRES AND SQUARE FEET ; SQ

CONVERSION TABLES FOR FRENCH AND ENGLISH MEASURES.—No. II. AREA.

SQUARE METRES AND SQUARE FEET; SQUARE CENTIMETRES AND SQUARE INCHES; HECTARES AND ACRES.

No.	Sq. M. = Sq. Ft.	Sq. Ft. = Sq. M.	Sq. Cm. = Sq. In.	Sq. In. = Sq. Cm.	Hectare = Acres.	Acres = Hectare
100	1076·	9·3	15·5	645·1	247·1	40·5
1	1087·	9·4	15·7	651·6	249·6	40·9
2	1098·	9·5	15·8	658·0	252·1	41·3
3	1109·	9·6	16·0	664·5	254·5	41·7
4	1119·	9·7	16·1	670·9	257·0	42·1
5	1130·	9·8	16·3	677·4	259·5	42·5
6	1141·	9·8	16·4	683·8	261·9	42·9
7	1152·	9·9	16·6	690·3	264·4	43·3
8	1163·	10·0	16·7	696·7	266·9	43·7
9	1173·	10·1	16·9	703·2	269·3	44·1
110	1184·	10·2	17·1	709·6	271·8	44·5
1	1195·	10·3	17·2	716·1	274·3	44·9
2	1206·	10·4	17·4	722·6	276·8	45·3
3	1216·	10·5	17·5	729·0	279·2	45·7
4	1227·	10·6	17·7	735·5	281·7	46·1
5	1238·	10·7	17·8	741·9	284·2	46·5
6	1249·	10·8	18·0	748·4	286·6	46·9
7	1259·	10·9	18·1	754·8	289·1	47·3
8	1270·	11·0	18·3	761·3	291·6	47·8
9	1281·	11·0	18·4	767·7	294·1	48·2
120	1292·	11·1	18·6	774·2	296·5	48·6
1	1302·	11·2	18·8	780·6	299·0	49·0
2	1313·	11·3	18·9	787·1	301·5	49·4
3	1324·	11·4	19·1	793·5	303·9	49·8
4	1335·	11·5	19·2	800·0	306·4	50·2
5	1346·	11·6	19·4	806·4	308·9	50·6
6	1356·	11·7	19·5	812·9	311·4	51·0
7	1367·	11·8	19·7	819·3	313·8	51·4
8	1378·	11·9	19·8	825·8	316·3	51·8
9	1389·	12·0	20·0	832·2	318·8	52·2
130	1399·	12·1	20·2	838·7	321·2	52·6
1	1410·	12·2	20·3	845·1	323·7	53·0
2	1421·	12·3	20·5	851·6	326·2	53·4
3	1432·	12·4	20·6	858·0	328·7	53·8
4	1442·	12·4	20·8	864·5	331·1	54·2
5	1453·	12·5	20·9	870·9	333·6	54·6
6	1464·	12·6	21·1	877·4	336·1	55·0
7	1475·	12·7	21·2	883·8	338·5	55·4
8	1485·	12·8	21·4	890·3	341·0	55·8
9	1496·	12·9	21·5	896·7	343·5	56·2
140	1507·	13·0	21·7	903·2	345·9	56·7
1	1518·	13·1	21·9	909·6	348·4	57·1
2	1529·	13·2	22·0	916·1	350·9	57·5
3	1539·	13·3	22·2	922·5	353·4	57·9
4	1550·	13·4	22·3	929·0	355·8	58·3
5	1561·	13·5	22·5	935·4	358·3	58·7
6	1572·	13·6	22·6	941·9	360·8	59·1
7	1582·	13·7	22·8	948·3	363·2	59·5
8	1593·	13·7	22·9	954·8	365·7	59·9
9	1604·	13·8	23·1	961·2	368·2	60·3
150	1615·	13·9	23·3	967·7	370·7	60·7
1	1625·	14·0	23·4	974·2	373·1	61·1
2	1636·	14·1	23·6	980·6	375·6	61·5
3	1647·	14·2	23·7	987·1	378·1	61·9
4	1658·	14·3	23·9	993·5	380·5	62·3
5	1668·	14·4	24·0	1000·	383·0	62·7
6	1679·	14·5	24·2	1006·	385·5	63·1
7	1690·	14·6	24·3	1013·	388·0	63·5
8	1701·	14·7	24·5	1019·	390·4	63·9
9	1712·	14·8	24·6	1026·	392·9	64·3
160	1722·	14·9	24·8	1032·	395·4	64·8
1	1733·	15·0	25·0	1039·	397·9	65·2
2	1744·	15·0	25·1	1045·	400·3	65·6
3	1755·	15·1	25·3	1052·	402·8	66·0
4	1765·	15·2	25·4	1058·	405·3	66·4
5	1776·	15·3	25·6	1064·	407·7	66·8
6	1787·	15·4	25·7	1071·	410·2	67·2
7	1798·	15·5	25·9	1077·	412·7	67·6
8	1808·	15·6	26·0	1084·	415·1	68·0
9	1819·	15·7	26·2	1090·	417·6	68·4
170	1830·	15·8	26·4	1097·	420·1	68·8
1	1841·	15·9	26·5	1103·	422·6	69·2
2	1851·	16·0	26·7	1110·	425·0	69·6
3	1862·	16·1	26·8	1116·	427·5	70·0
4	1873·	16·2	27·0	1123·	430·0	70·4
5	1884·	16·3	27·1	1129·	432·4	70·8
6	1895·	16·3	27·3	1135·	434·9	71·2
7	1905·	16·4	27·4	1142·	437·4	71·6
8	1916·	16·5	27·6	1148·	439·9	72·0
9	1927·	16·6	27·7	1155·	442·3	72·4
180	1938·	16·7	27·9	1161·	444·8	72·8
1	1948·	16·8	28·1	1168·	447·3	73·2
2	1959·	16·9	28·2	1174·	449·7	73·7
3	1970·	17·0	28·4	1181·	452·2	74·1
4	1981·	17·1	28·5	1187·	454·7	74·5
5	1991·	17·2	28·7	1193·	457·2	74·9
6	2002·	17·3	28·8	1200·	459·6	75·3
7	2013·	17·4	28·9	1206·	462·1	75·7
8	2024·	17·5	29·1	1213·	464·6	76·1
9	2034·	17·6	29·3	1219·	467·0	76·5
190	2045·	17·6	29·5	1226·	469·5	76·9
1	2056·	17·7	29·6	1232·	472·0	77·3
2	2067·	17·8	29·8	1239·	474·5	77·7
3	2078·	17·9	29·9	1245·	476·9	78·1
4	2088·	18·0	30·1	1252·	479·4	78·5
5	2099·	18·1	30·2	1258·	481·9	78·9
6	2110·	18·2	30·4	1264·	484·3	79·3
7	2121·	18·3	30·5	1271·	486·8	79·7
8	2131·	18·4	30·7	1277·	489·3	80·1
9	2142·	18·5	30·8	1284·	491·7	80·5
200	2153·	18·6	31·0	1290·	494·2	80·9
1	2164·	18·7	31·2	1297·	496·7	81·4
2	2174·	18·8	31·3	1303·	499·2	81·7
3	2185·	18·9	31·5	1310·	501·6	82·2
4	2196·	19·0	31·6	1316·	504·1	82·6
5	2207·	19·0	31·8	1323·	506·6	83·0
6	2217·	19·1	31·9	1329·	509·0	83·4
7	2228·	19·2	32·1	1335·	511·5	83·8
8	2239·	19·3	32·2	1342·	514·0	84·2
9	2250·	19·4	32·4	1348·	516·5	84·6
210	2261·	19·5	32·6	1355·	518·9	85·0
1	2271·	19·6	32·7	1361·	521·4	85·4
