OUR SECOND-CLASS IRONCLADS.

THE ironclad navies of the chief maritime Powers may be said to be composed of four types or classes of vessels—viz., the first class, or line-of-battle ships; the second class, or cruising armour-clads; the third class, or obsolete and insufficiently protected vessels; and the fourth class, or coast defenders. We purpose in this article to deal only with the second class, or cruising ironclads. It is of course a matter of some difficulty to define exactly the limits of the above four classes of armoured vessels, but it is generally understood that a modern line-of-battle ship must be protected by at least 10in. of armour, and carry an armament of not less than 10in. calibre. Experience has shown that 10in. iron armour affords considerable protection against even the 30·5 centimetre, thirty-five calibres long, Krupp breech-loading gun, if struck at an angle, although a direct shot from this gun will perforate 19in. of iron, or about 13in. of Wilson's compound armour.

The second class, or cruising ironclad, is usually recruited from the worn-out portion of the line-of-battle fleet—in so far, at least, as the British Navy is concerned; whilst the French and German Governments have continuously built vessels for this special purpose, ranging, in the case of the French Navy, from the Belliqueuse, with 5⅞in. armour, launched in 1865, to the Duguesclin, with 9⅞in. Wilson's compound armour, launched in 1883; and in the German Navy, from the Hansa, with 6in. armour, launched in 1872, to the Oldenburg, with 12in. Wilson's compound armour, launched in 1884. In justice to our own Admiralty we must, however, observe that the question of cruising ironclads has not been entirely neglected, for within the last seventeen years eleven such vessels, including the Vanguard, have been launched, but of this number only two, viz., the Impérieuse and Warspite, are protected by modern armour. It is a remarkable fact that we have five iron-built armour-clad cruisers, sister ships, designed by Sir E. J. Reed, which are at the present moment practically of no more use than so many unarmoured corvettes. We refer to the vessels of the Swiftsure type, an ironclad of 6910 tons, 4910-horse power, with a speed of 12 knots. Her principal armament consists of ten 9in. muzzle-loading guns, and she is protected by 8in. iron armour. The Triumph a sister ship of the Swiftsure, has been provided with breech-loading guns of modern design, whereby her power of offence has been considerably augmented, and were she provided with steel-faced armour also, she would be an efficient armoured cruiser for some years to come. Supposing the 8in. iron armour of the Triumph were replaced by compound plates, the fighting power of the vessel would be increased at least 25 per cent., thus transforming her quickly, and at a comparatively small cost, into a vessel suitable for modern warfare.

This subject seems not undeserving of the attention of the Admiralty, the more so as several foreign Governments have already put the same into practice. Germany and Holland have each re-armoured several of their ironclads with compound plates, and the Chilian ship of war, Blanco Encalada, recently arrived in the Tyne, is to undergo the same process, to be followed shortly by the Almirante Cochrane, another ironclad belonging to the same Power. If our old ironclads, launched some twenty years since, are destined to serve as flagships of squadrons much longer, it will certainly be advisable to increase their offensive and defensive powers to the utmost practicable limit, as, armed and armoured as they are at present, they are war-ships for peaceful times only.

The proceedings of the Evolutionary Squadron cannot have failed to convey to the general reader the conviction that England is by no means so badly off for first-class ships of war as is generally supposed. Thirteen large vessels assembled in Portland Harbour. Some of these vessels are very "large" indeed, but the fighting power of a vessel is not regulated by her size. In fleet-actions it has always, from the time of the sailing ship-of-the-line to the present period, been considered an essential condition towards securing a successful issue of the combat to place vessels of similar steering qualities, size, speed, and armament together in batches or squadrons, so that the necessary manœuvres may be carried out with some degree of uniformity. The following is a list of the vessels comprising the Squadron of Evolution, together with a few particulars of the respective ships, which make further comment unnecessary:—

1.	Minotaur (flagship) ..	Length,	400ft.;	5½in. armour;	speed, 14 knots.
2.	Agincourt	,,	400ft.;	5½in. ,,	,, 14 ,,
3.	Hercules	,,	325ft.;	9in. ,,	,, 13 ,,
4.	Shannon	,,	260ft.;	9in. ,,	,, 12 ,,
5.	Iron Duke	,,	280ft.;	8in. ,,	,, 12 ,,
6.	Sultan	,,	325ft.;	9in. ,,	,, 14 ,,
	The above are either broadside or casemate ships.				
7.	Devastation	Length,	280ft.;	14in. armour;	speed, 13 knots.
8.	Ajax	,,	278ft.;	16in. ,,	,, 13 ,,
9.	Hotspur	,,	235ft.;	11in. ,,	,, 13 ,,
	The above are turret ships.				
10.	Lord Warden	Length,	275ft.;	5½in. armour;	speed, 12 knots.
11.	Repulse	,,	250ft.;	6in. ,,	,, 11 ,,
	The above are converted wooden line-of-battle ships.				
12.	Polyphemus	Experimental unarmed vessel;			speed, 18 knots.
13.	Hecla	Purchased merchant steamer;			,, 15 ,,

Of the above vessels, only two, viz., the Ajax and Hotspur, are plated with compound armour.

LOWER THAMES VALLEY MAIN SEWERAGE.

By HENRY ROBINSON, M. Inst. C.E.

THE Bill for the dissolution of the Thames Valley Drainage Board having passed Parliament, and the many questions concerned in the sewerage of the several places represented by the Board having been thrashed out, some account of the subject will be found of interest.

The Board at its formation had to decide on the adoption of a system of main sewerage and of sewage disposal for the districts of East and West Molesey, Esher, Thames Ditton, Hampton, Kingston, Surbiton, Long Ditton, Kingston (Rural), New Malden, Hook, Hampton Wick, Teddington, Ham, Petersham, Richmond, Kew, Mortlake, Barnes, Heston, and Isleworth, which places had a population, according to the census of 1881, of 117,000. A condition was decided upon at the outset to the effect that all the main sewers should be made large enough to serve for three times that population—or 351,000—and that the sewage disposal works should be sufficient for 30 per cent. more than the then population—or for 152,100—and that the volume of sewage to be provided for should be based on a contribution of 250 gallons per house per day.

Probably no Board could have been placed in a position of greater difficulty than this was by reason of the unsatisfactory state of technical knowledge and the wide divergence of opinion on the subject of sewage disposal which existed at the time the joint Board was called upon to deal with the sewage of the large district over which it had jurisdiction. The difficulties which the Board encountered were not so much with repect to sewering the district, but were mainly as to the method to be adopted for the disposal of the sewage; and the eight years during which the Board has been in existence have seen a great advance in practical knowledge of matters which previously had been approached from the point of view of prejudice and ignorance, both which have been lessened by the light that has been thrown on the subject in the course of that period.

The Board appear to have acted upon the assumption that in a multitude of counsellors wisdom was to be found, as they invited schemes from a number of engineers—myself among the number—and in the result many were submitted which were based on the alternatives of (*a*) purification of the sewage on land; (*b*) total diversion of the sewage from the district to a point seaward without treatment; (*c*) chemical precipitation. In the great majority of schemes—I believe in the whole of them with the exception of my own—the concentration of the sewage of the whole district at one point was recommended. Since 1878, when these schemes were submitted, the Board have unsuccessfully promoted several schemes which were all based on concentrating the sewage at one point. They tried them in the following order: (1) Purification on land by broad irrigation; (2) total diversion; (3) chemical treatment without filtration of the effluent. At the time when the Board was constituted, and the advice of engineers was sought, there was on record an important expression of opinion by the late Colonel Cox, R.E., one of the inspectors of the Local Government Board, who had occasion to hold several inquiries as to the disposal of the sewage of the Thames Valley. He said, when considering the sixteen districts between Hampton and the western boundary of the Metropolitan District, "I think these places might with advantage be grouped, say, in five or six groups for works and management."

When I investigated the matter I came to the conclusion that it would be better to arrange the various districts constituting the Joint Board into a series of groups, according to their physical conditions, and to lay out several systems of sewerage and of sewage disposal for these groups, in preference to having one large system of sewerage and of sewage disposal for the whole district. I also recommended that the method of disposing of the sewage of each group should be by chemical precipitation, with subsequent filtration of the effluent through a small area of land, although I held then, as I hold now, that the disposal of sewage by irrigation on land is the best system, where suitable land can be obtained at reasonable rates. When the Board in 1878 had to decide what plan to adopt, they regarded chemical precipitation as a system not deserving attention; and the prejudice which existed against it then was not altogether groundless, owing to the exaggerated claims which were advanced in favour of it. Precipitationists were, in fact, as sanguine as irrigationists that sewage was a commodity out of which wealth could be extracted, instead of fluid refuse to be made harmless, and to be got rid of at the least cost to the community. Precipitation works were then generally carried on so as to be a nuisance, either owing to the chemicals which were employed not being deodorants, or in consequence of offensive deposits of sludge being allowed to accumulate. My experience at that time—and it has been abundantly confirmed since—convinced me that sewage precipitation works, if properly designed and efficient chemicals employed, would be quite free from the objections which had been previously held to exist.

This opinion was founded on two considerations which had only then been clearly established. One was that by using certain combinations of chemicals, satisfactory purification of sewage could be effected without any nuisance and with a minimum amount of sludge; the other was that the sludge could be converted into a portable form by pressing it in an appliance just then perfected.

I was engaged on behalf of various interests in opposing all the attempts of the Board, and in every case I adhered to my original opinion in favour of grouping the district, dealing with the sewage by chemical treatment, with subsequent filtration of the effluent through a small area of land. When at last in 1884 the Board resorted to chemical precipitation, their scheme was for concentrating the sewage at Mortlake, and treating it there by chemicals without filtration of the effluent. I then, in conjunction with Mr. E. Pritchard, M. Inst. C.E., was engaged in opposing it, one ground of opposition being that a series of groups was the best solution of the difficulty. The groups we recommended were settled from a general knowledge of the district, and without consultation with the representatives of the several localities—who were then mostly supporting the Board of which they formed a part—but it is possible that the arrangement of the groups may be susceptible of modification. Works of sewerage and of sewage disposal for these groups were matured, and suitable sites were selected at which the sewage could be disposed of economically and efficiently by chemical precipitation with subsequent filtration of effluent through a small area of land or artificial filter. The subdivision of the whole district into groups is still in my judgment the right solution of the difficulty of disposing of the sewage of the lower Thames Valley. The views which I have held from the first in favour of grouping were confirmed by the decision of the Committee of the House of Commons which threw out the Bill last year, as will be seen by the following extracts from the special report of that Committee.

"The Joint Board during its existence has sought but failed to obtain power for various schemes for the total diversion of the sewage, or for its treatment by irrigation at some one place, and the present scheme is another attempt to treat it at one place by chemical precipitation according to the best methods which recent experience suggests."

"Your Committee are of opinion that these improved methods do not demand the treatment of the sewage at one spot, and that the continuance of the Joint Board is not only unnecessary, but operates as a hindrance to the several authorities successfully purifying the sewage of their respective districts."

"Your Committee therefore recommend that the district be subdivided; that Heston and Isleworth form one district; that Richmond and the Richmond Union Sanitary Authority be combined as another district; and that the southern portion be formed into one or more groups for the treatment and disposal of the sewage."

"Your Committee are satisfied that each of these districts will be able to treat its sewage more speedily and with greater efficiency and economy than the Joint Board; and they recommend that the necessary facilities be given them for their separation from the Joint Board, and for the formation of such new groups as we have suggested. Your committee believe that in these cases the process of filtering the chemically purified effluent through earth ought, if possible, to be adopted, which was not provided for in the scheme under their consideration. Your Committee are satisfied also that the oxidising power of the Thames water on the purified effluent will be most effective when such effluent is delivered at several points in the river. The disposal of the compressed sludge for agricultural purposes will be more easy if it is produced at several sewage works. Much stress was laid by various witnesses on the necessity of the sewage being carried off as rapidly as possible so as to reach the purifying works in a fresh condition. This condition points to the desirableness of short systems of sewers and of the treatment of the sewage by the same authority that produces it. If each sanitary authority was responsible for the purification of its own sewage, the difficult question of the limitation of the quantity of sewage per house per day to be delivered to the purification authority would be avoided. On the other hand, it is desirable, not unnecessarily, to multiply the number of purification works; and your Committee consider that the satisfactory solution of the problem will not be reached until the whole system of drains from the dwelling-house to the Thames in each district is under the control of the same authority."

One objection which has been invariably urged against grouping is that it involves several oppositions and difficulties, instead of only one, which would be the case where the whole of the sewage is concentrated at one point; but this I consider to be an unsound view to take in this case. Although people are prepared to admit the reasonableness of submitting to some inconvenience in order to enable the district in which they live, and that of their immediate neighbours, to be preserved in a healthy state, they resist any attempt to make their neighbourhood the receptacle for the sewage of a vast district. The limitation of the evil to the sewage of a small area which naturally drains to a point where simple and inexpensive works are possible would cause any opposition to be disposed of more readily than where it is directed against a scheme which is bad as regards finance, sentiment, and engineering.

An illustration of this is afforded by the fact that several areas in the Lower Thames Valley which were not included in the joint district have successfully dealt with their own sewage difficulties during the existence of this Board. Even two of its own constituents—Heston and Isleworth—have matured a sewage scheme for themselves, in spite of prophecies to the contrary, as a noble duke having large interest in the district was thought to be certain to oppose any scheme involving the sewage being disposed of anywhere in it. I had to advise in the matter, and having pointed out a site to which the minimum of objections would apply, it was adopted, and the threatened opposition disappeared, it being recognised that some such works were for the public good, and the least objectionable site was selected. I believe the same would be the case with the other groups. Opposition would not succeed if it was shown that the schemes were well considered. Too much stress, I think, has been laid on the necessity for obtaining the consent of the owners of a site previous to a scheme involving its acquisition being proceeded with. This practice would, if it became a recognised principle, be a serious drawback to carrying out sewage disposal works on the best engineering lines, as the most undesirable sites from an engineering point of view would often be adopted, and permanent and heavy expenses would be imposed on a district simply because opposition—which could not have succeeded—was threatened to the selection of a better site.

In the Lower Thames Valley the advantages which are experienced in some cases from forming a combination of large areas with an outfall common to the whole do not exist, as there is a want of that identity of interests which is essential to a permanent and harmonious co-operation of districts. The want of this has from the first caused the Board to have opposition within itself. The incidence of taxation having been to some extent inequitable has added to the grounds for dissatisfaction. The configuration of the districts does not admit of an economical arrangement of sewerage and outfall works. Heavier pumping is necessary where the sewage of this district is concentrated at one point than where it is subdivided into several outfalls. This would have been felt to be a heavy and unequally distributed burthen, inasmuch as parts, such as Richmond and Kingston, have an existing system of sewers which are admittedly leaky, and the limit of 250 gallons per house per day, if rigidly enforced, would have involved considerable works of sewering or else a liability to penalties for discharging the excess into the Thames. I have ascertained that the cost of sewers and of pumping is much less in grouping than in concentration, and have found that a series of grouping schemes with chemical precipitation can be carried out for a first cost of about £100,000 less than for the best concentration scheme; and, further, that they can be worked for about

£40000 a year less. During the last ten years chemical precipitation of sewage has been advanced from the untrustworthy position which it then occupied, and has been placed on a sound basis. The illusions which surrounded it, and the prejudices which existed against it, have disappeared before the practical results which have been obtained. It is now acknowledged by those familiar with the subject that if proper chemicals are employed no nuisance arises at precipitation works, and that the cause of nuisance arose when the precipitated sludge was allowed to collect, as it used to do at nearly all such works, but which is obviated by the system of pressing the sludge and converting it into a portable form, which is now the accepted method of dealing with it. By this means it is reduced in bulk and made available for agricultural purposes. Many interesting experiments have lately been made by eminent chemists which tend to show that the present sludge from efficient chemical systems has an agricultural value which will ensure its ready disposal on land by farmers. The distribution of the sludge for utilisation on land is more readily effected where there are several centres of distribution in the Thames Valley, as the Committee stated in their Report. A portable sludge from a chemical precipitation works, which retains the chief manurial ingredients in the sewage with the minimum of enfeebling chemicals, is now recognised as a manure worth putting on land, and this will ensure the disposal of the sludge with a prospect of some financial return from it, especially in view of the large number of market gardens in the Thames Valley.

As regards the chemicals that should be employed, I consider that there are several systems which effect deodorisation and precipitation of sewage and give good results. I prefer my own process, which employs a protosulphate of iron (copperas) in addition to crude sulphate of alumina and lime. The method of working this process was described by Dr. Tidy last year to the Committee of the House of Commons, which had before it the Mortlake scheme of the Lower Thames Valley Board. The following is a brief summary of his description:—After screening the sewage, to remove large substances, milk of lime is added. This forms carbonate of lime, which acts as a weighting material for the matters in suspension, thus aiding their deposition. Part of the lime also combines with some of the organic matter in solution, forming an insoluble compound. The sewage is now slightly alkaline, and the organic matter in it is reduced by about 50 per cent. After an interval of a couple of minutes—during which the particles aggregate together—crude sulphate of alumina and protosulphate of iron in a dissolved state are added together to it. The addition of the iron has certain advantages which he described as being due to its being a very powerful precipitating agent, and also a disinfectant. The alumina and iron oxide are set free by the alkalinity of the sewage due to the lime, and these combine with a further portion of the organic matter in solution, increasing the suspended matter in the fluid which is deposited as sludge, containing all the chemicals, except, perhaps, a trace of sulphate of lime, which, being slightly soluble, passes off in the effluent. The chemicals, if mixed in proper proportions, were described as producing the finest effluent which is practicable, having no sewage odour. Although a good effluent can be obtained from an efficient precipitating process, I consider it desirable to provide a small area of land or an artificial filter of burnt clay or other material—where the land is clayey and unsuited for filtration—to pass the effluent through, although this is not absolutely required except as a safeguard, or where the highest standard of purity is required. The experience which has been gained during the last few years shows that where porous land is not available for the purification of sewage water, either as sewage proper or as effluent from chemical precipitation works, a clayey soil can be converted into an artificial filter, which can oxidise enormous volumes of sewage polluted water. The oxidation of sewage matter in the soil is now known to be due not only to the atmospheric air, but also to the action of minute organisms of the bacteria family. Where artificial filters are made by burning clay into ballast, the top 9in. or so of the filter should be formed of natural soil, as this is necessary for the development of those organisms which form so important a part in the work of oxidation.

I believe that in some cases in the Thames Valley, where chemical treatment has been previously considered unavoidable, it will be obviated altogether by the conversion of a small area of land into an artificial filter of sufficient power to effect the purification of the sewage it is called upon to deal with. The natural action of oxidation by the air and by the organisms referred to would then be relied on in lieu of the artificial action of chemicals.

The discharge of the effluent from grouping schemes at several points into the river Thames would—as stated in the report of the Parliamentary Committee—enable the oxidising action of the river to be more capable of being exercised, and every trace of organic matter more readily removed in a short run of the river than would be the case if the whole volume of effluent was discharged at one spot, as the minute organisms and plants in the river—which are instrumental in destroying organic impurity—would be more free to act in the former case than in the latter. Where filtration of the effluent through land is resorted to, as I recommend, there would be no such pollution to require the oxidising action of the river to be called into play at all.

By the Act of Parliament for dissolving the Lower Thames Valley Main Sewerage Board, it is provided that any two or more sanitary authorities mentioned in a schedule which is appended to the Act—these being the Sanitary Authorities forming the existing Board—may within twelve months after the passing of the Act form a united district. This enables the constituent authorities after their dissolution to rearrange their districts into groups. It is also provided that no penalties shall be incurred by the several Sanitary Authorities lately composing the Joint Board with reference to the pollution of the river Thames, for a period of two years from the passing of the Act dissolving them. During this time the several districts ought to be able to mature their plans, and be in a fair way to carry out works on the lines I have referred to, which appear to be those most likely to ensure success.

EAST SCOTTISH HARBOURS.

One feature of the Home Rule movement has been the claim that Scottish convicts should be employed in Scotland. The advantages which such places as Portland, Chatham, Haulbowline, &c., have derived from penal works have suggested that North British interests might be promoted by corresponding means. The loss of life on the north-east coast in 1881 and the Fishery Exhibitions drew attention to the necessity for refuge; and this point has been strenuously insisted on by the Edinburgh press. The Convict Employment Committee of 1882 reported that "in May, 1882, there were in English convict prisons 771 male convicts who had been sentenced in Scotland," but added that this number was "probably in excess of what may be expected in future years if the present decrease in sentences of penal servitude should continue." In the same report, the opinion is expressed that a harbour of refuge at Peterhead is "the most likely project for benefitting the shipping and fishing interests of the country at large, and at the same time profitably employing convicts."

This report was received with some dissent by the port authorities of Aberdeen, and as Scrabster, Wick, Fraserburgh, Stonehaven, Arbroath, &c., were each anxious to put forward its respective claims, the Convict Employment Committee deputed a sub-committee to hear and consider locally the various proposals. The position and character of the officers thus chosen insured the impartial consideration of the points at issue; but the inquiry was saddled with the condition that there was to be a "National Harbour of Refuge," which the sub-committee took to mean one with depth sufficient for the heaviest draught ships of war.

The importance of this point will be realised when it is considered how greatly the cost of breakwaters increases with the depth of water they stand in. At Peterhead the beach shelves steeply, and the pierheads as finally proposed by Messrs. Stevenson are in eight or nine fathoms of water, the line of enclosure extending approximately from Keith Inch to Salthouse Head. The estimate for forming about 200 acres of harbour is £526,579; but the sub-committee prudently recommended the addition of 100-ton blocks to protect the seaward face of the breakwater; and as a convict establishment and fortifications, besides other permanent expenses, will also be necessary, one may perhaps assume the total outlay contemplated at about three-quarters of a million. Comparing this with the Report of the Royal Commission on Harbours of Refuge in 1859, we find therein the following paragraph.

"We recommend the enclosure of the South Bay (Peterhead) at a cost not exceeding £300,000; and considering the proportion which the shipping trading to the port will bear to those of the passing trade which will resort to it for refuge purposes, we are of opinion that the amounts of national and local benefit conferred will be fairly represented in the proportion of $\frac{1}{3}$ and $\frac{2}{3}$ respectively. We therefore submit that a grant of £100,000 be made in aid of the proposed harbour, to be met by a sum of £200,000 raised in the locality, and to be applied to the same purpose."

The principle of making national expenditure contingent upon a local contribution seems sound, and, if acted on, would meet the objection which has sometimes been made, that State aid chills local effort. The apportionment of the outlay is, however, an after question. In the first instance it is of consequence to ascertain carefully what the full total is likely to be. It is understood that the late Government consulted Sir John Coode on the subject, and that the necessary data are being got for his further report and estimate. When these have been furnished it is to be hoped that they, as well as the estimates of the prison and military authorities, will be made public, so that, before this extensive scheme is entered upon, it may be fully considered, and its capabilities and cost compared with alternatives. The Bay of Peterhead facing to the south-east is open to the heaviest seas from that quarter, and the precedents which Wick and Aberdeen afford—especially the former, where about £150,000 have been spent fruitlessly—are not encouraging, when it is considered that the top of Messrs. Stevenson's proposed breakwater stands only about 8ft. or 10ft. above high-water spring tides, differing in this respect from most of those which have been placed in even less exposed situations.

The Convict Sub-Committee appended to its Report a tabulated wreck-record from July 1st, 1871, to June 30th, 1883, which merits careful examination, and gives the following results:—Total recorded loss of life, 517 lives; deduct (as irrelevant)—In ships from the westward, which never reached the North Sea, 24; total, 493. Deduct—Wrecked on Shetlands and Orkneys, 93; wrecked from Dunnet Head to Buchan Ness, 70; total lost between Buchan Ness and Fife Ness, 330.

Of these 330 deaths to the south of Buchan Ness, about 287 seem due to winds ranging from east to south; so that *more than $\frac{4}{5}$ of the recorded loss of life* has been of this character. Taking the annual averages and excluding fractions, we get:—Shetland and Orkneys, 8 lives lost; Dunnet Head to Buchan Ness, 6; Buchan Ness to Fife Ness, 27. Total annual average, 41.

In spite then of the numerous petitions that have been signed these figures seem to prove that however much the saliency of Peterhead may recommend it as a fishery-station, or as a strategic base for observing the Skager Rack, its claims to large national outlay can hardly be advanced on the score of humanity. A vessel which can weather Keith Inch on an east or south-east wind is pretty sure of reaching the Moray Firth, while two-thirds of the loss of life is well to the south of Peterhead Bay. Shelter for comparatively small craft, perhaps at Invernetty, is, however, no doubt required.

Since the Royal Commission of 1859, steamers have largely superseded sailing vessels; but the crowding of the Channel increases, thus inducing skippers to prefer the North-about route to America. Few, however, of the ships which appear in the Sub-Committee's wreck tables were of the Atlantic-crossing type. The average tonnage of the "passing vessels" lost between Buchan Ness and Fife Ness is about 195 tons. They were chiefly plying to and from Northumbrian and Scottish ports—the former preponderating. Whatever may have been their ports of departure and destination—and these range from Bergen to Gibraltar, including much Baltic trade—they were driven to the north-westward, embayed in the recess of East Scotland, and either beached to save life, or driven ashore without that alternative.

This aspect of the case seems to have weighed with Mr. Majoribanks' Committee of 1884, when they recommended that a technical Commission should examine the coast from Aberdeen to the Firth of Tay, to determine the exact site at which refuge works could best be carried out. The late Government refused to appoint such a special Commission; but the point deserves the fullest investigation. It seems, however, to be narrowed within comparatively small limits, since both Stonehaven and Arbroath are very open, and the latter faces to the south-east. The sands at the mouth of the Tay extend five or six miles to seaward.

The Convict Sub-Committee has spoken of the "natural advantages" of Lunan Bay, which is well protected from south-east winds by the high cliffs of Red Head; and as the beach there does not shelve so steeply as at Peterhead, a harbour for ordinary ships could probably be made there at considerably less cost. It is doubtless a great advantage to have good natural shelter from the wind which is most fatal on that coast; and even if it veered to the eastward, the shipping would then have such protection as an artificial breakwater could afford. The only port possessing the advantage of an inner harbour as a refuge from weather and from enemy is Montrose. Its drawback is the shallowness of the entrance, there being only about 6ft. at low-water spring tides; but this may be curable. Provost Napier, when examined before the Royal Commission of 1859, stated that, with a grant of £60,000, £70,000, or £80,000, ample accommodation could be provided for half a dozen second-class vessels, and that, if it were necessary, they could have "a harbour studded with men-of-war." Other witnesses corroborate these statements as to a future Scottish Portsmouth, which seem worthy of careful consideration. This Portsmouth has no Isle of Wight to protect it, but northern breakwaters on the Annat Bank have from time to time been proposed, and might be carried out, so as to avoid the mistakes that were made in the nearly parallel case of Aberdeen.

Attention has lately been directed to the defence of the Tay and Forth, the Pendjeh incident having reminded us that Russia is the only European Power with whom we have been at war during the last seventy years. It is also recalled that, in 1781, a French cruiser fired into Arbroath on being refused a demand for £30,000. The guardship usually lies at Queensferry, thirty-five miles inside the Isle of May, and it has even been suggested that an active enemy might turn the Inchkeith guns upon Leith.

A swift British cruiser, stationed at Montrose or Lunan, would be ready to dispute the line of retreat with any enemy that should venture up the Forth or Tay estuaries. If Montrose is rather farther from the mouth of the Baltic than Peterhead, it is sixty miles nearer to our chief naval and military centres, to coal-fields, and to the large fish-consuming towns, communicating with them both by the North British and Caledonian Railways. If there is less work for convicts to do, rendering their housing proportionally more expensive, the chance of selling it profitably is greater in a more thickly peopled district. Land would also naturally rise in value on the completion of such works.

More recent than the Convict Reports which have been quoted above is the decision as to Government loans at low rates to harbour authorities. It will naturally induce Aberdeen and other commercial ports to undertake improvements, leaving the State free to address itself to the more national question of protecting British shipping. England has national works at Woolwich, Chatham, Sheerness, Dover, Portsmouth, Portland, and Plymouth; Wales, at Pembroke and Holyhead; Ireland, at Donaghadee, Ardglass, Howth, Kingstown, and Cork Harbour; while all that has hitherto been done for Scotland is the abandoned harbour of Portpatrick—a precedent which hardly encourages sea works at exposed salients of our coast. Few, therefore, are likely to dissent from the principle that offenders against Scottish law should be employed to promote Scottish interests, though difference of opinion may well exist as to the best site for their labours.

Chesterfield and Derbyshire Institute of Mining, Civil, and Mechanical Engineers.—The Annual General Meeting was held on Thursday, 25th June, in the Guildhall, Derby, Mr. John Jackson, M. Inst. C.E., vice-president, in the chair. Three new members, elected by ballot, were announced. The Council's report, and financial statements, showed the number of continuing members 263. The Society having almost from its commencement in 1871 included nearly all the chief mining engineers and colliery managers in the Midland Mines Inspection District of Derby, Notts, Leicester, and Warwick, it was decided to amend the title to be in future "Chesterfield and Midland Counties Institution of Engineers." An adjourned discussion took place "On Colliery Explosions." A paper by Mr. A. H. Stokes, H.M. Inspector of Mines, was followed by a very animated discussion, adjourned, "On Colliery Winding Ropes and their Attachment to the Cage," by Mr. P. M. Chester. The new papers, taken as read, were "The Kaiping Coal Mines, China," by Mr. James Stevens, Kaiping; "Description of a Firedamp Indicator," by Mr. A. H. Maurice, Cardiff. The new Council, elected by ballot, are, president, Lord Edward Cavendish, M.P.; vice-president, Messrs. Alfred Barnes, M.P., H. A. Allport, C. Binns, E. Bromley, J. W. Fearn, J. Jackson, G. Lewis, W. Oliver. Councillors: Messrs. T. D. Croudace, E. Eastwood, H. Fisher, G. Hewitt, W. D. Holford, G. Howe, J. Humble, H. Lewis, J. A. Longden, M. H. Mills; treasurer, E. Bromley; secretary, W. F. Howard. The members afterwards dined together at St. James's Hotel; Thomas Evans, Esq., H.M. Inspector of Mines, in the chair. The excursion meeting is proposed to be arranged to take place in September.

MAP OF MACHINERY DEPARTMENT, ROYAL AGRICULTURAL SOCIETY'S SHOWYARD, PRESTON.

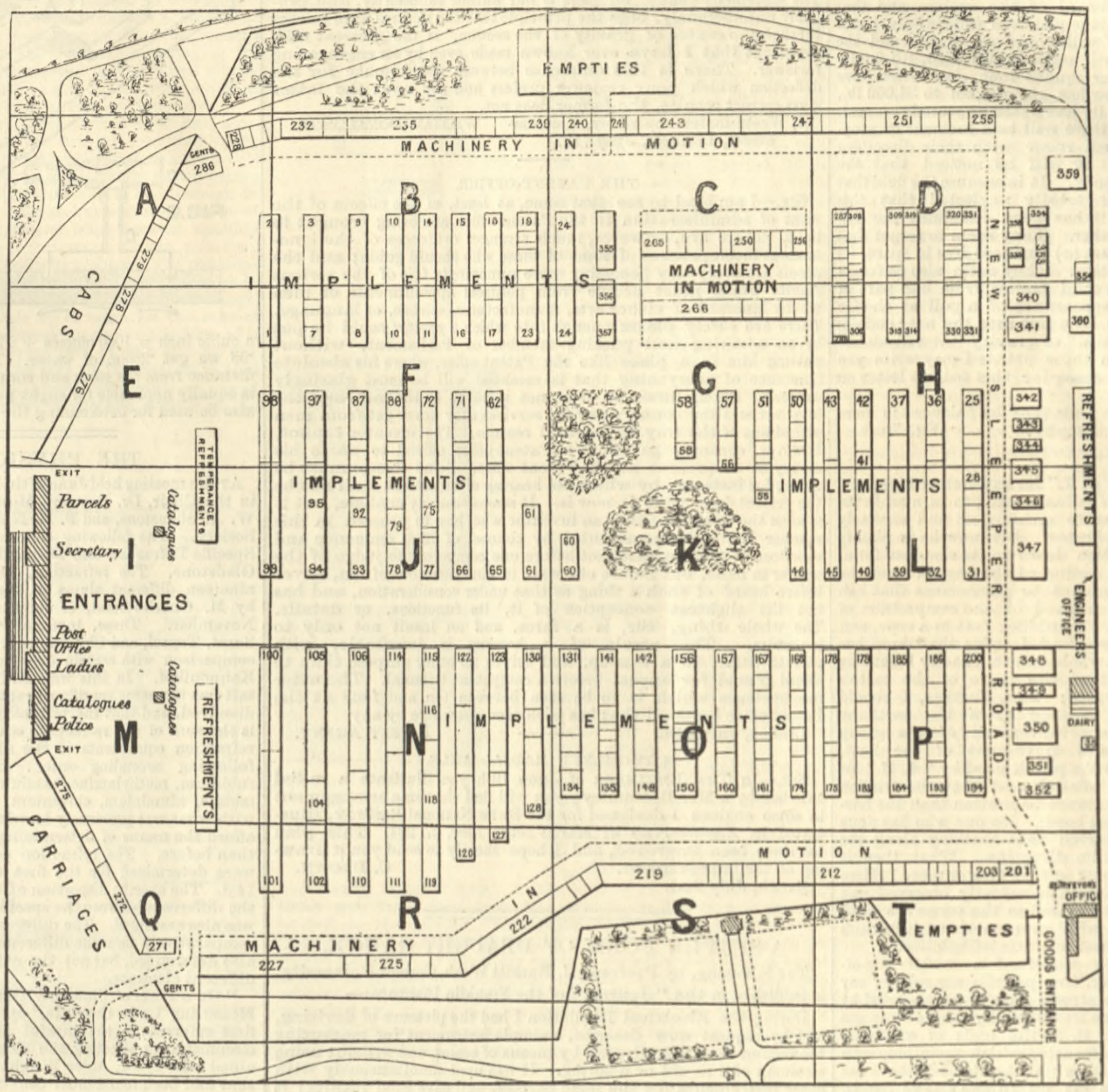
Exhibitor.	Block	No
Ayre Bros.	D	336
Atmospheric Churn Co.	P	196
Arnold and Son	D	333
Aveling and Porter	M	100
Allan, J. D., and Sons	J	76
Atkinson Bros.	H	34
Adams, Matthew	G	49
Agricultural and Horticultural Association	D	317
Affleck, William	J	80
Alexander and Loveridge	O	140
Amos and Hunt	G	52
Albion Ironworks	N	128
	N	221
Aylesbury Dairy Co.	P	200
Askham Bros. and Wilson	D	253
Avery, W. and T.	O	156
Atkinson, Joseph	L	38
Andrew, J. E. H., and Co.	T	205
Allchin, Linnell, and Co.	B	239
Begg, Alex.	D	286
Bigg, Thomas	P	173
Barrows and Stewart	C	263
Baker, John	O	129
Bamford, H., and Sons	N	114
Bibby, J., and Sons	D	329
Bristol Wagon Works Co.	L	39
Brown and May	S	217
Baker, W. B.	F	71
Barford and Perkins	B	3
	B	233
Baker, Thomas	O	150
Bamlett, A. C.	N	106
Bradford, T., and Co.	P	183
	P	209
Blakeley, E. F., and Co.	L	346
Baldwin and Amies	P	188
Baxter, W. H., and Co.	D	254
Bellamy, John	O	141
Blackman Air Propeller Ventilation Co.	A	228
Brenton, Wm.	F	11
Bentall, E. H., and Co.	R	119
Boley, Robert	A	2
Blunt, E. T.	P	351
Bell and Riddle	H	305
Bradley and Craven	S	214
Bamber and Co.	P	198
Bailey, W. H., and Co.	T	202
Bone, Wm.	N	125
Burrell, C., and Sons	R	225
Burlingham, Innes, and Paternoster	C	240
Bligh Brothers	H	26
Briggs, Thomas	L	35
Baen, U., and Co.	G	48
Ball, George	P	175
Bracher, P. H., and Co.	P	180
Bayliss, Jones, & Bayliss	F	23
	F	257
Bracewell, H.	H	42
Braggins, G. F., and Co.	H	47
Bruce and Still	G	51
Ball, W., and Son	P	179
Canadian Government	Q	271
Corbett, John	F	5
Clayton and Shuttleworth	P	99
Coleman and Morton	J	66
Carruthers and Co.	D	326
Crook, John, and Sons	P	353
Clarke's Crank Co.	G	54
Clay, Charles	K	60
Crosskill, W., and Sons	P	185
Cooch, Henry	N	126
Cooke, John	J	61
Cradock, G., and Co.	F	7
Carter and Co.	Q	272
Catchpool, Stannard, and Stanford	F	68
Coulthas, James	B	19
	B	238
Crook, J. L.	B	14
Crowley, J., and Co.	N	120
Cadle, Cornelius	A	231
Crampton Bros.	O	153
Crump, Henry S.	O	134
Cowley, J., and Son	T	204
Coleborn, T., and Sons	H	41
Corbett, Thos.	O	131
Carson and Toone	R	224
Coterell and Co.	C	241
Cæsar, Henry	H	360
Coles and Matthews	S	220
Carbolic Sanitary Co., New	D	306
Constantine, Thos J.	C	256
Crossley Brothers	T	203
Cowen, Jacob, and Sons	B	13
Carter, J. H.	D	251
Corbett, S., and Sons	C	265
Darkin, Walter	D	283
Day and Sons	D	287
Dickson, Brown, and Tait	E	277
Driffield and East Riding Cake Co.	H	327
Dennis, W. F., and Co.	H	56
Dell, U. R., and Son	C	246
Day, Son, and Hewitt	H	300
Dickson, F. & A., & Sons	Q	274
Dickson, James. and Sons	E	279
Dickson and Robinson	A	282
Dairy Supply Co.	T	210
Davis, Joseph, and Co.	D	332
Davey, Sleep, and Co.	F	16
Denton, Henry	F	72

Exhibitor.	Block	No
Davis, H. and Co.	D	311
Evans and Co.	D	323
Eagle Range and Foundry Co.	C	257
Evans, T. W. A.	F	82
Entwisle and Kenyon	O	161
Errington, Roger	D	325
Elliott, Edmonson, and Olney	O	167
East Yorkshire Cart and Wagon Co.	L	40
Edgington, B.	L	347
Foster and Pearson	H	341
Fawcett, T., and Co.	D	324

Exhibitor.	Block	No
Hathorn, Davey, and Co.	T	201
Haagen, T. H., Son, and Co.	H	296
Howorth, James	H	344
Hunt and Tawell	R	127
Hepburn and Gale	H	299
Hughes, J. R.	B	21
Hillerns, O., and Co.	P	181
Howard, James	D	334
Halliday, R., and Co.	D	340
Hatton, Joseph	A	229
Hancock, F., and Co.	P	191
Hathaway, George	P	193
Holden and Brooke	O	155
Hooke, David Bradwell	D	292

Exhibitor.	Block	No
Hopperton, U. B.	P	199
Hayes, H., and Son	L	32
Inman, Hy., Exors. of	D	359
Jeyes Sanitary Compounds Co.	D	288
Jones, John Milton	D	307
Jenkinson and Giblett	N	109
Jones, David	J	83
Johnson, Wm.	S	215
Jeffrey and Blackstone	B	18
	B	237
Johnstone Harvester Co.	N	113
Jack, Alex., and Sons	F	63
Jenkins, Robert, and Co.	F	6

Exhibitor.	Block	No
Little and Ballantyre	A	280
Lister, Rd., and Co.	G	264
Madan, C. S.	H	290
Murton, Henry A.	O	169
McLaren, J. and H.	H	226
Morris, Little, and Son	H	308
Marston, J., and Co.	H	37
Morris and Griffin	H	314
Murray, G. W., and Co.	J	77
Metcalf and Dilworth	G	270
Morton, Francis, and Co.	G	24
	G	356
Maynard, Robert	O	258
Matthew, John	D	339