2	2282·	19·7	32·9	1368·	523·9	85·8

No.	Sq. M. = Sq. Ft.	Sq. Ft. = Sq. M.	Sq. Cm. = Sq. In.	Sq. In. = Sq. Cm.	Hectare = Acres.	Acres = Hectare
3	2293·	19·8	33·0	1374·	526·3	86·2
4	2304·	19·9	33·2	1381·	528·8	86·6
5	2314·	20·0	33·3	1387·	531·3	87·0
6	2325·	20·1	33·5	1393·	533·8	87·4
7	2336·	20·2	33·6	1400·	536·2	87·8
8	2347·	20·3	33·8	1406·	538·7	88·2
9	2357·	20·3	33·9	1413·	541·2	88·6
220	2368·	20·4	34·1	1419·	543·6	89·0
1	2379·	20·5	34·3	1426·	546·1	89·4
2	2390·	20·6	34·4	1432·	548·6	89·8
3	2400·	20·7	34·6	1439·	551·1	90·2
4	2411·	20·8	34·7	1445·	553·5	90·6
5	2422·	20·9	34·9	1452·	556·0	91·0
6	2433·	21·0	35·0	1458·	558·5	91·4
7	2443·	21·1	35·2	1464·	560·9	91·9
8	2454·	21·2	35·3	1471·	563·4	92·3
9	2465·	21·3	35·5	1477·	565·9	92·7
230	2476·	21·4	35·7	1484·	568·4	93·1
1	2487·	21·5	35·8	1490·	570·8	93·5
2	2497·	21·6	36·0	1497·	573·3	93·9
3	2508·	21·6	36·1	1503·	575·8	94·3
4	2519·	21·7	36·3	1510·	578·2	94·7
5	2530·	21·8	36·4	1516·	580·7	95·1
6	2540·	21·9	36·6	1523·	583·2	95·5
7	2551·	22·0	36·7	1529·	585·6	95·9
8	2562·	22·1	36·9	1535·	588·1	96·3
9	2573·	22·2	37·0	1542·	590·6	96·7
240	2583·	22·3	37·2	1548·	593·1	97·1
1	2594·	22·4	37·4	1555·	595·5	97·5
2	2605·	22·5	37·5	1561·	598·0	97·9
3	2616·	22·6	37·7	1568·	600·5	98·3
4	2626·	22·7	37·8	1574·	602·9	98·7
5	2637·	22·8	38·0	1581·	605·4	99·1
6	2648·	22·9	38·1	1587·	607·9	99·5
7	2659·	23·0	38·4	1593·	610·4	100·0
8	2670·	23·0	38·5	1600·	612·8	100·4
9	2680·	23·1	38·7	1606·	615·3	100·8
250	2691·	23·2	38·8	1613·	617·8	101·2
1	2702·	23·3	38·9	1619·	620·2	101·6
2	2713·	23·4	39·1	1626·	622·7	102·0
3	2723·	23·5	39·2	1632·	625·2	102·4
4	2734·	23·6	39·4	1639·	627·7	102·8
5	2745·	23·7	39·5	1645·	630·1	103·2
6	2756·	23·8	39·7	1652·	632·6	103·6
7	2766·	23·9	39·8	1658·	635·1	104·0
8	2777·	24·0	40·0	1664·	637·5	104·4
9	2788·	24·1	40·1	1671·	640·0	104·8
260	2799·	24·1	40·3	1677·	642·5	105·2
1	2809·	24·2	40·5	1684·	645·0	105·6
2	2820·	24·3	40·6	1690·	647·4	106·0
3	2831·	24·4	40·8	1697·	649·9	106·4
4	2842·	24·5	40·9	1703·	652·4	106·8
5	2853·	24·6	41·1	1710·	654·8	107·2
6	2863·	24·7	41·2	1716·	657·3	107·7
7	2874·	24·8	41·4	1723·	659·8	108·1
8	2885·	24·9	41·5	1729·	662·3	108·5
9	2896·	25·0	41·7	1735·	664·7	108·9
270	2906·	25·1	41·9	1742·	667·2	109·3
1	2917·	25·2	42·0	1748·	669·7	109·7
2	2928·	25·3	42·2	1755·	672·1	110·1
3	2939·	25·4	42·3	1761·	674·6	110·5
4	2949·	25·4	42·5	1768·	677·1	110·9
5	2960·	25·5	42·6	1774·	679·6	111·3
6	2971·	25·6	42·8	1781·	682·0	111·7
7	2982·	25·7	42·9	1787·	684·5	112·1
8	2992·	25·8	43·1	1793·	687·0	112·5
9	3003·	25·9	43·2	1800·	689·4	112·9
280	3014·	26·0	43·4	1806·	691·9	113·3
1	3025·	26·1	43·6	1813·	694·4	113·7
2	3036·	26·2	43·7	1819·	696·8	114·1
3	3046·	26·3	43·9	1826·	699·3	114·5
4	3057·	26·4	44·0	1832·	701·8	114·9
5	3068·	26·5	44·2	1839·	704·3	115·3
6	3079·	26·6	44·3	1845·	706·7	115·7
7	3089·	26·7	44·5	1852·	709·2	116·1
8	3100·	26·8	44·6	1858·	711·7	116·5
9	3111·	26·8	44·8	1864·	714·1	117·0
290	3122·	26·9	45·0	1871·	716·6	117·4
1	3132·	27·0	45·1	1877·	719·1	117·8
2	3143·	27·1	45·3	1884·	721·6	118·2
3	3154·	27·2	45·4	1890·	724·0	118·6
4	3165·	27·3	45·6	1897·	726·5	119·0
5	3175·	27·4	45·7	1903·	729·0	119·4
6	3186·	27·5	45·9	1910·	731·4	119·8
7	3197·	27·6	46·0	1916·	733·9	120·2
8	3208·	27·7	46·2	1922·	736·4	120·6
9	3219·	27·8	46·3	1929·	738·9	121·0
300	3229·	27·9	46·5	1935·	741·3	121·4
1	3240·	28·0	46·7	1942·	743·8	121·8
2	3251·	28·1	46·8	1948·	746·3	122·2
3	3262·	28·1	47·0	1955·	748·7	122·6
4	3272·	28·2	47·1	1961·	751·2	123·0
5	3283·	28.3	47·3	1968·	753·7	123·4
6	3294·	28·4	47·4	1974·	756·2	123·8
7	3305·	28·5	47·6	1981·	758·6	124·2
8	3315·	28·6	47·7	1987·	761·1	124·6
9	3326·	28·7	47·9	1993·	763·6	125·0
310	3337·	28·8	48·1	2000·	766·0	125·4
1	3348·	28·9	48·2	2006·	768·5	125·9
2	3358·	29·0	48·4	2013·	771·0	126·3
3	3369·	29·1	48·5	2019·	773·5	126·7
4	3380·	29·2	48·7	2026·	775·9	127·1
5	3391·	29·3	48·8	2032·	778·4	127·5
6	3402·	29·4	48·9	2039·	780·9	127·9
7	3412·	29·4	49·1	2045·	783·2	128·3
8	3423·	29·5	49·3	2052·	785·8	128·7
9	3434·	29·6	49·4	2058·	788·3	129·0
320	3445·	29·7	49·6	2064·	790·7	129·5
1	3455·	29·8	49·8	2071·	793·2	129·9
2	3466·	29·9	49·9	2077·	795·7	130·3
3	3477·	30·0	50·1	2084·	798·2	130·7
4	3488·	30·1	50·2	2090·	800·6	131·1
5	3498·	30·2	50·4	2097·	803·1	131·5

No.	Sq. M. = Sq. Ft.	Sq. Ft. = Sq. M.	Sq. Cm. = Sq. In.	Sq. In. = Sq. Cm.	Hectare = Acres.	Acres = Hectare
6	3509·	30·3	50·5	2103·	805·6	131·9
7	3520·	30·4	50·7	2110·	808·0	132·3
8	3531·	30·5	50·8	2116·	810·5	132·7
9	3541·	30·6	51·0	2122·	813·0	133·1
330	3552·	30·7	51·2	2129·	815·5	133·5
1	3563·	30·7	51·3	2135·	817·9	134·0
2	3574·	30·8	51·5	2142·	820·4	134·4
3	3585·	30·9	51·6	2148·	822·9	134·8
4	3595·	31·0	51·8	2155·	825·3	135·2
5	3606·	31·1	51·9	2161·	827·8	135·6
6	3617·	31·2	52·1	2168·	830·3	136·0
7	3628·	31·3	52·2	2174·	832·8	136·4
8	3638·	31·4	52·4	2181·	835·2	136·8
9	3649·	31·5	52·5	2187·	837·7	137·2
340	3660·	31·6	52·7	2193·	840·2	137·6
1	3671·	31·7	52·9	2200·	842·6	138·0
2	3681·	31·8	53·0	2206·	845·1	138·4
3	3692·	31·9	53·2	2213·	847·6	138·8
4	3703·	32·0	53·3	2219·	850·1	139·2
5	3714·	32·1	53·5	2226·	852·5	139·6
6	3724·	32·1	53·6	2232·	855·0	140·0
7	3735·	32·2	53·8	2239·	857·5	140·4
8	3746·	32·3	53·9	2245·	859·9	140·8
9	3757·	32·4	54·1	2252·	862·4	141·2
350	3768·	32·5	54·3	2258·	864·9	141·6
1	3778·	32·6	54·4	2264·	867·4	142·0
2	3789·	32·7	54·6	2271·	869·8	142·4
3	3800·	32·8	54·7	2277·	872·3	142·8
4	3811·	32·9	54·9	2284·	874·8	143·3
5	3821·	33·0	55·0	2290·	877·2	143·7
6	3832·	33·1	55·2	2297·	879·7	144·1
7	3843·	33·2	55·3	2303·	882·2	144·5
8	3854·	33·3	55·5	2310·	884·6	144·9
9	3864·	33·4	55·6	2316·	887·1	145·3
360	3875·	33·4	55·8	2322·	889·6	145·7
1	3886·	33·5	56·0	2329·	892·1	146·1
2	3897·	33·6	56·1	2335·	894·5	146·5
3	3907·	33·7	56·3	2342·	897·0	146·9
4	3918·	33·8	56·4	2348·	899·5	147·3
5	3929·	33·9	56·6	2355·	902·0	147·7
6	3940·	34·0	56·7	2361·	904·4	148·1
7	3950·	34·1	56·9	2368·	906·9	148·5
8	3961·	34·2	57·0	2374·	909·4	148·9
9	3972·	34·3	57·2	2381·	911·8	149·3
370	3983·	34·4	57·4	2387·	914·3	149·7
1	3994·	34·5	57·5	2393·	916·8	150·1
2	4004·	34·6	57·7	2400·	919·3	150·5
3	4015·	34·6	57·8	2406·	921·7	151·0
4	4026·	34·7	58·0	2413·	924·2	151·4
5	4037·	34·8	58·1	2419·	926·7	151·8
6	4047·	34·9	58·3	2426·	929·1	152·2
7	4058·	35·0	58·4	2432·	931·6	152·6
8	4069·	35·1	58·6	2439·	934·1	153·0
9	4080·	35·2	58·7	2445·	936·5	153·4
380	4090·	35·3	58·9	2452·	939·0	153·8
1	4101·	35·4	59·1	2458·	941·5	154·2
2	4112·	35·5	59·2	2464·	944·0	154·6
3	4123·	35·6	59·4	2471·	946·4	155·0
4	4133·	35·7	59·5	2477·	948·9	155·4
5	4144·	35·8	59·7	2484·	951·4	155·8
6	4155·	35·9	59·8	2490·	953·8	156·2
7	4166·	36·0	60·0	2497·	956·3	156·6
8	4177·	36·0	60·1	2503·	958·8	157·0
9	4187·	36·1	60·3	2510·	961·3	157·4
390	4198·	36·2	60·5	2516·	963·7	157·8
1	4209·	36·3	60·6	2522·	966·2	158·2
2	4220·	36·4	60·8	2529·	968·7	158·6
3	4230·	36·5	60·9	2535·	971·1	159·0
4	4241·	36·6	61·1	2542·	973·6	159·4
5	4252·	36·7	61·2	2548·	976·1	159·8
6	4263·	36·8	61·4	2555·	978·6	160·3
7	4273·	36·9	61·5	2561·	981·0	160·7
8	4284·	37·0	61·7	2568·	983·5	161·1
9	4295·	37·1	61·8	2574·	986·0	161·5
400	4306·	37·2	62·0	2581·	988·4	161·9
1	4316·	37·3	62·2	2587·	990·9	162·3
2	4327·	37·3	62·3	2593·	993·4	162·7
3	4338·	37·4	62·5	2600·	995·9	163·1
4	4349·	37·5	62·6	2606·	998·3	163·5
5	4360·	37·6	62·8	2613·	1001·	163·9
6	4370·	37·7	62·9	2619·	1003·	164·3
7	4381·	37·8	63·1	2626·	1006·	164·7
8	4392·	37·9	63·2	2632·	1008·	165·1
9	4403·	38·0	63·4	2639·	1011·	165·5
410	4413·	38·1	63·6	2645·	1013·	165·9
1	4424·	38·2	63·7	2652·	1016·	166·3
2	4435·	38·3	63·9	2658·	1018·	166·7
3	4446·	38·4	64·0	2664·	1021·	167·1
4	4456·	38·5	64·2	2671·	1023·	167·5
5	4467·	38·6	64·3	2677·	1026·	167·9
6	4478·	38·6	64·5	2684·	1028·	168·3
7	4489·	38·7	64·6	2690·	1030·	168·7
8	4499·	38·8	64·8	2697·	1033·	169·2
9	4510·	38·9	64·9	2703·	1035·	169·6
420	4521·	39·0	65·1	2710·	1038·	170·0
1	4532·	39·1	65·3	2716·	1040·	170·4
2	4543·	39·2	65·4	2722·	1043·	170·8
3	4553·	39·3	65·6	2729·	1045·	171·2
4	4564·	39·4	65·7	2735·	1048·	171·6
5	4575·	39·5	65·9	2742·	1050·	172·0
6	4586·	39·6	66·0	2748·	1053·	172·4
7	4596·	39·7	66·2	2755·	1055·	172·8
8	4607·	39·8	66·3	2761·	1058·	173·2
9	4618·	39·9	66·5	2768·	1060·	173·6
430	4629·	39·9	66·7	2774·	1063·	174·0
1	4639·	40·0	66·8	2781·	1065·	174·4
2	4650·	40·1	67·0	2787·	1068·	174·8
3	4661·	40·2	67·1	2793·	1070·	175·2
4	4672·	40·3	67·3	2800·	1072·	175·6
5	4682·	40·4	67·4	2806·	1075·	176·0
6	4693·	40·5	67·6	2813·	1077·	176·4
7	4704·	40·6	67·7	2819·	1080·	176·8
8	4715·	40·7	67·9	2826·	1082·	177·3