Exhibitor.	Block	No
Foden, Edwin, and Sons	O	236
Farmer, Robey, Brown, and Co.	O	259
Foster, Wm., and Co.	N	104
Fawcett, T. C.	S	213
Fowler, John, and Co.	Q	101
Follows and Bate	N	124
Fenton, Joseph B.	J	91
Goulding, W. and H. M.	D	309
Gee and Co.	P	166
Gibbons and Robinson	C	261
Gray, John	P	195
Gardner, Wm.	C	245
Green, Thomas, and Son	P	182
	P	208
Gower, A. W., and Son	J	92
Gardner, J., and Son	G	268
Garrett, R., and Sons	F	97
Gilkes, Gilbert, and Co.	B	232
Guy and Stevens	J	78
Glover, Wm., and Sons	L	45
Henri's Patent Cattle Feed Co.	D	320

Exhibitor.	Block	No
Hall, John	A	285
Hart, Samuel	L	29
Harrison, McGregor, & Co.	F	10
Hunter, James	A	281
Hind and Lund	C	247
Henson and Co.	P	358
Handyside and Co.	R	102
Hornsby, R., and Sons	R	222
Hope, W. A., and Sons	D	321
Hill and Smith	K	46
	K	355
Holmes and Sons	E	96
Hiell Wagon Works	P	178
Hunter, T.	F	62
Howard, James	Q	227
Humphries, Ed.	J	95
Hetley, Alfred	F	88
Hopkinson, C.	D	248
Hoakes, David	F	69
Holyoak, T., and Sons	F	12
Helliwell, T. W.	D	354
Hart, David, and Co.	O	142
Hindley, E. S.	R	223

Exhibitor.	Block	No
James and Son	O	148
Kell, Meats, and Co.	J	65
Keyworth, J. H., and Co.	N	109
Kirkstall Forge Co.	D	255
Kenworthy, En., and Co.	O	164
Kearsley, Geo.	N	118
Knapp, L. R., and Co.	J	89
King, Wm.	L	28
Kaye, Joseph, and Sons	D	335
Langley, T., and Son	K	55
Lankester and Co.	R	111
Lyon, Arthur	P	192
Larkworthy, J. L., and Co.	E	1
Lloyd, Lawrence, and Co.	P	194
Leyland Rubber Co.	O	170
Lawrence and Co.	T	211
Larmuth, T., and Co.	A	230
Lightfoot, Wm.	O	145
Lloyd, T., and Sons	G	59
Llewellin, G., and Sons	P	189
Lawton, J. A., and Co.	H	25
Lloyd, Henry	H	33
Lowe, D., and Sons	P	349

Exhibitor.	Block	No
Morgan and Co.	H	36
Marsden, H. R.	D	252
Martineau and Smith	O	144
Mattison, F., and Co.	N	108
Moule's Patent Earth Closet Co.	O	163
Musgrave and Co.	O	136
Marshall, Sons, and Co.	S	219
Moore, Murton, and Varley	O	165
Muller, H. L.	T	206
McMullen, H., and Son	L	30
Molden Ironworks Co.	G	57
	G	267
Mackinder, Edwin	D	318
Manley and Hartley	F	8
Myerscough, J., and Sons	O	151
Marshall, T., and Co.	C	260
Moore and Co.	O	146
Nash Brothers	N	112
Norris, S. E., and Co.	H	298
Newton, Chambers, and Co.	G	269
Nicholson, W. N., & Son	B	9
	B	234

Exhibitor.	Block	No
Native Guano Co.	H	315
Nicholls, Richardson, & Co.	J	70
Nell, Frederick	C	244
Nalder and Nalder	S	218
Odams' Chemical Manure Co.	H	313
Oates and Green	O	137
Owens, S., and Co.	O	139
Oakshott, E. G.	E	278
Ofveriem Estates Co.	J	64
Phœnix Oil Mill Co.	H	328
Paget, R. G., and Son	O	171
Porritt, J. W.	O	143
Penney and Co.	G	58
Page, E., and Co.	J	93
Proctor and Ryland	D	316
Pickering, Jonathan	S	216
Port, John	P	176
Peck, J. H., and Co.	O	174
Preller's Leather Co.	D	293
Perkins and Bellamy	O	132
Picksley, Sims, and Co.	C	266
Peake and Sons	L	44
Powell Bros. and Whittaker	N	121
Potter, F. P.	B	22
Plimpton, J. C., and Co.	F	84
Potter Bros.	O	172
Robinson, T., and Son	C	250
Ruston, Proctor, and Co.	E	98
Richmond and Chandler	N	123
Robey and Co.	C	243
Richardson, W., and Co.	P	348
Rainforth, W., and Sons	N	130
Reeves, R. and J., and Son	F	87
Reid, Ben., and Co.	J	79
Reynolds and Co.	P	352
Randell, F. and H.	H	43
Ridges and Sons	H	27
Roberts, C. G.	O	138
Richmond, W. and F.	P	184
Richardson, J., and Sons	O	147
Ransomes, Sims, & Jefferies	B	235
Reading Ironworks	F	4
Robinson, John	F	74
Rochdale Corporation	H	312
Richardson, Edmund	P	190
Ruston, Richard	J	81
Robinson, E.	P	197
Ramsden, T. H.	R	103
Rollins, J. G., and Co.	F	86
Remington Bros.	H	295
Rendle, W. E., and Co.	H	342
Spear and Jackson	F	85
Sanitas Co.	D	289
Summerscales, W., & Sons	O	157
Spencer, C., and Sons	D	322
Samuelson and Co.	N	105
Sanitary Dry Lime Co.	D	304
Strawson, George	H	302
Slack's Emery Wheel and Machine Co.	O	158
Salmon, T., and Co.	O	159
Smith and Paget	O	160
Spratt's Patent	H	331
Smith and Grace	J	75
Sutton and Sons	N	275
Simpson, Fawcett, and Co.	O	162
Shuker, Wm.	C	53
Stubbs, W. B.	O	133
Silcock, Richard	D	310
Savage, F.	F	73
Spencer, Carter, and Co.	C	262
Thorley, Joseph	O	337
Tomlinson and Hayward	H	303
Taylor and Wilson	D	186
Turner, Wm.	F	67
Theobald, J. H.	H	301
Turner, E. R. and F.	J	94
Tomlinson, James	D	249
Thomas, E., and Co.	O	149
Unite, John	O	168
Venton and Co.	A	284
Vipan and Headley	B	15
Waterloo Mills Cake Co.	H	330
Wilder, John	N	116
Windover, Charles, Sandford, and Co.	L	31
Webb and Son	E	276
Watson and Haig	C	242
Wilcox, W. H., and Co.	D	291
Whitehead, J., and Co.	T	212
Wright and Holmes	D	338
Wood, Walter A.	R	110
White, Joseph, and Co.	H	294
Warner, John, and Sons	G	50
	G	343
Wagstaff, J. G.	O	154
Wilcock, Mark	H	297
Whiteley, W., and Sons	O	152
Willacy, Robert	P	177
Walker, Francis	J	90
Williams, J., and Son	N	122
Woods and Co.	F	17
Wilder, R. J. and H.	N	115
Warde, Wm.	P	187
Warburton, J. L., and Co.	N	117
Warwick Washing Machine Co.	T	207
Walker and Smith	D	319
Willesden Paper and Canvas Co.	P	350
Whalley, Thomas	Q	273
Weighill, John	B	20
Yorath, Henry	L	345

LETTERS TO THE EDITOR.

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

THE LAWS OF MOTION.

SIR,—In continuation of my letter of June 8th. The draw-bar problem is included in the tug-of-war problem. I will therefore state and solve a case of the latter, and hope that the result will be to reconcile Professor Lodge and "Φ. Π." Living agents are very complex dynamic instruments. For simplicity's sake therefore I will suppose that the "tug" is between two locomotive engines instead of between two boys.

(1) Imagine a locomotive engine E ‡—> set to travel east, weighing, with its water, 35 tons—of which total the working parts are one-tenth—with all its wheels coupled. With its fire just drawn, but its boiler still filled to its usual level with water at 356 deg. Fah. giving a steam pressure of 130 lb. per square inch nearly. Suppose that the total area of its pistons is 300 square inches, that it works with perfect expansion—*i.e.*, exhausts at atmospheric pressure and has no back pressure—and that the radiation from its surfaces is under perfect control.

(1*a*) We support this engine on blocks of wood so that its wheels can revolve freely, and we open the throttle valve fully. The molecular velocity of the steam at once sets up a thrust on the pistons (= at start $130 \times 300 = 39{,}000$ lb.), and this thrust causes motion of the parts with a velocity whose rate of acceleration will at first be 80 ft. per second nearly. As velocity accumulates the rate of acceleration will diminish, till, when the pistons are moving so quickly that the steam escapes as easily as if they were not there, it will become *nil* and velocity will be constant, or rather, will fall as the steam pressure falls.

(2*a*) We close the throttle valve when the steam pressure has fallen 10 lb., *i.e.*, has become 120 lb.; neglecting friction, the velocity of the moving parts will remain constant.

(3*a*) We apply a break of solid gold. The dazzling blue light which instantly flashes forth, and the incandescence of the golden spherules that are immediately scattered about show, with even superfluous emphasis, that the molecular velocity—heat—which had been parted with by the steam in giving molar velocity—motion—to the mechanism is again being transformed into heat preparatory to being dissipated into space. When all has been so transformed the velocity will be *nil*. Our block of gold will be considerably diminished in size and the steam pressure in E —> will be 120 lb. instead of 130 lb. "Work" has been "done" against "cohesion." This preliminary experiment shows that the engine E —> really consists of three bodies, viz., (*a*) the boiler, the cylinders, and all parts in rigid connection therewith; (*b*) the water and steam; (*c*) those parts of E —> which are either not in contact at all with (*a*), or else are in *sliding* contact with it, viz., the pistons and other working parts. But, says the reader, where is the *tug of war?*

(2) Imagine also another engine <—‡ W, similar in all points to E —>, as described in par. 1, except that it is set to travel westward, and that its steam pressure is 120 lb., as that of E now is also. Imagine that <—‡ W and E —> are coupled together, and

(3) Set on a straight level railway weighing 700 tons, and mounted on friction rollers so that it is indefinitely movable eastward or westward on the earth's surface, as railways usually are *not*.

Let us suppose that the engines have perfect bite on this railway, and let us neglect friction in every shape and form, then (1, 2, 3*a*) we set both engines down thus coupled at the west end of the railway, and we open both their throttle valves.

Result: Motion, *nil*; thrust of steam on pistons in each engine, $120 \times 300 = 36{,}000$ lb.; tension strain against cohesion in draw-bar, ditto; tangential thrust on each wheel, $\frac{36{,}000}{6}$ = total ditto ditto; compression strain against cohesion on portion of left-hand and right-hand rail under the draw-bar and between the engines $\frac{36{,}000}{2}$ total, ditto ditto, *i.e.*, tension on draw-bar = compression on rails. Both are static. Work done, *nil*; motion, *nil*.

The above calculations and any that follow are made *neglecting leverage*, as it does not affect the issues that are before us. (1, 2, 3*b*) We instantaneously reduce the temperature of the water in engine <— W 18 deg. Fah.

Result: The steam pressure falls from 120 lb. to 90 lb. While the thrust on the pistons of engine E remains as before, that on those of W will now be 30×300 ($= 9000$ lb.) less. What effect has this upon matters?—now comes the tug between "Φ. Π." and Professor Lodge. Answer: The thrust on the pistons of engine E will remain as before; the static tension on the draw-bar will remain as before; but the answering thrust of engine W, and therefore the total static compression strain on the rails between E and W, will be $36{,}000 - 9000 = 27{,}000$ lb. Therefore, so far as the answering thrust of engine W is concerned, E will be exerting an unbalanced pull of 9000 lb. "Oh!" cries "Φ. Π.," "but there is no such thing as an unbalanced pull." Reply: Granted, dear

Sir—or Madam—but though unbalanced by the answering thrust of engine W, this 9000 lb. is imparted to the whole mass of the railway, and is balanced by the reaction of its inertia. So both engines begin to move as one mass eastward, with a velocity on the railway accelerating at first by about 0·92ft. per second. But though they move at this rate eastward on the railway, they move only nine-tenths of this rate eastward on the earth, because the railway, whose weight or mass is ten times that of the two engines —700 tons to 70 tons—is pushed westward at one-tenth of the rate by which the engines jointly travel eastward.

While this continues three separate forms of work are being performed—(*a*) velocity eastward is being imparted, *vis inertiæ* is being overcome, momentum is being given to, the engines. (*b*) Velocity westward—viz., momentum—is being imparted to the railway. (*c*) Air is being pumped into the boiler of W by the reversed action of its pistons (let us suppose that instead of air the substance being pumped in is the exhaust steam of E) thus:—When steam in E has fallen 15 lb., that in W will have risen 15 lb.; the pressures in both engines will therefore be 105 lb., and acceleration of velocity will cease; the tension on the draw-bar will now again be equal to the thrust on the rails, but each will be 31,500 lb., *i.e.*, 4500 lb. less than at first. If at this moment we put the boilers of both engines in free communication with each other, the velocity eastward of the engines, and that westward of the railway, will continue uniform indefinitely, but if not, then the pressure in boiler W will continue to rise and the velocities of engines and railway will begin to diminish, till finally the former has reached 120 lb. per square inch, the latter have become *nil*, the tension on draw-bar has risen again to 36,000 lb., and the unbalanced thrust of 9000 lb. has again appeared reversed. When this point has been reached there will be a moment of stoppage, then all the phenomena will recur with their directions reversed, and so on indefinitely. It will be noticed that the coupled engines act always as one body. It is because the field that this remark points to is almost totally neglected that this controversy has arisen, and until it has been examined the disputants will not understand each other. They seem to forget that the only real boundaries of bodies are (*a*) surfaces free in space, (*b*) surfaces where motion causes friction. They seem also to forget that the transference of force by solid bodies from one part of themselves to another—*e.g.*, the appearance of a pull at the far end of a bell wire, which pull has been put into the near end—is as mysterious in its way as the "action" of gravity "at a distance" is mysterious in another way. On these points I may write you again, Mr. Editor, if you can find space for this tedious letter on points that no one should dispute.

"Φ. Π." should remember that a force may be balanced in more ways than are dreamed of in his philosophy. Wm. Muir.

Edmonton, July 6th.

Sir,—I really must apologise to "Φ. Π." for my former flippancy, since I had hitherto thought he was endeavouring to turn aside the discussion from the subject matter to ontological and similarly recondite questions of words and phrases. But now he is plainly endeavouring to narrow the question down to its simplest form. He is even willing to eliminate the motion of the oxygen from the discussion, and to limit it for the present to phenomena that can conveniently be dealt with by the method of the composition of forces. Well, I see a group of men all holding fast to a rope, and the group presently appears to move, and I infer that there has been an opposite movement of the whole earth exactly balancing this movement which I see, so that the poise of the earth's centre of mass is unaffected in space; and, further, I should expect that if the group were isolated from the earth by standing on a floating body, every movement of the group would be balanced by an opposite movement of the float, and therefore I should suppose that the plank used by "Φ. Π." for his experiment was not sufficiently isolated, and that the friction of the rollers opposed a greater resistance to motion than the friction between the water and a floating boat. No one who has done much boating can fail to have observed that walking along the boat gives it a motion in the opposite direction. What, then, is the difference between one person doing so and two or more? Here is a question of fact; when we have satisfactorily observed and experimented, it will be time enough to define the terms we shall use, and to endeavour to grapple with more serious difficulties which lie on the threshold of fundamental unintelligibility.

Since writing the above I have contrived a model tug-of-war. A drawing board is my floor, two pencils my rollers, my plank is 12in. by 5in. by ⅜in. The strong boy is represented by two nails driven into the plank, the weak boy by a bit of iron gas barrel, with a pencil passed through it, to the ends of which are looped two rubber bands, Perry's aromatic, which again loop over the nails. A thread attached to another nail holds back the weak boy after a strain or stress has been set up in the elastic bands. The whole has considerable longitudinal stability, nevertheless when the word "go" is given, preferably by allowing a taper to burn down to and so sever the thread, the weak boy being at once pulled up to the strong boy, a traverse of 3½in. along the plank, the plank recoils about 2in. I cannot supply the weights, velocities, or co-efficients of friction, but if I pass your way will leave the model at your office for inspection. On the whole I begin to believe in Dr. Lodge's psychology.

Kensington, July 6th. W. A. S. Benson.

Sir,—Unhappily I could not go to Henley this year to enjoy myself and see the novelties. A real novelty might have been, if I understand rightly a controversy in your columns, the spectacle of a boat without oars or sculls, sails or paddles, or even any form of propulsion involving a mystery of electricity, shooting about with ease and comfort hither and thither, the sole occupants being Dr. Lodge in the stern and a little boy in the bow, apparently playing with becoming *gravity* the little game of tug-of-war, under varying conditions of success. Indeed, it would seem that the University boat-race might be conducted under similar conditions in a single boat.

In a "Girton Girl's" argument it seems to me a mere ignorance that the word "friction" should have made its appearance, somewhere somehow. E.

Gipsy-hill, July 3rd.

SOLID BEAMS.

Sir,—I was very pleased to see the appearance in your columns of the long-promised review of my work. The scientific attainments of your reviewer are not, however, sufficient to enable him to understand the reasoning out of the formulæ which he affects to despise. His brain has evidently been bemuddled by studying Rankine's "Applied Mechanics," a work which I frankly acknowledge I do not, and I am firmly convinced Rankine did not, understand. The gentleman who reviewed my work on "Water-wheels" acknowledged that Rankine could not have understood what he was writing about in that section of his work on prime movers which treats of fluid impact.

Most critics seize upon the most salient features of the works they undertake to review. My principal object in writing the little book was to prove that no formulæ for ascertaining the loads which solid beams can support could give correct results, which did not take account of the modulus of compression as well as the modulus of extension, and to obtain a formulæ which did take account of both. Such a formulæ I have succeeded in working out. On page 25 there is a table in which the breaking weights of rectangular cast iron bars of various sections and lengths calculated from the ordinary formulæ and my own new formulæ, are compared with the experimental breaking weights ascertained by Hodgkinson. Those calculated from my own formulæ in nearly every instance coincide with results of experiments, whilst those obtained from the ordinary formulæ give results equal only to about 50 per cent. of the actual breaking weight. How is it that your reviewer has failed to notice this special feature and this remarkable coincidence? "Facts are stubborn chiels which winna ding." If the calculated breaking weights ascertained from my new formulæ coincide with the breaking weights ascertained by experiments, the formula itself must be correct, and if the formulæ is correct, the reasoning on which it is based cannot be fallacious.

Your reviewer states that the distribution of the shearing stress per unit of area of cross section obeys the law $f = \frac{F}{I} \int_{y}^{h} y \, d \, y'$, F being the total shearing stress and I the moment of inertia of the section. I am sure it will be as interesting to the rest of your readers as it will be to myself to know whether this formulæ which displays an utter contempt for the law of dimensions is based on experimental data or imaginary assumption. Perhaps your reviewer will work out the formulæ step by step, and will, at the same time, define what he means by the moment of inertia of a surface. Does your reviewer deliberately intend to affirm that the whole of Rankine's calculations of the loads of solid beams do not rest on the assumption that the neutral axis in every case passes through the centre of gravity of the section? Most assuredly they do. The neutral axis, however, can only pass through the centre of gravity when the modulus of extension is equal to the modulus of compression. The statement that "on page 3 our author innocently, and probably unconsciously, begs the principle that the neutral axis passes through the centre of gravity of the section," is the grossest misstatement that I have ever known made even by an engineering reviewer. There is this difference between the formulæ for the deflection which your reviewer prefers and my own: the latter gives correct results, the former does not.

4, Westminster-chambers, Victoria-street, London, July 7th. William Donaldson.

THE PATENT-OFFICE.

Sir,—I am glad to see that some, at least, of the effects of the want of administration in the Patent-office are being brought to light. There are, however, much stronger evidences of the ignominious incompetence of some of those who should guide; and the proofs are every day becoming more annoyingly felt of the serious results which must accrue from political appointments of men wholly ignorant of either arts, manufactures, science, or language. There are surely places enough into which a *protégé* could be put by an admiring and pushing member of Parliament, without putting him in a place like the Patent-office, where his absolute ignorance of everything that is essential will be most glaringly exposed. Such, however, does not seem to be the case, and the inventor and the country pay for services they never get from men placed out of the way for political reasons. The inventor cannot, however, continue to allow a Patent-office official to waste his money as at present at the Patent-office. Some change must be made, for instance, by which the hearing of objections shall not be the perfect farce that it now is. It seems scarcely credible, but it is none the less true, that an inventor who has to proceed in this manner has to be represented by counsel of high eminence and solicitors to argue a case, not before one competent to judge of the matter in hand, but before one who, in nine cases out of ten, never before heard of such a thing as that under consideration, and has not the slightest conception of it, its functions, or details. The whole thing, Sir, is a farce, and an insult not only to inventors. The result of a hearing is describable, with perfect truth, as a toss-up, and serves no other purpose than to afford ground for appeal before a competent tribunal. The utter incompetence which is to be seen between ten and four at the Patent-office beats all that has been seen elsewhere by any

London, July 6th. Patent Agent.

BOTTOMLEY'S RADIAL AXLE.

Sir,—In The Engineer of June 19th you illustrate a radial axle-box by a Mr. Bottomley; you will find the same arrangement in some engines I designed for the Swiss National Railway, illustrated in *Engineering* of March 19th, 1880, p. 224. This plan has since been improved, and I hope shortly to send you a drawing of the improvement. C. Brown.

Zurich, July 2nd.

A SIMPLE FORM OF DRAUGHT GAUGE.

The following, by Professor J. Burkitt Webb, Cornell University, is published in the "Journal" of the Franklin Institute:—

During the Electrical Exhibition I had the pleasure of devising, and by request now describe, a simple instrument for measuring the vacuum in a flue directly by means of scales, and without using a column of a liquid or a spring. It was used simultaneously with other instruments for the same purpose, and gave good results; it is to be recommended for the directness and certainty with which the results are obtained, and the absence of any necessity of standardising it to get at the true value of its readings. Any form of scales may be used, weighing, preferably, to fractions of an ounce. Upon the scale pan A—see Figs. 1 and 2—is placed a board B, in which there is an annular groove filled with mercury; this and the scales are the only moving parts of the apparatus. The rest consists of the lid C, whose edge dips into the mercury in the groove, and the pipe D, which connects this lid with the interior of the flue or stack, so that the same vacuum exists beneath C as in the stack. This pipe also serves to support the cover while the mercury joint allows the board to rise and fall with the scales. It is evident, therefore, that the atmosphere will press upon the board everywhere except beneath the cover, where there will be a less pressure, so that if the scales have been balanced for the weight of the board and mercury, they will be drawn upward by the suction of the vacuum under the cover. The amount of this is clearly equal to the area beneath C multiplied by the number of pounds per square inch difference between the vacuum and the atmospheric pressure, and can be obtained directly from the scales and the difference of pressure calculated. In the pipe D there is a diaphragm *d*, through which there is a small hole; this prevents rapid fluctuations from disturbing the balance, while it allows the same average vacuum beneath C as in the stack, there being no leakage past the mercury joint. It serves a further purpose, also, in connection with the plug *c*; by withdrawing this plug the atmosphere has access beneath C, so that the scales can be balanced at any time without the vacuum in the flue affecting them. The edge or rim of C should be thin, and not soluble in mercury; it can be made of sheet iron rivetted and the joint made air-tight by varnish. The area of C can be calculated from measurements of its diameter, or by impressing its edge upon any soft surface it can be obtained with a planimeter. The mercury should be pure enough not to clog the motion, and its buoyant effect upon the cover, whose edge will necessarily be of some thickness, can be utilised to make the scales weigh to small fractions of an ounce, provided only that the knife edges be in good order. To accomplish this, a pointer *b* is fastened to the scale beam so that it will play over a roughly graduated arc upon the card *a* and indicate the exact position of the beam; to find the value of the divisions in parts of an ounce, remove *c* and note how many divisions the pointer moves over when the pee is moved a quarter or half ounce; the thicker the rim of C the greater will, of course, be the value of each division. This pointer and scale also allows small changes in the vacuum to be noted without moving the pee. A modification of the apparatus, which dispenses with the use of mercury, consists in using a shallow metal cylinder in place of B, and a flat disc in place of C, acting as a piston, the latter being a thousandth or two smaller than the cylinder, so as to move freely in it and yet allow no appreciable amount of air to pass by it. In this form of instrument the diaphragm *d* must be replaced by a cock, which can be shut to balance the scales, and has when open sufficient passage way to prevent what little air passes the piston from affecting the vacuum under it to any appreciable extent. The piston must also be hung from D by a rubber tube, so that it can hang freely in, and without pressing against, the cylinder. Suppose, now, the cover to have an area of 50 square inches, and the scales to read as follows: With stopper out, 28·50 oz.; with stopper in, 20·25 oz.; difference, 8·25 oz. Dividing by 50 we have 8·25 ÷ 50 = ·165 oz. as the pressure per square inch of the vacuum below the atmosphere; to express this in inches of water divide by the weight of

FIG. 1

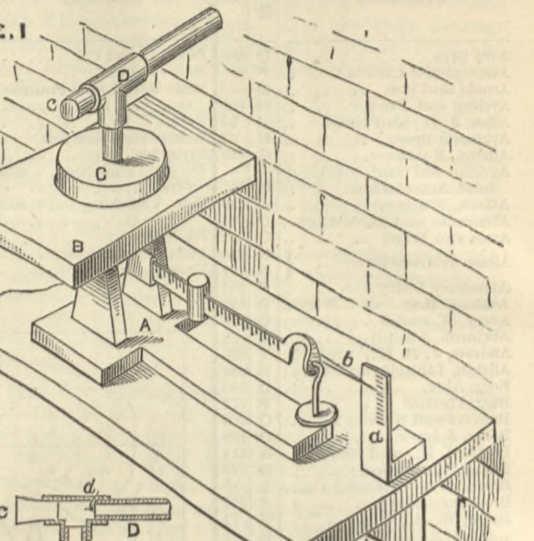
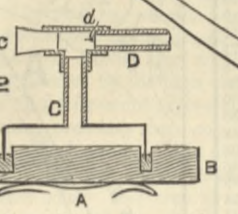


FIG. 2



a cubic inch = 1000 ounces ÷ 1728 = ·58 ounce. Dividing ·165 by ·58 we get ·286in. of water. The gauge may be set up at any distance from the stack and connected by a pipe or hose, and as it is equally applicable for slight pressures above atmospheric, it may also be used for determining the pressure of a blast.

THE PHYSICAL SOCIETY.

At the meeting held June 27th, 1885, Professor Guthrie, President, in the Chair, Dr. Ramsay, Messrs. T. Hands, F. W. Sanderson, W. A. Shenstone, and F. H. Nalder, were elected members of the Society. The following communications were read:—"On the Specific Refraction and Dispersion of the Alums," by Dr. J. H. Gladstone. The refraction, dispersion and specific gravity of nineteen different alums in the crystalling form were published by M. Charles Soret, of Geneva, in the *Comptes Rendus* for last November. These, together with some additional data from Soret, Topsol, and Christiansen, were employed by the author for comparison with certain experimental results of his own and of Kannonikof. In this way additional proof was obtained that a salt has the same specific refraction, whether it be crystallised or dissolved, and that the refraction equivalent of a compound body is the sum of the refraction equivalent of its components. The refraction equivalents of the alkalies in these alums are in the following ascending order:—Sodium, potassium, ammonium, rubidium, methylamine, caesium, and thallium; and of the other metals, aluminium, chromium, and iron. This is in accordance with what was previously known; but Soret's observations do not afford the means of determining the equivalents more accurately than before. The refraction equivalents of indium and gallium were determined for the first time, giving respectively 17·4 and 14·8. The specific dispersion of the same compounds, measured by the difference between the specific refractions for the lines A and G, was also examined. The differences of dispersion are much greater comparatively than the differences of refraction. The order was also determined, but not the actual dispersion equivalents of the different elements.

"On a Form of Standard Daniell Cell, and its application for Measuring Large Currents," by Dr. J. A. Fleming. The author first referred to the careful and thorough investigation of the circumstances affecting the electro-motive force of Daniell's and allied cells by Dr. Alder Wright. He then described a form of all that had been found most convenient and reliable in practice. It consists of a U tube, in the two limbs of which are the two solutions of sulphate of copper and sulphate of zinc of the same specific gravity. Electrodes, consisting of freshly electro-deposited copper and pure zinc that has been twice distilled, dip into the two limbs. The electro-motive force of this cell is 1·102 and the variation of electro-motive force with temperature is practically *nil*.

"On the Phenomenon of Molecular Radiation in Incandescent Lamps," by Dr. J. A. Fleming. Some years ago Dr. Fleming had called attention to a phenomenon in incandescent lamps very analogous to that of discharge in high vacua, observed by Mr. Crookes. The inner surface of the lamp-glass was sometimes found to be coated with a deposit of carbon, with the exception of a clear line marking the intersection of the glass with the plane of the loop, and being in fact a shadow of the loop, apparently caused by an emission of matter from the terminals. Dr. Fleming has since found how to produce this appearance at pleasure, by passing a very strong current momentarily through a lamp, and has succeeded in obtaining similar deposits of various metals that had been used as terminals. These deposits show colours by transmitted light, and as a general result the author concludes that red metals such as gold and copper appear green by transmitted light, whereas white metals, like silver and platinum, appear brown, a conclusion which, however, was challenged by Captain Abney, in the discussion ensuing.

"On Problems in Networks of Conductors," by Dr. J. A. Fleming.

"Lecture Experiments on Colour Mixtures," by Capt. Abney. The apparatus employed by Capt. Abney is a modification of Maxwell's colour box; the spectrum, instead of being formed upon a screen, is received upon a convex lens, which forms an image of the face of the prism upon a screen. If all the light from the prism falls upon the lens this image is colourless, but by interposing a screen with a slit in the spectrum close to the lens, so as only to allow light of a given colour to fall on the lens, the image appears coloured with that light. By using two or more slits different lights may be mixed in any required proportions.

"On the Thermo-electric Position of Carbon," by Mr. J. Buchanan. It having been observed that the carbon filaments of incandescent lamps usually gave way at the negative end, experiments were instituted to find if the destruction could be due to the "Peltier effect" causing a local generation of heat. Observations on a platinum carbon thermo-couple showed that a generation of heat would result from a current passing from carbon to platinum, but the effect was too small to account for the observed phenomenon. It was found that a couple of carbon-iron rose considerably in electro-motive force by maintaining the hot joint for some time at 250 deg. Cent.

"On some Further Experiments with Sulphur Cells," by Mr. Shelford Bidwell. The paper contains (1) a description of a class of cells which give a constant voltaic current, the electrolyte consisting of a solid metallic sulphide; (2) an explanation of the unilateral conductivity exhibited by selenium and by sulphur cells; and (3) a description of a cell which gives, as the result of passing a current through it, a current in the same direction as the primary current.

SINKING THE CYLINDERS OF THE TAY BRIDGE BY PONTOONS.*

By Mr. ANDREW S. BIGGART.

ONE of the most common forms of foundations now adopted on which to build the superstructure of a modern bridge is the cylinder. But, as the foundations are often in positions difficult to get at, and, when there, to remain at, owing to causes such as the rise and fall of the tide, rapidity of the current, storms, &c., a difficult problem in connection with the building is often, How are the cylinders to be sunk? One of the easiest, and at the same time most sure, methods now in vogue is to build a wooden stage around the place where each cylinder is to be sunk, and from this as a working platform lower, dig out, concrete, and carry them up to the desired height. Some cylinders are of sufficient capacity to float themselves with perfect safety to their respective positions, as well as be made to carry all the sinking apparatus and platform necessary to regulate their descent into their final resting place. Or again, if we drop to the smallest form of cylinder, we would instance the screw and the hollow pile, the former of which is sent home by the simple, though sometimes difficult, process of screwing into the ground, while the latter is driven. While work can and is being done every day by methods similar to these, it is readily understood that much is done, especially if a stage has been constructed, which requires to be undone with a consequent loss of time and money. To use the old method of staging for such a work as the New Tay Viaduct would have required almost a forest of timber for this alone, and, owing to the great depth of water, the work would have been both tedious and expensive.

Before proceeding to sketch the novel method which has, however, been adopted, let us look at the primary conditions which must necessarily be fulfilled by whatever form of platform is used—(1) There must be a working platform, on which can be placed cranes and other machinery; (2) the platform must be high enough to permit of work being conducted from and upon it at all states of the tide; (3) it should also be capable of being removed speedily from one position to another. These primary conditions, enhanced by many other advantages, are practically realised in the pontoons designed by Mr. Arrol, and now used successfully by him in sinking the cylinders of the New Tay Viaduct. The pontoons used, of which there are four, are all made up of tanks, for the sake of convenience, which are rigidly fastened together in the form of a rectangle, and they vary in size from 56ft. by 36ft. 6in. by 6ft. deep, as in the smallest, to 81ft. by 66ft. by 7ft. deep, as in that of the largest. We propose to confine our description to one of these, as all are the same in principle, varying only in some of the details.

Fig. 1.

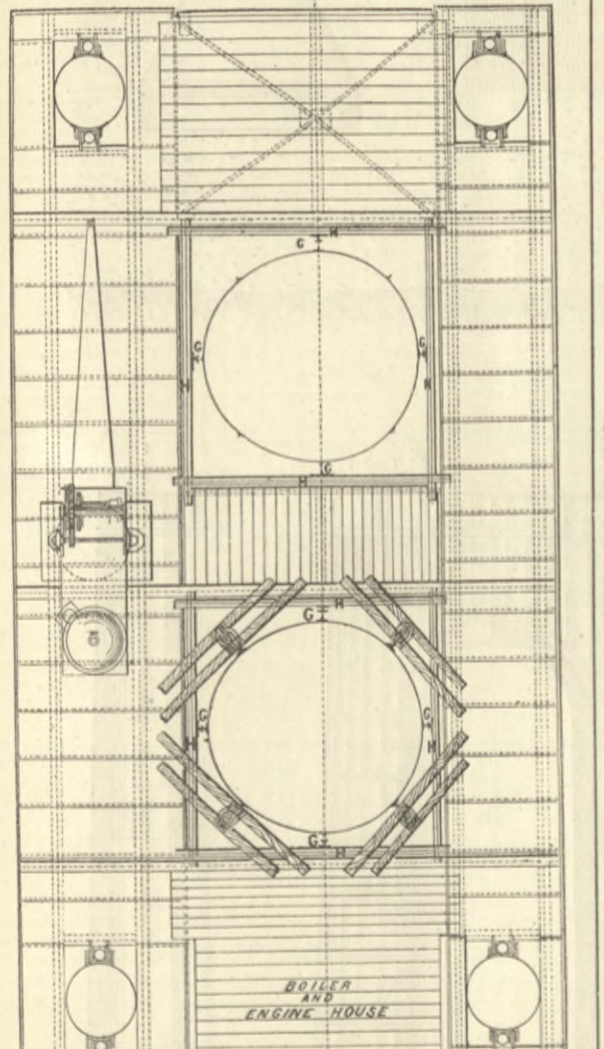
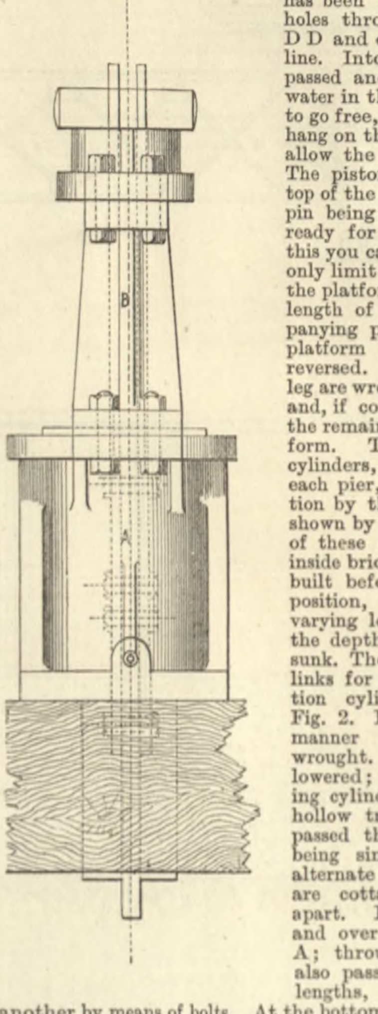


Fig. 1 presents a plan of No. 2 pontoon. You will observe there are two main tanks running the whole length of the platform, connected together by one small tank, and several main cross girders, the full depth of the tanks, as well as top and bottom outer cross girders. In both of the main tanks there are two rectangular openings, one at each end. Through these the legs are passed which are used for raising and lowering the platform. To the tanks are fixed at these openings steel plates for carrying the hydraulic cylinders required to perform this action. Equally from the centre, and at the distance of 26ft., centre to centre, the large cylinders are lowered, one at a time, through the centre openings in the platform, and this, too, by special hydraulic machinery, being guided in their descent by the vertical guides G, which in their turn are attached to the cross girders H H fixed at the top and bottom of the tanks. The cross girders are only temporarily fastened, so that in the event of the platform being raised somewhat out of position they can be shifted, and with them the guides, thus making it practicable with almost a minimum of labour to lower the cylinders in their true position, even although the pontoon has been pitched slightly out of place. On one of the main tanks there is fixed a crane which is used for lifting material on to the platform, and also for excavating by means of mechanical diggers the sand and earth within the cylinders. In the small connecting tank is placed a boiler and engine, used for driving the hydraulic pumps, working windlass, &c., as may be required. Other machinery and gear, such as portable boiler and engine, centrifugal pumps, capstans, bollards, fairleads, workshops for the men, all find a place on this sometimes floating staging, at other times stationary and high out of the water.

Before this description can be of much practical value it will be necessary to describe more in detail the principal parts of the pontoon, and the mode by which it is wrought. The method of raising and lowering the platform is shown by Fig. 3. A is one of the legs, which is 5ft. in diameter, and of a conical shape at the bottom, to prevent the ground on which it rests being scoured from underneath. On it is fixed four heavy steel plates B B, two on each side, about 16in. apart, having holes C C passing through them, spaced about 6in. apart. Sliding within these two plates, but fixed to the platform, are other two D D, having holes the same size and pitch as in the outside plates, and carrying between them a hydraulic cylinder E, provided with a piston P, piston rod R, and crosshead I. The action is as follows:—Suppose the piston P to be at the top of the cylinder, through the crosshead I and outer plates B B a steel pin is passed; when water is admitted, the cylinder E is forced up, because the outer plates B B on which the pin rests are fixed to the leg A, which in its turn bears on the ground. The plates D D are thus lifted, and with them the platform. When the cylinder has been raised about 6in., the holes through the inner plates D D and outer plates B B are in line. Into one of these is now passed another steel pin. If the water in the cylinder E is allowed to go free, the platform will now hang on the pin just inserted, and allow the first to be withdrawn. The piston is now forced to the top of the cylinder, and the first pin being again inserted, all is ready for another lift. From this you can readily perceive the only limit to the height to which the platform may be raised is the length of the leg and its accompanying plates. In lowering the platform this action is simply reversed. Both cylinders at each leg are wrought at the same time, and, if convenient, the others at the remaining corners of the platform. The large foundation cylinders, two of which are in each pier, are lowered into position by the hydraulic apparatus shown by Figs. 1, 3, and 4. Each of these cylinders, including an inside brick ring, which must be built before being lowered into position, weighs about 50 tons, varying less or more according to the depth to which it is to be sunk. The hydraulic cylinder and links for lowering these foundation cylinders are shown by Fig. 2. Figs. 1 and 3 show the manner in which these are wrought. C is the cylinder to be lowered; A the hydraulic lowering cylinder; P the piston and hollow trunk through which is passed the steel links L, these being single and double every alternate length, and through all are cottar holes about 10in. apart. B is a bow, fixed on to and over the hydraulic cylinder A; through it the links are also passed, they being in short lengths, and attached to one another by means of bolts. At the bottom of the cylinder C these links are firmly fixed to a plate, which, in its turn, is securely bolted to the cylinder. The action in lowering is as follows:—Suppose the combined piston and trunk P is almost raised to the top of its stroke, by admitting water through a cock at Q, a cottar is able to be inserted through the hole H. Upon water being again admitted, the links are raised, and with them the cylinder C, thus relieving the top cottar—presently resting on the bow—which is then withdrawn and inserted in the first hole higher up. The water being now allowed to escape, the piston P and links L, with the large cylinder C attached, descend till the top cottar again rests on the bow B. The lower cottar is then free to be withdrawn and inserted in the first hole higher up, and this done we are ready to begin a new stroke, and so continuing the cylinder C is gradually lowered till it reaches the river bed. Four of these hydraulic cylinders are employed in lowering one foundation cylinder. The water for all the hydraulic machinery is obtained from the pumps already mentioned. The diggers used are of various types, but principally consist of those with hinged automatic doors, which are open when the digger is dropped into the ground, and closed by links in the act of withdrawal. These are used principally in excavating the sand and other soft materials, others having hydraulic cylinders for opening and closing strong toothed doors, in order to tear and bring away the softer rocks and hard clays, have been used, but to no extent. In some cases a centrifugal pump has been utilised to great advantage for taking out the silty sand within the cylinders. The main suction pipe has two inlets, to each of which is attached a flexible rubber pipe. While the nozzle of the one inlet is being held to the sand by a diver, the other is loose and sucking in clean water. By using this precaution the pump seldom gets choked, and with some kinds of deposit this method is found to give excellent results.