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9	4726·	40·8	68·0	2832·	1085·	177·7
440	4736·	40·9	68·2	2839·	1087·	178·1
1	4747·	41·0	68·4	2845·	1090·	178·5
2	4758·	41·1	68·5	2852·	1092·	178·9
3	4769·	41·2	68·7	2858·	1095·	179·3
4	4779·	41·2	68·8	2864·	1097·	179·7
5	4790·	41·3	69·0	2871·	1100·	180·1
6	4801·	41·4	69·1	2877·	1102·	180·5
7	4812·	41·5	69·3	2884·	1105·	180·9
8	4822·	41·6	69·4	2890·	1107·	181·3
9	4833·	41·7	69·6	2897·	1110·	181·7
450	4844·	41·8	69·8	2903·	1112·	182·1
1	4855·	41·9	69·9	2910·	1114·	182·5
2	4865·	42·0	70·1	2916·	1117·	182·9
3	4876·	42·1	70·2	2922·	1119·	183·3
4	4887·	42·2	70·4	2929·	1122·	183·7
5	4898·	42·3	70·5	2935·	1124·	184·1
6	4909·	42·4	70·7	2942·	1127·	184·5
7	4919·	42·5	70·8	2948·	1129·	184·9
8	4930·	42·5	71·0	2955·	1132·	185·3
9	4941·	42·6	71·1	2961·	1134·	185·7
460	4952·	42·7	71·3	2968·	1137·	186·1
1	4962·	42·8	71·5	2974·	1139·	186·6
2	4973·	42·9	71·6	2981·	1142·	187·0
3	4984·	43·0	71·7	2987·	1144·	187·4
4	4995·	43·1	71·9	2993·	1147·	187·8
5	5005·	43·2	72·1	3000·	1149·	188·2
6	5016·	43·3	72·2	3006·	1152·	188·6
7	5027·	43·4	72·4	3013·	1154·	189·0
8	5038·	43·5	72·5	3019·	1156·	189·4
9	5048·	43·6	72·7	3026·	1159·	189·8
470	5059·	43·7	72·9	3032·	1161·	190·2
1	5070·	43·8	73·0	3039·	1164·	190·6
2	5081.	43·8	73·2	3045·	1166·	191·0
3	5092·	43·9	73·3	3052·	1169·	191·4
4	5102·	44·0	73·5	3058·	1171·	191·8
5	5113·	44·1	73·6	3064·	1174·	192·2
6	5124·	44·2	73·8	3071·	1176·	192·6
7	5135·	44·3	73·9	3077·	1179·	193·0
8	5145·	44·4	74·1	3084·	1181·	193·4
9	5156·	44·5	74·2	3090·	1184·	193·8
480	5167·	44·6	74·4	3097·	1186·	194·2
1	5178·	44·7	74·6	3103·	1189·	194·6
2	5188·	44·8	74·7	3110·	1191·	195·1
3	5199·	44·9	74·9	3116	1194·	195·5
4	5210·	45·0	75·0	3122·	1196·	195·9
5	5221·	45·1	75·2	3129·	1198·	196·3
6	5231·	45·1	75·3	3135·	1201·	196·7
7	5242·	45·2	75·5	3142·	1203·	197·1
8	5253·	45·3	75·6	3148·	1206·	197·5
9	5264·	45·4	75·8	3155·	1209·	197·9
490	5275·	45·5	76·0	3161·	1211·	198·3
1	5285·	45·6	76·1	3168·	1213·	198·7
2	5296·	45·7	76·3	3174·	1216·	199·1
3	5307·	45·8	76·4	3181·	1218·	199·5
4	5318·	45·9	76·6	3187·	1221·	199·9
5	5328·	46·0	76·7	3193·	1223·	200·3
6	5339·	46·1	76·9	3200·	1226·	200·7
7	5350·	46·2	77·0	3206·	1228·	201·1
8	5361·	46·3	77·2	3213·	1231·	201·5
9	5371·	46·4	77·3	3219·	1233·	201·9
500	5382·	46·4	77·5	3226·	1236·	202·3
1	5393·	46·5	77·7	3232·	1238·	202·7
2	5404·	46·6	77·8	3239·	1240·	203·1
3	5414·	46·7	78·0	3245·	1243·	203·5
4	5425·	46·8	78·1	3251·	1245·	204·0
5	5436·	46·9	78·3	3258·	1248·	204·4
6	5447·	47·0	78·4	3264·	1250·	204·8
7	5458·	47·1	78·6	3271·	1253·	205·2
8	5468·	47·2	78·7	3277·	1255·	205·6
9	5479·	47·3	78·9	3284·	1258·	206·0
510	5490·	47·4	79·1	3290·	1260·	206·4
1	5501·	47·5	79·2	3297·	1263·	206·8
2	5511·	47·6	79·4	3303·	1265·	207·2
3	5522·	47·7	79·5	3310·	1268·	207·6
4	5533·	47·8	79·7	3316·	1270·	208·0
5	5544·	47·8	79·8	3322·	1273·	208·4
6	5554·	47·9	80·0	3329·	1275·	208·8
7	5565·	48·0	80·1	3335·	1278·	209·2
8	5576·	48·1	80·3	3342·	1280·	209·6
9	5587·	48·2	80·4	3348·	1282·	210·0
520	5597·	48·3	80·6	3355·	1285·	210·4
1	5608·	48·4	80·8	3361·	1287·	210·8
2	5619·	48·5	80·9	3368·	1290·	211·2
3	5630·	48·6	81·1	3374·	1292·	211·6
4	5640·	48·7	81·2	3381·	1295·	212·0
5	5651·	48·8	81·4	3387·	1297·	212·5
6	5662·	48·9	81·5	3393·	1300·	212·9
7	5673·	49·0	81·7	3400·	1302·	213·3
8	5684·	49·0	81·8	3406·	1305·	213·7
9	5694·	49·1	82·0	3413·	1307·	214·1
530	5705·	49·2	82·2	3419·	1310·	214·5
1	5716·	49·3	82·3	3426·	1312·	214·9
2	5727·	49·4	82·5	3432·	1315·	215·3
3	5737·	49·5	82·6	3439·	1317·	215·7
4	5748·	49·6	82·8	3445·	1320·	216·1
5	5759·	49·7	82·8	3451·	1322·	216·5
6	5770·	49·8	83·0	3458·	1325·	216·9
7	5780·	49·9	83·1	3464·	1327·	217·3
8	5791·	50·0	83·3	3471·	1329·	217·7
9	5802·	50·1	83·4	3477·	1332·	218·1
540	5813·	50·2	83·7	3484·	1334·	218·5
1	5823·	50·3	83·9	3490·	1337·	218·9
2	5834·	50·4	84·0	3497·	1339·	219·3
3	5845·	50·4	84·2	3503·	1342·	219·7
4	5856·	50·5	84·3	3510·	1344·	220·1
5	5867·	50·6	84·5	3516·	1347·	220·5
6	5877·	50·7	84·6	3522·	1349·	221·0
7	5888·	50·8	84·8	3529·	1352·	221·4
8	5899·	50·9	84·9	3535·	1354·	221·8
9	5910·	51·0	85·1	3542·	1357·	222·2
550	5920·	51·1	85·3	3548·	1359·	222·6
1	5931·	51·2	85·4	3555·	1362·	223·0

No.	Sq. M. = Sq. Ft.	Sq. Ft. = Sq. M.	Sq. Cm. = Sq. In.	Sq. In. = Sq. Cm.	Hectare = Acres.	Acres. = Hectare