Fig 4



After this preliminary description you will readily follow the mode of working the pontoon during the sinking of a pier. The first thing necessary to be done is to float out the pontoon as nearly as possible to its true position, immediately over where the cylinders are to be sunk. It is taken to its place by means of the crane already on it, acting as a windlass, the ropes and chains being fastened to buoys and the piers of the old bridge. Placed in position, it is only the work of a few minutes to drive away the temporary supports on which the legs are resting—the pins at this time being all removed—when they gradually sink to the bottom. The hydraulic apparatus used in raising the platform—already described and shown in Figs. 4—is now brought into requisition, and made to lift it to the desired height. This is generally attained when the bottom of the pontoon is about 2ft. under high water level. The best, and occasionally the only time the pontoon can be brought into position, before being raised, is at high tide. It is the best because the platform is about as high as it requires to be, and occasionally it is the only time, on account of the depth of water required to float it in. Anchors and chains are now called into requisition to assist the legs in keeping the platform steady, which, by the way, is found to be remarkably so, even in the roughest weather. When standing on the platform, during a high wind, and carefully watching the movement at high tide, when the waves are dashing against it, the oscillation is found to be very slight, even with both these adverse circumstances to its steadiness in play. All done we have a fixed platform, above the influence of the tide, and at the same time in the best attainable position relative to the pier at which work is about to be commenced. Upon the platform is also placed all the necessary apparatus for the lowering, sinking, and building of the cylinders, material, of course, excepted. The cylinders are now built over one of the central openings of the platform, being brought in complete rings, for convenience in handling, as part of the fixing together has to be done while they are thus being built in position. As section after section of iron is added—within—on the inner side, is built a ring of brick in cement, thereby increasing the weight, which assists during the process of digging to sink the cylinder and also keep it in form, as well as fulfilling the primary object of its being there, namely, to insure the safety of the structure in the event of the iron being corroded away. While the rings are in course of being added, all at the same time is lowered by the hydraulic apparatus already described till the cylinder reaches the river bed. The digger is now set to work and gradually excavates the material from within the cylinder, and thereby makes a way for it to settle down into the ground, and this is continued until it reaches its proper depth. Although apparently easy and simple on paper, the difficulties in the way preventing the desired end being attained are sometimes enormous; for example, you may come on a bed of boulders—this is found in many piers, being the protecting rubble of the old bridge piers—or even one large one, say one quarter within and the remainder outside of the cylinder, or get into clay so hard that the digger can barely cut into it, and yet so leaky as to make it impossible to pump the cylinder dry. Or there may be difficulties, the causes of which, if known, could be as easily counteracted and overcome as was the case when the sand saddened within the cylinder during the ebbing of the tide, on account of the water being higher within than without; the digger in these circumstances brought up only a small quantity at a time, nothing to be compared to what was done when the water was kept a little lower within than without. This is easily accomplished by the artificial means of pumping, the effect of which is to cause a little water to be constantly leaking through the sand into the cylinder, thereby keeping it loose, and consequently making it easy to be dug into. At other times the diggers are completely useless for excavating the material within the cylinders; a good alternative—if at all possible—in a case of this kind, is to force the cylinder down by piling on weights, till it becomes practicable to pump it dry, after which it can be dug out by hand. Before this has been accomplished, in some cases it has been necessary to add as much as 400 tons of artificial loading to some of the 15ft. diameter cylinders. If the cylinder cannot be made water-tight, then in a case of this kind resort has to be had to divers.

When a cylinder has reached the desired depth, and provided the bottom is satisfactory, filling in with concrete is commenced, and continued till it reaches the top of the ironwork. The material for making the concrete—gravel and cement—is in most cases lowered from the old viaduct, which is only 60ft. to the eastward, and runs parallel with the new, except a short piece at the ends. The gravel is emptied out of the trucks into a shoot resting on the pontoon platform, and is there mixed and afterwards thrown or lowered into the cylinders, as the case may require. The second cylinder having been placed in position in a similar manner to the first, the platform is now lowered and at high tide is floated away over the top of the now sunk cylinders, the tops of which are only visible at extreme low water, thus leading the uninitiated to suppose little has been done because little is seen. Cast iron weights are now built on girders above the cylinders for the purpose of testing the sufficiency of the foundation. Sufficient weight is laid on to cause a pressure of five tons per square foot on the whole area under the cylinders. If they sink at all, these weights are allowed to remain until all indications of such are stopped, after which they are transferred on to the next set by means of a wire cable or barge. It is here worthy of notice that the test load placed on the piers is 33⅓ per cent. in excess of the weight that would be brought, although the two lines were fully loaded with trains. On the removal of the weights, temporary caissons are fixed to the permanent cylinders by bolts and pumped dry. The remaining blue brick, outer shell, concrete, and stone work above low-water is then executed. Twenty feet down into this are built the holding-down bolts, sixteen in number, in each pier, all 2¼in. diameter. The caissons are removed, and afterwards the connecting piece between the cylinders and the remainder of the pier is built up to and underpinned beneath the iron base on which the wrought iron superstructure rests. Progress is thus going on at several piers at one and the same time:—(1) The pontoon, lowering, digging, and concreting; (2) testing the value of the foundations; (3) building under high-water within the temporary caissons; (4) finishing remainder of pier to underside of ironwork. This, again, is but the starting point from which the iron superstructure, as shown in Fig. 5, begins to rise—in stages also—to be followed by the placing of the girders and flooring, on which, finally, the track is laid.

Although the advantages gained by using pontoons such as those described are apparent to all, it is at the same time evident they could not be used to advantage, except on works of some magnitude, where, for instance, there are a goodly number of piers to be put down, and also difficulties to be overcome, for grappling which they are peculiarly suited. The new Tay Viaduct furnishes such work and difficulties. The pontoons on the Dundee side sunk and concreted one complete pier—of two cylinders, 10ft. diameter each—per week, for nearly two months on end, the greatest difficulty to contend with being the shallowness of the water in which it had to work. The depth to which each of these cylinders is sunk varies from about 16ft. to 26ft. under the bed of the river.

Such is a very brief *résumé* of the foundation work, and the mode by which it is being accomplished at this viaduct at the present time. Time alone will tell, when the results are balanced, if the decision was altogether wise which fixed on this novel method of carrying out a vast undertaking.

* Paper read before the Institution of Engineers and Shipbuilders in Scotland, 28th April.

TENDERS.

LEICESTER SEWAGE WORKS.

FOR supplying and fixing a wrought iron hurdle fence 72 yards long, with one wrought iron single field gate, for the Leicester sewage works. Quantities by Mr. J. Gordon, C.E., borough surveyor.

	£	s.	d.
Hydes Wigfull, Sheffield—accepted	48	5	6
Wright Bros., Leicester	55	2	0
W. T. Burbidge, Leicester	59	15	0
Cort and Paul, Leicester	80	0	0

For the pulling down of the present boundary and cross wall, and the building of a new boundary and retaining wall, at the Leicester sewage works. Quantities by the borough surveyor, Mr. J. Gordon, C.E.

	£	s.	d.
F. Major, Leicester—accepted	80	0	0
J. O. Jewsbury, Leicester	82	19	0
E. T. Hutchinson, Leicester	89	0	0
T. and H. Herbert, Leicester	92	10	0
S. W. Pilling and Co., Manchester	127	1	0

SUTTON-IN-ASHFIELD, NOTTS, WATERWORKS.

Mr. George Hodson, C.E., Loughborough, and Mr. Herbert Walker, C.E., Nottingham, joint engineers.

	£	s.	d.
Stanton Iron Company—accepted	3434	2	6
Clay Cross Iron Company	3432	8	4
Butterley Iron Company	3460	0	0
Staveley Iron Company	3504	8	7
James Okes and Co.	3594	0	0
Firmstone and Brothers	3612	12	4
Cochrane and Co.	3876	10	6
Macfarlane, Strang, and Co.	4658	0	0

CRICCIETH.—EXTENSION OF MAIN SEWERS.

Mr. Thomas Roberts, Assoc. M. Inst. C.E., engineer.

	Railway station.			Manchester House.			Outfall.			Total.		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Jones, Criccieth	—			—			—			442	18	0
Owen, Portmadoc	66	0	0	186	0	0	75	0	0	327	0	0
Thomas, Barmouth	62	15	0	147	0	0	82	10	0	292	5	0
Hughes, Portmadoc	60	14	3	152	5	9	69	0	0	282	0	0
Mathews, Criccieth	90	0	0	129	0	0	59	0	0	278	0	0
Davies, Portmadoc	80	0	0	133	0	0	57	0	0	270	0	0
W. Jones, Criccieth	81	16	0	121	16	0	54	0	0	257	12	0
Engineer's estimate	87	1	6	183	12	1	79	4	0	349	17	7

SINKING THE CAISSONS OF THE TAY BRIDGE PIERS.

(*For description see page 25.*)

Fig. 3.

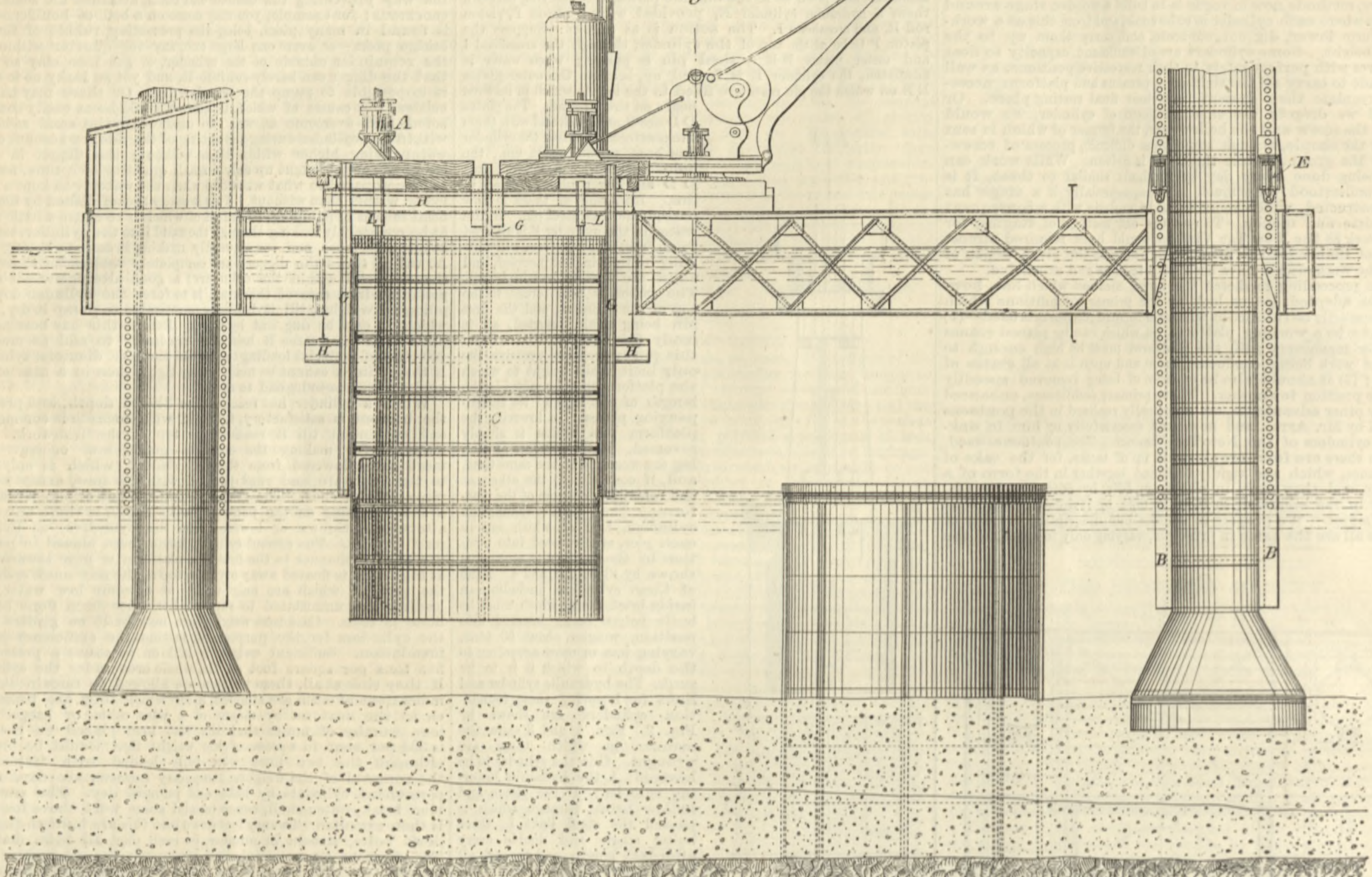


Fig 4.

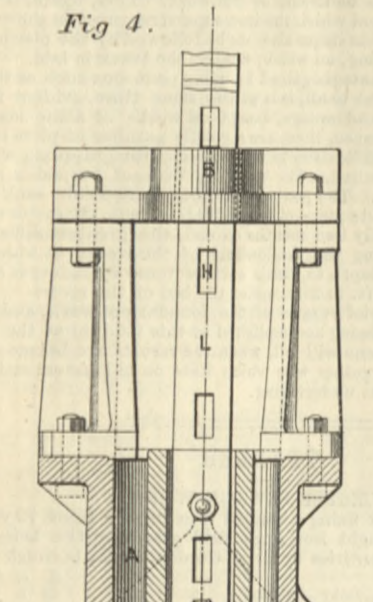


Fig 2.

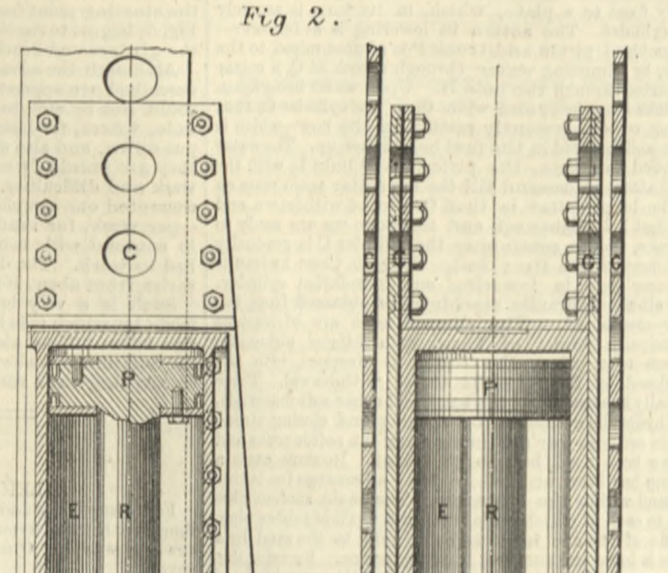
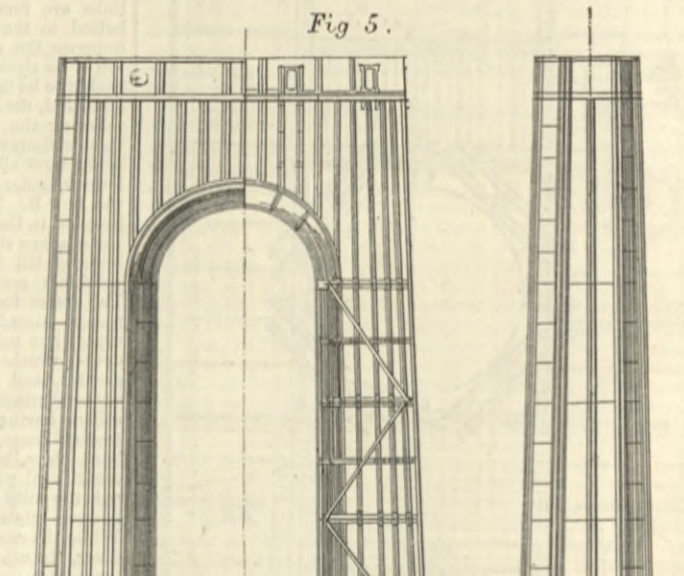
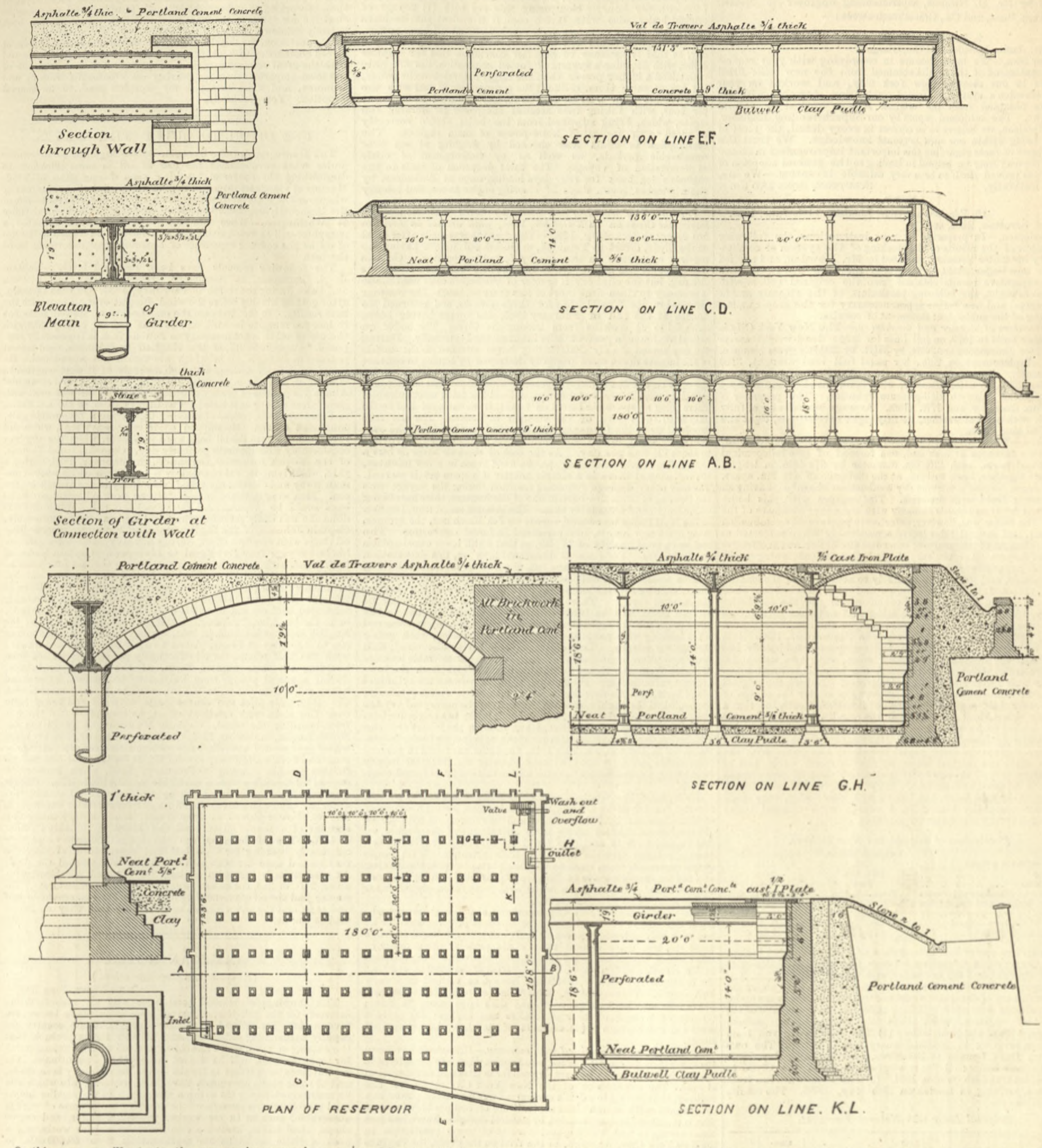


Fig 5.



COVERED SERVICE RESERVOIR, NOTTINGHAM WATERWORKS.

MR. OGLE TARBOTTON, M.I.C.E., ENGINEER.



ON this page we illustrate the new service reservoir, constructed under Mr. Ogle Tarbotton, and known as the Park-row Reservoir. It is finished, and was opened on the 22nd of June. The original reservoir was made in the year 1832, and was a small open one; and being shallow and exposed to the air the water was liable to continuous atmospheric and other contamination. In the summer time it was necessary to empty the reservoir and clean it out, by a large body of men, every three weeks; and in the winter periods at intervals of about six or eight weeks. These operations caused a large loss of water, and much temporary inconvenience to the district supplied from the reservoir. The old reservoir was connected directly with the supply of water from the old Trent Pumping-station; that is to say, the water supplied to the town was obtained from the river Trent, and pumped direct from the now disused station through a 15in. main. It was the first high-pressure and constant service supply in the kingdom of England constructed by Mr. Hawksley. It was also supplemented by a small supply from the springs at Scotholme. Both these sources of supply have been discontinued since the waterworks came into the hands of the Corporation, and now the reservoir is mainly fed from the Bagthorpe wells. Water can be and is frequently run in from Bestwood and Papplewick. The new reservoir possesses some points of interest, as it is of peculiar construction. Owing to the contracted area of the land, and the imperious demands of the public for the improvement of the adjacent streets, the formation had to be somewhat different to that usually employed. Service reservoirs of this kind are generally constructed of brickwork with puddle backing, and of course the piers and arches, as in the case of the lately built high-service reservoir on Mapperley Plains, occupied a considerable area and involved corresponding expense. It is simply a large tank, without puddle, except to a certain extent on the floor, the whole of the interior faces of the walls being lined with Portland cement plastering. The size of the reservoir is 180ft. by 141ft.; the height is 16ft.; and the shape on plan is rhomboidal. The roof is constructed of light brick arches, which are covered with Portland cement concrete, and the latter is finally coated with Val de Travers asphalte. The arches are supported by cast iron columns and wrought iron girders, and the whole of the framing of the roof is tied together by transverse girders of wrought iron. The floor is formed of puddle and Portland cement concrete with a coating of pure cement, and the columns are hollow and made to hold the water inside, therefore the holding power of the huge tank is reduced only by the thickness of the metal of the columnar supports. The capacity of the reservoir is about 2¼ million gallons, and this large volume will be pumped into the reservoir every day and used for the supply of the low level zone, for the service of which the reservoir is constructed.

The work has been constructed in a short space of time, Mr. Smart, Nottingham, being the contractor. The cost, including the widening of two streets known as Park-street and Ropewalk-street, will be about £12,000. The inhabitants of the large water area now supplied by the Corporation of Nottingham do not now possess a single uncovered reservoir. They are supplied with water from wells.

ACTION OF TIDAL STREAMS ON IRON AND STEEL.—At the meeting of the Royal Society, June 18th, a paper was read on "The action of Tidal Streams on Metals during Diffusion of Salt and Fresh Water, Experimental Research, Part II. (Gravimetric)," by Thomas Andrews, F.R.S.E., communicated by Professor G. G. Stokes, Sec. R.S. In a paper last session on "The Electromotive Force during diffusion in Tidal Streams" (see "Proceedings," Royal Society, No. 232, the author recorded the electrical part of this investigation. The present communication contains the concluding gravimetric experiments of the research. The effects attending the diffusion of the salt and fresh water in tidal estuaries, on parts of the same metal, of known composition and general properties, were estimated in each case for a period of one year, during which bright plates of the following metals:—viz., wrought iron—combined carbon none—"Soft" Bessemer steel (c.c. 0·15), "soft" Siemens-Martin steel (c.c. 0·17), "soft" cast steel (c.c. 0·46), "hard" Bessemer steel (c.c. 0·51), best cast metal, "No 1," (c.c. 0·39), common cast metal, "No. 2" (c.c. 0·67), were constantly exposed to conditions of galvanic action similar to those obtaining in some tidal streams. The results demonstrate that electric disintegration of the nature alluded to in this and the former paper—viz., the galvanic destructive action on parts of even the same metal, arising from difference of electrical potential during diffusion between the surface and lower waters in a tidal stream—is, on comparison with other investigations by the author, apparently of much greater extent than the loss either from simple corrosion in sea water alone, or than that which ensues from the action on each other of dissimilar metals of this group—such as wrought irons, cast metals, and steels—in galvanic connection in sea water. Compared with simple corrosion in sea water only the increase in loss varied from about 15 up to 50 per cent., according to the nature of the metals. The results of the experiments in this and the former paper indicate, therefore, that the tidal action on any vessel or metallic structure, of sea and fresh water whilst diffusing is, in the case even of the same metal thus exposed to the simultaneous action of top and bottom waters, considerably more destructive in its nature and character than the action of sea water alone. Moreover, the author has found it in some instances to exceed from about 55 to 120 per cent. the loss caused by galvanic action between dissimilar metals of the iron and steel group in circuit in sea water.

HOWDEN'S SYSTEM OF FORCED COMBUSTION.

THE following report on the working of Howden's system on board the West India line steamer New York City has been prepared by Mr. D. Nicolson, superintending engineer to Messrs. Scrutton, Sons, and Co., Gracechurch-street:—

9, Gracechurch-street, London, 11th June, 1885.

Messrs. James Howden and Co., Glasgow.

Dear Sirs,—We have pleasure in complying with your request for a statement of the results obtained from the new boiler fitted by you in our steamer New York City, and worked on your Mr. Howden's system of forced combustion, together with the results obtained from the original boilers worked by natural draught. The subjoined report by our Superintending Engineer, Mr. Nicolson, we believe to be correct in every detail, the most of them being within our own personal knowledge. We trust this statement of facts regarding this important improvement in steamship economy may be helpful in leading to the general adoption of what has proved itself to be a very valuable invention.—We are, yours faithfully, SCRUTTON, SONS AND CO.

10, Fenchurch-avenue, London, 11th June, 1885.

Messrs. Scrutton, Sons, and Co.

Gentlemen,—In preparing by your instructions the following statement of the results of the working of the system of combustion by air under pressure, patented by Mr. Howden, and applied to the new boiler fitted by his firm in the New York City, with the comparative results obtained from the original boilers with natural draught, the following particulars of the steamer and of the original and new boilers appear necessary for the proper understanding of the subsequent statement of results.

Particulars of steamer and machinery.—The New York City is a steamer built in 1879, on full lines for large dead-weight carrying. Her dimensions are 260ft. by 34½ft. by 22¼ft.; gross tonnage, 1724; displacement on 20ft., her usual full load draught, 3700 tons nearly. The engines, which are ordinary compound, have cylinders 33in. by 61in. diameter, with 33in. stroke, and without an expansion valve to high-pressure cylinder. The propeller is 14ft. 6in. diameter and 17ft. pitch. Average speed at sea, fully loaded, with neutral weather, at fifty-eight revolutions, eight and a-half to nine knots.

Boilers.—The original boiler, though worked as one double-ended, with two furnaces at each end, was formed of two independent cylindrical parts, each 12ft. 6in. diameter by 6ft 4½in. in length, and tied together, back to back, at the distance of 4ft. 3in. apart, which space formed a common dry combustion chamber, having an iron casing lined with fire-brick. The engines with this boiler compared fairly as regards economy with the other steamers of the line. The boiler was, however, defective in parts of the combustion chamber, and several tubes leaked considerably when subjected to sudden changes of temperature; otherwise the boiler was as effective as other boilers. The tendency of the boiler to leak, owing to the unequal expansion and contraction arising from its design and construction, and the advantages likely to accrue from the smaller boiler proposed by Messrs. Howden and Co., worked on their system of forced combustion, led to the ordering of the new boiler in May, 1884, though the original boiler had not then been in use much over four years. The present boiler, of the dimensions given below, was fitted on board at Glasgow in September, 1884. It is single-ended, with one stokehole, and occupies considerably less space than the original double-ended boiler, with two stokeholes. The fire-grate, which is 4ft. 1½in. over the bars, is reduced somewhat in width with closely fitting side pieces. Before the original boiler was removed, it was for three voyages under the charge of the present chief engineer, who worked it satisfactorily, so that a very fair comparison can be made of the results from working the larger boiler, under normal conditions, by natural draught, and the smaller by forced combustion. It should also be noticed here that the engines in every respect remained the same with the new as with the original boiler, so that a more exact test of the performance of the new boiler is afforded than if new engines had been supplied at same time. In the voyages aftermentioned, No. 2 with original boiler, and 1 and 2 with new boiler, were made with same propeller blades, No. 1 voyage with original boiler having a different set of about equal effect.

Particulars of Original and New Boilers.

	Original Boiler.	New Boiler.
Length without uptake	17ft.	11ft.
Diameter	12ft. 6in.	14ft.
Steam domes	Two	None
Number and diameter of furnaces	Four, 3ft. 5in.	Three, 3ft. 4in.
Number, length, and dia. of tubes	372—6ft. 4½in. by 3¼in.	210—8ft. by 3in.
Tube surface	2173 sq. ft.	1319 sq. ft.
Length of fire bars over all	5ft. 6in.	4ft. 1½in.
Aggregate fire grate	75 sq. ft.	36 sq. ft.

Comparative power and consumption of fuel of the two boilers.—To make a proper comparison between the original boiler with natural draught and the new boiler with forced combustion, it is necessary to select voyages made as nearly as possible under the same conditions of draught of vessel and weather. Two runs under such conditions were made with each boiler under the charge of the same chief engineer, which afford fair means of comparison. These are, with the original boiler: (1) The homeward run from Barbadoes, arriving in London January 1st, 1884. (2) The outward run from London to Barbadoes, leaving 20th May, 1884. With the new boiler: (1) The run outwards from the Clyde to Trinidad, leaving 13th October, 1884. (2) The homeward run from Barbadoes, arriving in London on 18th May, 1885. The results are as follows:—

Original Boiler with Natural Draught.

Voyage.	Draught. Aft.	Draught. Forward.	Average revolut'ns	Average I.H.P.	Coal.	Consumpt'n per 24 hours	Weather.
1 Homew'ds	20ft. 3in.	19ft. 3in.	56	564	Welsh.	13½ tons	Fair.
2 Outwards	20ft. 4in.	18ft. 10in.	59	Not taken.	Ryhope	15 tons	"

New Boiler with Forced Combustion.

Voyage.	Draught. Aft.	Draught. Forward.	Average revolut'ns	Average I.H.P.	Coal.	Consumpt'n per 24 hours	Weather.
2 Outwards	20ft. 4in.	18ft. 10in.	57	Not taken.	Scotch	11 tons.	Fair.
1 Homew'ds	20ft. 3in.	19ft. 6in.	60	623	Welsh.	9½ tons.	*

* Fair and head winds.

Remarks on above voyages.—On (2) voyage of the original boiler no reliable diagrams were taken, nor on first run with new boiler, owing to defective indicator; but the indicated horse-power always closely approximates to the revolutions under the same conditions. The Ryhope coal used on the (2) voyage with original boiler is an excellent steaming coal, and taking the increased revolutions into account, gave about as good results as the Welsh coal. The Scotch coal used on the first run out with the forced combustion boiler was of a dirty character, leaving much clinker, and requiring fires cleaned about every six hours. The vessel, however, ran straight from the Clyde to Trinidad, making a good average passage, and consuming only 11 tons per day of this inferior coal. On (2) homeward run with forced combustion and Welsh coal, the engineer—having previously discovered and made good a leakage of steam from the high-pressure to low-pressure casings, which had affected the outward run, and having got the inexperienced firemen into better training—maintained steadily and with ease a higher power than the engines had ever previously worked to at sea, the revolutions averaging sixty per minute from day to day, and consumption of coals falling to 9½ tons per twenty-four hours. The engineer reports that as the steam was maintained at a constant pressure of 80 lb. to 82 lb. from day to day, and no alteration made in the steam admission to the cylinders, the diagrams which show 623 indicated horse-power at sixty revolutions is the mean horse-power developed from a consumption of 9½ tons per day, or 7·916 cwt. per hour. Comparing this run with (1) voyage of original boiler, also with Welsh coal, it is evident that to have maintained, on that voyage, sixty revolutions and 623-horse power, the consumption could not well have been less than 15 tons per day, so that it appears to be a fair conclusion that the smaller boiler, with Howden's system of forced combustion, has not only maintained a higher power than the larger natural draught boiler, but has, at same time, reduced the consumption of coal with the same engines from 2·24 lb. to 1·42 lb. per indicated horse-power per hour, with taking into account the power for working fan engine, which, being supplied from the boiler, should correctly be added to the indicated horse-power of main engines. The consumption of coals was checked by weighing at sea over considerable periods, as well as by measurement of coals at termination of voyage. The total deduction of coals in the engineer's log book for four days loading cargo at Barbadoes, by steam winches, seven days of steering engine at sea, and twenty days galley and all other fires, is 6 tons 15 cwt.

Particulars of working new boiler by forced combustion since leaving the Clyde on 13th October, 1884, until arrival in London last voyage on 18th May, 1885.—The first run was made after trial on the Clyde, direct to Trinidad, engineers and firemen having no previous experience in working by forced combustion. On the passage out it was attempted to run the fires twelve hours without cleaning, but the clinkery character of the Scotch coals used made it necessary to clean fires more or less every six hours. The steamer remained in the West Indies for three months, and returned to London at the end of February 1885, the voyage having been, extended to 4½ months from leaving the Clyde. The boiler on arrival was found in perfect order internally and externally. During the stay abroad the air distributing boxes attached to the inside of the furnace doors were partially destroyed by coming in contact with the flame, in consequence of the fireman usually heaping up the coals on the dead plate, a practice which should not be adopted, especially with forced combustion, a level fire being most suitable. There being no spare air boxes on board, those damaged had to do duty until the return of the steamer to London. The too free supply of air to the furnaces, through the burnt boxes and the coal used being small, raised the consumption on the homeward voyage to about 12½ tons per day. As the cost of these air boxes is but a few shillings each, and they can be fixed at sea in a few minutes, the replacing of these is a simple matter if a spare set is carried. The only other damage requiring mention during the voyage was the twisting of some fire-bars in one of the furnaces, these bars being in one length and unusually thin. The steamer sailed from London to the West Indies on second voyage on 7th March last, the firemen being again new hands, inexperienced in forced combustion. The coal was a good quality of Welsh, so that a still lower consumption was looked for. For reasons discovered later on, this expectation was not realised on the voyage out, the average revolutions having been 58, steam 78 lb., and consumption 11½ tons. There was likewise trouble on several occasions with the fire bars giving way on the outward voyage. This was apparently due to their being of soft raw metal, and to inattention of the firemen, and not to the effect of the air pressure combustion, as the same injury occurred when working with natural draught, on one occasion, when going through the islands. The chief engineer having discovered, and made good before beginning the return voyage, a considerable leakage of steam from the joint plate dividing the high from the low-pressure valve casings—these being together between the cylinders—and having got the fireman to follow his directions more carefully, accomplished the highly successful results of the homeward voyage already described with ease, and without injury to a single fire bar. The boiler tubes were only swept out once on the homeward run and the fires were, kept in good order, cleaning only every twelve hours. On arrival in London, on May 18th, the boiler was found in perfect order inside and out, and without showing the slightest injury from having worked seven months under this system of forced combustion.

Air supply.—The whole air for combustion is supplied by a 36in. Gunther fan driven by a Tangye vertical engine, having a cylinder of 6½in. diameter by 7½in. stroke, and working at an average of 190 revolutions. After some little adjustment of the engine on first voyage, both it and the fan have worked during the seven months without trouble and with little attention. With some simple protection from dust to working parts of engine, the driving of a fan for supplying air to furnaces apparently requires no more attention than the working a centrifugal pump for supplying water of condensation to marine engines.

General remarks.—From the experience of the continuous working of this system of combustion for upwards of seven months at sea, with inexperienced firemen, and under conditions that have made the test more severe than would probably often occur in other trades, the advantages anticipated, and which were claimed by Mr. Howden in his paper on his system of combustion, read at the Institution of Naval Architects, have been realised in a very high degree. These claims, shortly stated, are:—(1) Increased power from smaller boilers, combined with large saving in fuel; (2) reduced wear and tear of boilers and fittings; (3) perfect control of combustion; (4) coolness of stokehole and absence of smoke.

Increase of power combined with economy.—Hitherto it has been the experience in using forced combustion that any considerable increase in power must be largely paid for in increased consumption of coal. The experience of the New York City shows, on the contrary, that with Howden's system a large increase of power can be obtained with much less expenditure of fuel per horse-power than is required for combustion by natural draught. There has not been occasion to test the highest increase of power practicable in the New York City, though, in the trial on the Clyde, the engines were run as high as 64 revolutions, while the coal which was being weighed out at the time indicated no lessened economy. On the present outward voyage on the run to Dartmouth, May 30th, diagrams were taken with the engines again running at 64 revolutions, and indicating 760-horse-power, which, being upwards of 20 indicated horse-power per square foot of fire grate, is a higher rate of power than, so far as I know, has ever been accomplished outside of torpedo boat trials and locomotives. I may say, so far as my experience of the New York City can guide me, I see no reason why a still higher rate of power should not be worked at on this system of combustion without injury to the boilers or reduction of its unique economy.

Less wear and tear of boiler and fittings.—The test of the working of the boiler in the New York City in these voyages has been from a conjunction of circumstances more than usually severe. The voyage is a prolonged one in a hot climate, and in these cargo steamers the working of the boiler and apparatus must necessarily be left very much in the fireman's hands. Besides this, owing to the discharge from the circulating pump being combined with the discharge from the air pump, a leakage of the sea water to hot-well occurred during these voyages, requiring a more or less frequent blowing off of water from the boiler. It has also happened from circumstances affecting the movements of the steamer that on neither of these voyages with forced combustion did the boiler receive any supply of fresh water while abroad, so that with the exception of the supply before leaving Glasgow in October, 1884, and London in March, 1885, the steamer had to fall back for seven months entirely on salt water, blowing off and filling from the sea when necessary. The non-injurious effect of this system of forced combustion has therefore, from these special causes, been tested in a manner exceptionally severe.

Perfect control of combustion.—This is a very valuable feature. The combustion is controlled by the movement of a handle, and when the engines are stopped no steam is wasted by blowing off at safety valves, as the closing up of the air valves entirely stops combustion, and the vessel may lie under steam for hours without waste of fuel and ready for immediate movement.

The absence of smoke and coolness of stokehole are very marked features in the working of the boiler, and it may be further stated that no more attention is required in working a boiler on this system than in working an ordinary boiler. It is not found necessary to shut the air valves to the furnaces in firing. Priming has been entirely unknown.

In conclusion, the highly successful working of this system of forced combustion with inexperienced hands without trouble and with the great economy experienced, proves it possesses merits of the most important character bearing on steamship working and economy, and which should in my opinion lead to its general adoption.—Yours faithfully, D. NICOLSON.

USE OF OIL TO QUIET THE WAVES.

THE Hydrographic Office has been collecting data to determine under what circumstances the use of oil is most efficacious in diminishing the danger of breaking seas during gales of wind. Masters of vessels are requested to make experiments in this matter whenever the opportunity occurs, and report the results to one of the Branch Hydrographic Offices, or directly to the Central Office at Washington. When sufficient data have been collected a pamphlet will be issued giving such directions in regard to the use of oil as the common experience of seamen may determine to be the best.