2	5942·	51·3	85·6	3561·	1364·	223·4
3	5953·	51·4	85·7	3568·	1367·	223·8
4	5963·	51·5	85·9	3574·	1369·	224·2
5	5974·	51·6	86·0	3581·	1371·	224·6
6	5985·	51·7	86·2	3587·	1374·	225·0
7	5996·	51·7	86·3	3593·	1376·	225·4
8	6006·	51·8	86·5	3600·	1379·	225·8
9	6017·	51·9	86·6	3606·	1381·	226·2
560	6028·	52·0	86·8	3613·	1384·	226·6
1	6039·	52·1	87·0	3619·	1386·	227·0
2	6050·	52·2	87·1	3626·	1389·	227·4
3	6060·	52·3	87·3	3632·	1391·	227·8
4	6071·	52·4	87·4	3639·	1394·	228·2
5	6082·	52·5	87·6	3645·	1396·	228·6
6	6093·	52·6	87·7	3651·	1399·	229·0
7	6103·	52·7	87·9	3658·	1401·	229·5
8	6114·	52·8	88·0	3664·	1404·	229·9
9	6125·	52·9	88·2	3671·	1406·	230·3
570	6136·	53·0	88·4	3677·	1409·	230·7
1	6146·	53·0	88·5	3684·	1411·	231·1
2	6157·	53·1	88·7	3690·	1413·	231·5
3	6168·	53·2	88·8	3697·	1416·	231·9
4	6179·	53·3	89·0	3703·	1418·	232·3
5	6189·	53·4	89·1	3710·	1421·	232·7
6	6200·	53·5	89·3	3716·	1423·	233·1
7	6211·	53·6	89·4	3722·	1426·	233·5
8	6222·	53·7	89·6	3729·	1428·	233·9
9	6233·	53·8	89·7	3735·	1431·	234·3
580	6243·	53·9	89·9	3742·	1433·	234·7
1	6254·	54·0	90·1	3748·	1436·	235·1
2	6265·	54·1	90·2	3755·	1438·	235·5
3	6276·	54·2	90·4	3761·	1441·	235·9
4	6286·	54·3	90·5	3768·	1443·	236·3
5	6297·	54·3	90·7	3774·	1446·	236·7
6	6308·	54·4	90·8	3780·	1448·	237·1
7	6319·	54·5	91·0	3787·	1451·	237·6
8	6329·	54·6	91·1	3793·	1453·	238·0
9	6340·	54·7	91·3	3800·	1455·	238·4
590	6351·	54·8	91·5	3806·	1458·	238·8
1	6362·	54·9	91·6	3813·	1460·	239·2
2	6372·	55·0	91·8	3819·	1463·	239·6
3	6383·	55·1	91·9	3826·	1465·	240·0
4	6394·	55·2	92·1	3832·	1468·	240·4
5	6405·	55·3	92·2	3839·	1470·	240·8
6	6416·	55·4	92·4	3845·	1473·	241·2
7	6426·	55·5	92·5	3851·	1475·	241·6
8	6437·	55·6	92·7	3858·	1478·	242·0
9	6448·	55·6	92·8	3864·	1480·	242·4
600	6459·	55·7	93·0	3871·	1483·	242·8
1	6469·	55·8	93·2	3877·	1485·	243·2
2	6480·	55·9	93·3	3884·	1488·	243·6
3	6491·	56·0	93·5	3890·	1490·	244·0
4	6502·	56·1	93·6	3897·	1493·	244·4
5	6512·	56·2	93·8	3903·	1495·	244·8
6	6523·	56·3	93·9	3910·	1497·	245·2
7	6534·	56·4	94·1	3916·	1500·	245·6
8	6545·	56·5	94·2	3922·	1502·	246·0
9	6555·	56·6	94·4	3929·	1505·	246·4
610	6566·	56·7	94·6	3935·	1507·	246·9
1	6577·	56·8	94·7	3942·	1510·	247·3
2	6588·	56·9	94·9	3948·	1512·	247·7
3	6599·	56·9	95·0	3955·	1515·	248·1
4	6609·	57·0	95·2	3961·	1517·	248·5
5	6620·	57·1	95·3	3968·	1520·	248·9
6	6631·	57·2	95·5	3974·	1522·	249·3
7	6642·	57·3	95·6	3980·	1525·	249·7
8	6652·	57·4	95·8	3987·	1527·	250·1
9	6663·	57·5	95·9	3993·	1530·	250·5
620	6674·	57·6	96·1	4000·	1532·	250·9
1	6685·	57·7	96·3	4006·	1535·	251·3
2	6695·	57·8	96·4	4013·	1537·	251·7
3	6706·	57·9	96·6	4019·	1539·	252·1
4	6717·	58·0	96·7	4026·	1542·	252·5
5	6728·	58·1	96·9	4032·	1544·	252·9
6	6738·	58·2	97·0	4039·	1547·	253·3
7	6749·	58·2	97·2	4045·	1549·	253·7
8	6760·	58·3	97·3	4051·	1552·	254·1
9	6771·	58·4	97·5	4058·	1554·	254·5
630	6782·	58·5	97·7	4064·	1557·	255·0
1	6792·	58·6	97·8	4071·	1559·	255·4
2	6803·	58·7	98·0	4077·	1562·	255·8
3	6814·	58·8	98·1	4084·	1564·	256·2
4	6825·	58·9	98·3	4090·	1567·	256·6
5	6835·	59·0	98·4	4097·	1569·	257·0
6	6846·	59·1	98·6	4103·	1572·	257·4
7	6857·	59·2	98·7	4110·	1574·	257·8
8	6868·	59·3	98·9	4116·	1577·	258·2
9	6878·	59·4	99·0	4122·	1579·	258·6
640	6889·	59·5	99·2	4129·	1582·	259·0
1	6900·	59·5	99·4	4135·	1584·	259·4
2	6911·	59·6	99·5	4142·	1586·	259·8
3	6921·	59·7	99·7	4148·	1589·	260·2
4	6932·	59·8	99·8	4155·	1591·	260·6
5	6943·	59·9	100·0	4161·	1594·	261·0
6	6954·	60·0	100·1	4168·	1596·	261·4
7	6965·	60·1	100·3	4174·	1599·	261·8
8	6975·	60·2	100·4	4180·	1601·	262·2
9	6986·	60·3	100·6	4187·	1604·	262·6
650	6997·	60·4	100·8	4193·	1606·	263·0
1	7008·	60·5	100·9	4200·	1609·	263·5
2	7018·	60·6	101·1	4206·	1611·	263·9
3	7029·	60·7	101·2	4213·	1614·	264·3
4	7040·	60·8	101·4	4219·	1616·	264·7
5	7051·	60·9	101·5	4226·	1619·	265·1
6	7061·	60·9	101·7	4232·	1621·	265·5
7	7072·	61·0	101·8	4239·	1624·	265·9
8	7083·	61·1	102·0	4245·	1626·	266·3
9	7094·	61·2	102·1	4251·	1628·	266·7
660	7104·	61·3	102·3	4258·	1631·	267·1
1	7115·	61·4	102·5	4264·	1633·	267·5
2	7126·	61·5	102·6	4271·	1636·	267·9
3	7137·	61·6	102·8	4277·	1638·	268·3

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4	7147·	61·7	102·9	4284·	1641·	268·7
5	7158·	61·8	103·1	4290·	1643·	269·1
6	7169·	61·9	103·2	4297·	1646·	269·5