The following accounts have been received lately:—Captain R. S. Thompson, ss. Sacrobosco, reports using oil in 1880, and twice during the month of February, 1885. In each instance, after getting his ship before the wind, he put over oil bags with the best results. In the first case the engines were slowed so as not to lose too much to leeward, and it was proved clearly that with the use of oil it is not necessary to run as fast as is generally supposed. Captain Smith, of the English bark Emma, used refined petroleum during a gale in which his vessel was abandoned. He found it entirely useless, although barrels of it were emptied to windward, and seven or eight bags of it were towed alongside. About five gallons of crude turpentine or pine oil was used with good effect as long as it lasted. Captain Geddes, of the s.s. Erato, in February, 1885, instead of heaving-to during a favourable gale, concluded to run. He shipped some very heavy seas, which did great damage until the oil bags were put over, when the ship ran comfortably with the decks perfectly dry. Captain Daniel Thomas, of the British barkentine Corisande, in January, 1885, during a gale, while lying-to, was boarded by a heavy sea which washed one man away and disabled the vessel, which lay in the trough of the sea. Men were stationed immediately to pour oil overboard until bags could be prepared and the vessel secured. When this was done she was easily got before the wind and ran very comfortably. Captain Johnson, of the English steamer Emerilda, reports using oil bags with excellent effect, during a heavy north-west gale, on his last voyage from Port Royal to Liverpool. Captain Moore, of the British bark Siddartha, says that during the last four years he has frequently used oil bags when hove-to or running, and has invariably found they made a wonderful change in the nature of the sea. His system is to fill a coarse bag with oakum, thoroughly saturated with oil, and to hang it over the weather bow, if hove-to, or to the bumkins, if running. Chief Officer John Matson, of the English steamer Edinboro, in 1881, while lying to in a mountainous sea in the Bay of Biscay, placed two oil-bags overboard forward with the best results, the oil effectually preventing the sea from boarding the ship. Captain Scott, of the English s.s. Briscoe, during a recent passage from Baltimore to London, experienced heavy gales from WNW. to WSW., with high seas sweeping over the ship. He filled two canvas bags with oil and towed them over the stern with excellent effect, as they prevented the seas from boarding the vessel. Captain Mumford, of the British s.s. North Anglia, in October, 1884, during a hurricane, had his main wheel gear carried away, and was obliged to steer aft. After the men had been washed away several times he tried oil and had no further trouble. Again, in February, 1885, while hove-to, he poured oil through a pipe on each side of the forecastle. Oakum was put loosely into the pipes to prevent the oil running too quickly. After commencing the oil no dangerous water was shipped. Mr. G. Foster Howell, of New York, sends a very interesting account of the use of oil while off the Horn in the ship Cavalier in 1876. The ship had been run too long, and heavy seas were constantly boarding her. At last one more powerful than the rest rushed upon her with awful violence and started the deck. At the writer's suggestion oil bags were towed overboard with about 25ft. of line, one on each quarter and one amidships. "No sooner had the oil commenced to leak than the sea ceased to boil and rage, and the waves became so harmless that they no longer broke upon us."

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, June 27th.

THE showings of railroad companies and all manufacturing interests for the half-year, so far as have been made known, are favourable. The railroad managers throughout the country are rapidly harmonising differences, and it now seems probable that the cutting of rates, which has characterised railroad management for months past, will be almost altogether discontinued. On several lines an advance in freight rates has already been made, and at some places agreements have been entered into which will be maintained during the autumn months. In the smaller industrial establishments throughout the country an increase of work is observable, such as in car works, machine, boiler, and engine shops, steel works, hardware establishments, wire works, and a host of little establishments representing from 50,000 dols. to 100,000 dols. capital. The downward tendency in prices still continues. Firmer prices are looked for during July. A great many requirements will be presented which will be withheld until the turn of the half-year. More active railroad construction will be inaugurated. Rail makers have inquiries for large quantities of rails for new lines. Small lots of rails are selling at 27 dols.; old rails are in active request at 17 dols.; old steel rails, 15 dols. But little business has been done in spiegeleisen, ferro-manganese, or English Bessemer. Home furnaces on Bessemer are doing well. The bar mills throughout the country have started up, and the probabilities are that there will be a steady run for the summer on a basis of 1 dol. 40c. for common iron to 1 dol. 60c. for medium. Refined cast steel is 8½c.; Bessemer, 3c. Bridge builders are placing orders for plate and bridge iron at 2c. to 2·15c. Beams and channels are firm at 3c. Wrought pipe mills are working full, with the prospects of abundant business to meet requirements for natural gas, water, and steam. Crop reports are less favourable. The wheat yield will be 360,000,000 bushels, against an average of 500,000,000 bushels. In other staple products a full crop is guaranteed.

Preparations are being made for an increase of production of pig iron in Eastern Pennsylvania. Some of the strongest companies there are piling up stocks rather than sell at present prices. A slight improvement in crude iron is looked for. Present tide water quotations are 15 dols. for forge, 16 dols. 50c. for No. 2, and 17 dols. 50c. for No. 1; Bessemer, 18 dols. to 19 dols. Ferro-manganese is offered at 70 dols. for 80 per cent. Domestic slabs are selling at 30 dols. to 32 dols. Cargo scrap is offered at 16 dols.; steel rails, 26 dols. to 28 dols.; light sections, 30 dols. to 38 dols., according to weight. Only current requirements of all kinds are being fulfilled. The movement in general merchandise is sluggish. Jobbers and brokers report unsatisfactory developments of the autumn trade. Several bridge iron markets have received important orders. The thirty-four nail factories of the Western Association are idle, in consequence of the dispute over wages.

RAILWAY MATTERS.

THE short railway joining the main lines of the London and South-Western and London and Brighton and South Coast Companies, within 400 yards of the pier at East Southsea, was recently completed. The line is one mile three furlongs in length, and the first sod was turned in March, 1884.

SUBSCRIPTIONS are being invited for the construction of a new railway to be known as the Liverpool, Southport, and Preston Junction Railway. The offices are at 22, Great Winchester-street, E.C. The only piece of new line in the system is between Hillhouse and Southport, the remaining distances being run on existing lines.

THE Delaware and Hudson Canal Company, which operates 634 miles of railway in New York and Pennsylvania, has decided to test all its trainmen for colour blindness. The tests given are the same as those followed by the Pennsylvania and other railway companies, and consist in matching a few colours by selecting yarns. There is no complexity whatever about the operation, and no man with ordinary vision fails to pass the test satisfactorily. Coloured signals are becoming so universally used now that railway companies are compelled by the interests of safety to make sure that their trainmen are capable of distinguishing colours.

AN accident occurred near Castletownroche Station, on the Great Southern and Western Railway, Ireland, on 30th June, to the passenger train leaving Lismore at 5 p.m. for Mallow. The left-hand connecting rod broke, and in violently striking the motion plate and sleepers was again broken near the centre. The end remaining on the crank axle was thrown round by it, and pierced a hole through the inner and outer fire-boxes, and through the barrel of the boiler. No injury was received by any of the passengers, but the fireman was slightly scalded about the hands, and the driver had one of his legs broken in getting away from the escaping steam.

THE down portion of the main line station on the North-Western Railway at Rugby has been opened. The platform at the junction is the largest "island" platform in England, being over a quarter of a mile long and 37 yards wide. In the centre is a three-storey pile of buildings, comprising the necessary offices and a refreshment-room 90ft. by 40ft. The signal-box at the entrance has 180 levers on a patent interlocking system, and the signal-boxes and platforms are provided with telegraphic and telephonic communication. The Stamford line, under the deviation scheme, runs over a viaduct of thirteen arches, 45ft. high, and the Northampton line over sixty-five low arches. It will be many months before the station is finally completed.

THE following old style train orders are given by the *Railroad Gazette*:—Mr. Andrew Quintin, of Trenton, N.J., one of the oldest conductors in the country, was a delegate to the recent annual convention of the Passenger Conductors' Life Insurance Society of the United States. He displayed before the convention a sample of the orders issued to him as a conductor in 1845, as follows:—"Instructions — Trenton and Pennsylvania Railroad. Line 3—Philadelphia, December 12th, 1845. To Andrew Quintin: Sir—You will leave Trenton at 7, Bordentown 7.30, and Burlington at 8 o'clock a.m. If no flag is up, remain on turnout till C. & A. R. R. line passes, and if no line is in sight when you get to Dank's, proceed on carefully with a man ahead at (curves), and give New York line the preference, and then continue on to Camden at regular speed; if you can get there by 9.28 (regular time to be there 9.20). If you cannot reach there by 9.28, stop at the deep cut if you get there by 9.35, and remain till 9.50, if mail pilot line does not arrive. If you cannot reach deep cut at 9.50, stop at Fish House turn-out till 9.55. If no line in sight, then proceed to Camden with man ahead as before.—Wm. H. Gatzmer. P.S. You will regulate your watch by the office clock in Philadelphia and you will take water at Rancocas when there is water there."

A STRIKE of tramcar drivers and conductors has been proceeding in Philadelphia. After laborious exertions by the police, the Chicago Tramcar Company succeeded in running six cars three times over one line on Friday last. The street was crowded with spectators, who maintained an orderly demeanour, but occasionally uttered jeering cries. The company found, however, that no one would enter the cars excepting the police. About sunset all the cars were withdrawn, and it was stated that the traffic would not be resumed till to-morrow. Quietness was then restored. No cars were run on Monday or Tuesday, as the Mayor needed the police elsewhere. He could not, owing to the necessity of patrolling the streets on Independence Day and again to-day, furnish an adequate guard for the tramcars. The strikers regarded this state of things as a victory. They had the general sympathy of the public, and large mass meetings were held advocating their cause. One man has died from injuries received during Friday's affrays. Yesterday's despatches, however, brought the news that the strike has been compromised, order is restored, and the cars are once more running. The company has yielded to the men on strike, finding it impossible to work the line, even with the aid of the police. Popular sympathy has throughout been exhibited with the men.

IN 1881 the management of the Pennsylvania and Reading Railroad issued an order to the mechanical department of that road that they should put on for trial any automatic car coupler any inventor might desire to have tested in train service. The *National Car Builder* says: "The result of this order was an enormous immigration of car coupler inventors to the Reading shops, all supplied with their pet devices. The crucial test of trial in ordinary train work soon showed that most of the devices were worthless, but a few good ones went through the ordeal successfully, and are now candidates for adoption. The mechanical officers of the Reading road learned a great deal about automatic car couplers during the four years that the practice of testing couplers was followed. Some couplers that appeared perfect in the models and drawings proved utterly worthless in service, and others that had an impracticable look in the models did surprisingly well on real cars. At one time there was lying in the Reading shop yards between four and five tons of castings of impracticable car couplers waiting to be claimed by their owners. The result of the training the mechanical department of the Reading Railroad received at this time was to make them very cautious about venturing an opinion about the merits of a car coupler till they see it tried in actual service.

THE first section of the Barrow-in-Furness Tramways was officially inspected by Major-General Hutchinson, R.E., of the Board of Trade, on Friday last, the 3rd of July, and it is expected that the certificate will be received in the course of a few days. The line, which has been well laid and appeared to give every satisfaction, commences on the Abbey-road not far from Furness Abbey, and passes along Abbey-road, Duke-street, Strand, and Salthouse and Roose-roads, and terminates at Roose; the total length being about four miles. The wide streets and roads of Barrow render the town particularly well adapted for tramways. The greater length of street through which the tramway is laid being 80ft. in width, a portion of the same about half a mile in length has just been completed by the Corporation. The gauge of the tramways is 4ft.; the rails are Gowans, manufactured by the Barrow Steel Company, weighing 84 lb. to the yard, and the paving is laid with Welsh setts except on one or two steep gradients. The general construction of the line has been carried out by the Barrow Tramways Company in accordance with the specification prepared for the Barrow Corporation by Mr. Fox, the borough engineer, which determines the gauge, the rails to be used, and the quality and method of paving and general mode of construction. Mr. Vawser, of Manchester, has acted as engineer of the lines for the company, and Mr. Pritchard, of Birmingham, for the rolling stock and depôts, Mr. Fell, of Leamington, being the contractor. Steam is to be the motive power. The engines being manufactured are by Messrs. Kitson of Leeds.

NOTES AND MEMORANDA.

THE census of the population of Austria at the close of 1884 has just been published. The total was 22,864,106, of whom 11,170,468 were males, and 11,693,638 females. The number of men serving in the Army and Navy was 162,423.

CRUCIBLES of nickel have lately been adopted in some chemical laboratories, in the place of the silver ones generally used for melting caustic alkalis. The "Journal" of the Society of Arts says they have given good results, and have the advantage, not only of being cheaper, but of being capable of resisting a higher temperature than the latter.

IN distilling equal volumes of benzol and water, successively, in the same apparatus and at the same temperatures, it is found that different weights of the two substances pass over in a unit of time. Extensive experiments with water, benzol, chloroform, &c., show that the times for equal weights, at the boiling points, are very nearly in inverse proportion to the molecular weights.

THE waste cuttings of cork are now being employed for making bricks, which can in some situations be used for walls, which are subject to dampness or to heat. The cork cuttings are reduced to powder in a mortar, and mixed with clay, and from this composition the bricks are made in the usual way. When dried, they are capable of resisting a crushing strain of 51·08 lb. per square inch. They are very light, having a specific gravity of 0·35. If such bricks can be made they no doubt would have some application, but what becomes of the cork when the brick is baked?

THE total number of blast furnaces built in England, Wales, and Scotland to June 30th, 1885, was, according to "Ryland's Iron Trade Circular," 899; total number of furnaces in blast June 30th, 1885, 428; decrease in the number of furnaces built since March 31st, 1885, 9; decrease in the number of furnaces in blast since March 31st, 1885, 0; the furnaces blown out since March 31st, 1885, were 13 in number; the furnaces blown in since March 31st, 1885, 13; furnaces pulled down since March 31st, 1885, 9; furnaces being built at present time, 13; furnaces being re-built at present time, 4.

IN a recent communication to the Physical Society of Berlin, Herr Kayser read a note concerning his experiments on the condensation of gases on surfaces, and Bunsen's criticisms thereon. In a paper published last year Bunsen had declared that the previous results under this head were erroneous, inasmuch as the observers had proceeded on the false assumption that a maximum of condensation was attained in a few hours or days, Bunsen himself finding that the condensation might go on slowly for years. Herr Kayser, however, had in reply pointed out that Bunsen had not been sufficiently careful in cleaning the glass surfaces on which his experiments were made, and he now had the satisfaction to announce that Bunsen, after repeating his experiments with the necessary precautions, had arrived at the same conclusion as himself, namely, that there was no demonstrably slow condensation, but that the maximum of condensation was reached with extraordinary rapidity.

A PAPER in the *Comptes Rendus* on "Alloys of Indium and Gallium," by M. L. de Boisbaudran, says that although the alloys of aluminium with gallium are readily decomposed by water, yet the alloys of gallium with its analogue indium remain unaltered, and require *aqua regia* for their complete solution. The determination of their points of fusion presents some difficulty, inasmuch as they pass through an intermediate pasty condition before liquefaction. An alloy containing two atomic proportions of indium and one of gallium begins to soften at 56 deg., and is completely melted at 75-80 deg.; alloys containing one atomic proportion of indium with one, two, and four proportions of gallium respectively begin to soften at 16·5 deg.; above that point, liquefaction proceeds more rapidly than even that of gallium. These alloys are soft, and, according to the "Journal" of the Chemical Society, of a white colour, but acquire a bluish tint on addition of a further quantity of gallium; they are only dissolved to a very slight extent by dilute hydrochloric acid.

MM. FOL ET SARASIN have published a paper on the depth to which the light of the sun will penetrate into the sea. In November last they recounted the results of their experiments on the same subject in the Lake of Geneva. The present paper describes similar experiments made in the Mediterranean off the zoological station and harbour of Villefranche. By means of photographic plates they have proved that in the month of March, in the middle of a sunny day, the rays of the sun do not penetrate beyond 400 metres below the surface of the Mediterranean. This is established by seven separate experiments, at varying depths and different hours of the morning. At 380 metres, shortly before 11 a.m., the impression on the plate was less than that which would have been left on exposure to the air on a clear night, without a moon. Between 1.20 and 1.30 p.m., at a depth of 405 to 420 metres, there was no trace of any impression whatever on the plate. Light clouds do not appear to cause any notable diminution in the depth to which the light penetrates. *Nature* says they also undertook a new series of investigations to determine the effect of the season on the penetration of light in the Lake of Geneva. They give 200 metres as the extreme limit for winter in the lake; but they found that there is as much light at 380 metres in the Mediterranean as at 192 metres in the Lake of Geneva; and by a comparison of these with previous experiments, it appears the light penetrates from 20 to 30 metres deeper in March than in September; in the month of August, perhaps the difference is a little more. Compared with the series of plates exposed in the lake, those of the Mediterranean are characterised by a slower and more regular gradation. This gives rise to the idea that while in the lake the light would be promptly intercepted by the deeper layers, more or less disturbed or muddy, in the Mediterranean the absorption proper to pure water would be the principal, if not the sole factor in arresting the luminous rays.

THE physical conditions involved in the injection, extrusion, and cooling of igneous matter, formed the subject of a recent paper by Mr. H. J. Johnston-Lavis, M.D., F.G.S., &c. *Nature* gives the following abstract:—"The great disproportion between the displays of volcanic activity in the same volcano at different times, and between the eruptions of different volcanoes, is a subject deserving the most attentive consideration. The violence of a volcanic outburst does not bear any relation to the quantity of material ejected. The union of water with lavas may be compared with the solution of a gas in water; but there is reason to believe that in their deep-seated sources lavas contain little or no water. If igneous matter be extruded through dry strata the eruption might take place without explosive manifestations. But if igneous matter be extruded through water-bearing beds, a kind of dialysis would take place between the igneous and aqueous masses. In this way the tension of the steam in the fluid rock may at last become so great that a fissure will be formed at the surface and volcanic action will follow. In their way the violence of a volcanic eruption will be determined by the quantity of water contained in the strata through which the lava passes in its passage to the surface, and by the temperature at which it reaches the surface. This theory explains the acknowledged sequence of volcanic outbursts of different degrees of violence, and the intervals which occur between them. It also explains the differences between the central and lateral eruptions of a great volcano and the phenomena attending its extinction. The structures of the igneous rocks, whether of basic or acid composition, are greatly modified by the presence in them of volatile ingredients. The succession of events indicated by the structure of Monte Somma and Vesuvius, Roccamonfina, Monte Vulture, and Monte Nuovo show that after a long cessation of volcanic activity we have an extensive production of fragmentary and scoriaceous material, and that this is gradually succeeded by the eruption of lava streams. The water and other volatile substances, such as sulphates and chlorides, which are given off abundantly in volcanic eruptions, may act as solvents for the various minerals which constitute lavas."

MISCELLANEA.

THE Bower-Barff Rustless Iron Company, Limited, notify change of address from 23, Queen Victoria-street, London, E.C., to Broadway-chambers, Westminster, S.W.

IT is said that the applications for space and concessions at the American Exhibition to be opened at Earl's Court, London, on May 1st, 1886, are arriving in great numbers.

A FEW days ago the *Times* described what it called an auto-accumulator, accredited to Mr. Jablochkoff and so constituted as to be a sort of perpetual motor, a character not likely to commend it.

THE foundation stone of the new pier, which will provide a fisherman's harbour of refuge, was laid recently at Newlyn, Cornwall. The cost of this pier will be £16,000, which sum has been lent by the Penzance Bank to the fishermen.

SOME very fine belts for a large electric lighting installation have been recently on view at 39, Queen Victoria-street, by Mr. J. Okes. They are 31in. and 24in. wide, and about 100ft. in length, of three thicknesses for the engine belts, and the dynamo belts are of the link type 24in. and 10in. in width.

IT is officially notified that classes of instruction in military engineering will be formed at the School of Military Engineering, Chatham, on the 4th proximo. They will comprise a field-work and surveying class of three and a-half months for officers, a pioneer class of five months for non-commissioned officers and men, and a field-work class of ten weeks for non-commissioned officers.

MESSRS. ROBERT NAPIER & SONS, of Glasgow, have received and order to build engines and boilers for several of the larger vessels of the Russian fleet. These contracts, together with the two belted cruisers they are to construct for the British Admiralty, and several vessels for the Eastern Telegraph Companies and the mercantile marine, will keep Napier's yards busy for several years to come.

MESSRS. MERRY AND CUNNINGHAME, of Carnbroe, Glengarnock, Ardeer, and Cannon-street, London, have nearly completed an extensive plant for producing steel by the basic process, at their Glengarnock ironworks, capable of producing 1500 tons of ingots per week, which they will roll into billets, blooms, slabs and plates for boiler making, shipbuilding, and other structural purposes. The works will be in operation very shortly.

THE Philadelphia correspondent of the *Times*, telegraphing on the 8th inst., says:—"The ironworkers on strike took full possession of the city of Cleveland yesterday. They marched to the various ironworks, compelling the managers to close them. One ironmaster was attacked and severely beaten. The police are apparently unable to cope with the situation, and the Militia were assembled at the armouries to-day ready for any emergency."

THE Admiralty have decided to arm the Swallow, now under construction at Sheerness, with eight 5in. breech-loaders mounted upon the Vavasseur system. A doubt, however, has arisen as to whether the broadside guns can be conveniently worked inside the shield as at present arranged. In order to clear up the doubt it has been deemed advisable to have a shield of the proposed size and shape set up in the Blazer, gunboat, and arrangements are to be made accordingly.

THE country spent a very large sum of money on the Challenger Expedition, and now that the narrative has been published, it has been done under the red-tape rule for dry-as-dust reports, and to cover the cost of production no less than £6 16s. 6d. is being charged on the 750 copies published. Here is a book the materials for which were obtained at public expense, being published at a price which precludes 99 per cent of those who would like it from even a hope of getting it. Government encouragement of scientific research will not gain much public favour this way.

A WELL-KNOWN London builder, on being asked by a self-important customer for men to do certain work immediately, said "yes, I keep men hung up on pegs ready for what any impatient customer thinks an emergency." The Sultan of Morocco seems to think engineers are obtained much the same way. The *Temps* states he has authorised the Moorish Embassy, as they are in Paris, to make use of the opportunity, and take back with them on their return to Morocco a few French engineers, in order to commence plans for the construction of a harbour at Tangiers.

THE death is announced, at the age of sixty-two, of Mr. Henry Johnson, sen., of Dudley, a mining engineer of considerable repute. The deceased gentleman had been seriously ill for some months. Mr. Johnson devoted much of his time and influence to assist in establishing the Dudley and Midland Geological Society and the South Staffordshire and East Worcestershire Institute of Mining Engineers, of both of which bodies he had been president. Mr. Johnson's most important services as a mining engineer appeared in the scheme which he inaugurated fourteen years ago, for opening up a coalfield nearer to Birmingham than before, and which resulted in the formation of the splendid Sandwell Park Colliery.

THE Adelaide Chamber of Commerce had, at departure of recent mails, the *Colonies and India* says, given considerable attention to the question of outer harbour accommodation. Mr. Phillips, of the firm of Messrs. George Wills and Co., who expressed satisfaction at the success which had attended the efforts of his firm to take a large ocean steamer up the Port River, and load her at the Port wharves, had given it as his opinion most decidedly that this sort of thing was only commercially practicable in cases where the whole cargo of the vessels was brought to and taken from South Australia. No steamer which had only to land a portion of its cargo at that port would find it profitable to wait for the tide, make its way up the stream, and then wait for a tide again with which to go out of harbour. The inference was that under present conditions the colony had absolutely no harbour accommodation for the largest, fastest, and most important class of steamers which visited South Australia.

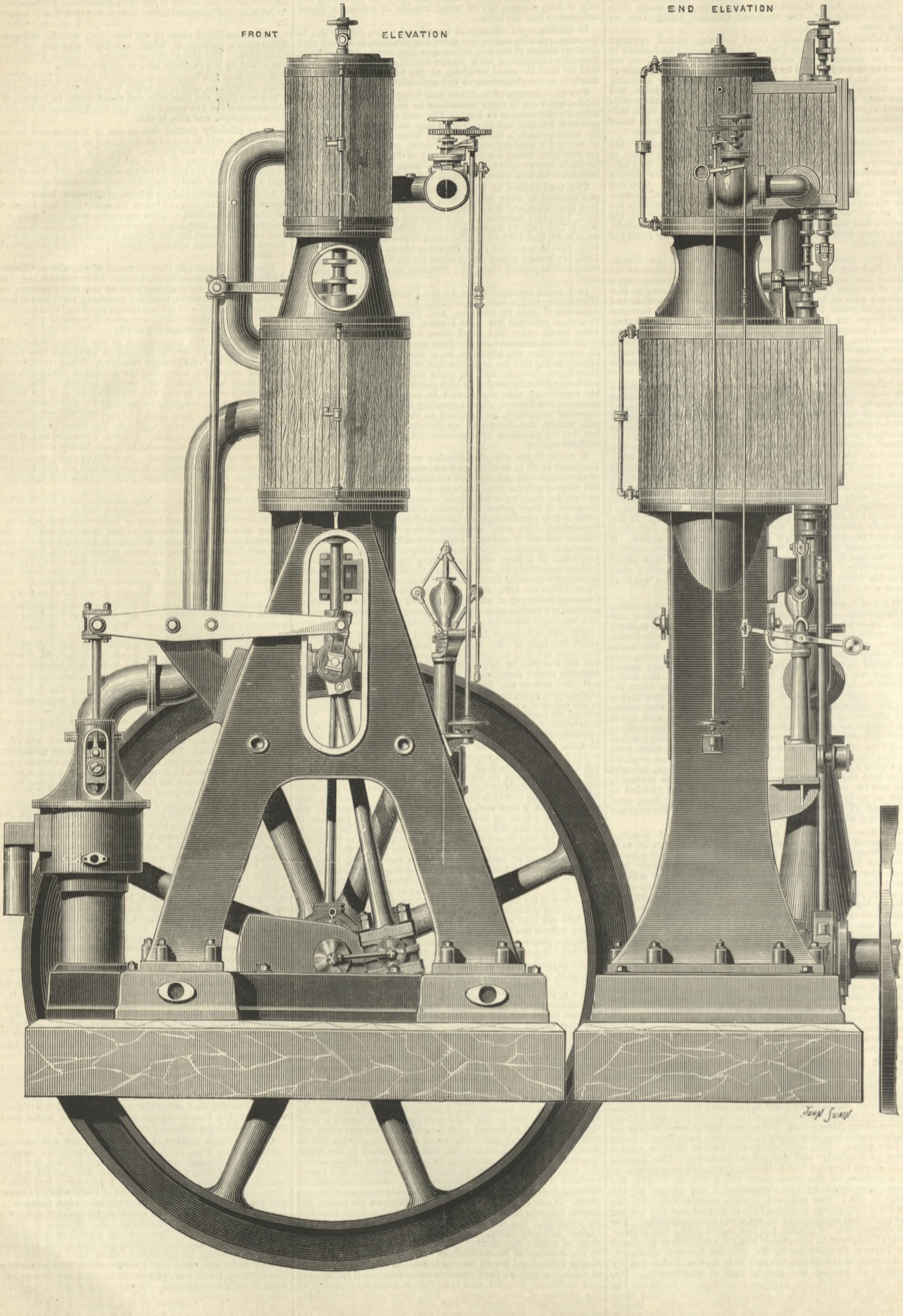
THE Berlin correspondent of the *Standard* says: "The first experience which China has had of the results of ordering iron-clad war vessels in Germany has been such that she is hardly likely to repeat the experiment in a hurry. The three vessels which started from a German port last week, and which are sailing under the German trade flag for China, were ordered in this country some years ago. They will only arrive at their destination, so to speak, after the feast. The vessels ought to have been delivered in China before the outbreak of the late war with France, where their services were urgently needed and so cruelly missed. Owing to the backward state of the shipbuilding industry and the dilatory habits of German manufacturers, these boats were only finished 'just in time to be too late.' They could not get out to the East before the war, and accordingly, during the whole of the Franco-Chinese struggle, two of them have been rusting and lying idle in a German harbour."

OF the large number of ingenious devices for automatically extinguishing fires, which produce most excellent results under carefully conducted experimental trials, very few are afterwards heard of producing similar results under the actual condition for which they have been designed. Last week, however, one of these inventions gave a good account of itself when it came under the real test of an actual outburst of fire. This invention, which is the Parmelee automatic sprinkler, manufactured by Messrs. Mather and Platt, of Manchester, the details of which have already been fully described, had been placed in a mill at Bolton. At this mill a fire suddenly broke out last week, and was apparently spreading beyond control, when the sprinkler automatically came into action, and a shower of water was thrown upon the burning machinery, with the result that the flames were very soon totally extinguished. There is little doubt that but for this automatic arrangement the mill, which contains 34,000 spindles, would have been destroyed, as the workpeople had been compelled to save themselves by flight. As it was, the damage done was comparatively trifling.

FIFTY-HORSE POWER VERTICAL COMPOUND MILL ENGINE.

MESSRS. SPENCER AND CO., MELKSHAM, WILTS, ENGINEERS.

(*For description see page* 35.)



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

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

C. E. C.—*Jenkin & Ewing's paper "On Harmonic Analysis of Certain Vowel Sounds," Trans. Royal Soc., Edinburgh, vol. xxviii., year* 1879.

J. D.—*We do not think the game would be worth the candle, as the tightening gear would hardly ever be used. A very similar device was employed in the old-fashioned marine engine with hemp-packed pistons, to tighten the junk ring without taking off the cylinder cover.*

W. T. F.—*There will be a lateral strain equal to the lateral effort on the pinion or trundle driving the mill. That, you will see, is pushed sideways when the mill is at work; just as much as it is pushed one way, the axle of the horizontal wheel will be pushed the other way. The carpenter is right.*

T. C.—(1) *We cannot do better than advise you to read Tyndall's "Heat as a Mode of Motion." It would take more space than we can spare here to answer your question intelligibly. As a matter of fact, energy is not lost by an elastic fluid flowing through a contracted orifice, provided the conditions are suitable.* (2) *It is not economical to control a steam engine by wire-drawing steam, but there is reason to conclude that the loss incurred in this way is not so great as some engineers suppose.*

TAPIOCA MACHINERY AND PLANT.

(*To the Editor of The Engineer.*)

Sir,—I shall be obliged by any correspondent who will send me the names of the manufacturers of machinery and apparatus for the preparation of tapioca. H. J. W.

London, July 6th.

SQUARE WROUGHT IRON GASPIPES.

(*To the Editor of The Engineer.*)

Sir,—I shall feel obliged if any of your readers can tell me the address of a firm in England which produces, or keeps on hand, square gaspipes of wrought iron: inside width, 6, 10, or 12 mm., or in other dimensions.

Vienna, July 2nd. J. C. A.

COPYING PROCESSES.

(*To the Editor of The Engineer.*)

Sir,—I am desirous of obtaining the latest method of copying letters—that is to say, of a person's own handwriting. I have been using the multiscript or multigraph—a gelatine tablet—but would prefer having a machine that did not require any washing after using. I would feel greatly obliged if any of your readers would kindly give me particulars as to where I could obtain a portable machine capable of being easily worked by one person, and of producing from 100 to 300 copies on ordinary writing paper. W. A.

Sydney, N.S.W., May 28th.

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DEATH.

On the 25th June, at Mount-street, Dublin, James Carlile Kertland, District Locomotive Superintendent, East Indian Railway, Jumalpore, engal, youngest son of the late William Kertland, aged 52.

THE ENGINEER.

JULY 10, 1885.

THE DOLPHIN.

In our last impression we published the report of a Board of experts appointed to examine the United States cruiser Dolphin and report thereon. We have now before us a statement of the particulars in which the ship is found wanting, and although we fail to find in them a justification for the sweeping condemnation that has been passed upon the ship, her defects are bad enough. Summed up in a few words, these defects consist in structural weakness, miserable leaking decks, and improperly arranged steering gear. For the decks no justification can be pleaded; and Mr. Roach, the builder, is, it is said, ready to make good all defects. The steering gear, too, is to be altered. It is proposed by the Board of Examiners that the hull should be strengthened, and this also may no doubt be done. When even all the improvements and alterations have been made that it seems possible to make, the vessel will be, we think, unsatisfactory, and the United States Government will find themselves in possession of a slow and weak ship, carrying one small gun. It is not very easy to see what purpose such a craft can serve. In still water when hard pushed she has barely made 15 knots, and her sea speed cannot be more than 13 knots, probably it will be about 12 knots. This is much too slow for a despatch boat; as a fighting ship she is of course entirely useless.

The contest about the merits and demerits of the Dolphin has now become a party question. The last Secretary of the Navy was Mr. W. E. Chandler, the present Secretary is Mr. Whitney. This gentleman denounces the Dolphin, and Mr. Chandler defends her, or rather Mr. Roach. "It is clear," he writes "as the sun at noonday that Mr. Roach is responsible only for good workmanship. The law of August 5, 1882, authorising certain ships and creating the Naval Advisory Board, provided that neither of the vessels should be 'contracted for nor commenced until full and complete detail drawings and specifications thereof, in all its parts, including the hull, engines, and boilers, shall have been provided or adopted by the Navy Department, and shall have been approved in writing by the said Board, or by a majority of the members thereof, and by the Secretary of the Navy.' This provision of the law was complied with, and Mr. Roach bid upon the designs of the Navy Department, and, justly and properly, was compelled to guarantee only good workmanship. He guaranteed neither speed, horse-power, nor anything else, except that the materials should be 'first-class and of the very best quality,' and well and faithfully put together, according to the plans and specifications of the Department and under the inspection and supervision of the Naval Advisory Board. There is no 'looseness of the contract' nor 'absence of effective stipulations,' as Mr. Whitney asserts, but all the provisions are to be found necessary to carry out the fundamental idea upon which the contract was based, namely, good work on Mr. Roach's part applied to the Department designs." This, it will be seen, is intended to exculpate Mr. Roach at the expense of the designers of the ship. The result will be much the same in either case to the American taxpayer; and no matter what view we take of the matter, it is equally discreditable to the Government officials. If the specification and design of the Dolphin were unsatisfactory, so much the worse for the reputation of the designers. If, on the contrary, the ship has not been built up to the specification, then so much the worse for the reputation of those who inspected her during construction. It was well known that Mr. Roach took the contract at a very low price. "It is true," says the *Army and Navy Register*, "that our shipbuilders do not possess the vast facilities of Armstrong, Mitchell, and Co., and other foreign establishments, and it is also true that Armstrong, Mitchell, and Co. are not in the habit of bidding several hundred thousand dollars under the cost of vessels for the sake of obtaining the contract, as it is well known that Mr. Roach did in the new cruisers laid down in 1883. It was a foolhardy experiment on the part of Mr. Roach which we could never understand on any other theory than that he expected to be helped out by some sort of favouritism at the Navy Department. His loss on the Dolphin is relatively greater than on any of the other vessels, and doubtless the attempt to scrimp the work on that vessel has been greater than on the others." The unwisdom of placing an important contract under such conditions would deserve severe comment, if we were not all but certain that the designers of the ships in question never had any adequate notion of what such vessels ought to cost. The fact that Mr. Roach was not to receive full value for these ships made it imperative that the inspection should have been extremely strict; but we are led to believe that the Dolphin was not built under inspection at all. How else is it possible to account for the presence of defects thus particularised by the Bellknap Board:—"In the after transom three beams are supported by stanchions, rendering the deck above of doubtful strength to withstand the shock and strain of a heavy sea boarding the vessel at that point, a thing not unlikely to happen in scudding. In the same part of the hull two reverse frames are stopped short, and a space of about 4in. separates them from the reverse frame, continuing to the deck stringer above, thus weakening the frame at that important point." No inspector worth his salt would have passed such defects as these. Again:—"The planking of the berth deck is of inferior quality, rough and knotty in various parts, some places indicating sap, and caulked in so poor a manner that the entire deck would leak like a sieve in case it became flooded with water, and so damage or destroy the perishable stores and equipments stowed below it, in the hold, store-rooms, sail-room, bread-room, and the like. The Board was unable to find more than two thin threads of oakum in any of the seams, the specifications calling for not less than three threads, and it was an easy matter to pull the threads out by the yard in various parts of that deck. Some of the seams in the cabin did not seem to have been caulked at all, and none of the seams of that part of the deck—cabin and wardroom—laid with white pine, are painted as required by the specifications." It seems that an attempt was subsequently made to caulk this deck, with the result that the whole deck was strained. The hatches could not be shut without difficulty, and the underside of the deck was split and splintered to some extent. It is, of course, absurd to say that the inspector who suffered such a deck to be laid did his duty. In the engine-room, again, we find that a wooden platform was interposed between the bed-plate of the engine and a second bed-plate laid, we presume, on the kelsons. This was a charming arrangement to begin with. To make it better, we learn concerning the holding-down bolts: "Each bolt was to be fitted with an iron filling in lieu of the wood, to make solid bolting, but the examination showed that some of the bolts lack such appliances, leaving to the wood alone the strain imposed by the working of the engine, the ultimate effect of which would tend to the loosening of the main connection and support." Again: "The supports to the shaft alley are not first-class in workmanship, the angles and brackets not being properly cut to fit down on the frame of the vessel so as to give the best support." We really cannot find fault with Mr. Roach's men if they scamped their work; the temptation to do it was more than human nature could stand. It is a remarkable fact that not one syllable is said in the report about inspection, and we are disposed to believe that there never was any. The theory seems to have been that the ship should be built first and inspected afterwards, which is a physical impossibility.

The whole transaction from beginning to end bears the stamp of the amateur. Of practical knowledge concerning the building or, even as it seems the buying of a man-of-war, there was none—of this the drawings of the cruisers and their engines, which we have published, give the clearest evidence. There was a general idea of what was wanted, but there was no intelligent perception based on experience of how it was to be got. The power stipulated for was too small to give the required speed except under very special conditions such as may no doubt exist on paper but not in reality. There is some reason to believe now that a better result would be got by altering the pitch of the screw, which appears to be too small, letting the engines run away, so to speak, faster than the boilers can supply steam. Nearly, if not quite, the same horse-power ought to be got with a slightly coarser pitch, and with a corresponding gain in speed. That is to say, more of the power is now expended wastefully than would be the case with better proportions. The addition of a few feet to the height of the chimney might make a very great difference. In a word, an experienced man could, we think, get more out of the engines and the ship than has been got out of them yet, or ever will be got while the gentlemen of the United States Navy have to deal with her. All that we wrote in the way of criticism concerning these ships has been justified in the case of the Dolphin at all events. It remains to be seen what will be the end of the other ships, namely, the Atlanta, Chicago, and Boston. The *New York Times* recently contained the following paragraph:—"Secretary Whitney expresses the confident belief that before long we shall have naval vessels worthy of our gallant navy, and he has caused plans for three new cruisers to be prepared. But how are we to get these new vessels? We may employ some one besides Mr. Roach to build them, but if the builder is required to follow specifications such as were given to Mr. Roach the ships will still be unsatisfactory. The truth appears to be that while we have had ample experience in building wooden ships, we have had little or none in building iron or steel ships. There is probably not one officer in the Navy who has any practical knowledge of iron shipbuilding, and Mr. Roach is about the only man who has built sea-going iron steamers on this side of the water. If we are to have good iron or steel ships we must have naval officers capable of making the drawings and specifications, or we must trust the work of designing as well as building to a competent builder; and where we are to find either the one or the other it is difficult to say." To this it is replied by other journals that there are various firms, such as W. Cramp and Sons, Harlem and Hollingsworth, and Pusey and Jones, who can do what is wanted. Far be it from us to say that they cannot, but we do say that they have had no experience whatever in building men-of-war of a modern type, and that even if they had they have not the proper workmen. Even in this country, it is well known that specially trained men are required to produce the particular quality of work put into men-of-war. They do not exist at all on the other side of the Atlantic. That Americans can build special types, such as river steamboats, better than any other nation in the world we admit; but they really do not know in any practical and with-ability-to-produce sense what a man-of-war is. Their proper course would be to pocket national pride; come to this country and order a man-of-war or two; send over to this country a few practical men who would watch the construction of this ship, and who would subsequently be able to form an opinion worth something as to whether American contractors and designers were or were not competent men. The ship herself would serve as a pattern, and would in any case be well worth a long price. Of course this advice will not be taken. The people of the United States have plenty of money. They do not feel the want of a Navy, and if they think it best to go blundering away in search of a man-of-war, we shall not complain. Only it would perhaps be as well that in future Americans should not boast too much of their powers of producing, let us say steel-shafting for one thing.