7	7180·	62·0	103·4	4303·	1648·	269·9
8	7191·	62·0	103·5	4310·	1651·	270·3
9	7201·	62·1	103·7	4316·	1653·	270·7
670	7212·	62·2	103·9	4322·	1656·	271·1
1	7223·	62·3	104·0	4329·	1658·	271·5
2	7234·	62·4	104·2	4335·	1661·	271·9
3	7244·	62·5	104·3	4342·	1663·	272·3
4	7255·	62·6	104·5	4348·	1666·	272·8
5	7266·	62·7	104·6	4355·	1668·	273·2
6	7277·	62·8	104·8	4361·	1670·	273·6
7	7287·	62·9	104·9	4368·	1673·	274·0
8	7298·	63·0	105·1	4374·	1675·	274·4
9	7309·	63·1	105·2	4380·	1678·	274·8
680	7320·	63·2	105·4	4387·	1680·	275·2
1	7330·	63·3	105·6	4393·	1683·	275·6
2	7341·	63·4	105·7	4400·	1685·	276·0
3	7352·	63·4	105·9	4406·	1688·	276·4
4	7363·	63·5	106·0	4413·	1690·	276·8
5	7374·	63·6	106·2	4419·	1693·	277·2
6	7384·	63·7	106·3	4426·	1695·	277·6
7	7395·	63·8	106·5	4432·	1698·	278·0
8	7406·	63·9	106·6	4439·	1700·	278·4
9	7417·	64·0	106·8	4445·	1703·	278·8
690	7427·	64·1	107·0	4451·	1705·	279·2
1	7438·	64·2	107·1	4458·	1708·	279·6
2	7449·	64·3	107·3	4464·	1710·	280·0
3	7460·	64·4	107·4	4471·	1712·	280·4
4	7470·	64·5	107·6	4477·	1715·	280·8
5	7481·	64·6	107·7	4484·	1717·	281·3
6	7492·	64·7	107·9	4490·	1720·	281·7
7	7503·	64·8	108·0	4497·	1722·	282·1
8	7513·	64·8	108·2	4503·	1725·	282·5
9	7524·	64·9	108·3	4509·	1727·	282·9
700	7535·	65·0	108·5	4516·	1730·	283·3
1	7546·	65·1	108·6	4522·	1732·	283·7
2	7557·	65·2	108·8	4529·	1735·	284·1
3	7567·	65·3	109·0	4535·	1737·	284·5
4	7578·	65·4	109·1	4542·	1740·	284·9
5	7589·	65·5	109·3	4548·	1742·	285·3
6	7600·	65·6	109·4	4555·	1745·	285·7
7	7610·	65·7	109·6	4561·	1747·	286·1
8	7621·	65·8	109·7	4568·	1750·	286·5
9	7632·	65·9	109·9	4574·	1752·	286·9
710	7643·	66·0	110·1	4580·	1754·	287·3
1	7653·	66·1	110·2	4587·	1757·	287·7
2	7664·	66·1	110·4	4593·	1759·	288·1
3	7675·	66·2	110·5	4600·	1762·	288·5
4	7686·	66·3	110·7	4606·	1764·	288·9
5	7696·	66·4	110·8	4613·	1767·	289·4
6	7707·	66·5	111·0	4619·	1769·	289·8
7	7718·	66·6	111·1	4626·	1772·	290·2
8	7729·	66·7	111·3	4632·	1774·	290·6
9	7740·	66·8	111·4	4639·	1777·	291·0
720	7750·	66 9	111·6	4645·	1779·	291·4
1	7761·	67·0	111·8	4651·	1782·	291·8
2	7772·	67·1	111·9	4658·	1784·	292·2
3	7783·	67·2	112·1	4664·	1787·	292·6
4	7793·	67·3	112·2	4671·	1789·	293·0
5	7804·	67·4	112·4	4677·	1792·	293·4
6	7815·	67·4	112·5	4684·	1794·	293·8
7	7826·	67·5	112·7	4690·	1796·	294·2
8	7836·	67·6	112·8	4697·	1799·	294·6
9	7847·	67·7	113·0	4703·	1801·	295·0
730	7858·	67·8	113·2	4709·	1804·	295·4
1	7869·	67·9	113·3	4716·	1806·	295·8
2	7879·	68·0	113·5	4722·	1809·	296·2
3	7890·	68·1	113·6	4729·	1811·	296·6
4	7901·	68·2	113·8	4735·	1814·	297·0
5	7912·	68·3	113·9	4742·	1816·	297·4
6	7923·	68·4	114·1	4748·	1819·	297·8
7	7933·	68·5	114·2	4755·	1821·	298·3
8	7944·	68·6	114·4	4761·	1824·	298·7
9	7955·	68·7	114·5	4768·	1826·	299·1
740	7966·	68·7	114·7	4774·	1829·	299·5
1	7976·	68·8	114·9	4780·	1831·	299·9
2	7987·	68·9	115·0	4787·	1834·	300·3
3	7998·	69·0	115·2	4793·	1836·	300·7
4	8009·	69·1	115·3	4800·	1838·	301·1
5	8019·	69·2	115·5	4806·	1841·	301·5
6	8030·	69·3	115·6	4813·	1843·	301·9
7	8041·	69·4	115·8	4819·	1846·	302·3
8	8052·	69·5	115·9	4826·	1848·	302·7
9	8062·	69·6	116·1	4832·	1851·	303·1
750	8073·	69·7	116·3	4839·	1853·	303·5
1	8084·	69·8	116·4	4845·	1856·	303·9
2	8095·	69·9	116·6	4851·	1858·	304·3
3	8106·	70·0	116·7	4858·	1861·	304·7
4	8116·	70·0	116·8	4864·	1863·	305·1
5	8127·	70·1	117·0	4871·	1866·	305·5
6	8138·	70·2	117·2	4877·	1868·	305·9
7	8149·	70·3	117·3	4884·	1871·	306·3
8	8159·	70·4	117·5	4890·	1873·	306·7
9	8170·	70·5	117·6	4897·	1876·	307·1
760	8181·	70·6	117·8	4903·	1878·	307·6
1	8192·	70·7	118·0	4909·	1881·	308·0
2	8202·	70·8	118·1	4916·	1883·	308·4
3	8213·	70·9	118·3	4922·	1885·	308·8
4	8224·	71·0	118·4	4929·	1888·	309·2
5	8235·	71·1	118·6	4935·	1890·	309·6
6	8245·	71·2	118·7	4942·	1893·	310·0
7	8256·	71·2	118·9	4948·	1895·	310·4
8	8267·	71·3	119·0	4955·	1898·	310·8
9	8278·	71·4	119·2	4961·	1900·	311·2
770	8289·	71·5	119·4	4968·	1903·	311·6
1	8299·	71·6	119·5	4974·	1905·	312·0
2	8310·	71·7	119·7	4980·	1908·	312·4
3	8321·	71·8	119·8	4987·	1910·	312·8
4	8332·	71·9	120·0	4993·	1913·	313·2
5	8342·	72·0	120·1	5000·	1915·	313·6

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6	8353·	72·1	120·3	5006·	1918·	314·0
7	8364·	72·2	120·4	5013·	1920·	314·4
8	8375·	72·3	120·6	5019·	1923·	314·8