It is amusing to note that Secretary Whitney is determined not to be outdone by ex-Secretary Chandler. He has ordered designs to be prepared for a new war cruiser, and his schemes are ambitious. He has taken our own Inconstant for his model—not too happy a selection—and the new cruiser is to have a displacement of 5000 tons, and to steam 18 knots. She is to be driven by twin screws, and to indicate 7700-horse power, steam being supplied by fourteen boilers, 12ft. diameter and 10ft. 4in. long. She is to be fitted with four 8in. breech-loaders in semi-turrets, and six 6in. rifles on each broadside. She is to carry 850 tons of coal. There are also to be built a 3700-ton boat of the Mersey class and a 1600-ton Scout. The question is, Who is to build them?

THE BEARINGS OF LARGE MARINE ENGINES.

No subject, probably, is of greater concern to a sea-going engineer outside of his boiler-room than the condition of his bearings when running. Unremitting attention is required under all circumstances, and with machinery of the best design occasional trouble seems to be experienced from heated brasses. In the vertical type of engine which is at present almost universally adopted a very heavy duty is placed, even in ordinary fine weather working, on the bearings of the cranks and connecting rods by the weight of pistons and rods, especially in the case of tandem engines, where masses of many tons weight have the direction of motion changed several times in a minute; but when at the end of a long run any slight slackness is present, or bad weather induces racing, the conditions are much more trying. Placed as they are between large and comparatively rigid portions of the machinery, such as shafts and connecting rods, or shafts and entablature, brasses seem certainly likely to get the worst in the encounter if anything approaching hammering occurs. It is generally found on examining bearings that have heated that an alteration in figure has to be explained, and the heating is usually given as the cause; but a little consideration will show that, instead of this causing the change of shape in the brasses, the converse is more reasonable, and the change of shape causes the heating; for supposing a shaft to have such a vertical load on it as will cause failure of the brass by compression, the intensity varies from the middle, where it is greatest, to the sides, where it is *nil*—that is to say, the portion immediately under the shaft is the most compressed, and tends to bring the sides in. This is recognised by some engineers, who make it their practice to secure the sides of the brasses by substantial screws in such a manner as to prevent any closing on the shaft. Many of the well-known alloys give excellent results where the only requirement is a bronze of suitable hardness to best resist wear and reduce friction; but such mixtures are usually deficient in the other qualities necessary for purposes of machinery bearings, such as rigidity and resistance to compression. Where the harder alloys are used, they are frequently introduced in pellets, and are backed up by a brass of suitable strength and thickness; but the tendency in recent years seems to incline towards the use of substantial bronze or gun-metal bearings of simple construction, well cleared at the sides to prevent gripping, and of as ample surface as the space at the disposal of the designer will allow.

The softer alloys of the various so-called antifriction types have still their adherents, and bearings lined as directed by the makers have given excellent results; but if any failure at all occurs the quantity of metal lost is usually so large as to require a stoppage to be made and the spare bearings fitted, whereas with brasses made of the harder alloys a little slowing down of the engines, and some continuous attention, will generally avoid such necessity, and any metal that is lost by abrasion will not be more in amount than enough to perhaps cause a little knocking. If any of the abraded metal adheres to the shaft it is usually, too, less in amount than with some varieties of the antifriction metals; but it is obvious that no combination of materials will stand any but the very smallest amount of this action. With a fairly hard brass, however, a little trouble occurring at one part, say at one end, may be kept within reasonable limits with some degree of probability; but bearings lined with soft metal have sometimes been known to fail from end to end in a very short time, the soft metal simply melting out into the crank pit. The perfect material of which to construct large bearings has yet to be met, combining, as it should, good wearing and antifriction properties, and the somewhat opposite qualities of rigidity for preventing change of form and ductility for preventing fracture.

The constant use of water and oil, which are allowed to form an emulsion in the bearings, is so usual now-a-days in marine practice, that any remarks calling it into question amount almost to heresy. It has been pointed out, however, by persons qualified to speak with some amount of authority on the subject, that the bearings that can be worked without water show much the better surfaces. A shaft that has been working with oil lubrication only offers a better face for frictional purposes than one that has been running continually with salt water in contact with it. The corrosive effects of sea water on iron are generally apparent, although, from the nature of the conditions, small in amount. The fact of water being so generally used may be taken to show that necessity or convenience demands it, the latter being more probably true. If any tendency to heating is present, it is evident that, to carry off heat, water offers special facilities from its properties, and it can be applied on the surfaces directly where the frictional influences are active; whereas if conduction is relied on to carry off heat to the neighbouring and cooler portions of the structure, it will prove utterly insufficient. Water directed on the outside of a bearing will be found generally quite useless; with the higher powers and speeds now usual, any heat must be removed by water in absolute contact with rubbing surfaces. Under these circumstances, with good management, the quantity of water used is extremely small if applied uniformly. Where heavy pressure is present the lubricant should of course be of a nature to resist squeezing out; but many oils that possess this quality at ordinary temperatures become very fluid with a very slight increase, even the heat of the engine-room causing an amount of fluidity that is undesirable. Some varieties of the mineral oils lately introduced, of a heavy quality, give great satisfaction in use. Castor oil, too, in spite of its rather high price, is found economical when used in suitable quantities, which by careful attention may be very small indeed. Its consistency is such that it travels slowly through the wicks and keeps well in the bearings. A point of great importance in the design of brasses of large sizes is that of providing ample bearing surface in the bed plates; motives of economy sometimes suggest large portions being cast in such a manner as only to give support here and there by ribs or other projections. This will generally lead to trouble in course of time; for although the principal effort may be in a vertical direction, subsidiary influences are at work tending to cause a lateral or a rolling motion of the shaft in its bearings. The varying angle of the connecting rod and the centrifugal tendency of the crank arms and pin, when counter-weights are omitted, as is very usual now, both encourage side play in the brasses, which in time accumulates, and leads to great difficulty in keeping the adjustment correct, more particularly where the brasses are square sided, and perhaps not as well fitted originally as round brasses.

The practice of clearing away the sides of bearings, to prevent gripping and encourage lubrication, is sometimes carried to extreme limits, the crank-pin brasses in quick running engines requiring in particular a certain amount of effective surface at their sides. The advantage of some slight amount of end play in journals has been too often pointed out to require notice.

LOWER THAMES VALLEY MAIN SEWERAGE.

THE unsatisfactory state of sewage disposal as a branch of engineering has seldom been so clearly shown as it has been by the history of what has been known as the Lower Thames Valley Main Sewerage Board. The district being unable to arrive at a satisfactory method of meeting the requirements of the Thames Conservancy Acts, this Board was formed for the purpose of uniting into one large block the several districts of Richmond, the Richmond Union—including Barnes, Kew, Mortlake, and Petersham; Kingston-on-Thames, Surbiton, New Malden, East Molesey, the Kingston Union—including Hampton, Esher, Hook, Long Ditton, Thames Ditton, West Molesey, and Kingston Special Drainage District, Hampton Wick, Ham Common, Heston, and Isleworth. The whole of these were united in one large district for the purpose of making a main sewer for the use of all the constituent sections. The purposes for which the United District was formed were defined by the Provisional Order of June, 1877, and Confirmation Act of September, 1877, and it was ordered that the duty of the Joint Board should be to carry out these purposes within three years from the latter date. Years went by, and other orders were obtained, proposals were considered, eminent engineers called in to devise methods of uniting the districts and carrying out the sewage disposal works; committees of inquiry formed, schemes examined, heavy expenditure incurred, and finally, after nearly eight years lapsed and nothing arrived at, Parliament has been called upon, and has passed the Lower Thames Valley Main Sewerage Act, 1885, the chief purpose of which has been to dissolve the Joint Board, but at the same time to define the terms under which any two or more of the sanitary authorities of the constituent districts may be combined to form a united district, and the purposes for which such a combination may be made. Under the new Act, the constituent authorities are to be indemnified against proceedings for discharging sewage into the Thames for two years. The Local Board of Hampton Wick and the Surbiton Improvement Commissioners are excluded from action under this Act.

During the existence of the Joint Board the schemes chiefly considered were one for treating the entire sewage of the united district by means of chemical precipitating works at Mortlake. The idea of centralising such a quantity of sewage in one spot, however, naturally raised great opposition on the part of the residents and property owners of the district; and although the scheme was supported by the Local Government Board, it was rejected by a Select Committee of the House of Commons after a protracted hearing of evidence for both sides. The Board subsequently adopted Sir Joseph Bazalgette's scheme for carrying the whole of the sewage down to Crossness; but, at the same time, several of the constituent district authorities took action to prove that the Thames Valley Board should be dissolved, so as to leave each district free to devise and execute its own scheme. The result was another long and costly official inquiry, which has ended in the passing of the Act of 1885 dissolving the Joint Board.

The subject is discussed in more detail in the article by Mr. Henry Robinson, which we publish on another page, and to this article, without endorsing all that Mr. Robinson has said, we direct attention. There are after all but few methods of dealing with town sewage. The first, most effective and least costly, is to carry it out to sea; but when the town to be drained is any considerable distance from the sea, the method becomes costly, and then filtration, and irrigation, or precipitation, or chemical treatment and filtration are necessary. None of these processes can be carried out very cheaply, but some are more effective than others, and each specially recommends itself under special circumstances. The system that would commend itself for a place on the sandy surroundings of Aldershot would not be the best for a low-lying district on the heavy land of Slough. It is quite impossible to say generally that any one system is the best, but it may safely be said that for any but drainage direct into the sea, it is only under exceptionally rare circumstances and conditions that several districts may be combined into one for sewage disposal. Combination for water or gas supply is a very different matter. Land for filtration purposes, of suitable character and position, is more easily obtainable in small lots than in one very large one. A very large sewage treating works or farm may be a nuisance, the existence of small works or farms need hardly be known. Above as well as below a certain size, the cost of the buildings, plant, materials, land, and operation, cost more per head of population, and difficulties or mishaps are less likely to be serious when each district deals with its own sewerage than when all are combined in one large concern.

The information which has been taken in evidence during recent inquiries fully confirms previously existing knowledge of the necessity for a treatment of every district according to its position, geographically as well as geologically and hyetographically considered, its size, and its character industrially. No one system is generally applicable, and the history of the Thames Valley Main Sewerage Board is a history of failure in the attempt to make one system adapt itself to the circumstances of a large number of places, differently situated in the various respects above alluded to.

SHIPPING AND THE ROYAL COMMISSION.

As some of the tables of the Board of Trade given in evidence before the Royal Commission were published in the shape of Parliamentary papers, the shipowners have taken a somewhat similar step by publishing the evidence given by one of their number; and it must be acknowledged that Mr. Scrutton, the witness in question, does make some fairly good assaults on the position of the Board of Trade. It may be remembered that the late President stated, and repeated the statement, that the loss of life at sea in a given year was at the rate of "one in sixty" of those engaged in British merchant shipping. Of course this was based on the statement of a given loss of life and a given number of seafaring men. Mr. Scrutton deals with the question by attacking both the divisor and the dividend. He affirms that the number of seafaring men at the time was considerably above that on which the statement rests. But whilst on this point there may be doubt, there is none on the question as to the number of deaths, for it is clearly shown, and seems to be admitted on the part of the Board of Trade, that there were duplicate entries in the lists of the seamen, that there were the entries of fishermen and others who were said to be excluded, and that there were also other errors. It is clear, then, that if the actual number of lives lost needs amendment, the proportionate loss will also be erroneous. The shipowners have then, in degree, proved their case—which was that the statements of loss of life were erroneous and exaggerated, and that it is needful that there should be greater care taken to have the figures revised and amended before "charges" are based upon them. Clearly the victory so far rests with the shipowners, and it will be interesting to notice the attitude of the new head of the Board of Trade to the shipping interest.

THE MADRAS HARBOUR WORKS.

WE are glad to hear that there are signs that the restoration of the breakwaters at Madras, destroyed some two years or so back, is to be undertaken immediately. We are informed that large consignments of cement have been received there, and that a careful overhaul is being made of the concrete blocks that had not been placed *in situ* when the destructive effect of the cyclone was experienced. Each of these has been carefully examined, and where any of them have suffered from their long exposure and weathering, the defects are being carefully made good. New machinery has also been provided for the ready laying of the blocks in position; and this fact affords, perhaps, the strongest evidence of early prosecution of the work of renewal. The trains have also recommenced to run from the quarries at Pallaveram to the beach; while the crushing machines at Royapooram are hard at work preparing the stone for the manufacture of further concrete blocks required. We have above used the term "renewal" in reference to these operations, but we regret to be without information as to whether that term can be justly applied. Even "reconstruction" would perhaps be equally inapplicable, for we hold that it cannot be intended to rebuild the breakwaters on the design which formerly proved to be so inefficient. If, as we presume, that design is to be greatly added to so as to strengthen the work, detail as to how this is to be effected would be of extreme interest, for it would seem to be an operation of great difficulty to add to the thickness of a partly constructed breakwater the faces of which have already been completed.

SHAM SHEFFIELD CUTLERY.

OUR American friends, in the hope of "getting into" the Sheffield cutlery trade, are stated to have named one of their Liliputian localities Sheffield, so that they could honestly say the cutlery made there was Sheffield cutlery. This expedient has not prospered, as American competition with Hallamshire-made knives and forks, and other goods with a cutting edge, has never prospered, and is now practically extinct so far as cutlery proper is concerned. Fear of American competition in cutlery manufacture has long since been infinitesimal. French and German makers are more determined and unscrupulous as to their rivalry. Sheffield manufacturers have very naturally been much incensed by a recent discovery made by the Customs authorities. A large quantity of cutlery had been brought from Germany to London to be transhipped for export. The goods were found to be stamped Sheffield, the intention no doubt being to export them as real Sheffield made products. The Customs, it was said, intended to return the goods to the makers, but to this course it is strongly objected that if the wares are sent back they will be forwarded to some other market where they will be foisted off upon inexperienced buyers. It is held at Sheffield that the only way to stop this kind of business is to stamp out the pest of spurious productions whenever found, on the principal of Carlyle, when you find a lie, kill it. Sheffield has suffered a great deal in the past from this kind of dishonesty, and ought to follow the example of several leading firms who expend large sums of money every year in prosecuting trade pirates who show no end of ingenuity in endeavouring to copy trade marks with which to sell unreliable rubbish.

LITERATURE.

Gas Engines. By W. MACGREGOR. London: Symons and Co. 1885. 231 pp.

THIS is the first book on the gas engine published in this country. Several have been published in Germany, where the gas engine itself seems to have a more general application to industrial purposes than here. Hitherto all we could boast were a few articles scattered here and there in the technical journals, giving the results of some gas engine trials and experiments, and a few papers read before scientific societies. The author has gathered together in his pages much of that which is worthy of gathering from these sources, and this, with casual references to the patent specifications, may be said to compose the book. This want of information, so far as the engineering public is concerned, is due entirely to the small number of firms engaged in the business, where each deems it advisable to hide his information, gained generally at great expense. On this account chiefly, this book cannot be said, as the author acknowledges, to be exhaustive.

The first chapter treats the subject historically, showing the steps taken to evolve the engine of the present day. Lenoir in 1860 was the first to make a gas engine which could be used for practical purposes. It was manufactured in this country by the Reading Ironworks Company. The engine was double-acting, and the combustible mixture was ignited by the electric spark; the defective ignition and its great consumption of gas contributed greatly to the non-permanency of its success.

M. Tresca tested two engines of Lenoir's. With an engine having a cylinder of 7·1in. and 4in. stroke, the power measured on the brake was ·57-horse power, and the gas consumed 112 cubic feet per brake horse-power per hour. M. Tresca also estimates the distribution of the heat generated as follows:—Heat carried off by water jacket and exhaust gases, 69 per cent.; heat converted into work at the brake, 4 per cent.; losses (radiation, &c.), 27 per cent.; total, 100 per cent. Defective ignition is caused by the conductor points in the cylinder getting wet, and thus preventing discharge of the spark at the proper time. The author speaks of Lenoir using air and gas in the proportion of 20 to 1. What proportion would the air have to the gas when mixed in the cylinder with a residuum equal to a third of the charge? Such a proportion of gas to air at atmospheric pressure is not ignitable, and the real proportion which Lenoir used was from about 10 to 14 to 1. M. Tresca says 10 to 1.

Hugon, though introducing his engine after Lenoir, seems to have devoted his attention for a long time previous to this to the improvement of the gas engine. His engine is arranged very much like Lenoir's, but remedied that engine's deficiencies by providing a flame ignition. In the slide which admitted the gaseous mixture to the cylinder was provided a pocket, which at the proper time communicated with the gas supply and a flame. The flame ignited the gas in the pocket, and just before the slide opened the pocket to the cylinder it was closed to the atmosphere, thus preventing escape of pressure. Hugon also injected water into the cylinder, to cool and lubricate it, the water being evaporated by the heat of the combustion as steam, and was intended to assist in the expansion of the gases.

Simon and Beechey, of Nottingham, later on also attempted, in a slightly different manner, the same thing. Round the top of the working cylinder a chamber was placed, partly filled with water, and on the heat of the explosion being communicated to the water, steam was generated and was allowed to enter through a slide valve to the working cylinder. But attempts like these to utilise steam in this manner are fallacious. With steam in the midst of a gaseous body at a temperature of 1500 deg. C. it would directly lower the temperature of combustion, and thereby diminish the expansion of the gases—the opposite effect from what was intended. Besides, the difference of the specific heats of steam and the combustible gases is so great, that to provide the same expansion twice the heat would be necessary. Hugon, however, managed to decrease the gas consumption as compared with Lenoir, and produced a more regularly working machine. It was manufactured in this country by Thos. Robinson and Son, Rochdale.

M. Tresca tested an engine of Hugon's with a cylinder of 13in. diameter and 12·7in. stroke. The explosive mixture was 1 of gas to 13·9 of air. The power measured on the brake was 2·07-horse power, and the gas consumption 90·93 cubic feet per brake horse-power per hour. While Hugon remedied the defects of Lenoir, he introduced others of his own creation, to wit, the flexible bellows in which was drawn the combustible mixture, which afterwards was pushed into the working cylinder. These bellows often burst, and there always was a great danger of leakage.

Barsanti and Matteucci, in 1857, were the first to introduce the atmospheric engine, which became ten years later, in a nearly similar arrangement, known as the Otto and Langen engine, called sometimes from its noise, "The Shooter Engine." The author says of the engine which was exhibited at the Paris Exhibition, 1867, "Opinion, however, of the new motor would have been unfavourable if the economy of consumption of gas, in comparison with others, had not been apparent. According to the publications of that time, the judges were forced to praise the engine for its economy, yet to blame it for its construction."

The Otto and Langen engine was introduced and manufactured in this country by Crossley Brothers, Manchester, and the results of a trial given by Mr. F. W. Crossley show conclusively the superiority of this engine over the Lenoir and Hugon in the consumption of gas. The engine had a cylinder of 6in. diameter and 40in. stroke. The explosive mixture was used in the proportion of one of gas to six and a-half of air. The brake horse-power was 2·12, with a gas consumption of 30 cubic feet per brake horse-power per hour. M. Tresca—often already quoted—gives the results of his tests as 48·63 cubic feet per brake horse-power per hour. Another person—Mr. W. A. Bradford, in the *English Mechanic*—gives the results of tests on an engine used by him as 22 cubic feet per brake horse-power. With such diverging results as these, it is impossible to arrive at any estimate of the real consumption of gas; but it is enough for the author's purpose to show that the consumption was less than that used in the Lenoir and Hugon engines.

No real advance was made with the gas engine until 1876, when Mr. Otto introduced his compression engine, which is so familiar in this country. In this engine, unlike all the preceding engines which we have mentioned, an ignition of the combustible mixture occurs every two revolutions of the crank. The cycle of operations used by Mr. Otto was not new, as it had been propounded by M. Alph. Beau de Rochas in the year 1862 in a treatise entitled "Nouvelles Recherches sur les Conditions Pratiques de plus Grande Utilisation de la Chaleur et en General de la Force Motrice." It is curious reading this work, as it describes word for word the operations which take place in Otto's engine. M. Beau de Rochas says:—"The question being thus propounded, the sole arrangement really practicable consists evidently in forthwith employing but one cylinder, so that it is the largest possible, and further in reducing the resisting movements of the gases to their absolute minimum. Then, and for the same side of the cylinder, we are naturally led to execute the following operations in a period of four consecutive strokes: (1) Suction during an entire stroke of the piston; (2) compression during the following stroke; (3) ignition at the dead point and expansion during the third stroke; (4) forcing out of the burnt gases from the cylinder on the fourth and last return stroke." This is exactly what Otto does, and he produces thereby a thoroughly practicable working machine, the only difference being, perhaps, that M. Rochas does not describe the elaborate system of stratification which Mr. Otto has attempted, and by which he says he gains gradual combustion. Mr. Otto says that all engines constructed before the date of his patent worked with sudden explosion, this being the difference between his and theirs. Here the author quotes from an article by Hirn in the *Polytechnisches Centralblatt*, 1861, "On the Theory of the Lenoir Gas Engine," which shows clearly that as early as the year 1861 the existence of the products of combustion in the cylinder of the gas engine was known, and that the non-recoiling action of the engine, because of this neutral gas, was also explained. To prove directly whether the explosion in Lenoir's engine was sudden or gradual, the author quotes Mr. Dugald Clerk, who in his paper "On the Theory of the Gas Engine," gives diagrams from a Lenoir engine, in which the time of explosion is found to be from one twenty-seventh to one-thirtieth of a second. Professor W. G. Adams, referring in his presidential address before the Society of Telegraph Engineers to the experimental tests made on gas engines at the Crystal Palace, says that the committee conducting the tests came to this conclusion, among others:—"With perfect ignition the rate of increase of pressure is very nearly uniform up to the maximum, which is reached in about the one-thirtieth of a second." The tests were made with several different sizes of Otto and Clerk engines, thus apparently proving that the combustion at the present time is not more gradual than it was at Lenoir's.

Mr. Otto ascribes the success of his engine to this so-called gradual combustion, and does not admit, as some experts assert, that compression, and compression only, has been the thing which has raised the gas engine from a scientific toy to a real competitor with the steam engine. Mr. Clerk has calculated the duty of an engine working with compression as Otto or Clerk's and one working without compression as Lenoirs; the duty of the compression engine being 0·45, the duty of the non-compression engine being 0·21, and Mr. Clerk says that "the great advantage of compression over no compression is clearly seen. By the simple operation of compression before heating, the former type of engine gives for the same expenditure of heat 2·1 times as much work as the first. What compression does," he says, "is to enable a great fall of temperature to be obtained due to work done with but a small movement of the piston." This, we think, sums up the matter, and shows that without compression we should have had very little advance on the old type of gas engine, even with "gradual combustion."

In Professor Thurston's experiments on an Otto engine of 10-horse power, the explosive mixture used varied from 1 volume of gas to 6·2 and 7·7 volumes of air, and the consumption of gas per brake horse-power per hour varied from 29 to 33·4 cubic feet. Many attempts have been made by different inventors to produce an engine more regular in working and smaller in bulk for the same power than the Otto, the most notable among these being Mr. Dugald Clerk's type of motor. This motor has an ignition every revolution of the crank, and to gain this advantage Mr. Clerk uses a second cylinder placed alongside the working cylinder, which he calls the displacer. The crank of the displacer piston precedes that of the working piston by a quarter of a revolution, and into the displacer is drawn for two-thirds of its stroke air and gas, and for the remaining third of the stroke pure air only. This pure air entering the displacer last is the first to be pushed out of it, and by the time that the displacer piston is returning, the piston of the working cylinder is uncovering the exhaust ports and allowing the pressure in the working cylinder to fall; this allows the pure air, being pushed out of the displacer, to enter the working cylinder and sweep out the products of combustion remaining in it. After the pure air comes the explosive mixture. It is claimed for this system that the air prevents premature ignition of the explosive mixture by sparks or lingering flame in the cylinder. The difficulty, it seems to us, is to keep the air pure from the mixture—a thing which, we think, cannot be accomplished satisfactorily. We have reason to believe that, perhaps from this cause, Mr. Clerk does not prevent premature ignition, and if not abandoned by him for something better, it is not insisted upon by him as the one thing necessary for success in his engine. However, Mr. Clerk has produced an engine small for its power, regular in working, and economical.

To overcome this difficulty of premature ignition in engines having an ignition every revolution of the crank, it has been proposed by some to govern the engine in a different manner—viz., instead of missing several ignitions when the engine overruns, to have always an ignition, but to reduce the quantity of combustible mixture ignited at each revolution when necessary. Such is the manner in which Messrs. Andrew and Atkinson govern their respective engines, and they seem to gain their object with more or less success, although we notice that both makers in later types of engines produced return to the older method of governing by cutting off the supply of gas. The reason for this is obvious. If the governing is effected by varying the quantity of gas instead of cutting it quite off, a mixture is frequently obtained that misses fire, but which may be sufficiently rich to ignite afterwards. The loss of gas by governing in this way is, moreover, very considerable when the engine is running on very variable work. This is one of the reasons for the economy of the Crossley engine on variable work.

The rest of this book, from which we have quoted considerably, is taken up with discussing the theory of the gas engine, but here the author's work is not at all satisfactory, especially from the thermodynamic point of view. The subject has been better treated in one, or we may say two German *brochures*, and the author is largely indebted to Mr. Clerk for one of the most satisfactory parts of his book. He hardly does justice to those from whom he has gained his information and illustrations, especially for the latter, to Herr Schottler's "Die Gasmaschine." Those who know little or nothing of the gas engine, and the principles on which it is founded, this volume will assist; but those who have devoted their attention to this subject, and who might be inclined to think that at last some of their difficulties would be cleared up, will despair at the result presented to them. However, this is not the author's fault, who has apparently, as far as practical details are concerned, done the best he could with the material at his hand.

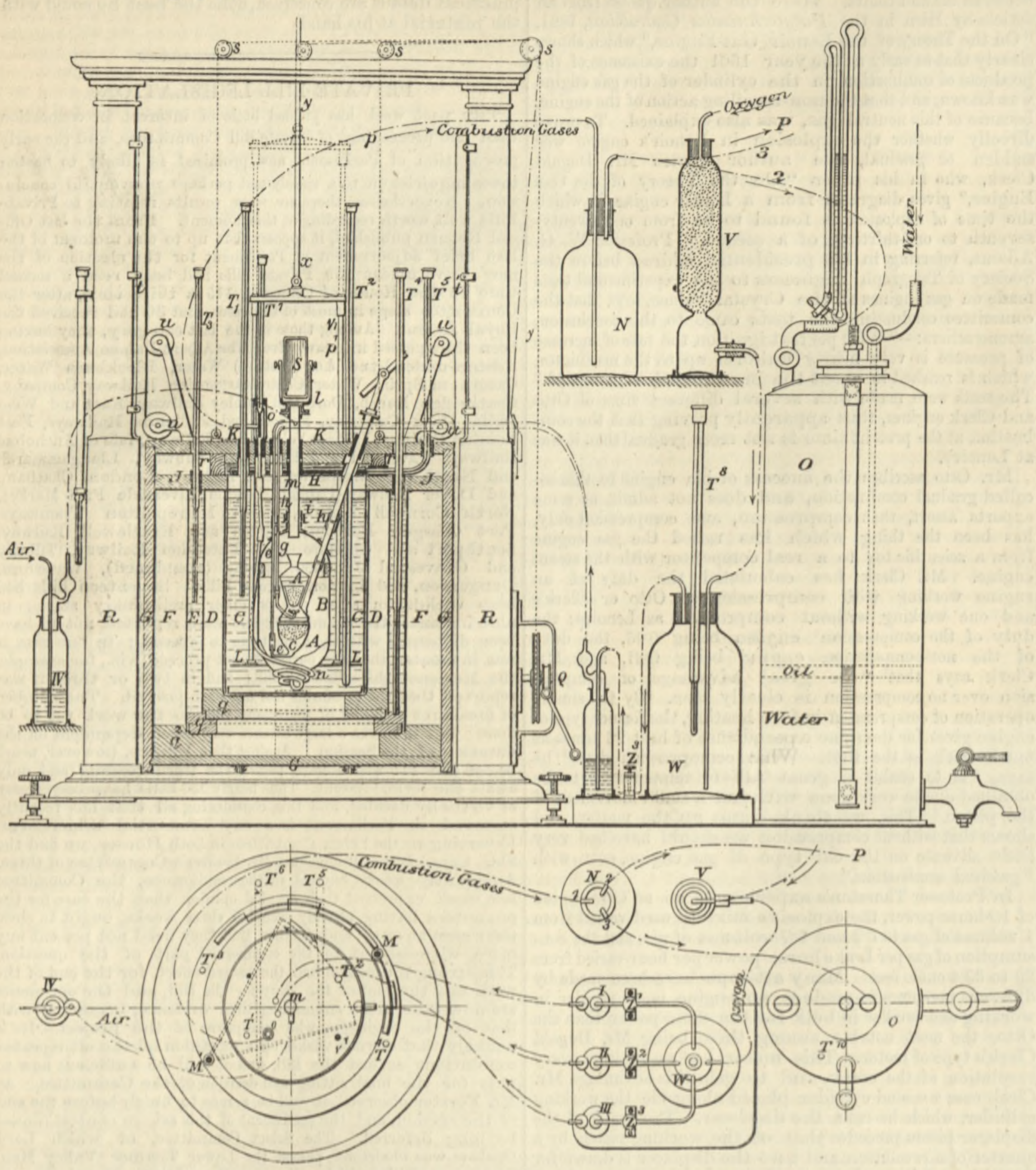
PRIVATE BILL LEGISLATION.

The past week has yielded little of interest in connection with the proceedings of Private Bill Committees, and the early prorogation of Parliament now promised is likely to hasten these inquiries on to a speedy and perhaps uneventful conclusion. Nevertheless, there are some results relating to Private Bills well worth recording at this moment. From the last Official Return published, it appears that up to the moment of the last brief adjournment of Parliament for the election of the new Government 159 Private Bills had been read a second time in the House of Commons, 115 a third time, after the Committee stage in most of the cases, and 39 had received the Royal Assent. Among those in the last category, they having been thus passed into law, were: The Albert Palace Association, Ashton-under-Lyne, &c. (District) Water, Blackburn Water, Caterham Spring Water, Central Argentine Railway Company, Coatbridge Burgh, Dore and Chinley Railway, East and West India Dock Company, Eastern and Midlands Railways, East London Railway, Eltham Valley Light Railway, Isle of Ancholme Railway, Liverpool and Birkenhead Subway, Llangammarch and Neath and Brecon Junction Railway, London, Chatham, and Dover Railway (Capital), London Riverside Fish Market, North Cornwall Railway, North Metropolitan Tramways, Port Glasgow Harbour, Skipton and Kettlewell Railway, Southport and Cheshire Lines Extension Railway, Tilbury and Gravesend Junction Railway (abandoned), Waterford, Dungarvon, and Lismore Railway Bills. Seventeen Bills had been withdrawn after one or other preliminary stage; in nine instances the Standing Orders were reported not to have been dispensed with to enable them to proceed; in one case it was intimated that the parties do not proceed, viz., for example, the Merionethshire Railway Bill; and in two or three it was reported that the preamble had not been proved. The number of measures disposed of materially reduces the work yet to be done; but it leaves a large balance very much dependent on the duration of the Session. Against that balance, however, must be set the 115 which have passed the third reading and only await the formal Assent. Thus nearly 350 Bills have been really or virtually decided, and this, considering all that has recently occurred in Parliament, is a very substantial achievement. Reverting to the Select Committees in both Houses, we find the Ship Canal Bill still engaging Mr. Forster's Committee of three. Apparently weary beyond further endurance, the Committee last week expressed their decided opinion that the case for the promoters having already occupied three weeks, ought to close their case at once; and, further, that they need not present any more witnesses as to the commercial part of the question. This strong intimation had the desired effect, for the end of the week saw the end of the story for the Bill, and the opponents are now once more submitting their evidence, beginning with that of the engineers who disapprove of the project. It is unlikely that anyone wishes for a repetition of the oft-repeated contentions against the Bill, and it will be sufficient now to wait for the final sitting and decision of the Committee. As Mr. Forster observed, it will be a race to finish before the end of the session, and the settlement of this severe contest cannot be long deferred. The Select Committee, of which Lord Onslow was chairman, passed the Lower Thames Valley Main Sewerage Bill, which dissolves the Joint Board—as we explained some time ago—and forms seventeen new united districts from the various local authorities in the Thames Valley, to deal with the sewage. The Bill was opposed in Committee from several quarters, especially from Hampton Wick, but this last opposition was withdrawn upon an undertaking being given that sewage works should not be placed on the eyots opposite Hampton Wick. This measure, it appears, has been amended in several important particulars since it left the House of Commons. In the form in which it will now be returned to the Commons it carries out the recommendations of the Local Government Board to levy all the expenses of any new Joint Boards which may be created within twelve months from the passing of this Act, upon an assessment in the new united districts based upon and in proportion to the rateable value of each district as reduced for a general district rate in the case of urban districts, and in the case of rural districts as reduced for special rating purposes, instead of upon the poor-rate assessment, as was proposed by the Bill. The Bill has also been so amended that no two or more sanitary authorities can agree to constitute themselves into new united districts unless such agreement is sanctioned by not less than three-fourths of the members of each sanitary authority. By an agreement, which led yesterday to the withdrawal of the opposition to this Bill, the Corporation of Kingston undertake in any future scheme not to deal with any sewage on the islands in the river Thames, except for the purpose of a pumping station, which, if erected, is to be made of a reasonably ornamental character, approved by the local authorities. They further agree not to deal with their sewage above ground.

In the House of Lords since the resumption on Monday last, two important discussions have taken place upon two first-class measures. In the first case, Lord Bramwell proposed that the Standing Orders should be dispensed with in respect of petitions lodged by the Metropolitan Board of Works to be heard by counsel against the Waterworks Clauses Act (1847) Amendment Bill. Lord Bramwell pointed out that this Bill involved dealing with property worth thirty millions sterling, and observing that in his view this proposal was quite unjustifiable, insisted that the Board of Works ought to be heard. Several peers entered into the subject, most of them opposing the motion, and eventually the motion was rejected. On the understanding that the Bill would be referred to a Public Committee, appointed by the Lords, the Bill was read a second time. In the other case Lord Ravensworth sought to suspend a Standing Order in respect to the Regent's Canal City and Docks Railway Bill, which prohibits the payment of interest out of capital during the construction of works. As this proposal related only to financial matters, and raised no question of interest as to the works, the motion was negatived and the Bill was read a second time.

South Kensington Museum.—Visitors during the week ending July 4th, 1885:—On Monday, Tuesday, and Saturday, free, from 10 a.m. to 10 p.m., Museum, 8519; mercantile marine, Indian section, and other collections, 2230. On Wednesday, Thursday, and Friday, admission 6d., from 10 a.m. to 6 p.m., Museum, 1730; mercantile marine, Indian section, and other collections, 211. Total, 12,690. Average of corresponding week in former years, 17,982. Total from the opening of the Museum, 24,127,836.

SCHWACKHOFER'S CALORIMETER.



Herr Fr. Schwackhofer has recently published—*Zeits. Anal. Chem.* 23, 453—an account of a calorimeter he has constructed for determining the calorific power of coal or other fuel. The calorimeters usually employed are only adapted for small quantities of substance—a fraction of a grm.—and produce smoke, indicating thereby incomplete combustion. The author claims that in his apparatus these disadvantages are entirely avoided. The construction is given in the accompanying diagram, which we reproduce from the *Journal of the Society of Chemical Industry*. A and A_1 are platinum combustion vessels, B a copper jacket, C the inner water vessel—the actual calorimeter—of nickled copper, D the inner non-conducting layer of eider-down, E a double-walled water vessel, F the exterior non-conducting layer of fine down, G a cylindrical wooden case, H the upper water vessel, J an annular cork board, K the lid, L the inner agitator, S and S_1 mirrors for observing the process of combustion T_1 to T_{10} thermometers. The most important part of the apparatus is the combustion vessel. It is of platinum, and divided into two parts; the lower A is for the sample of coal, the upper A_1 for sugar charcoal. The chambers have openings at *a* and *b*, for introducing the fuel, and also for removing the sieves *c* and *d* after each experiment. The sieves are of platinum foil, perforated specially for the apparatus. The perforations of the lower sieve *c* are so small that they are only visible by transmitted light. In the upper sieve the holes are somewhat larger. Each is provided with an upright rim, which fits tightly to the side, and keeps it in its place. These tubes are connected with the chamber A. *e* conducts oxygen from beneath the coal. The tube *f* has a double use—(1) to bring oxygen above the coal in order to ensure complete combustion of the evolved gases; (2) to observe the process of combustion by reflection from the mirror S_1. This is necessary, as the stream of oxygen requires to be carefully regulated, and the end of the combustion ascertained. The side tube *g* terminates under the sieve *d*. It is provided with a cross piece, and perforated on the upper side. It conducts oxygen to the upper chamber. All these tubes—*e*, *f*, *g*—are connected with well-fitting tubes, let into the lid of the case. After determining the actual thermal value of given volumes of water in the different vessels composing the calorimeter, it is next necessary to prepare and analyse quantitatively and calorimetrically the sugar charcoal to be used in the experiments. The calorimeter is then manipulated as follows:—The vessel C is filled with 5200 cc. of water at the temperature of the air, and 5·6 grm. of the finely powdered sample of coal, and 2·4 grm. of the charcoal weighed out. The quantities should be so chosen that the rise of temperature in C may be about 10 deg. C. The combustion lasts about an hour. The coal is introduced into A, the charcoal into A_1, the two pieces then put together, and the jacket B screwed down, the lid is lowered, the thermometers inserted, and the mirrors mounted. When the apparatus indicates a constant temperature, the combustion is commenced. Oxygen is led through *f*, the cap S raised, a small glowing chip thrown in and the cap refitted. The charcoal in A_1 is kindled, and the aspirator O is put in action. The bottle N is then closed, and after some minutes the smaller aspirator is set going. The flow of water from O and P is regulated so that about five-sixths of the gases collect in O and one-sixth in P. When the charcoal is almost burnt, sparks fall through the sieve and kindle the coal beneath. A quicker stream of oxygen is then passed through *f* and introduced through *g*; towards the end of the experiment the oxygen through *g* is stopped and *e* is opened. The combustion proceeds regularly, and not a trace of smoke appears in N. The combustion of both charcoal and coal should be complete. When the combustion is finished the aspirators are disconnected, the water is agitated by the mixer until the thermometers T_1 and T_2 stand at the same temperature, and the other thermometers are then read off. The volume of gas collected in the aspirators is noted, and the gas in P analysed. From these data the author has made a number of calorimetric determinations, which agree well together, and are somewhat higher than the value calculated by Dulong's formula from the percentage composition.

CHEAP-HORSE CORN PLANTER.

We are indebted to an American correspondent for the following example of United States Patent-office practice. Although our correspondent has drawn on his imagination, the invention is quite as likely to prove useful as a great many which obtain official sanction. The yellow dog plays such an important part in a certain class of United States literature just now that our friend has shown a wise discrimination in not attempting to claim him as a novel device. His introduction, however, no doubt lends finish to the statement of claim. Tails have formed the subject of so many patents in the States that we were disposed to look with some doubt on the novelty of Claim 5. We have reason to believe, however, that the claim is valid; its validity being due to the vertical arrangement.

CHEAP-HORSE CORN PLANTER.