9	8385·	72·4	120·7	5026·	1925·	315·3
780	8396·	72·5	120·9	5032·	1927·	315·7
1	8407·	72·6	121·1	5039·	1930·	316·1
2	8418·	72·6	121·2	5045·	1932·	316·5
3	8428·	72·7	121·4	5051·	1935·	316·9
4	8439·	72·8	121·5	5058·	1937·	317·3
5	8450·	72·9	121·7	5064·	1940·	317·7
6	8461·	73·0	121·8	5071·	1942·	318·1
7	8471·	73·1	122·0	5077·	1945·	318·5
8	8482·	73·2	122·1	5084·	1947·	318·9
9	8493·	73·3	122·3	5090·	1950·	319·3
790	8504·	73·4	122·5	5097·	1952·	319·7
1	8515·	73·5	122·6	5103·	1955·	320·1
2	8525·	73·6	122·8	5109·	1957·	320·5
3	8536·	73·7	122·9	5116·	1960·	320·9
4	8547·	73·8	123·1	5122·	1962·	321·3
5	8558·	73·9	123·2	5129·	1965·	321·7
6	8568·	73·9	123·4	5135·	1967·	322·1
7	8579·	74·0	123·5	5142·	1969·	322·5
8	8590·	74·1	123·7	5148·	1972·	322·9
9	8601·	74·2	123·8	5155·	1974·	323·3
800	8611·	74·3	124·0	5161·	1977·	323·7
1	8622·	74·4	124·2	5168·	1979·	324·1
2	8633·	74·5	124·3	5174·	1982·	324·6
3	8644·	74·6	124·5	5180·	1984·	325·0
4	8654·	74·7	124·6	5187·	1987·	325·4
5	8665·	74·8	124·8	5193·	1989·	325·7
6	8676·	74·9	124·9	5200·	1992·	326·2
7	8687·	75·0	125·1	5206·	1994·	326·6
8	8698·	75·1	125·2	5213·	1997·	327·0
9	8708·	75·2	125·4	5219·	1999·	327·4
810	8719·	75·3	125·6	5226·	2002·	327·8
1	8730·	75·3	125·7	5232·	2004·	328·2
2	8731·	75·4	125·9	5239.	2007·	328·6
3	8741·	75·5	126·0	5245·	2009·	329·0
4	8752·	75·6	126·2	5251·	2011·	329·4
5	8773·	75·7	126·3	5258·	2014·	329·8
6	8784·	75·8	126·5	5264·	2016·	330·2
7	8794·	75·9	126·6	5271·	2019·	330·6
8	8805·	76·0	126·8	5277·	2021·	331·0
9	8816·	76·1	126·9	5284·	2024·	331·4
820	8827·	76·2	127·1	5290·	2026·	331·8
1	8837·	76·3	127·3	5297·	2029·	332·2
2	8848·	76·4	127·4	5303·	2031·	332·6
3	8859·	76·5	127·6	5309·	2034·	333·1
4	8870·	76·5	127·7	5316·	2036·	333·5
5	8881·	76·6	127·8	5322·	2039·	333·9
6	8891·	76·7	128·0	5329·	2041·	334·3
7	8902·	76·8	128·2	5335·	2044·	334·7
8	8913·	76·9	128·3	5342·	2046·	335·1
9	8924·	77·0	128·5	5348·	2049·	335·5
830	8934·	77·1	128·7	5355·	2051·	335·9
1	8945·	77·2	128·8	5361·	2053·	336·3
2	8956·	77·3	129·0	5368·	2056·	336·7
3	8967·	77·4	129·1	5374·	2058·	337·1
4	8977·	77·5	129·3	5380·	2061·	337·5
5	8988·	77·6	129·4	5387·	2063·	337·9
6	8999·	77·7	129·6	5393·	2066·	338·3
7	9010·	77·8	129·7	5400·	2068·	338·7
8	9020·	77·9	129·9	5406·	2071·	339·1
9	9031·	77·9	130·0	5413·	2073·	339·5
840	9042·	78·0	130·2	5419·	2076·	339·9
1	9053·	78·1	130·4	5426·	2078·	340·3
2	9064·	78·2	130·5	5432·	2081·	340·7
3	9074·	78·3	130·7	5439·	2083·	341·1
4	9085·	78·4	130·8	5445·	2086·	341·6
5	9096·	78·5	131·0	5451·	2088·	342·0
6	9107·	78·6	131·1	5458·	2091·	342·3
7	9117·	78·7	131·3	5464·	2093·	342·8
8	9128·	78·8	131·4	5471·	2095·	343·2
9	9139·	78·9	131·6	5477·	2098·	343·6
850	9150·	79·0	131·8	5484·	2100·	344·0
1	9160·	79·1	131·9	5490·	2103·	344·4
2	9171·	79·2	132·1	5497·	2105·	344·8
3	9182·	79·2	132·2	5503·	2108·	345·2
4	9193·	79·3	132·4	5509·	2110·	345·6
5	9203·	79·4	132·5	5516·	2113·	345·9
6	9214·	79·5	132·7	5522·	2115·	346·4
7	9225·	79·6	132·9	5529·	2118·	346·8
8	9236·	79·7	133·0	5535·	2120·	347·2
9	9247·	79·8	133·0	5542·	2123·	347·6
860	9257·	79·9	133·3	5548·	2125·	348·0
1	9268·	80·0	133·5	5555·	2128·	348·4
2	9279·	80·1	133·6	5561·	2130·	348·8
3	9290·	80·2	133·8	5568·	2133·	349·2
4	9300·	80·3	133·9	5574·	2135·	349·6
5	9311·	80·4	134·1	5580·	2138·	350·1
6	9322·	80·4	134·2	5587·	2140·	350·5
7	9333·	80·5	134·4	5593·	2142·	350·9
8	9343·	80·6	134·5	5600·	2145·	351·3
9	9354·	80·7	134·7	5606·	2147·	351·7
870	9365·	80·8	134·9	5613·	2150·	352·1
1	9376·	80·9	135·0	5619·	2152·	352·5
2	9386·	81·0	135·2	5626·	2155·	352·9
3	9397·	81·1	135·3	5632·	2157·	353·3
4	9408·	81·2	135·5	5638·	2160·	353·7
5	9419·	81·3	135·6	5645·	2162·	354·1
6	9430·	81·4	135·8	5651·	2165·	354·5
7	9440·	81·5	135·9	5658·	2167·	354·9
8	9451·	81·6	136·0	5664·	2170·	355·3
9	9462·	81·7	136·2	5671·	2172·	355·7
880	9473·	81·7	136·4	5677·	2175·	356·1
1	9483·	81·8	136·6	5684·	2177·	356·5
2	9494·	81·9	136·7	5691·	2180·	356·9
3	9505·	82·0	136·9	5697·	2182·	357·3
4	9516·	82·1	137·0	5703·	2184·	357·7
5	9526·	82·2	137·2	5709·	2187·	358·1
6	9537·	82·3	137·3	5716·	2189·	358·5
7	9548·	82·4	137·5	5722·	2192·	359·0

No.	Sq. M. = Sq. Ft.	Sq. Ft. = Sq. M.	Sq. Cm. = Sq. In.	Sq. In. = Sq. Cm.	Hectare = Acres.	Acres = Hectare
8	9559·	82·5	137·6	5729·	2194·	359·4