I am aware that a quadruped has heretofore been used in combination with an agricultural implement, and consequently I do not claim such a combination broadly; but what I claim, and desire to secure by Letters Patent is—

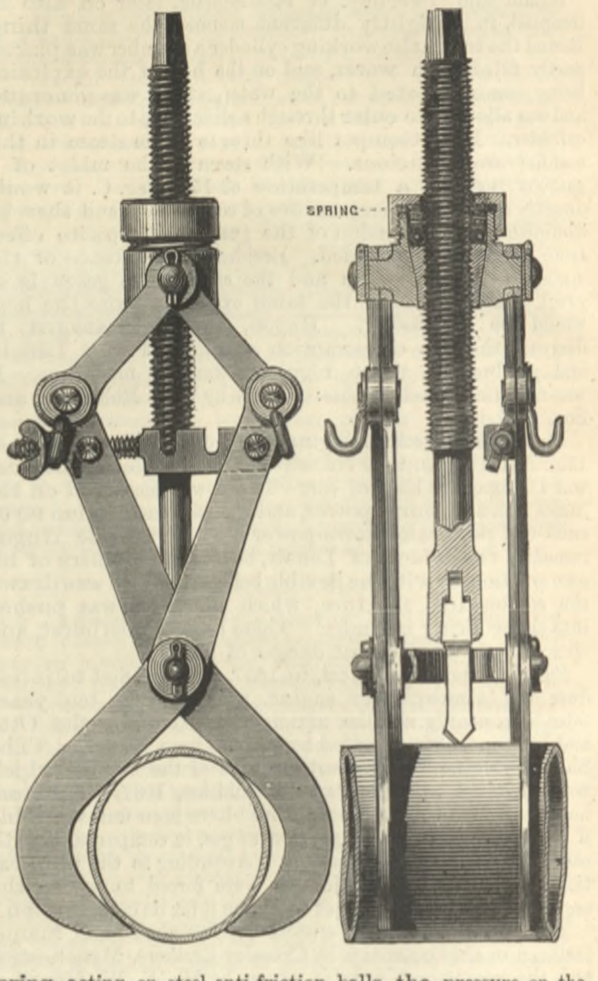
1. The planters B B, in combination with the beast A, constructed and operated as described.
2. The bands *i i*, and pulley *c c*, in combination with the hind legs of a cheap-horse A, to operate the planters and prevent kicking, substantially as set forth.
3. I claim the cheap-horse A, clipped, as shown, in combination with the corpulent driver D, to prevent his travelling too fast, as described.
4. I claim the guide *o*, in combination with the "tail of a cheap-horse," when said tail is put in a vertical position, as shown and described.
5. In a cheap-horse corn-planter I claim the tail *b*, when arranged vertically, to frighten the crows *a a*, as set forth.
6. I claim the worms (not shown) in combination with the "early birds" *a a*, for the purpose set forth.

The yellow dog, with few friends, being an old device and somewhat at a discount in these days, we do not *set anything on him*, but merely throw him in to accompany the driver D, to give a general effect to the patent after it is granted.

Patent applied for through the Agency of A. H. Evans and Co.,
Solicitors of
U.S. and Foreign Patents,
Phœnix Building,
Washington, D. C.

PATTERSON'S PATENT PORTABLE DRILLING AND TAPPING APPARATUS.

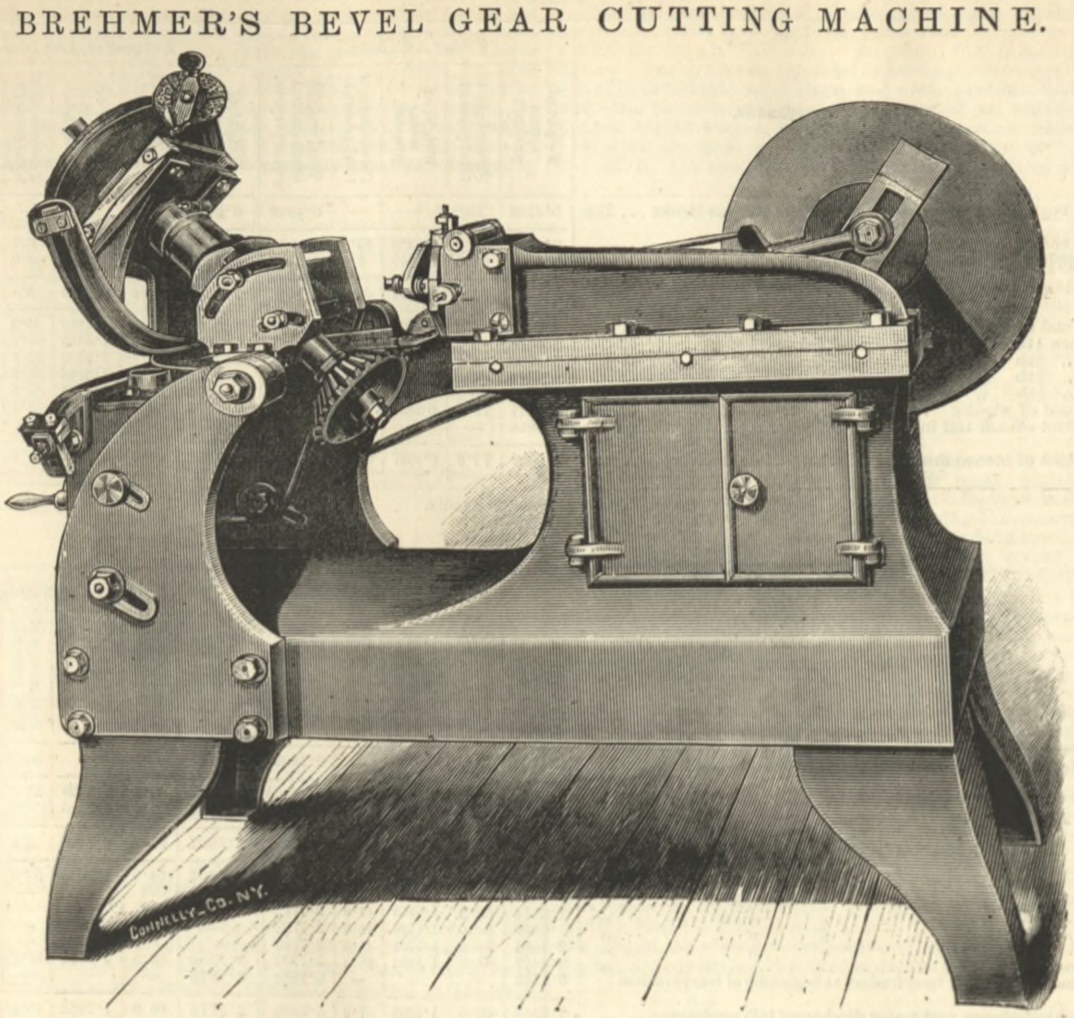
We illustrate below a neat form of portable drill, the invention of Mr. Patterson, an engineer in the employment of the Southwark and Vauxhall Water Company, which was exhibited by that company last year at the International Health Exhibition. The apparatus has been specially designed for drilling and tapping water and gas pipes, but is also applicable for girders and rails, or, indeed, any kind of work which affords a suitable means of attachment. By referring to the section, it will be seen that the drill spindle, which is screwed, passes through a conical bush pressed down into its seat by a



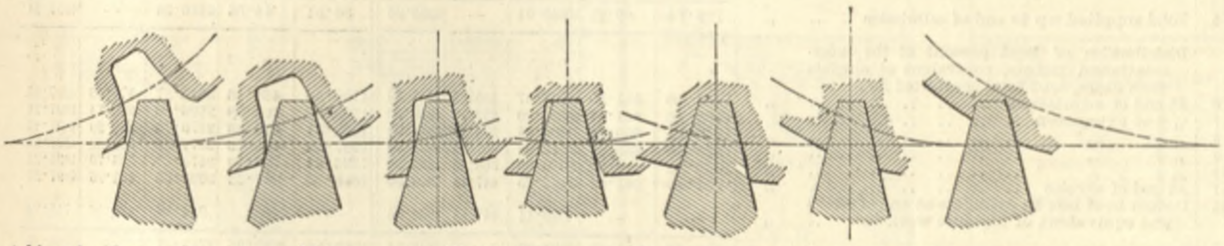
spring acting on steel anti-friction balls, the pressure on the spring being capable of variation at will by means of a nut. The object of this arrangement is to give an automatic feed. So long as the drill is away from its work the conical bush is held firmly in its seat, and rotation of the spindle merely produces a travel due to the pitch of the thread upon it. As soon, however, as the drill comes up to its work, the spring is compressed, and the conical bush being raised slightly from its seat, is free to turn with the spindle, until by the cutting and descent of the drill it is again held fast, when the action is repeated. The feed may be varied by altering the initial pressure on the spring. In the engraving the spindle is shown squared at the top for receiving an ordinary wrench handle, but it is also made with a ratchet. The mode of attachment of the apparatus will be apparent from an inspection of the engravings, which illustrates the method adopted for pipes up to 6in. diameter. For larger sizes, and for general work, it is convenient to employ chains, which pass round the object to be drilled, and are made fast to the hooks at the upper end of the jaws. We understand that this drill is largely used by the Southwark and Vauxhall Company, and is found to be a very convenient and handy tool. It is extremely light, weighing only 14 lb., and is therefore readily transported from place to place.

Silver Smelting in New South Wales.—The work of utilising the many rich silver mines in New South Wales has been seriously impeded by the absence of facilities for treating the ore, which is generally of a most refractory description, and consequently has to be sent to America or Germany to be smelted. Recently some smelting works were erected at Sunny Corner, and the success of these has led to the erection of another at Clyde, some few miles distant from Sydney, the first ore smelted being from the Silver King mine at Sunny Corner, taken from a large body of stone, the width of which has never been tested, but which has been sunk on to a depth of about 50ft., all in ore that has assayed from 40 oz. to 190 oz. of silver per ton. The furnace was constructed under the personal supervision of Mr. J. B. Gafford, who has patented this particular class of furnace in all the Australian Colonies. Before coming to New South Wales, Mr. Gafford was connected with silver milling and smelting in America from the year 1868 till his departure, having been engaged in assisting to get into operation the United States Mint at Denolaga, Georgia, in constructing the Swansea and Denver Valley smelting and reducing works, and in constructing furnaces and milling plant in California, Arizona, Detroit, and other places, at least so says an official publication.

BREHMER'S BEVEL GEAR CUTTING MACHINE.



WE illustrate a new machine for this purpose made by Messrs. Brehmer Bros., Philadelphia. Making accurate bevel gear wheels, which will work smoothly without rattling or waste of power, has until within a comparatively recent period been one of the most difficult jobs coming into a machine shop, and has been a kind of work in which many have failed. In correctly formed teeth of a bevel gear the curvature of the sections is not uniform, so that formed tools cannot give correct results, but the novel machine shown in the accompanying illustration is intended to obviate all defects arising from this cause. The principle of this machine is based on the fact that any two gear wheels which gear correctly with one rack belonging to an interchangeable set of gears will gear correctly with one another. By a mutual rolling against each other of a gear blank and such a rack, the teeth of the wheel must obviously be formed with perfect accuracy. It is convenient to consider all the motions as



taking place in one plane, as would be represented by the diagram in Fig. 2, where it is shown how the tooth of an involute rack would cut its way through a rolling blank, thus forming one of the spaces between two teeth. In this case the cutting tool represents one tooth of a rack pertaining to an interchangeable set of gears, and it obtains a reciprocating motion in the manner of a shaper tool, the blank receiving a movement as though it were rolling on its pitch surface.

The machine embraces two principal parts: the shaper which holds and operates the tool, and the spindle which turns the blanks. As the blank should imitate the movement of a rolling cone, the bearing of its spindle is held in an inclined position between two uprights attached to a semicircular horizontal plate, which can be oscillated on a vertical axis passing through the apex of the blank. The spindle also receives the proper rotation by a portion of a cone attached to it, corresponding with the pitch cone of the blank, and held by steel bands which prevent the cone from making any but a rolling motion when the spindle receives a conical swinging motion.

The feed mechanism of the machine effects a slow, intermittent movement of the semicircular plate, rolling the blank while the reciprocating tool forces its way through the metal. The spindle carrying the blank can be rotated independent of the rolling cone by means of a worm wheel and worm and index plate, which enable the blank to be presented to the cutting device at properly spaced divisions, corresponding with the number of teeth desired in the wheel. There is a gauge by which the tool can be adjusted so that the lowest point of its cutting side shall move exactly toward the apex of the blank, and a distance block is used between this gauge and the tool so that variations of distances can be detected with the touch instead of by sight. The diagram, Fig. 2, shows how the tool takes out the stock when a wheel is to be cut out of the solid, the tool being first adjusted at a slight distance from its correct position, and all spaces being afterward treated in the same mannner by using the index device. The tool is then carefully adjusted to its correct position, first for one and afterwards for the other side to finish both sides of the teeth. The inclination of the spindle holding the blank is made adjustable, to adapt it to the angle of gear desired, and the rolling cone is detachable, to be replaced by such cones as correspond with the angle of the blank to be cut, but by a special device the machine is so adjustable that a limited number of cones may be made to suffice for a large variety of work.

The cutting tool is a triangular bar of steel, so formed as to make an angle of fifteen degrees on each side, and held by a special holder, the up-and-down and sideway adjustment being effected by slides working at right angles and operated by screws, the clamp which fastens the tool holder also clamping the slides to the apron, and giving great stability. A device for lifting the apron during the return stroke prevents the dragging of the tool, the oscillating movement of the connecting rod being employed for this purpose by having a bar hinged at one end to a clamp which can be shifted on the connecting rod while the other end impinges on the apron. It is easy to so adjust the clamp that this lifting action will occupy the time of the return stroke.

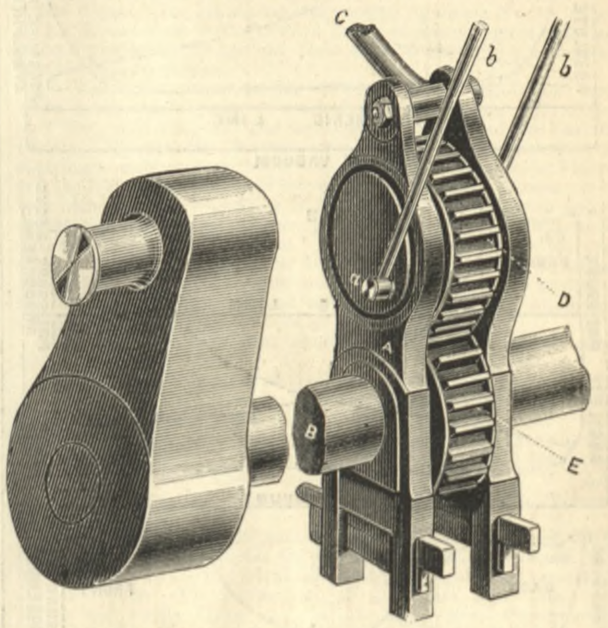
50-HORSE POWER VERTICAL COMPOUND MILL ENGINE.

THE type of engine illustrated on page 30 is one that possesses many advantages, though it is not often used in mills or for stationary purposes. The engine occupies very little floor space, the cylinders and pistons wear equally in all directions, the strains are direct, the rotating parts are low down and can be accurately balanced. This engine has been erected in the flour mill of Mr. John Taylor, of Melksham, taking the place of a smaller one which was not powerful enough for the demands made upon it. The cylinders are 16½in. and 28in. diameter by 2ft. 6in. length of stroke, the high-pressure cylinder being steam jacketted. The pressure in the boilers is 75 lb., and a steady vacuum is maintained of 13½ lb. at a speed of eighty-two revolutions per minute. The power is taken off the crank shaft, which is of hammered steel, through a pair of spur wheels and two belts, thus being communicated to the mill at three points. The engine works in conjunction with two turbines when water is plentiful, but as the water is very fluctuating, the steam power is sufficient for the whole mill, and Mr. Taylor is thus independent of the water. To meet these fluctuations an expansion valve is applied to the high-pressure cylinder, variable by hand, and worked by a rod from the air pump levers. The engine is simple and strong, and works very steadily and economically. It is fed with steam from two Cornish boilers which are set on Livet's patent system of flues, and the result in saving of coal and facility of access for cleaning and examination has been proved to be most satisfactory.

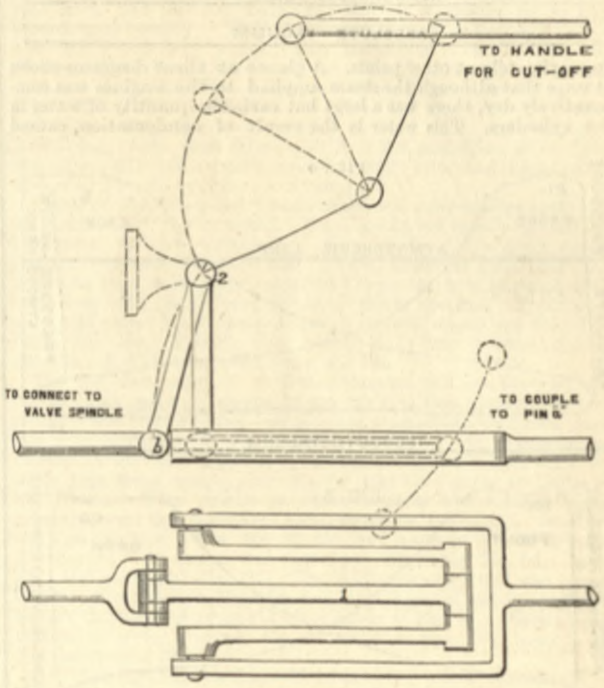
THE ANTWERP EXHIBITION.—The Belgian Government having requested Earl Granville to make appointments of British jurors, his lordship has communicated the accompanying list to Baron Solvyns, the Belgian Minister at this Court:—Chairman, Mr. C. M. Kennedy, C.B., head of the Commercial Department of the Foreign Office, chairman of the Jury for Paper, Printing, &c., at the Inventions Exhibition. Group I.—Education and Instruction —Apparatus and Processes of the Liberal Arts—Mr. Edmund Gosse, Lecturer on English Literature, Trinity College, Cambridge; Mr. Henry Spicer, juror at the Inventions Exhibition. II.—Furniture and Accessories—Mr. J. S. Templeton, member of the Glasgow Chamber of Commerce; Mr. T. C. Moore, member of the North Staffordshire Chamber of Commerce. III.—Textile Fabrics —Clothing and Accessories—Sir Joseph Lee, member of the Manchester Chamber of Commerce; Mr. Harold Lee, assistant juror. IV.—Mining Industries—Raw and Manufactured Products—Mr. H. Bauerman, F.C.S., juror at the Inventions Exhibition; Mr. H. Grimshaw, F.C.S., formerly Demonstrator of Chemistry at Owens College, Manchester; Mr. W. J. Bush, F.C.S. V.—Machinery—Apparatus and Processes used in the Mechanical Manufactures, and Tests of the same—Captain Galton, C.B., F.R.S.; Mr. William Anderson, C.E. VI.—Alimentary Products—Mr. Walter Low, juror at the Health Exhibition, 1884. VII.—Navigation and Life Saving—Mr. Hamilton Dunlop, member of the Southampton Chamber of Commerce. IX.—Commerce of Importation and Exportation—Exports for the use of the natives in countries out of Europe. Commercial Museums—Mr. Bateman, principal of the Commercial Department, Board of Trade, honorary secretary of the Statistical Society. Section IV.—Electricity—Captain Abney, R.E., F.R.S.; Mr. W. H. Preece, F.R.S., assistant engineer and electrician to the Post-office.

BEVERIDGE'S VALVE GEAR.

THIS valve gearing, which we illustrate below, is patented by Mr. James Beveridge, of Soho Foundry, Barrow-in-Furness, and was designed with a view of simplifying the existing methods of working the slide valves of steam engines. The advantages claimed by the inventor are (1) rigidity, and absence of vibration at the most essential parts; (2) non-liability of the valves to work untrue, resulting through this arrangement only requiring two joints to work the valve in place of seven where



excentrics and link motion are used; (3) to be more economical and durable than any other system, both as regards first cost and afterwards; (4) to be certain of immediate and true action on account of the absence of complicated parts.

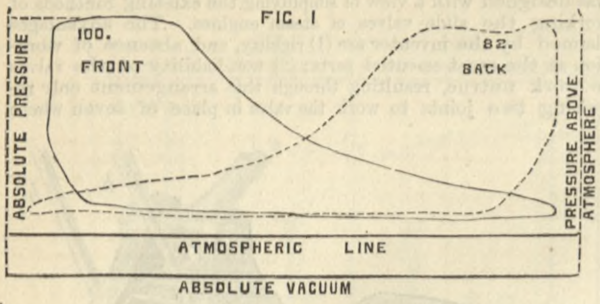


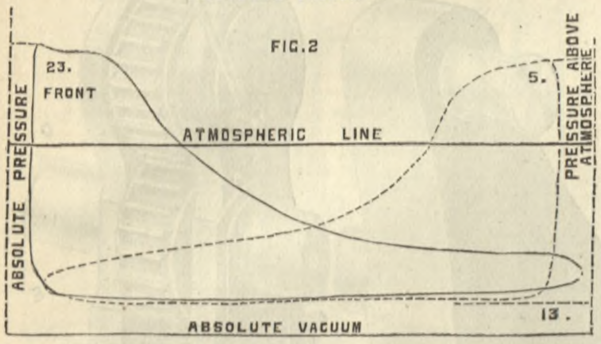
The invention, as will be seen by referring to sketch, consists of a pair of wheels, D, E, geared into one another; one of them, a split one, E, is keyed on the crank shaft; the other wheel is keyed on a spindle, which works loose between a pair of steel links A, or in a box frame enclosing the wheels. A pin, *a*, is turned on at each side of the spindle, to which the valve rods, *b b*, are coupled direct; at one end of the links the reversing lever *c* is attached. The principle of working the gearing is as follows: The frame is set at the requisite angle to the cranks, and the pins *a a* are so arranged as to give the proper amount of "lead;" when the engine requires to be reversed, the links are simply thrown over to the same angle as it makes with the vertical plane on the opposite side.

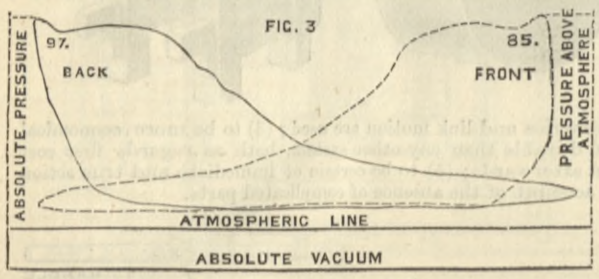
TRIAL OF A PAIR OF HORIZONTAL COMPOUND TANDEM ENGINES.

(*Continued from page 507.*)

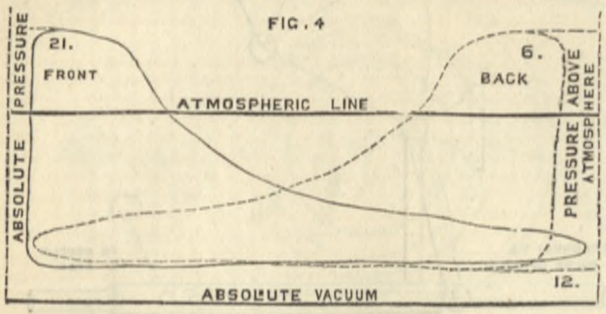
Action of the cylinder metal.—In order to understand the conditions affecting the economy, it is desirable to investigate what happens in the cylinders during the period of a revolution. For reasons which will appear as we go on, it is most convenient to commence this investigation at the moment when the exhaust port closes and compression begins. Starting at this point, therefore, we may begin by forming the following tables showing the quantities of steam and water present in the cylinders at different points. The points chosen are the beginning and end of the compression and admission, the end of the expansion and points at one, two, three, and five-ninths of the distance the pistons have to travel after the steam has been cut off. Table II. refers to the non-condensing, and Table III. to the condensing cylinders, the two being treated in each case as one of double the capacity of either. In the last line of Table II. it is seen that the discharge from the small cylinders, which, of course, is equal in weight to the supply from the boilers, consists of 72·6 per cent. of steam and 27·4 per cent. of water. It does not enter the large cylinders in these proportions however, as part of the water is evaporated during the exhaust by the heat stored in the cylinder metal during compression and admission, and by the work done upon it during the expulsion. Hence, before constructing the table for the large cylinders, the quantity so evaporated must be ascertained. To avoid breaking the thread of the report, the question is considered in Note 2 in the Appendix, where it is shown that the weight evaporated was 0·7262 lb. on the Friday and 1·0960 lb. on the Wednesday, so that the initial figures in Table III. will be obtained by adding these quantities to the steam and deducting them from the water shown in the last line of Table II. As figures are objectionable to many persons, the diagrams Figs. 9 and 12 have been constructed to illustrate these tables. A, B, C, D, is supposed to represent the cylinder, within which is drawn an indicator diagram to show the points mentioned on page 55. Through these points vertical lines numbered 1, 2, 5, 6, 7, 8, 9, and 10 are drawn, and upon them are plotted points at distances corresponding to the figures in the lines similarly numbered in the tables. These points being joined, the vertical distances between the joining lines show the weights of steam and water present accurately on the numbered verticals

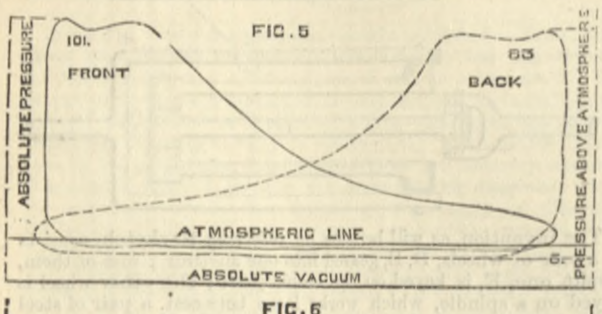


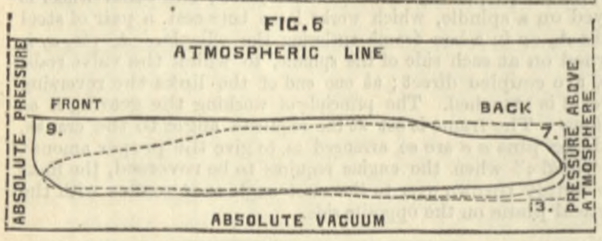




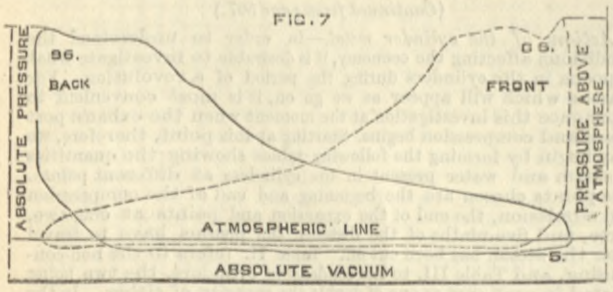
approximately at other points. A glance at these diagrams shows at once that although the steam supplied to the engines was comparatively dry, there was a large but variable quantity of water in the cylinders. This water is the result of condensation, caused

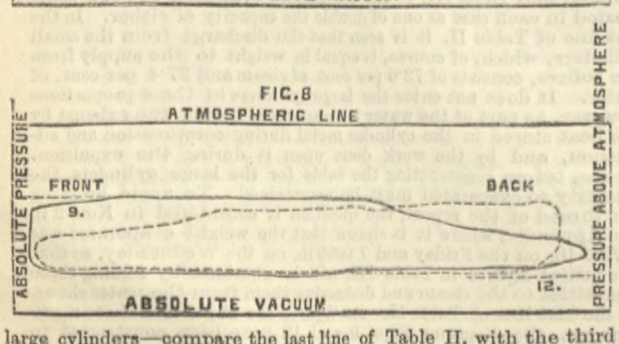






primarily by absorption of heat by the metal of which the cylinders are made,* and secondarily by conversion of heat into mechanical work during the expansion, just as the re-evaporation of the water discharged from the small into the





large cylinders—compare the last line of Table II. with the third in Table III.—is due to convection and radiation of heat from the metal and to the work done upon the steam during the expulsion. During the admission, a certain quantity of heat flows into the cylinders from the boilers, and this quantity remains in the cylinders throughout the stroke and is discharged at the end, less the amount equivalent to the work performed, which is that work expressed in foot-pounds divided by 772, this being the number of foot-pounds of work one unit of heat is capable of producing. The distribution of the balance between the three bodies, iron, steam, and water, which constitute the heat-converting machinery, is different at different parts of the stroke, and Tables IV. and V. have been calculated to show what proportion of the total heat supplied each of these three bodies contains at

* See Note 3 in Appendix.

TABLE II.*

	Non-condensing cylinders.		Friday, 13th June. Weight of steam present.	Percentage of total present.	Weight of water present.	Percentage of total present.	Total weight of steam and water present.	Wednesday, 18th June. Weight of steam present.	Percentage of total present.	Weight of water present.	Percentage of total present.	Total weight of steam and water present.
1	At beginning of compression left from previous stroke ..	lbs.	0·4848	100	—	—	0·4848	0·2573	100	—	—	0·2573
2	At end of compression	,,	0·3726	77·0	0·1122	23·0	0·4848	0·2348	91·3	0·0225	8·7	0·2573
3	Supplied by boiler during admission	,,	3·4765	97·0	0·1075	3·0	3·5840	3·7497	97·0	0·1160	3·0	3·8657
4	Total weights supplied up to end of admission ..	,,	3·8491	94·6	0·2197	5·4	4·0688	3·9845	96·6	0·1385	3·4	4·1230
5	At end of admission	,,	2·7078	66·6	1·3610	33·4	4·0688	2·6871	65·0	1·4359	35·0	4·1230
6	When ⅕th of the expansion has been performed	,,	2·6474	65·7	1·4214	34·3	4·0688	2·5675	62·3	1·5555	37·7	4·1230
7	,, ⅖th ,, ,, ,, ,, ...	,,	2·6702	65·6	1·3986	34·4	4·0688	2·5604	62·1	1·5626	37·9	4·1230
8	,, ⅗th ,, ,, ,, ,, ...	,,	2·6874	66·5	1·3814	33·5	4·0688	2·5646	62·2	1·5584	37·8	4·1230
9	,, ⅘th ,, ,, ,, ,, ...	,,	2·7605	67·8	1·3083	32·2	4·0688	2·5746	62·5	1·5484	37·5	4·1230
10	At end of stroke	,,	3·0881	75·9	0·9807	24·1	4·0688	2·7574	66·9	1·3656	33·1	4·1230
11	Deduct steam left in cylinders at beginning of compression	,,	0·4848	—	—	—	0·4848	0·2573	—	—	—	0·2573
12	Weight of steam and water discharged into receiver ..	,,	2·6033	72·6	0·9807	27·4	3·5840	2·5001	64·7	1·3656	35·3	3·8657

* See Note 1 in Appendix.

TABLE III.*

	Condensing cylinders.		Friday, 13th June. Weight of steam present.	Percentage of total present.	Weight of water present.	Percentage of total present.	Total weight of steam and water present.	Wednesday, 18th June. Weight of steam present.	Percentage of total present.	Weight of water present.	Percentage of total present.	Total weight of steam and water present.
1	At beginning of compression left from previous stroke ..	lbs.	0·1862	100	—	—	0·1862	0·1975	100	—	—	0·1975
2	At end of compression	,,	0·1308	70·2	0·0554	28·8	0·1862	0·1246	63·1	0·0729	36·9	0·1975
3	Supplied by small cylinders during admission	,,	3·3295	90·3	0·2545	9·7	3·5840	3·5961	93·0	0·2696	7·0	3·8657
4	Total weights supplied up to end of admission ..	,,	3·4603	91·8	0·3099	8·2	3·7702	3·7207	91·6	0·3425	8·4	4·0632
5	At end of admission	,,	2·1029	55·8	1·6673	44·2	3·7702	2·7007	66·5	1·3625	33·5	4·0632
6	When ⅕th of the expansion has been performed	,,	1·9418	51·5	1·8284	48·5	3·7702	—	—	—	—	—
7	,, ⅖th ,, ,, ,, ,, ...	,,	1·9814	52·2	1·7888	47·8	3·7702	—	—	—	—	—
8	,, ⅗th ,, ,, ,, ,, ...	,,	2·0356	54·0	1·7346	46·0	3·7702	—	—	—	—	—
9	,, ⅘th ,, ,, ,, ,, ...	,,	2·1964	58·2	1·5738	41·8	3·7702	—	—	—	—	—
10	At end of stroke	,,	2·4420	64·8	1·3282	35·2	3·7702	2·7750	68·3	1·2882	31·7	4·0632
11	Deduct steam left in cylinders at beginning of compression	,,	0·1862	—	—	—	0·1862	0·1975	—	—	—	0·1975
12	Weight of steam and water discharged into condensers ..	,,	2·2558	63·0	1·3282	37·0	3·5840	2·5775	66·6	1·2882	33·4	3·8657

* See Notes 1 and 2 in Appendix.

TABLE IV.*

	Non-condensing cylinders.		Friday, 13th June. Heat contained in metal.	Heat contained in water.	Heat contained in steam.	Equivalent of work.	Total.	Wednesday, 18th June. Heat contained in metal.	Heat contained in water.	Heat contained in steam.	Equivalent of work.	Total.
1	Left from previous stroke	th. un.	—	—	539·11	—	539·11	—	—	284·18	—	284·18
2	Absolute work of compression	,,	—	—	—	37·68	37·68	—	—	—	21·09	21·09
3	Distribution of heat at end of compression ..	,,	123·14	33·53	420·12	—	576·79	36·31	6·00	262·96	—	305·27
4	Supplied from boilers	,,	—	35·69	4220·82	—	4256·51	—	38·56	4553·38	—	4591·94
5	Total supplied up to end of admission	,,	123·14	69·22	4640·94	—	4833·30	36·31	44·56	4816·34	—	4897·21
	Distribution of heat present at the under-mentioned points, equivalent of absolute work done, and total accounted for:—											
6	At end of admission	,,	1144·58	441·35	3067·37	180·00	4833·30	1209·50	466·46	3043·87	177·38	4897·21
7	,, ⅕ of expansion	,,	1182·16	431·11	2987·30	232·73	4833·30	1303·03	468·98	2896·06	229·14	4897·21
8	,, ⅖ ,, ...	,,	1149·11	405·08	3004·88	274·23	4833·30	1302·21	444·98	2879·73	270·29	4897·21
9	,, ⅗ ,, ...	,,	1123·68	385·08	3017·02	307·52	4833·30	1287·54	429·76	2877·69	302·22	4897·21
10	,, ⅘ ,, ...	,,	1066·82	314·20	3089·08	363·20	4833·30	1263·34	400·73	2878·35	354·79	4897·21
11	At end of stroke	,,	701·45	241·62	3442·78	447·45	4833·30	1068·15	327·25	3069·65	431·16	4897·21
12	Deduct heat left in cylinders at end of stroke and equivalent of absolute work done ..	,,	—	—	539·11	447·45	986·56	—	—	284·18	432·16	716·34
13	Discharged from small cylinders	,,	701·45	241·62	2903·67	—	3846·74	1068·15	327·25	2785·47	—	4180·87
14	Add equivalent of absolute work of expulsion	,,	—	—	—	153·89	153·89	—	—	—	76·39	76·39
15	Total heat received by connecting pipe	,,	—	—	—	—	4000·63	—	—	—	—	4257·26
16	Effective work measured from diagram.. ..	,,	—	—	—	255·88	255·88	—	—	—	334·68	334·68
17	Total heat received from boilers and accounted for	,,	—	—	—	—	4256·51	—	—	—	—	4591·94

* See Note 4 in Appendix.

TABLE V.*

	Condensing cylinders.		Friday, 13th June. Heat contained in metal.	Heat contained in water.	Heat contained in steam.	Equivalent of work.	Total.	Wednesday, 18th June. Heat contained in metal.	Heat contained in water.	Heat contained in steam.	Equivalent of work.	Total.
1	Left from previous stroke	th. un'	—	—	202·82	—	202·82	—	—	215·21	—	215·21
2	Absolute work of compression	,,	—	—	—	10·70	10·70	—	—	—	10·81	10·81
3	Distribution at end of compression..	,,	60·96	9·16	143·40	—	213·52	77·56	11·91	136·55	—	226·02
4	Supplied from small cylinders	,,	—	58·53	3942·10	—	4000·63	—	49·89	4207·37	—	4257·26
5	Total supplied up to end of admission	,,	60·96	67·69	4085·50	—	4214·15	77·56	61·80	4343·92	—	4483·28
	Distribution of heat present at the under-mentioned points, equivalent of absolute work done, and total accounted for:—											
6	At end of admission	,,	1371·94	377·31	2334·01	130·89	4214·15	1081·61	248·74	2971·18	181·75	4483·28
7	,, ⅕ of expansion	,,	1518·56	375·37	2145·26	174·96	4214·15					
8	,, ⅖ ,, ...	,,	1475·02	346·44	2184·30	208·39	4214·15					
9	,, ⅗ ,, ...	,,	1412·30	322·81	2240·63	238·41	4214·15					
10	,, ⅘ ,, ...	,,	1249·35	274·61	2412·53	277·66	4214·15					
11	,, end of stroke	,,	985·30	213·71	2674·72	340·42	4214·15	990·42	214·93	3029·19	248·74	4483·28
12	Deduct heat left in cylinders at end of stroke and equivalent of absolute work done ..	,,	—	—	202·82	340·42	543·24	—	—	215·21	248·74	463·95
13	Discharged from large cylinders	,,	985·30	213·71	2471·90	—	3670·91	990·42	214·93	2813·98	—	4019·33
14	Equivalent of absolute work of expulsion ..	,,	—	—	—	69·81	69·81	—	—	—	73·31	73·31
15	Total heat received by condensers	,,	—	—	—	—	3740·72	—	—	—	—	4092·64
16	Effective work measured from diagrams in small cylinders	,,	—	—	—	255·88 }	515·79	—	—	—	334·68 }	490·30
17	Effective work measured from diagrams in large cylinders	,,	—	—	—	259·91 }		—	—	—	164·62 }	
18	Total heat received from boilers and accounted for	,,	—	—	—	—	4256·51	—	—	—	—	4591·94

* See Note 5 in Appendix.

different periods, and what proportion is transformed into mechanical work. As the cylinders are coolest at the end of the exhaust, we begin these tables also at this point, by writing down the quantity of heat remaining from the previous stroke. This is contained entirely in the steam about to be compressed, for since the exhaust ports are on the under side, all the water may be supposed to have departed,* and since accumulation of heat in the metal evidently does not take place, there is no other body which can hold it. These tables are, unfortunately, rather complicated. The complication arises from the necessity of securing brevity by

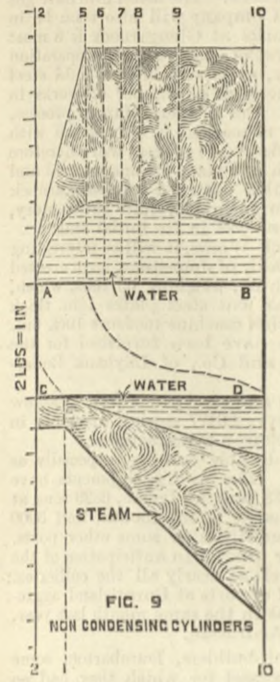


FIG. 9
NON CONDENSING CYLINDERS

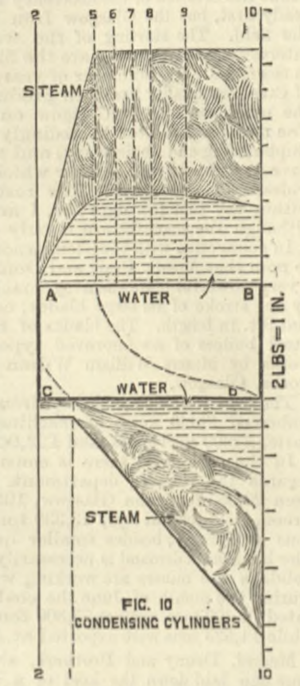


FIG. 10
CONDENSING CYLINDERS

including in a single statement figures which properly belong to two accounts—one of receipts and expenditure of heat, the other a balance-sheet, or, rather, a series of balance-sheets, showing the amount of heat present at different periods and its allocation. In the hope of making them clearer the diagrams Figs. 13 and 16 have been constructed, one for each cylinder, somewhat in the same

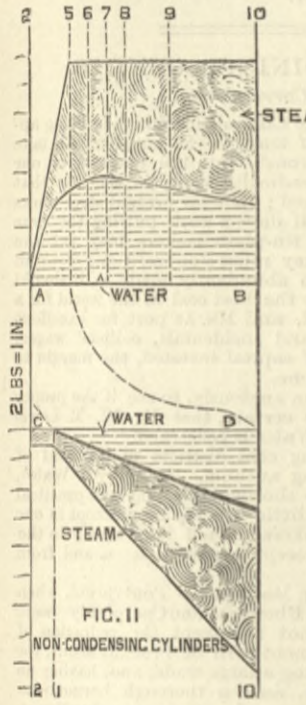


FIG. 11
NON-CONDENSING CYLINDERS

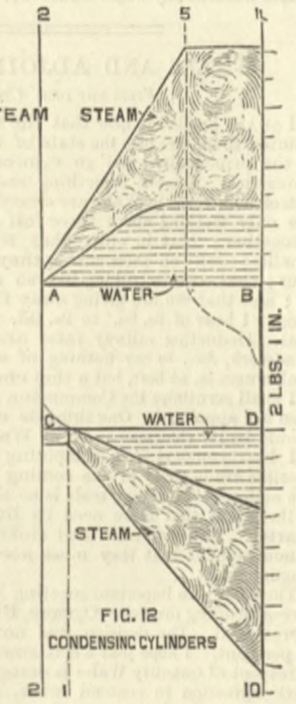


FIG. 12
CONDENSING CYLINDERS

way as those illustrating Tables II. and III., only in this case the distances measured upon the vertical lines show the quantities of heat present in the metal, water, and steam at the different points, the scale being 2000 thermal units to the inch. The heat in the metal is represented next the cylinder, then that in the water, and outside again that in the steam, while above the last is shown the

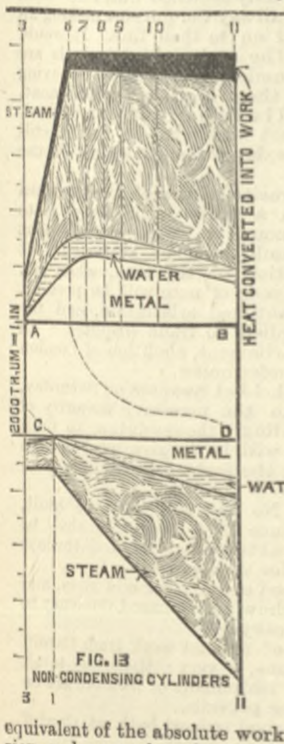


FIG. 13
NON CONDENSING CYLINDERS

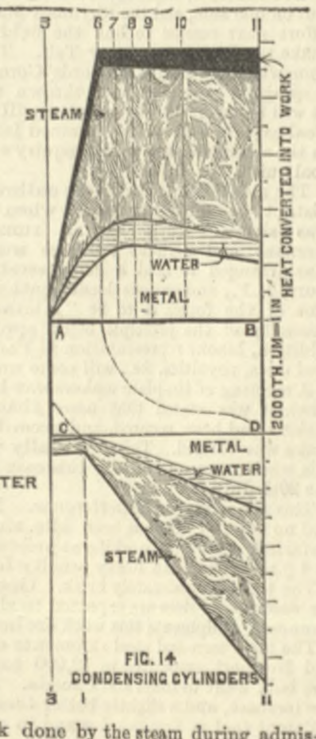


FIG. 14
CONDENSING CYLINDERS

equivalent of the absolute work done by the steam during admission and expansion, in order that the total heat present and converted during these periods may appear. These diagrams, with the figures in Tables II. to V., indicate the general nature of the action of the cylinders upon the steam. The first thing that strikes us in considering them is the great amount of heat absorbed by the metal during the compression and admission, and the large proportion of steam condensed in consequence—viz., 1144·58 thermal units and 1·2535 lb. on the Friday, and 1209·50 thermal units and 1·3199 lb. on the Wednesday. To make the meaning of these figures clearer, they are expressed below as percentages of the total quantities of heat, and of steam and water present, and compared with the percentages obtained in the case of an unjacketted compound engine working with practically the same initial pressure, but with the more moderate ratio of expansion of 1 : 8·27, the cut-off in the small cylinder taking place at 0·294 of the stroke.*

* See Note 3 in Appendix.