9	9569·	82·6	137·8	5735·	2197·	359·8
890	9580·	82·7	138·0	5742·	2199·	360·2
1	9591·	82·8	138·1	5748·	2202·	360·6
2	9602·	82·9	138·3	5755·	2204·	361·0
3	9613·	83·0	138·4	5761·	2207·	361·4
4	9623·	83·1	138·6	5768·	2209·	361·8
5	9634·	83·1	138·7	5774·	2212·	362·2
6	9645·	83·2	138·9	5780·	2214·	362·6
7	9656·	83·3	139·0	5787·	2217·	363·0
8	9666·	83·4	139·2	5793·	2219·	363·4
9	9677·	83·5	139·3	5800·	2222·	363·8
900	9688·	83·6	139·5	5806·	2224·	364·2
1	9699·	83·7	139·7	5813·	2226·	364·6
2	9709·	83·8	139·8	5819·	2229·	365·0
3	9720·	83·9	140·0	5826·	2231·	365·4
4	9731·	84·0	140·1	5832·	2234·	365·8
5	9742·	84·1	140·3	5838·	2236·	366·2
6	9752·	84·2	140·4	5845·	2239·	366·6
7	9763·	84·3	140·6	5851·	2241·	367·0
8	9774·	84·4	140·7	5858·	2244·	367·4
9	9785·	84·4	140·9	5864·	2246·	367·9
910	9796·	84·5	141·1	5871·	2249·	368·3
1	9806·	84·6	141·2	5877·	2251·	368·7
2	9817·	84·7	141·4	5884·	2254·	369·1
3	9828·	84·8	141·5	5890·	2256·	369·5
4	9839·	84·9	141·7	5897·	2259·	369·9
5	9849·	85·0	141·8	5903·	2261·	370·3
6	9860·	85·1	142·0	5909·	2264·	370·7
7	9871·	85·2	142·1	5916·	2266·	371·1
8	9882·	85·3	142·3	5922·	2268·	371·5
9	9892·	85·4	142·4	5929·	2272·	371·9
920	9903·	85·5	142·6	5935·	2273·	372·3
1	9914·	85·6	142·8	5942·	2276·	372·7
2	9925·	85·7	142·9	5948·	2278·	373·1
3	9935·	85·7	143·1	5955·	2281·	373·5
4	9946·	85·8	143·2	5961·	2283·	373·9
5	9957·	85·9	143·4	5968·	2286·	374·3
6	9968·	86·0	143·5	5974·	2288·	374·7
7	9979·	86·1	143·7	5980·	2291·	375·1
8	9989·	86·2	143·8	5987·	2293·	375·5
9	10000·	86·3	144·0	5993·	2296·	375·9
930	10011·	86·4	144·2	6000·	2298·	376·4
1	10022·	86·5	144·3	6006·	2301·	376·8
2	10032·	86·6	144·5	6013·	2303·	377·2
3	10043·	86·7	144·6	6019·	2306·	377·6
4	10054·	86·8	144·8	6026·	2308·	378·0
5	10065·	86·9	144·9	6032·	2310·	378·4
6	10075·	87·0	145·1	6038·	2313·	378·8
7	10086·	87·0	145·2	6045·	2315·	379·2
8	10097·	87·1	145·4	6051·	2318·	379·6
9	10108·	87·2	145·5	6058·	2320·	380·0
940	10118·	87·3	145·7	6064·	2323·	380·4
1	10129·	87·4	145·9	6071·	2325·	380·8
2	10140·	87·5	146·0	6077·	2328·	381·2
3	10151·	87·6	146·2	6084·	2330·	381·6
4	10161·	87·7	146·3	6090·	2333·	382·0
5	10172·	87·8	146·5	6097·	2335·	382·4
6	10183·	87·9	146·6	6103·	2338·	382·8
7	10194·	88·0	146·8	6109·	2340·	383·2
8	10205·	88·1	146·9	6116·	2343·	383·6
9	10215·	88·2	147·1	6122·	2345·	384·0
950	10226·	88·3	147·3	6129·	2348·	384·5
1	10237·	88·4	147·4	6135·	2350·	384·9
2	10248·	88·4	147·6	6142·	2352·	385·3
3	10258·	88·5	147·7	6148·	2355·	385·7
4	10269·	88·6	147·9	6155·	2357·	386·1
5	10280·	88·7	148·0	6161·	2360·	386·5
6	10291·	88·8	148·2	6167·	2363·	386·9
7	10301·	88·9	148·3	6174·	2365·	387·3
8	10312·	89·0	148·5	6180·	2367·	387·7
9	10323·	89·1	148·6	6187·	2370·	388·1
960	10334·	89·2	148·8	6193·	2372·	388·5
1	10344·	89·3	149·0	6200·	2375·	388·9
2	10355·	89·4	149·1	6206·	2377·	389·3
3	10366·	89·5	149·3	6213·	2380·	389·7
4	10377·	89·5	149·4	6219·	2382·	390·1
5	10388·	89·6	149·6	6226·	2385·	390·5
6	10398·	89·7	149·7	6232·	2387·	390·9
7	10409·	89·8	149·9	6238·	2390·	391·3
8	10420·	89·9	150·0	6245·	2392·	391·7
9	10431·	90·0	150·2	6251·	2394·	392·1
970	10441·	90·1	150·4	6258·	2397·	392·5
1	10452·	90·2	150·5	6264·	2399·	392·9
2	10463·	90·3	150·7	6271·	2402·	393·3
3	10474·	90·4	150·8	6277·	2404·	393·8
4	10484.	90·5	151·0	6284·	2407·	394·2
5	10495·	90·6	151·0	6290·	2409·	394·6
6	10506·	90·7	151·3	6297·	2412·	395·0
7	10517·	90·8	151·4	6303·	2414·	395·4
8	10527·	90·9	151·6	6309·	2417·	395·8
9	10538·	90·9	151·7	6316·	2419·	396·2
980	10549·	91·0	151·9	6322·	2422·	396·6
1	10560·	91·1	152·1	6329·	2424·	397·0
2	10571·	91·2	152·2	6335·	2427·	397·4
3	10581·	91·3	152·4	6342·	2429·	397·8
4	10592·	91·4	152·5	6348·	2432·	398·2
5	10603·	91·5	152·7	6355·	2434·	398·6
6	10614·	91·6	152·8	6361·	2437·	399·0
7	10624·	91·7	153·0	6367·	2439·	399·4
8	10635·	91·8	153·1	6374·	2441·	399·8
9	10646·	91·9	153·3	6380·	2444·	400·2
990	10657·	92·0	153·5	6387·	2446·	400·6
1	10667·	92·1	153·6	6393·	2449·	401·0
2	10678·	92·2	153·8	6400·	2451·	401·4
3	10689·	92·3	153·9	6406·	2454·	401·9
4	10700·	92·3	154·1	6413·	2456·	402·3
5	10710·	92·4	154·2	6419·	2459·	402·7
6	10721·	92·5	154·4	6426·	2461·	403·1
7	10732·	92·6	154·5	6432·	2464·	403·5
8	10743·	92·7	154·7	6438·	2466·	403·9
9	10754·	92·8	154·8	6445·	2469·	404·3
1000	10764·	92·9	155·0	6452·	2471·	404·7