TABLE VI.

		June 13, 1884.	June 18, 1884.	Oct. 25, 1881.
1	Initial pressure, absolute lb. per sq. in. ..	94·78	94·25	96·40
2	Total ratio of expansion	1 : 14·66	1 : 14·68	1 : 8·27
3	Percentage of total heat abstracted by cylinder during compression and admission	23·7	24·7	9·8
4	Percentage of mixture of steam and water condensed during same periods	30·8	32·0	12·1
5	Consumption of dry saturated steam per T.H.P. per hour (see Table 1.)	16·04	17·66	14·53

These are some of the most instructive figures derived from the experiments, and the lesson they teach most plainly is that excessive ratios of expansion cannot be indulged in with impunity where cylinders are unjacketted. By increasing the quantity of steam kept permanently in the cylinders, in contradistinction to that received from the boiler and discharged each stroke, we should increase the total weight of steam and total quantity of heat present—since the only loss of heat from this steam is that due to radiation, which is small—and thus diminish the percentages of water and of heat absorbed, as well as the absolute amounts, and improve the performance of the engines. This can be done to some extent by closing the exhaust ports earlier. Passing on to the period of expansion in the smaller cylinders, we notice considerable differences in the water re-evaporated and heat restored by the cylinder metal on the two days—differences which are probably traceable ultimately to the alteration of the steam valves of the larger cylinders on the Wednesday. The figures relating to this period open up questions too long to be discussed here, but one point which should not be passed over is referred to in the Appendix.† In the condensing cylinder we again notice an enormous amount of initial condensation, particularly on the Friday, when the quantity of water at the end of the admission reached 44·2 per cent. of the total weight of steam and water present. The expansion presents no peculiarities, and may be passed over with the remark that the absorption of heat by the metal does not cease at the end of the admission, but continues after the steam port has closed, thus indicating that the maximum temperature attained by

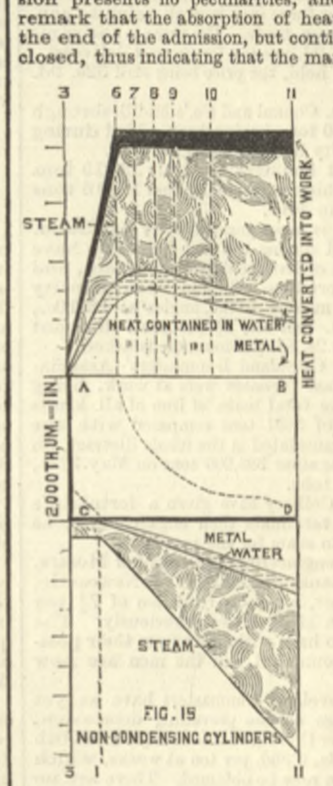


FIG. 15
NON CONDENSING CYLINDERS

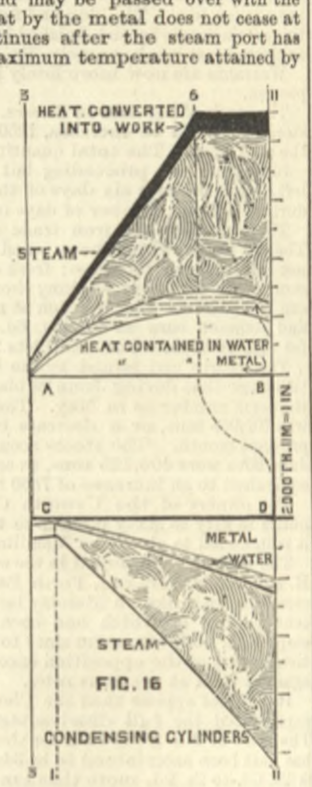


FIG. 16
CONDENSING CYLINDERS

the metal is not that of the entering steam, but one somewhat lower. The figures relating to the exhaust, however, require notice. On the Friday the percentage of water at the end of the stroke, which shows the final result of all the changes through which the mixture of steam and water has passed, is less than on the Wednesday; also the percentage of heat made unavailable for work by being locked up in the cylinder metal, commonly termed "the exhaust waste," is less, so that it would at first sight appear as though, on the whole, more had been got out of the steam on the last day than on the first. The reverse actually happened. Why was this? The answer is furnished by the second law of thermo-dynamics, which briefly stated amounts to this—that any heat engine which works between given limits of temperature gives the maximum useful effect when all the heat is received by the medium used—steam in the present instance—at the highest temperature and discharged at the lowest. Heat and temperature are two very different things. Just as the amount of work which a certain quantity of water will perform varies with the head or pressure under which it is employed, so the amount of work a certain quantity of heat will do varies with the difference between the temperature at which it is supplied and that at which it is discharged. That the engines contravened this law on both days is evident from the figures in the tables. During the admission a certain quantity of heat was absorbed by the metal and given out gradually to the steam during the expansion and exhaust at the temperature then prevailing in the cylinders, a temperature continually falling more and more below the temperature of the boiler, the higher limit, and continually approaching that of the condenser, the lower limit. But on the Wednesday the contravention was more flagrant, as may be seen by comparing the figures for the two days, and noting how much larger a proportion of the heat abstracted by the metal during the admission was restored in the small or high temperature cylinder on the Friday. These figures furnish the explanation of the paradox. Finally, in line 15 of Table V. we have the quantities of heat received by the condenser. These would have been most important had the experiments been complete, because the same quantities could then have been calculated independently from the weight and temperature of the ejection water, and the two values compared as a test of the accuracy of the observations.

(*To be continued.*)

AT Cleveland, Ohio, the ironmasters having sought to resume with new workpeople, the men on strike invaded the mills, forced all the strange workmen to desist from labour, and banked the fires. They have now succeeded in closing all the mills, and 3500 men are idle.

* See trial of the engine and boiler at Audley Hall Weaving Shed, Blackburn, by the company's engineer, 25th October, 1881.

† See Note 6.

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

(*From our own Correspondent.*)

THE Midsummer quarterly meetings have been held this week, and have drawn together a large number of traders from all parts of the kingdom. There were abundant inquiries from merchants and consumers alike to test prices, but the amount of new business which has been done is not heavy.

The demand for stamping and working up sheets is also large. In no department are forward orders at present prices courted, makers preparing to go on from hand to mouth in the hope of possible improvements.

At Wolverhampton to-day—Wednesday—no alteration was made in the crucial price of marked bars, which were re-declared at £7 10s., with 12s. 6d. per ton extra for the bars of the Earl of Dudley. The market, however, regarded the £7 10s. quotation as applying to only one or two firms, such as Wm. Barrows and Sons and the New British Iron Company, since the block houses, who have hitherto been regarded as marked bar firms, made no secret of their preparedness to accept orders at £7, and for second qualities at £6 10s. per ton. The competition from other bar makers was indeed such as to leave the marked bar firms no alternative but to accept this course if they desired to do business. Merchants especially refused to concede the £7 10s. quotation except for special indented orders.

Medium quality bars were abundant at £6, while common were £5 10s. down to £5 5s.

The quotations for bars of the New British Iron Company are as follows:—Best Corngreaves, £6 10s.; Lion, £7 10s.; best Lion, £9; best best scrap Lion, £10; best best best Lion, £11; best charcoal, £11 10s.; best Corngreaves plating, £7; Lion plating, £8; best Lion plating, £9 10s.; best Lion turning, £11; best Lion rivet, £9; best best Lion rivet, £10; best Lion chain, £9; best best Lion chain, £10; best Corngreaves horseshoe, £6 10s.; and Lion horseshoe. £7 10s.

The quotations for slit rods of the same firm are:—Best Corngreaves rods, £6 5s.; C. G. C., £7; Lion, £7 10s.; best Lion, £9; best charcoal, £11 10s.; steel, £8; best Corngreaves slit horseshoe, £6 10s.; Lion slit horseshoe, £7 10s.; and best Lion, £9. Hoops and strips from 15 to 19 b.g.:—Best Corngreaves, £7; Lion, £8; best Lion, £9 10s.; best charcoal, £12; and steel £8 10s.

The list of John Bagnall and Sons stands at date as: Sheets, to 20 w.g., £9; 24 w.g., £10 10s.; 27 w.g., £12; ordinary boiler plates to 5 cwt., £9; best, £10; double best, £11; and treble best £12. For hoops from 14 to 19 w.g. they ask £8; for angles, fullered shoe bars, and plating bars, £8; and for rivet iron, £9 to £10, according to quality. Their burning and horseshoe bars are £7 10s. The firm's ordinary smithy bars are as here: 1in. to 6in., flat, £7 10s.; 6½in., 7in., 8in., and 9in., flat, £8. Round and square, 7/16in. to 3in., £7 10s.; 3⅛in. to 3¼in., 3⅜in., and 3½in., £8; 3⅝in., 3¾in., 3⅞in., and 4in., £8; 4⅛in. and 4¼in., £8 10s.; 4⅜in. and 4½in., £9; 4⅝in. and 4¾in., £9 10s.; 4⅞in. and 5in., £10. Round only, 5⅛in. and 5¼in., £10 10s.; 5⅜in. and 5½in., £11; 5⅝in. and 5¾in., £11 10s.; 5⅞in. and 6in., £12; 6¼in. and 6½in., £13; 6¾in. and 7in., £14; 7⅛in. and 7¼in., £15.

Prices of sheets varied considerably, and some makers preferred to stand out of the market. Hard doubles are mostly quoted £7, but some makers would not refuse £6 15s. for a good order. Lattens were generally £7 10s. Messrs. Crowther Bros. and Co.'s best coke tin sheets were quoted at £24 per ton; best charcoal, £26; extra best, £28; and best soft steel sheets also £26. Their ordinary cold rolled and close annealed charcoal sheets are £15; best ditto, £16 10s.; F.S.S. steel sheets, £11; best S steel sheets, £12 10s.; and best homoid ditto, £13 10s.

The pig iron market at Wolverhampton did not show by any means large sales, thought it was reported that during the past two or three weeks some considerable transactions had been negotiated in advance of the quarterly meetings. The business was mostly in Midland qualities. Shropshire and Staffordshire all-mine pigs were announced 80s. for cold blast sorts and 60s. for hot blast. The prices at which business was actually done, however, were for hot blast sorts, about 55s. to 57s. 6d. Staffordshire part-mines were 40s. to 45s., and common 35s. to 37s. 6d. The Spring Vale make was quoted at:—Hydrates, 52s. 6d.; mine, 45s., and common, 37s. 6d. The Willingsworth brand was quoted at 40s. First-class hematites were mostly quoted at 54s., but some buyers declared they could place orders at 52s. 6d. Second-class hematites were quoted 45s.; Derbyshire pigs, 40s. easy; and Northamptons, 38s.

At Birmingham to-day—Thursday—the prices announced at Wolverhampton were alike as to pig and finished iron fully confirmed. Business was tame in all departments, confidence having been somewhat interfered with by arrangements which are in progress for private compositions by two iron and two hardware firms. Forward orders were not regarded by sellers with much favour. In a fortnight or so, however, the market will settle down, and more orders will be distributed.

The yards of the constructive engineers mostly keep well supplied with work, and valuable additional contracts continue to be put upon the market for competition. One of the best of these just now out is for eight bridges of 100ft. span required by the Indian State Railways, and wrought iron girders needed by the Bombay, Baroda, and Central India Railway Company.

Pipe founders speak of the fine point to which business is still cut, and of the large number of firms who immediately tender directly any contracts appear upon the open market. This week the Holt Water and Sewage Works authorities are inquiring for over 2000 yards of cast iron pipes of 2in., 3in., and 4in. sizes, together with small pumping machinery.

Galvanised sheet makers report good export inquiries from Australia, South America, and India; but on account of the prices affixed many of them have to pass on to other firms who are situated near the ports.

In the rivet trade a good deal of speculation is rife as to who will be the firms who will secure contracts with the Admiralty for a twelvemonth's supply of rivets now needed by them. The average ordinary consumption of these goods by the Department is some 3480 cwt.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—The whole tendency of trade is still in the direction of continued depression. The demand for all descriptions of iron not only shows no improvement, but in most of the large iron consuming branches of industry there is a slackening off which indicates the possibility of even lessened requirements, and the prospects for the future are generally regarded with a feeling of despondency. Prices are already so low that there is really no margin for any further inducements in this direction as a stimulus to trade. The difficulty that has to be faced is in fact not one of price, but of an absence of demand which only an increased volume of trade generally can stimulate. There seems, however, to be nothing to indicate from whence this increased volume of trade is to come, and the immediate future shows no prospect of reviving activity to be at all probable.

The Manchester iron exchange meeting on Tuesday was but a repetition of the previous extremely dull markets which week after week have been recorded for a considerable time past. If anything, inquiries were even fewer than they have been, and the actual business done was exceedingly small. Quoted prices were about the same, except that an increasing tendency is shown to give way upon the nominal list rates that have long been above the current market rates; this, however, does not lead to any actually increased selling, but simply to orders being secured which otherwise would have gone into other hands. Lancashire pig iron makers are firm at 39s. for forge and 39s. 6d. for foundry, less 2½ as their minimum for delivery equal to Manchester, but the business they are doing is limited to an occasional small order from regular customers using their iron. District brands, which are practically represented solely by Lincolnshire iron, meet with only a small inquiry, and the current selling prices average 38s. to 39s., less 2½, delivered here. Middlesbrough iron is only in very poor demand, and good foundry brands are quoted at about 40s. 6d. to 40s. 10d. net cash delivered equal to Manchester.

Hematites still meet with practically little or no inquiry, and prices continue extremely low, good foundry brands delivered into this district being readily obtainable at about 51s. 6d., less 2½.

The business doing in the manufactured iron trade continues only very indifferent; neither the home trade nor the shipping trade shows any improvement, and forges are only kept very irregularly employed, with orders coming forward slowly from hand to mouth. Prices also continue extremely low; it is only in exceptional cases that more than £5 5s. per ton is being got for Lancashire and North Staffordshire bars delivered into the Manchester district. Hoops average £5 15s. to £5 17s. 6d., and sheets £6 15s. to £7 per ton.

In most branches of the engineering trade a decided slackening off continues to be reported, and many of the large firms in this district are now only very indifferently employed. The returns for the past month, issued by the Secretary of the Steam Engine Makers' Society, show no very material change in the condition of employment in the various districts connected with the society. There is a slight increase, as compared with last month, in the number of members in receipt of out-of-work support, but this is too small to affect the general average, which remains at about 2½ per cent. of the total membership on the books for out-of-employment donation. The prospects of trade are reported not to show any improvement; in odd cases here and there rather more activity is reported, but this is fully counterbalanced by increased depression in other districts. As regards the shipbuilding trade the northern districts show an improvement, but generally this branch of industry continues in a very depressed condition. Other branches of trade are reported to be about the same; locomotive builders are still fairly busy, and tool makers and stationary engine builders, except in the colliery and shipbuilding districts, are moderately employed.

The coal trade continues in much the same depressed condition as reported last week. For all descriptions of fuel there is a very poor demand, which does not keep pits going more than three to four days a week, and prices still show a tendency to give way. At the pit mouth best coal averages 8s. to 8s. 6d.; seconds, 6s. 6d. to 7s.; common, 5s. to 5s. 6d.; burgy, 4s. 3d. to 4s. 9d.; best slack, 3s. 6d. to 4s.; and common, 2s. 6d. to 3s. per ton.

The shipping trade is only indifferent, with good steam coal delivered at the high level, Liverpool, or the Garston Docks quoted at 7s. to 7s. 3d., and some sorts offering at 6s. 9d. per ton.

Barrow.—I hear complaints from all quarters that trade is going from bad to worse. There is not a speck indicative of improvement on the whole horizon. Wearied out with long waiting for orders, which consumers seem utterly unwilling to place, makers have at length felt bound to submit to a reduction in prices, although they have been working for months at unremunative rates. Quotations have fallen a shilling per ton for mixed parcels of Bessemer, but even at this figure it is questionable whether consumers will give any impetus to production. Some small orders for steel rails have come to hand, but manufacturers have a great deal of plant lying idle. The outlook all round is dull. For finished iron the demand has dimished, though mills are still kept fairly employed. Hematite ore has been slightly reduced in value, quotations being now from 8s. 6d. to 9s. 6d. per ton, with moderate demand. Coal and coke meet with slow sale at prices a little easier. The Mona's Queen, built by the Barrow Shipbuilding Company, for the Isle of Man Steam Packet Company, made her trial trip on Tuesday and succeeded in a rough sea in doing 19½ knots an hour, or nearly 22 miles. She is claimed by the builders to be the fastest passenger steamer afloat.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

The Elsecar Iron works (Milton and Elsecar, to write more correctly) have now passed out of existence so far as Mr. George Dawes' famous tenancy is concerned. It will be remembered that the lease of the works held by Mr. Dawes, under the ground landlord, Earl Fitzwilliam, terminated on the 31st December last, and that his lordship allowed Mr. Dawes six months' grace in which to remove his portion of the property. Mr. Dawes immediately set about the dismantling of the works, and on the 6th instant, the machinery, engines, boilers, patterns, stores, and general loose plant were sold by public auction. With the exception of the local collieries and foundries, the district of Milton and Elsecar has been dependent upon these works, which Mr. Dawes has conducted for a period of upwards of thirty years, paying on an average about £1500 per week in wages. I remember hearing it stated when Mr. Dawes' lease terminated last December, that he estimated the valuation to an incoming tenant at £60,000. The various buildings, with the engines, furnaces, &c., which belong to Earl Fitzwilliam, have not been dismantled, and it is generally hoped that his lordship will not permit the iron industry of Elsecar to become extinct. A well-known local coal and iron company was stated to be negotiating with a view to acquiring the establishment, but I cannot obtain confirmation of this statement, and the present condition of the iron trade does not encourage enterprise in that direction.

The accident to the Gallia—Cunard liner—which caused a delay of several days, excited a good deal of interest in Sheffield. According to the telegram first received, the misfortune was due to the breaking of the shaft. It was known that the steel crank shaft for the Gallia's engines had been made by Messrs. Charles Cammell and Co., and a failure in that direction might have had a serious bearing on that department of local business. On Sunday, however, all fears were set at rest by the receipt of a telegram stating that the accident had been due to the breaking of the third section of the tunnel shaft, which is made of iron. The use of iron for either the crank or the tunnel shafts of large ocean-going steamers will not be promoted by this incident. The repairing of the tunnel shaft at sea is regarded here as a fine example of engineering skill. It was fortunate that fine weather prevailed at the time.

The visit of Prince Albert Victor to Sheffield has an important influence on the wage-receiving classes. Monday is "Saint Monday," and the work done is limited. H.R.H. came on Tuesday afternoon and remained till Wednesday afternoon. During these two days very little work was done, the artisans being fully occupied in the congenial work of sight-seeing. It is at the bank that the full effect is observable. One firm who usually draw £800 a week for wages, drew £500; another lessened its call from £700 to £300; and others diminished their demands by from £500 to £100. It would be interesting to know the exact cost of the royal visit in lessened wages to the working classes; that added to the amount spent in holiday-making and the loss to the employers in idle machinery, interest on capital, &c., would make a goodly bill for Hallamshire loyalty, even at a time when work is scarcer than workmen.

At Denaby Main it is pretty clear that the strike is wearing itself out. Hands from a distance are not all willing to stay; but a few remain, and this, going on gradually, is encouraging the company in the struggle. It is said that several of the old hands would be very glad to resume their occupation if it were not for the master-spirits who usually "rule the roast" at such times. The company's cottages, from which the men were evicted six weeks ago, are now being slowly filled again by foreign hands, many from Staffordshire, where employment is harder to get than even in South Yorkshire. In the Derbyshire district there are some disputes in the coalfield. At Hartington Colliery, Staveley, the men are on strike against a proposed change in working which, they say, would mean a considerable reduction in their earnings, and having recently submitted to a reduction of 10 per cent., the men resent being interfered with at present. At South Kirby Colliery the miners and topmen are to receive twenty-eight days' notice, with a view, no doubt, to rearrangements.

In the South Yorkshire coal trade there is no improvement to report. Most of the collieries are making short time, in spite of the efforts of salesmen to push coal in the market at very low prices. Quotations still have a downward tendency. The tonnage conveyed by both the Midland and Great Northern lines to the metropolis is not up to the average; but Messrs. Newton, Chambers, and Co., during the month, have sent a fair quantity. Steam coal is in rather better demand for the Humber ports. Locomotive coal and engine fuel are in fair demand at low rates. The Board of Trade has completed the inspection of the Hull and Barnsley line, which will have a most important bearing on the coal trade. It is expected to be open for traffic on the 15th inst.

At local ironworks trade is very quiet, and the general steel trade remains unaltered. Several firms are well supplied with orders for castings, and one or two engineering establishments, though generally dull, are actively employed in several departments. Railway wagon builders are remarkably quiet. Messrs. Craven Brothers, Darnall Works, are building two large dining saloon carriages for the Great Northern Railway. In the lighter departments of saws, files, and edge tools, as well as in silver and electro-plated ware, languor is the rule, and as the cutlery trades —except to one or two markets—are similarly lifeless, and the work done is at very little profit, the complaints in manufacturing circles seem to increase as the year advances.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

The quarterly meeting of the Cleveland iron market was held at Middlesbrough on Tuesday last. The attendance was poor and only a moderate amount of business was done. The prices which ruled last week were maintained, and it seems scarcely likely that lower ones wlll now be taken. Merchants quoted 32s. per ton for No. 3 g.m.b., but were very cautious, and sold only small lots. Makers are still well supplied with orders booked some time since, and are not anxious to sell in the present state of the market. As a rule they quote 32s. 6d. per ton for No. 3, but in some instances have taken less. The demand for forge iron is weak owing to continued slackness in the finished iron trade. The price is the same as quoted last week, namely, 31s. 9d. per ton for prompt delivery.

Warrants are now more firmly held, the price being still 32s. 9d. per ton.

The stock of pig iron in Messrs. Connal and Co.'s Middlesbrough stores continues to increase, 1250 tons having been added during the past week. The total quantity held is now 53,982 tons.

Shipments are proceeding but indifferently. Only 12,213 tons left during the first six days of this month, as against 16,616 tons during the same number of days in June.

The manufactured iron trade is in an unsatisfactory condition. The low prices which have ruled during the past few weeks have not led to much business; fresh orders are difficult to obtain, and some of the mills are working short time. Ship plates in quantity can be had at £4 15s. per ton at makers' works, angles at £4 10s., and common bars at £4 17s. 6d.—all less 2½ per cent. discount for cash on 10th. For small lots 2s. 6d. per ton more is asked.

The returns just issued by the Cleveland Ironmasters' Association show that during June 98 blast furnaces were at work, being the same number as in May. The total make of iron of all kinds was 207,968 tons, or a decrease of 5631 tons compared with the previous month. The stocks accumulated in the whole district on June 30th were 406,125 tons, as against 398,295 tons on May 31st, equivalent to an increase of 7830 tons.

The owners of the Usworth Colliery have given a fortnight's notice to fifty to sixty colliers to terminate their engagements, as it is intended to close the Maudlin seam for the present.

The workmen employed in the engineering department of Messrs. R. and W. Hawthorne, Forth Banks Engine Works, Newcastle, came out on strike on Monday last, against a reduction of 7½ per cent., notice of which had been given a week previously. The employers, however, seem since to have withdrawn from their position in view of the opposition encountered, and the men are now again at work at previous rates.

It does not appear that the Cleveland ironmasters have as yet experienced the full disadvantage of the prevailing depression. The price of No. 3 pig iron for the three months ending June 30th has just been ascertained to be 34s. 6·86d. per ton at works, which is 2s. 6d. to 2s. 9d. more than can now be obtained. There are no sliding scales current at the moment in Cleveland, all having been terminated recently pending revision. If the one relating to blast furnace men and miners had remained in operation, the above ascertainment would not have affected the former at all, and the latter only very slightly. The average price realised during the first quarter of the year was higher, but only to the extent of about 1½d. per ton. With no immediate prospect of lower wages, it is manifest that the current quarter will be a very trying one to smelters. They considered themselves badly enough off during the first half of the year; but now their prices are 8 per cent. lower, without any prospect that they will be able to reduce cost proportionately.

Two of the bore-holes which the Newcastle Chemical Works Company has for some time been occupied with on the northern bank of the Tees have now reached a depth of 1000ft. The salt bed will probably be entered before 200 more feet have been bored.

The lead market seems to be an exception to the general rule of depression and despondency. Lead in all forms and shapes has been rising in value of late, and there is still an upward tendency. The reason for this is not very obvious, especially as the demand for warlike purposes must now have ceased. There is no war of importance in progress anywhere.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

There was a fair business in warrants at the close of the past week, but little doing in the course of the past few days. The shipments of pigs were poor, amounting to 7410 tons, compared with 6549 in the preceding week, and 14,162 in the corresponding week of 1884. The exports to Canada were 1103 tons, but to other countries much less was sent. To date, the total shipments for the year are 234,627 tons against 295,934 in the same period last year. Stocks have been increasing at a greater rate than usual, the week's addition to the stock in Messrs. Connal and Co.'s Glasgow stores having been about 2300 tons, and the total being now 603,454, compared with 588,732 twelve months ago. There are ninety furnaces in blast against ninety-six at the same date last year.

Business was done in the warrant market on Friday at 40s. 10½d. Monday's market was quiet, with a few transactions at 40s. 9d. cash. On Tuesday the quotations were 40s. 9d. to 40s. 10½d. cash. Business was done on Wednesday at 40s. 10½d. to 40s. 11d. cash. To-day—Thursday—market was firm, with business up to 41s. cash, and 41s. 1d. one month.

The current values of makers' iron are without much change, as follow:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 47s. 6d.; No. 3, 44s. 6d.; Coltness, 48s. 6d. and 47s.; Langloan, 48s. and 47s.; Summerlee, 47s. 6d. and 44s. 6d.; Calder, No. 3, 44s. 6d.; Carnbroe, 46s. 6d. and 44s. 6d.; Clyde, 46s. 3d. and 42s. 3d.; Monkland, 41s. and 39s.; Quarter, 40s. 6d. and 38s. 6d.; Govan, at Broomielaw 41s. and 39s.; Shotts, at Leith, 48s. 6d. and 48s.; Carron, at Grangemouth, 51s. and 47s.; Kinneil at Bo'ness, 43s. 6d. and 42s. 6d.; Glangarnock, at Ardrossan, 46s. 6d. and 41s. 6d.; Eglinton, 41s. 6d. and 38s. 6d.; Dalmellington, 44s. and 41s. 6d.

Since last report Messrs. Merry and Cunninghame have begun at their Glengarnock Ironworks the manufacture of pig iron to be converted directly into steel on the basic system. The Glasgow Iron Company several years ago acquired the right to use the Thomas-Gilchrist process of making steel in Scotland. They gave a sub-lease to Messrs. Merry and Cunninghame, and both firms set about the erection of the necessary works. The latter firm have got ready first, but the Glasgow Iron Company will also soon be in the field. The starting of the works at Glengarnock is a most interesting event, as they are the first of the kind set in operation in Scotland. For a number of years, as is well known, mild steel of excellent quality has been produced at a number of works in the neighbourhood of Glasgow on the Siemens-Martin process. The material has been exceedingly successful in connection with shipbuilding and engineering, and the basic process will therefore have to compete with another which has made an unequivocal and widespread reputation. The results obtained at Glengarnock within the past few days are, I am informed, quite satisfactory, although the manufacture is only as yet in its initial stages.

In connection with the Glengarnock Works, it will be interesting to note that Messrs. Craig and Donald, of Johnstone, have erected a very powerful plate shearing machine, weighing 60 tons, which, by one stroke of its large blades, can cut steel plates 1½in. thick and 9ft. in length. The blades of this machine measure 10ft. 6in. Steel boilers of an improved type have been furnished for the works by Messrs. William Wilson and Co., of Lilybank Boilerworks, Glasgow.

The past week's shipments of iron and steel goods from Glasgow embraced £6140 worth of machinery, £6477 sewing machines in parts, £1600 steel goods, and £22,000 iron manufactures.

In the coal trade there is considerable activity, especially as regards the shipping department. The week's shipments have been 26,355 tons from Glasgow, 1938 tons at Irvine, 6829 tons at Troon, 7648 tons at Ayr, 13,339 tons at Grangemouth, and 5000 tons at Bo'ness, besides smaller quantities at some other ports. The household demand is necessarily quiet. In anticipation of the holidays the miners are working well at nearly all the collieries. During the month of June the coal exports at Burntisland aggregated 74,400 tons, against 55,806 tons in the same month last year, while 14,523 tons were exported at Ardrossan.

Messrs. Denny and Brothers, shipbuilders, Dumbarton, some time ago laid down the keel of a vessel for which they had no immediate order, with the object of keeping their workmen employed. The vessel has now progressed so far as to be in the hands of the rivetters and caulkers, who have offered to show their appreciation of the generous conduct of their employers by submitting to a reduction of 10 per cent. in their wages. The men have also intimated their readiness to work for two weeks on the vessel without any wages whatever.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

I shall be glad to hear that the Commission which is being appointed to inquire into the state of trade in the kingdom will take in the principality, and go vigorously into the question of our industries. There is something radically wrong in the fact that fifteen ironworks in Wales are closed; that the present steel works are only working about three full days a week putting the time altogether; that in order that tin-plate makers may get the smallest profit on their make, they must stop work one week in four; that coke is nothing like so abundantly made as it should be; and that we are giving away the best coal in the world for a song. I hear of 9s. 6d. to 9s. 9d. and 10s. at port for excellent coal. Deducting railway rates and incidentals, colliers' wages, deadwork, &c., to say nothing of capital invested, the margin to coalowners is, at best, but a thin one.

I shall scrutinise the Commission anxiously, to see if the proper men are appointed. One thing is certain, that Mr. W. T. Lewis should be its chairman as far as Wales is concerned.

I hear rumours from competing coal districts in England of possible trade strife in the coming autumn. As regards Wales, the action of the sliding scale is so thoroughly pacific and practical in its action that there need be little anxiety here except in one quarter. The enginemen and stokers do not take kindly to the announcement that they must accept a reduction on and from August 1st.

They held an important meeting last week at Pontypridd, when several leading districts—Ogmore, Rhondda, and Caerphillly—were represented. The decision was not to accept the reduction of 2½ per cent. I hope that a settlement will be brought about, for in respect of quantity Wales is doing a large trade, and, having no work agitation to contend with, and a thorough harmonious adjustment of arrangements, the flow of coal from coal valley to ships' bunkers and holds is as brisk and smooth as ever I have known it.

The great virgin coal district to which I have often referred, from Risca to Caerphilly, is going to have another champion before the House.

Two schemes, well supported and ably sketched out, have been put on one side, and the Rhymney Railway Co. purpose making an effort next session to link the field on to their line. It would make the Rhymney another Taff. The coal trade principals are somewhat wroth with the Lords' Commissions at present for having "spragged" useful Bills or thrown them over the Embankment. It will be interesting to see what will be the result of a third trial. Coal exports were well maintained last week. Steam coal is still in the ascendant, and a good inquiry exists for small steam. House coal quiet.

The monthly meeting of the anthracite colliers of the Swansea district was held last week, when a fairly satisfactory state was shown. There was a rumour, it was stated, that Garnant and Dynant collieries would soon be restarted. It was arranged to hold a demonstration on the 18th, when Mr. Burt, M.P., and various local gentlemen of note will be present. One of the topics is to be "international arbitration, and the necessity of the principle being applied to trade disputes." In addition, labour representation in Parliament, abolition of London coal dues, royalties, &c., will come under notice.

A meeting of tin-plate makers was held at Swansea on Saturday, when it was stated that more than the necessary majority of makers had been secured, and accordingly the resolution to limit make was carried. This practically will be to give workmen an idle week every month. In this case the first week will date from the 20th July.

This is not the only interference. No new mill is to be built, and no old mill that has been idle since 31st December shall be restarted. All mills working at present to be stopped on Saturdays at 4 p.m. There is a heavy penalty for violation.

The trade is moderately brisk. Good enquiry for odd sizes, and for wasters. Prices are expected to show an increased tendency to firmness. Shipments this week are heavy.

The total iron and steel shipments of the last week from Cardiff and Newport amounted to 12,000 tons, a very satisfactory total. The bulk went to India and Canada. Shipments of iron ore are on the increase, and a slightly better tone prevails.

Patent fuel is firm in price and in good request both at Cardiff and Swansea. It is early yet to refer to Newport.

The Swansea shipping trade of last week shows a steady improvement. The tone of trade in the district is healthy generally. Some collieries, I hear, are about changing hands. In the Newport district there is an important colliery movement afloat, affecting a large virgin district. I believe it will take the form of a new and powerful company.

NEW COMPANIES.

The following companies have just been registered:—

Birmingham Refrigeration Company, Limited.

This is the conversion to a company of the business of manufacturer of machines for ice-making and refrigeration, and of mechanical engineer, carried on at Birmingham by Mr. Samuel Puplett. It was registered on the 27th June, with a capital of £25,000 in £10 shares. The subscribers are:—

	Shares.
*Samuel Puplett, Westmoor, Knowle, Birmingham, engineer	1
J. Sincock, Altrunhann, Cheshire, engineer	1
H. Puplett, jun., Westmoor, Knowle, commission agent	1
*W. Doubleday, 67, Colmore-road, Birmingham, architect	1
*Howard Lane, C.E., 115 and 116, Palmerston-buildings	1
J. Pollit, Sowerby Bridge, Yorkshire, engineer	1
Eustace Wigzel, Sowerby Bridge, Yorkshire, engineer	1

The number of directors is not less than three, nor more than five; qualification, 25 shares; the first are the subscribers denoted by an asterisk.

Clive, Son, and Myott, Limited.

This company was constituted by deed of settlement on the 3rd June, and registered as a limited liability company on the 27th June. It proposes to acquire the business of colliery proprietors and oil manufacturers, carried on by Messrs. Clive, Son, and Myott, at Tunstall, parish of Wolstanton, Stafford. The capital is £50,000, divided into 1000 preference and 1500 ordinary shares of £20 each; 204 preference and 12,600 shares have been taken, and (with the exception of four preference shares) are deemed to be paid up in full by means of the assets brought into the company by Mrs. Anne Clive, and Messrs. Robert Clive and James Myott. The remaining four shares are paid up in cash. The members are:—

	Shares. Pref.	Ord.
*Annie Clive, Tunstall, widow	75	420
*R. C. Clive, Tunstall, colliery proprietor	—	420
*James Myott, Tunstall, colliery proprietor	125	420
H. H. Clive, Porthill, Stafford, widow	1	—
Mary Clive, Hartshill, Stafford	1	—
W. B. Clive, Tunstall, colliery manager	1	—
A. Clive-Meir, Tunstall, earthenware manufacturer	1	—

The number of directors is not to be less than three, nor more than seven; the first are the three first subscribers. The company in general meeting will determine remuneration.

Jarrow Chemical Company, Limited.

This company was constituted by deed of settlement, and articles of association, dated 25th May, 1885, and was registered on the 1st inst. as a limited company, with a capital of £250,000 in £50 shares, the whole of which are taken up, and are fully paid. The object of the company is to take over the business carried on under style of the Jarrow Chemical Company, at South Shields, Friars Goose, near Gateshead, and at Newcastle-on-Tyne. The members are:—

	Shares.
*J. C. Stevenson, M.P., South Shields, chemical manufacturer	1000
*J. Williamson, Westoe, South Shields, chemical manufacturer	1000
*Sir C. Tennant, Bart., M.P., The Glen, Peebles.	750
*A. S. Stevenson, Tynemouth	500
*W. J. J. Stevenson, 58, Ladbroke-grove, widow	500
Wm. Stevenson, Glasgow, merchant	125
Nathaniel Stevenson, 51, Wimpole-street, surgeon dentist	158
*F. J. Stevenson, Union Club, Trafalgar-square.	159
H. Stevenson, St. Helier, Jersey	150
L. R. Stevenson, Liverpool, merchant	158

The number of directors is not to be less than three, nor more than seven; qualification, shares of the nominal value of £5000; the first are the subscribers denoted by an asterisk. The company will determine remuneration.

Johore Tin Streaming Company, Limited.

For some time past this company has advertised and circulated its prospectus; but although purporting to be a limited company, it had no legal existence as such until its registration on the 30th June. It proposes, with a capital of £175,000, in £1 shares, to carry on mining operations at Johore, in the Malay Peninsula, but no particulars are given in the registered documents as to the particular properties to be taken over by the company, nor the amount of the consideration to be paid for the purchase thereof. The subscribers are:—

	Shares.
*Edmund Gabbutt, Oakes-street, Liverpool, contractor	1000
*R. Dendett, Nottingham	500
Charles Wells, 13, St. Edmund's-road, Bootle, contractor	500
*T. Catterall, Stone Leigh, Up-Holland, contractor	1000
J. W. Catterall, Stone Leigh, Up-Holland, contractor	100
F. Goddard, Nottingham, engineer	500
*E. F. Mahony, London-road, Liverpool, hosier.	500

The number of directors is not to be less than four, nor more than nine; qualification, 500 shares; the first are the subscribers denoted by an asterisk. Remuneration, £1 1s. to each director for every board or committee meeting attended.

Karatara Exploration Company, Limited.

On the 1st inst. this company was registered with a capital of £5000 in £100 shares, to take over the right and interest of Mr. Samuel Archer Deacon, of Hot Springs, near Uniondale, South Africa, with respect to the supply and use within the district of Kingsna, Cape Colony, of certain dredging machinery, patented by Mr. Charles Ball, C.E., known as the "Ball Dredger." The subscribers are:—

	Shares.
A. B. Mitchell, Edgbaston, Birmingham, steel pen maker	1
B. Smith, Holloway Head, Birmingham, manufacturer	1
R. F. Martineau, Holloway Head, Birmingham, manufacturer	1
F. S. Bolton, Broad-street, Birmingham, metal dealer	1
T. F. Proud, 26, Exchange-buildings, Birmingham, architect	1
H. S. Smith, 37, Bennett's-hill, Birmingham, chartered accountant	1
C. Westwood, Handsworth, gold and silver refiner	1

The number of directors is not to be less than three, nor more than five; the first are Messrs. F. D. Deare, 19, Coleman-street, E.C.; Robert King, Berkeley-street, Birmingham; and H. F. Osler, of Broad-street, Birmingham. Qualification, shares or stock of the nominal value of £200. The company in general meeting will determine remuneration.

Strontia Company, Limited.

This company proposes to acquire from Messrs. Bolton and Partners, Limited, certain mines and deposits of strontia and baryta, the manufactory, &c., known as the Heworth Chemical Works, at Gateshead-on-Tyne, now used for the manufacture of strontia; the manufactory at Lavenham, Suffolk, now used for the manufacture of sugar, and certain patents relating to such businesses. It also proposes to develope the business of manufacturing strontia, baryta, the salts thereof, and other chemical products, and to manufacture and refine sugar by the strontia process or otherwise. It was registered on the 1st inst., with a capital of £300,000, in £1 shares. The subscribers are:—

	Shares.
Harmar A. Bass, M.P., Burton-on-Trent	1
Sir Francis Bolton, 19, Grosvenor-gardens	1
W. E. J. B. Farnham, J.P., Loughborough, Leicester	1
F. S. A. Hanbury Tracy, M.P., 116, Queen's-gate.	1
J. Hick, C.E., Whalley, Lancaster	1
R. H Milward, 1, New-square, Lincoln's-inn, solicitor	1
P. A. Scratchley, 4, The Sanctuary, Westminster, barrister	1

The number of directors is not to be less than three, nor more than nine; the subscribers are to appoint the first; qualification, 1000 shares. Remuneration: chairman, £6 6s.; and each director, £4 4s., for every board meeting attended.

THE PATENT OFFICE.

The Comptroller-General of patents, designs, and trade marks, recently issued in the form of a Parliamentary paper his report, the second since the passing of the Act of 1883. That the new Act has worked well in the interest of inventors may be seen from the fact that the number of applications for patents, which had risen with some variations, almost constantly in the course of thirty years, from 1211 in the year 1852, to 6,241 in 1882, leaped with a bound to 17,110 in 1884. There was a slight depression in 1883, possibly on account of the change of the law, which makes last year's numbers the more remarkable. The increase is in fact as between the years 1883 and 1884 no less than 195 per cent. The report claims an increase of about 280 per cent. for this year, on the average of 1882-83. This must be a misprint for 180 per cent., for the increase claimed is not borne out by the figures, which are for 1882, as has already been said, 6241, and for 1883, if the report be correct, 5993, or an average for the two years of 6117. This represents an increase of 189 per cent. on the average of the two years. Seventy-nine per cent. of the applications were made by persons resident in the United Kingdom, namely, 12,356 being residents in England and Wales, 901 in Scotland, and 254 in Ireland. Of the rest the largest numbers were from the United States 1181, from Germany 890, and from France 788. Residents from 27 other countries also made application to the office, 13 such countries being British possessions, from which 175 applications were made, and 3, it may be added, were made from Egypt. Surely the Report is inaccurate where it states that only 3 appeals were made in the course of the year against the decision of the Comptroller. We think we could increase the figure considerably. The greatest number of applications made in any month was in January, 2499; the smallest in August, 992. The greatest number made in any single day was, as might be supposed, on January 1, 266. The total number of patents sealed upon the 17,110 applications will not be known before next year. The number of readers who frequented the Free Library of the Patent-office in 1884 was 39,508, as against 32,748 in the previous year. Sets of the publications of the office have been sent to 46 towns, to a large number of public offices, and seats of learning in the United Kingdom; to 9 British colonies, and to 9 foreign States. Complete series of abridged specifications have also been sent to nearly 280 mechanics' literary and scientific institutes in various parts of the United Kingdom and the United States. The number of designs registered in 1884 was 19,515, as compared with 17,166 in 1883; and the number of trade-marks applied for was 7104, to 4105 in 1883. The receipts of this office amounted to £103,827, of which £88,996 was for patents' fees, £3477 for designs' fees and stamps, £7014 for trade-marks' fees, and more than £4000 for the sale of publications. The chief payments made were £36,225 for salaries—all of which are set forth in detail in the report—and £17,000 to Messrs. Eyre and Spottiswoode for printing. There was a surplus income of nearly £40,000. Tables are added showing the different classes of designs and trade-marks, with the fees paid for each.

Iron Production in the United States.—The principal statistics for 1884 are as follows:—Iron ore mined, 8,200,000 long tons; value at mine, 22,550,000 dols. Domestic iron ore consumed, 7,718,129 long tons; value at mine, 21,224,854 dols. Imported iron ore consumed, 487,820 long tons; total iron ore consumed, 8,125,949 long tons. Pig iron made, 4,097,868 long tons, a decrease of 497,642 tons as compared with 1883; value at furnace, 73,761,624 dols., or 18,148,576 dols. less than in 1883. Total spot value of all iron and steel in the first stage of manufacture, excluding all duplications, 107,000,000 dols., a decline of 35,000,000 dols. from 1883. Fuel consumed in all iron and steel works, including blast furnaces, 1,973,305 long tons of anthracite, 4,226,986 long tons of bituminous coal, 3,833,170 long tons of coke, and 62,110,660 bushels of charcoal, besides a notable quantity of natural gas.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

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

Applications for Letters Patent.

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

30th June, 1885.

7892. Clocks, &c., G. Bennett, Sheffield.
7893. Gas-lighting and Heating, T. G. Marsh, Failsworth.
7894. Starting Gear for Tram-cars, &c., A. M. Vereker and S. M. Yeates, Dublin.
7895. Breech-loading Fire-arms, G. Jefferies, Norwich.
7896. Goffer for Fancy Frilling, T. Adams and Co. and R. Davis, Nottingham.
7897. Driving Belts, &c., J. Moxon, Sheffield.
7898. Air or Gas-compressing Engines, E. Holt, Redcliffe.
7899. Spinning Textile Materials, W. Noble, Manchester.
7900. Ventilating Private Houses, &c., H. Cooper.—(*J. Flavitsky, Russia.*)
7901. Smoothing Irons, J. Ritchie, Glasgow.
7902. Door Furniture, G. Wicks, Ayton.
7903. Correctly Estimating the Influence of Wind on the Flight of Projectiles, &c., P. Brodigan, Dublin.
7904. Reservoirs for Attaching to Plates and Dishes, C. A. McCalla and Edward Trow, Birmingham.
7905. Plate and Dish with Receptacle on Rim to Contain Mustard, &c., C. A. McCalla and E. Trow, Birmingham.
7906. Hand-machine for Slicing Potatoes, &c., W. H. Keates, Stoke-on-Trent.
7907. Grain-drying Processes, S. Simpson.—(*Messrs. Lock and Thompson, United States.*)
7908. Detachable Drive Chains, W. Buxton, London.
7909. Steam Engines, L. B. Carricaburu, London.
7910. Mixing Cut Hay, &c., J. Ritchie, Edinburgh.
7911. Making Button-holes, H. J. Allison.—(*The Wheeler and Wilson Manufacturing Company, United States.*)
7912. Lacings for Corsets, &c., H. J. Allison.—(*A. S. Mann, United States.*)
7913. Notators for Music, B. Greiner, London.
7914. Vulcanised Soft Rubber, F. Wilhöft, London.
7915. Glazed Leather, T. R. Clark, London.
7916. Copying Written Manuscripts, J. L. Young, Tarrytown, U.S.
7917. Forcing and Drawing Liquids, &c., A. N. Porteous and R. L. Urquhart, Glasgow.
7918. Treating Cheques for Preventing Fradulent Alterations, H. S. Carpenter, London.
7919. Actuating the Valves of Direct-acting Engines, E. G. Colton.—(*F. W. Jenkins, United States.*)
7920. Gas Engines, H. T. Dawson, London.
7921. Horse-rakes, E. Fisher, London.
7922. Suspending Trousers, L. Schnerb, London.
7923. Inspection Gully Trap, C. B. Broad and G. Harris, London.
7924. Screw Thread Gauge, J. J. Shedlock, Barnet.
7925. Lubricators, P. M. Justice.—(*The Peerless Oil Ejectôr Company, United States.*)
7926. Slubbing Frames for Treating Fibrous Materials, S. A. Luke, Leeds.
7927. Instantaneous Grip Vices, J. W. Midgley, Halifax.
7928. Parallel Vices, J. W. Midgley, Halifax.
7929. Gas Motor Engines, O. T. Newton, London.
7930. Spanner, W. Martin, Willesden-green.
7931. Embroidery Laces, J. Krüsi, London.
7932. Pulp Strainers, C. H. and F. L. Roeckner, London.
7933. Casks or Barrels, A. Dunbar, London.
7934. Steam Engines, T. Hunt, London.
7935. Safety Appliances for Two-wheeled Vehicles, V. C. di Tergolina, London.
7936. Knitting Machines, S. and H. H. Donner and O. Floss, London.
7937. Making Pottery, Glassware, &c., C. C. Thompson, London.
7938. Elbows for Stove Pipes, A. W. Cram, London.
7939. Governing the Speed of Engines, E. F. Piers, London.
7940. Governing the Speed of Engines, E. F. Piers, London.
7941. Neckties, Cravats, &c., M. A. Ternisien, London.
7942. Bonding Bricks, W. B. Smith, London.
7943. Adjustable Reamers, P. A. Newton.—(*P. J. Kelly and J. Groves, United States.*)
7944. Gas-motor Engines, J. F. Schnell, Manchester.
7945. Cartridges for Small-arms, A. S. Lyman, London.
7946. Cartridges for Ordnance, A. S. Lyman, London.
7947. Extinguishing Fires, G. F. Redfern.—(*Wirth and Co., Germany.*)
7948. Paper Boxes, A. J. Boult.—(*F. P. Birley, Canada.*)
7949. Rotary Engines, A. J. Boult.—(*H. Sewrey, Canada.*)
7950. Ploughs, G. B. Casaday, London.
7951. Ploughs, G. B. Casaday, London.
7952. Ploughs, G. B. Casaday, London.
7953. Belting, J. v. D. Reed.—(*B. L. Stowe, U.S.*)
7954. Belting, J. v. D. Reed.—(*B. L. Stowe, U.S.*)
7955. Car Brakes, E. A. Westcott and E. R. Bristol, London.
7956. Sewing Machines, A. J. Boult.—(*R. D. Tucker, United States.*)
7957. Grinding Mills, A. J. Boult.—(*J. C. L. Pestrup and G. Diers, Germany.*)
7958. Purifying Water, W. H. Hartland, Glasgow.
7959. Lubricators, R. McDowell, Glasgow.
7960. Checks, &c., A. M. Clark.—(*W. T. Doremus, U.S.*)
7961. Preservation of Liquid in Casks, H. H. Lake.—(*Madame Marcoux, née A. Morel, France.*)
7962. Bogies, H. H. Lake.—(*W. H. H. Sisum, U.S.*)
7963. Mechanical Movements, H. H. Lake.—(*L. D. Farra and J. C. Humphreys, U.S.*)
7964. Evaporating Apparatus, H. H. Lake.—(*F. J. Oakes, U.S.*)
7965. Demolition of Subaqueous Objects, H. H. Lake.—(*J. Lauer, Austria.*)
7966. Fire-grates and Stoves, W. White, London.

1st July, 1885.

7967. Fire-proof Flooring, A. H. Stott, J. A. Stott, and A. H. Stott, jun., Manchester.
7968. Locks and Latches, G. Dawes and R. Dawes, Wolverhampton.
7969. Moustache Guards, C. B. S. Webb, Colchester.
7970. Securing the Cords of the Cloths used for Covering Railway Wagons, H. Smith, near Coventry.
7971. Separating Honey from the Comb, G. O. Wray, Bedford.
7972. Purification of Glycerine, O. C. Hagemann, London.
7973. Purifying and Concentrating Glycerine, O. C. Hagemann, London.
7974. Air and Water-tight Coffin, W. E. Heys.—(*L. P. A. Mundt and C. A. Lindemann, Prussia.*)
7975. Ladies' Dress Bustles, G. Rittershaus, London.
7976. Devices for Locking Screw Nuts, J. Bennie.—(*W. Bennie, Australia.*)
7977. Obstruction Detector for Drivers of Locomotives, C. Payant, Manchester.
7978. Withdrawing Ferrules from Tubes, G. W. Rothery, Parton.
7979. Regulating Knives in Horse Hoes, J. Searby and I. Howe, Rotherham.
7980. Watch Protector, S. Davey, Birmingham.
7981. Bicycles, W. H. Anderson, Dublin.
7982. Steam Engines, A. MacLaine, Belfast.
7983. Bakers' Oven, W. Cook, Glasgow.
7984. Lawn Tennis Rackets, G. Marshall, London.
7985. Steam Traps, J., W., and J. Kirkham, London.
7986. Chemical Fire Extinguishers, J. K. J. Foster and J. Haslam, London.
7987. Egg Beater, J. G. Wilson.—(*P. Diehl and Co., United States.*)
7988. Seaming the Edges of Looped Fabrics, J. G. Wilson.—(*W. Pearson, United States.*)
7989. Rifles, G. E. Vaughan.—(*The Austrian Small-arms Manufacturing Company, Austria.*)
7990. Sight Feed Lubricator, E. Brearley, Heckmondwike.
7991. Air-tight Boxes or Boats, J. Carter, London.
7992. Side Light Parallel Automatic Head Landaus, J. and J. Robertson, Glasgow.
7993. Gas Regulators, F. Clouth, London.
7994. Plaiting Machines, D. R. Malcolm, London.
7995. Locks or Latches, H. Wakefield and A. C. Thomas, London.
7996. Indicating Apparatus, J. S. Raworth, London.
7997. Boilers, E. Edwards.—(*O. Bomnitz, Austria.*)
7998. Liquid Measuring Taps, H. M. Thomas, London.
7999. Pianofortes, F. Bapty.—(*H. Koch, Russia.*)
8000. Crystallised Grape Sugar, A. Seyberlich and A. Trampedach, London.
8001. Horseshoes, F. A. Roe, London.
8002. Sweeping and Scraping Roads, &c., J. Smithers and R. Thomas, London.
8003. Ear-jewels, P. Jensen.—(*J. Abel and J. H. Riess, Austria.*)
8004. Lawn Tennis Scorers, R. C. Hope, London.
8005. Compressed Artificial Fuel, W. A. McI. Valon, London.
8006. Latch, C. R. Blathwayt, London.
8007. Self-acting Mules, J. Threlfall and J. Pickles, London.
8008. Utilisation of Bye-products, &c., P. C. Bunn, London.
8009. Woven Fabric for Covering Floors, F. Bolton, London.
8010. Automatic Expansion Valve Gear, J. N. Paxman, London.
8011. Chiming Apparatus, J. Harrington, London.
8012. Treating Celluloid, &c., A. J. Boult.—(*W. C. Zeidler, Canada.*)
8013. Fishing by the Aid of Light, J. W. and L. Haylock, London.
8014. Device to be used for Metal Fencing, J. T. Selby, London.
8015. Treadle Movements for Pedomotive Vehicles, A. W. L. Reddie.—(*G. J. Taylor, United States.*)
8016. Gassing Yarns, J. W. Dawson, London.
8017. Closing India-rubber Pouches, &c., A. Oldroyd, London.

2nd July, 1885.

8018. Machine for Splitting Wood, R. Hutchinson London.
8019. Tricycles, R. L. Burnell, London.
8020. Fuel Economisers, A. Bell, Manchester.
8021. Making Fustians, J. Schofield and A. Taylor, Manchester.
8022. Cutting Down Weeds in Gardens, E. Brown, Birmingham.
8023. Combined Bicycle and Tricycle, J. H. Keeping, Eastbourne.
8024. Stop Motions, B. A. Dobson and J. Hill, Manchester.
8025. Spindles and Partition Plates, W. Turner, Halifax.
8026. Dressing Stone, &c., J. Coulter, Halifax.
8027. Apparatus for Heating Water, T. Drake, Halifax.
8028. Double-acting Motor Engines, J. P. Lea, Birmingham.
8029. Sanitary Closet Pans, &c., A. F. Hartshorn, Birmingham.
8030. Producing Photographic Pictures, R. W. Vining, Liverpool.
8031. Furnaces, H. Caswell, London.
8032. Solitaires, &c., J. McI. Ballantyne, Glasgow.
8033. Variable Crank Motion, G. Browning, Glasgow.
8034. Rotary Cutting Tools, A. M. Clark.—(*La Société Heilmann-Ducommun and Steinlen, Mulhouse.*)
8035. Wire Fence Standards, P. J. Dowling, Dublin.
8036. Electric Telegraphs, H. C. Mance, Brockley.
8037. Cleaning Grass and other Seeds, J. McAdoo, London.
8038. Packing Cases, K. J. L. Best, London.
8039. Tinning and Finishing Tin and Terne Plates, H. Bain, London.
8040. Railway Station Indicators, A. Saloway and J. E. Groves, Brixton.
8041. Registering the Time of Attendance of Workmen, &c., T. W. Morris, London.
8042. Cylinders of Gas Engines, C. J. Eyre, London.
8043. Measuring Distances, H. R. A. Mallock, London.
8044. Preventing the Spread of Fire, E. Stewart, H. S. R. K. Spencer, and J. D. Lee, London.
8045. Hand Power Gear for Velocipedes, E. H. Grey, London.
8046. Communicating Variable Speed to Sewing Machines, A. Easton, S. McGaw, and J. M. Collins, Glasgow.
8047. Securing Together Joists and Carrying Girders, R. McConnel, Glasgow.
8048. Drying Substances Exposed to the Action of Salt Water, C. T. Heycock and E. H. Griffiths, Cambridge.
8049. Feed Regulating Mechanism of Electric Arc Lamps, C. F. Cooke and T. Robinson, London.
8050. Preparing Pigments from Sulphate of Iron, T. Terrell, London.
8051. Treating Soap Leys, O. T. Hagemann, London.
8052. Twist or Lever's Lace Machines, H. Hitchin, London.
8053. Covering for Table Tops, M. G. Wood, London.
8054. Metal Bodied Rubber Type, E. M. Richford, London.
8055. Hats, T. and A. P. Townend, London.
8056. Ear-studs, M. H. Tilley, London.
8057. Sewing Needle, W. R. May, London.
8058. Treating Sewage, &c., W. B. G. Bennett, London.
8059. Roofing Tiles, &c., J. Hamblet, London.

3rd July, 1885.

8060. Cord-holding, &c., Apparatus, H. P. Hoghton, Manchester.
8061. Hoisting and Traversing Goods, &c., B. H. Thwaite and J. Neville, London.
8062. Securing Strips of Leather to the Edges of Woven Belts, &c., S. Ogden and I. Jackson, Manchester.
8063. Watches, C. J. Willday, Birmingham.
8064. Support for Flowers or Plants, G. J. Williams, Birmingham.
8065. Raising and Lowering Heavy Bodies, S. G. Bennett, Edgbaston.
8066. Driving and other Chains, W. Morgan, Birmingham.
8067. Plyers, J. Horabin, sen., and J. Horabin, jun., Liverpool.
8068. Connecting Geared Wheels on Tricycles, &c., H. Emanuel, Surbiton.
8069. Carding Engines, J. Elce and T. S. Whitworth, Manchester.
8070. Doffer Comb, J. Elce and T. S. Whitworth, Manchester.
8071. Advertising, J. C. Sellars, Liverpool.

8072. SILENT CLOSING and RETAINING DOOR SPRINGS, J. Adams, London.
8073. CONSTRUCTING BOILERS for TREATING WOOD, &c., C. C. Springer, Manchester.
8074. SULPHUROUS ACID GAS, C. C. Springer, Manchester.
8075. DRILL BRACES, R. Snook, Poole.
8076. ELECTRICAL CONDUCTING MATERIAL, C. S. Bradley, London.—24th February, 1885.
8077. NET SAILS for WRITING upon for ADVERTISEMENT, D. W. C. Piggott, London.
8078. HANGING MEAT SAFE, E. B. Pearse, London.
8079. MAKING TUYERES, &c., A. and H. E. Mason, London.
8080. SCREW FAN, J. Thornton, Halifax.
8081. BUFFERS for RAILWAY, &c., VEHICLES, J. Trippett and T. and H. Searls, Sheffield.
8082. TYPE WRITERS, F. Roberts, London.
8083. FANCY, &c., LOOMS, A. G. Brookes.—(G. Crompton, United States.)
8084. TREATMENT of SEWAGE, S. H. James, Tottenham.
8085. TRAMWAY LOCOMOTIVE ENGINES, D. G. Morrison, Glasgow.
8086. PUMPING MACHINERY, H. D. Pearsall, Lower Clapton.
8087. MARKING POINTS at CARDS, &c., C. E. Hoevel, London.
8088. GULLEY or TRAP GRATES, J. S. Barks, London.
8089. CLEANING MILLERS', &c., SACKS, T. Clauderay, London.
8090. DOBBIES or SHEDDING MOTIONS, R. Ecroyd, London.
8091. EXTINGUISHING FIRES, J. Carter, J. Allmark, and J. H. Pickford, Manchester.
8092. TRAM-CARS, &c., A. G. Meeze, R. P. N. Laurie, and J. G. Jebb, London.
8093. METALLIC, &c., BEDSTEADS, L. Brierley, London.
8094. BALANCE or HYDRAULIC LIFTS, G. Andrews, London.
8095. HOLDERS for PENCILS, &c., H. J. Haddan.—(S. Dünkelsbühler, Germany.)
8096. PLASTER, R. Stone, London.
8097. PREVENTING NUISANCE from SMOKE, H. J. W. Raphael and J. Syme, London.
8098. INJECTORS, H. H. Lake.—(F. Brunbauer, Austria.)
8099. MASHING, &c., VEGETABLES, &c., J. L. P. Leman and J. A. Atkin, London.
8100. ORNAMENTAL CUSHIONS, E. W. Futvoye, London.
8101. MECHANICAL CHANGE of the SHOW PIECES in SHOP WINDOWS, &c., J. H. Helberger, London.
8102. FISH HOOKS, H. L. Hunter, London.
8103. BAIT for FISHING, W. J. Hunter, London.
8104. TAPS or STOP-COCKS, F. H. Wenham and J. H. Sheldrake, London.

4th July, 1885.

8105. DRESSING WOVEN FABRICS, A. Entwisle, Manchester.
8106. CISTERNS, D. Miller, Greenock.
8107. LOOM PICKERS, J. S. Sadler.—(H. Stancliffe, Russia.)
8108. BROOCH with DIALS, R. Walsham and J. Walsham, Birmingham.
8109. TREADING, &c., MOTIONS of LOOMS, R. L. Hattersley and J. Hill, Keighley.
8110. COVERS of CARDING ENGINES, E. Tweedale, Halifax.
8111. GLOBE LAMPS, S. Snell and G. Pearce, Birmingham.
8112. MINERS' SAFETY LAMPS, J. Sedgwick, Clay Cross.
8113. MAKING GAS HOT PLATES, A. Hill, Birmingham.
8114. BLOCKS for CHOPPING MEAT, &c., J. Fullwood, Birmingham.
8115. GRADING WHEAT, &c., J. and J. B. Holgate, London.
8116. REGULATION of GAS MOTORS, J. H. Johnson.—(E. Korting and G. Lieckfeldt, Prussia.)
8117. LANTHORNS for SHIPS' ANCHOR or RIDING LIGHTS, W. Harvie, Glasgow.
8118. IRON CLOTHS, G. T. Kearns and J. H. Noble, Hamilton, Ontario.
8119. COMPOUND MARINE ENGINES, E. R. Allfrey, London.
8120. PRODUCING ENSILAGE, G. F. Muntz, London.
8121. PRINTING DESIGNS on GLASS, &c., A. G. Brookes.—(Messrs. Vantillard and Lamy, France.)
8122. ELECTRO-TELEPHONIC TRANSMITTERS, A. A. Campbell-Swinton, London.
8123. FISH-TORPEDO TOY, W. J. Brewer, Westminster.
8124. BREAKING FLAX, &c., H. J. Haddan.—(J. Dalle, France.)
8125. MATCH-BOXES and CIGAR CUTTERS, H. J. Haddan.—(W. T. Winkler, Austria.)
8126. BRUSHES, R. B. Breidenbach, London.
8127. SEWING MACHINES for HEM STITCHING, D. McGlashan, Glasgow.
8128. SWITCH for ELECTRIC CIRCUITS, E. Zeller, Glasgow.
8129. FLATTENING EMERY CLOTH, &c., A. and R. J. Edwards, London.
8130. VEGETABLE or PAPER PARCHMENT, T. R. Shillito.—(C. Arnold, Germany.)
8131. AERATED or GASEOUS BEVERAGES, J. E. Cousté, London.
8132. LINK-MOTION for VALVES, &c., A. D. Bryce-Douglas, London.—28th May, 1885.
8133. THINNING CORNERS of BOILER PLATES, C. J. Galloway and J. H. Beckwith, London.
8134. GAS ENGINE, F. W. Crossley, London.
8135. DRILLING HOLES in SIDES and FLANGES of CYLINDERS, C. J. Galloway and J. H. Beckwith, London.
8136. TORPEDOES, M. R. Ward, London.
8137. PERCUSSION FUSES, O. Jones, London.
8138. WINDOW SASH FASTENER, H. A. Williams, London.
8139. RENDERING WOOD INCOMBUSTIBLE, G. F. Redfern.—(R. Tanczos, Austria.)
8140. ACOUSTIC TELEPHONE LINES, A. L. N. Foster, London.
8141. FORCING FLUIDS, S. H. Johnson and C. C. Hutchinson, London.

6th July, 1885.

8142. VENTILATING MALT KILNS, G. Smallman, Newnham, near Tenbury.
8143. SAVING of FUEL in FIRE-GRATES, W. Green, Harborne.
8144. SHEDDING MOTION, C. Bedford and T. Kershaw, Halifax.
8145. GARDEN TOOL BARROW, H. W. B. Mackay, Exeter.
8146. PIANOFORTE ACTIONS, A. Craig, Belfast.
8147. REGULATING the PRESSURE of GAS, J. Shaw, Halifax.
8148. SIGNAL LAMPS, J. Pumphrey, Birmingham.
8149. WINDING FRAMES, W. Noton, Manchester.
8150. PREVENTING the FORMATION of LAP on the DRAWING OFF ROLLERS of COMBING MACHINES, W. H. Greenwood and F. Farrar, Bradford.
8151. WHEELS, W. Shiels, Edinburgh.
8152. OIL LAMPS, J. H. Ross, Dublin.
8153. RENDERING CEMENTS HYDRAULIC, W. P. Thompson.—(R. Bosse and F. Wolters, Germany.)
8154. POSITION FINDERS, A. W. P. Ross, Liverpool.
8155. ACTUATING the HEALDS of POWER LOOMS, A. Sowden, Bradford.
8156. HOSIERY MACHINERY, W. H. Dorman, Stafford.
8157. FINISHING MACHINE for CUT PILE FABRICS, J. Clare, Oldham.
8158. LUBRICATORS, G. Fletcher, Halifax.
8159. MULES for SPINNING, J. H. Holden, London.
8160. GAS ENGINES, C. T. Wordsworth and J. Wolstenholme, London.
8161. ALLOY, W. E. Gedge.—(G. Guillemin, France.)
8162. SEPARATION of SOLID and LIQUID MATTER, W. Hucks, London.
8163. GAG, H. G. Rogers, London.
8164. RAILROAD SPIKES, A. O. Morford, United States.
8165. FILLING BOTTLES, A. Werner, United States.
8166. SPLIT PULLEYS and WARP BEAMS, H. Underwood and C. Schweizer, United States.
8167. POCKET UMBRELLA, C. Scotter, London.
8168. FIRE BRIDGES, A. Mackie, London.
8169. LANDAUS, A. Boycott, London.
8170. ORNAMENTAL TURNING, G. W. Budd, London.
8171. OPENING or CLOSING ELECTRICAL CIRCUITS, W. Buck, London.
8172. TELEGRAPH INSTRUMENTS on BOARD of STEAMERS, J. Childs, Southwick.
8173. DRILLING, BORING, &c., APPARATUS, T. Lishman, London.
8174. STEAM BOILERS or GENERATORS, T. Lishman, London.
8175. CRICKET STUMPS, C. S. Snell, London.
8176. CLEANING and PREPARING GRAIN, &c., H. J. Haddan.—(E. Fritsch, Saxony)
8177. REFRIGERATORS, T. Fishburn, Scarborough.
8178. FUEL ECONOMISERS, E. Green, London.
8179. DRYING APPARATUS, T. R. Shillito.—(M. Hecking, Germany.)
8180. FRAMEWORK of TRICYCLES, &c., G. Singer, London.
8181. HAND BAGS, R. J. S. Joyce, London.
8182. SAFETY DEVICE for SCREW FASTENINGS, A. J. Boult.—(Erdman and Gross, Germany.)
8183. TREATING MUD, SLOP, &c., from ROADS, J. B. Alliott, London.
8184. HYDRAULIC MAINS for DISTILLING COAL, L. T. Wright, London.
8185. LAMPS, A. J. Boult.—(C. Weiss, Austria.)
8186. TOOLS, T. Sutcliffe, London.
8187. SUPPLYING HEATED AIR to FURNACES, R. Wyllie and D. B. Morison, London.
8188. STIRRUPS for RIDING, E. G. Kempe and J. Ridley, London.
8189. CRACKING NUTS, &c., J. C. Mewburn.—(A. Le Masson, France.)
8190. EVAPORATING, &c., APPARATUS, J. C. Mewburn.—(F. C. E. Simon, France.)
8191. PREPARING DRESS BODIES, E. Faithfull, London.
8192. SECURING LIDS to EARTHENWARE, &c., VESSELS, T. Clare, A. Chadwick, and J. Clarke, Hanley.
8193. VELOCIPEDES, M. Offord, London.
8194. SALT and SODA, B. J. B. Mills.—(J. M. Duncan, United States.)
8195. STAMPS or TICKETS, C. B. Harness, London.
8196. ELECTRICAL ACCUMULATORS, W. R. Lake.—(J. B. Rognetta and N. de Kabath, Italy.)

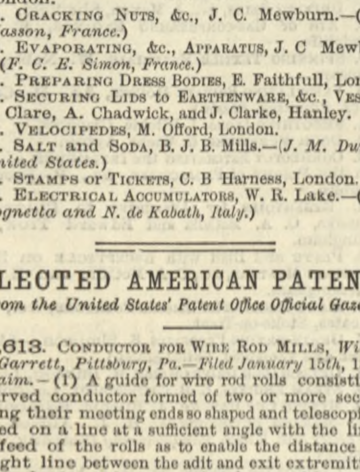
SELECTED AMERICAN PATENTS.

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

318,613. CONDUCTOR FOR WIRE ROD MILLS, *William Garrett, Pittsburg, Pa.—Filed January 15th, 1885.*

Claim.—(1) A guide for wire rod rolls consisting of a curved conductor formed of two or more sections having their meeting ends so shaped and telescopically united on a line at a sufficient angle with the line of the feed of the rolls as to enable the distance on a straight line between the adit and exit extremities of the conductor to be increased or decreased by moving the sections telescopically one within the other, sub-

318,613

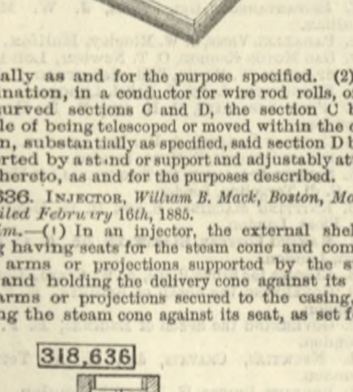


stantially as and for the purpose specified. (2) The combination, in a conductor for wire rod rolls, of the two curved sections C and D, the section C being capable of being telescoped or moved within the other section, substantially as specified, said section D being supported by a stand or support and adjustably attachable thereto, as and for the purposes described.

318,636. INJECTOR, *William B. Mack, Boston, Mass.—Filed February 16th, 1885.*

Claim.—(1) In an injector, the external shell or casing having seats for the steam cone and combing cone, arms or projections supported by the steam cone, and holding the delivery cone against its seat, and arms or projections secured to the casing, and holding the steam cone against its seat, as set forth.

318,636

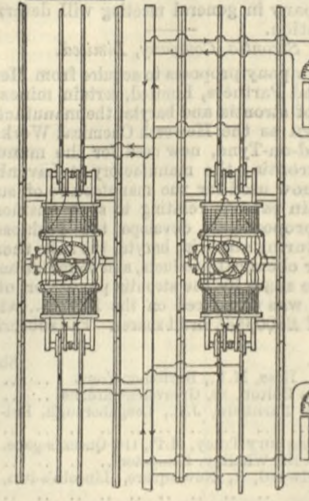


(2) The combination of the casing, the cones a b, bearing on seats formed in the casing without positive attachment thereto, the ring c, having arms c^1, supported by the cone a, and bearing against the cone b, and the collar or filling piece e, positively secured to the casing, and having arms f, which bear against the cone a, and thereby hold both cones in place.

318,668. METHOD OF OPERATING ELECTRIC RAILWAY TRAINS, *Frank J. Sprague, New York, N.Y., assignor to the Sprague Electric Railway and Motor Company.—Filed December 22nd, 1885.*

Claim.—(1) The method herein described of braking an electric railway train, which consists in increasing the counter electro-motive force of the motor propelling the train until it exceeds the initial electro-motive force on the line. (2) The method herein described of braking an electric railway train, consisting in increasing the strength of the field magnet of the motor propelling the train until the counter electro-motive force developed by its armature exceeds the initial electro-motive force on the line. (3) The method of operating electric railways herein described, which consists in increasing the counter electro-motive force of each motor when slowing down until it exceeds the initial electro-motive force on the line. (4) The method of operating electric railways herein described, which consists in increasing the counter electro-motive force of each motor when running on a down grade until it exceeds the initial electro-motive force on the line. (5) The method herein described

318,668

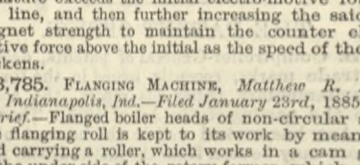


of maintaining the counter electro-motive force of an electric railway motor above the initial when the train is slowing down, which consists in increasing the strength of the field magnet of the motor as the speed of the train slackens. (6) The method herein described of slowing down or stopping an electric railway train, which consists in increasing the strength of the field magnet of the motor propelling the train until the counter electro-motive force of the armature exceeds the initial electro-motive force on the line, and then further increasing the said field magnet strength to maintain the counter electro-motive force above the initial as the speed of the train slackens.

318,785. FLANGING MACHINE, *Matthew R. Moore, Indianapolis, Ind.—Filed January 23rd, 1885.*

Brief.—Flanged boiler heads of non-circular shape. The flanging roll is kept to its work by means of a stud carrying a roller, which works in a cam groove on the under side of the rotary former, which carries the blank. *Claim.*—(1) The revolving irregular former C, having a groove C^1 and the holder F, capable of also revolving, in combination with each other and with the carriage H and roller H^2, traversing on fixed

318,785

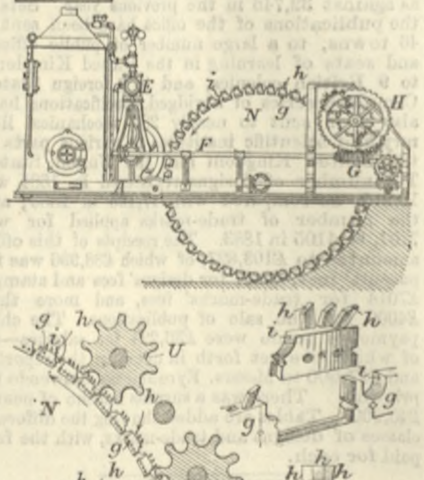


ways toward and from the axis of C, and with a roller M, and means for carrying the latter strongly downward and changing its inclination, so as to form the irregular flange required against the periphery of C, as herein described. (2) The revolving shaft B, irregular former C, having the groove C^1 and follower F and its operating means, in combination with each other, and a reciprocating carriage H, having an arm H^1 and roller H^2, vertically adjustable carriage I, rocking piece K K^1, roller M, and operating means L L^1 L^2, arranged for joint operation, as herein specified.

318,962. STONE-CUTTING MACHINE, *John Crump and Richard Brereton, Philadelphia, Pa.—Filed January 23rd, 1885.*

Claim.—(1) The combination, in a stone-channelling machine, of one or more discs N, provided with a series of detachable blocks g, each having a recess i for the teeth of the driving wheel to bear against, and one or more driving wheels U having its teeth arranged to engage with and bear against the recesses in said blocks, with mechanism, substantially such as shown, for imparting motion to the same. (2) The detachable blocks g, arranged to fit in recesses in the periphery of the disc N, said blocks being provided with a series of sockets of differing inclinations laterally for the reception of the straight teeth or tools h, whereby the projecting points of said teeth are made to spread and

318,962

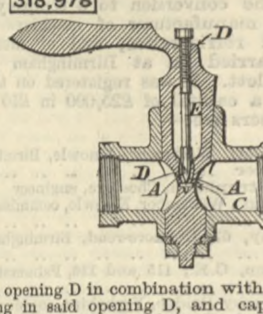


cut a channel of greater width than the thickness of the discs or blocks without any curvature of the teeth or any lateral cutting lips formed thereon, substantially as shown and described. (3) The combination, in a stone-cutting machine of the frame A, with one or more cutting discs N mounted therein, and an engine E mounted on said frame and having its shaft P connected at opposite sides by means of bevel gear with shafts F, mounted in bearings at opposite sides of the frame, said shafts being each provided with a worm G, engaging with worm wheels H, connected by suitable intermediate gearing with the drive wheel U, having its teeth or ribs arranged to engage with notches in the periphery of the discs N, the whole being arranged to operate substantially as shown and described.

318,978. GAS COCK, *Thomas Gordon, Philadelphia, Pa.—Filed April 28th, 1884.*

Claim.—A gas cock or valve adapted to fit a gas pipe and regulate the flow of gas therein, consisting of a plug recessed on its periphery to form a gas port or passage A, and cross-drilled through such recess to form a second gas port or passage C, open when the first is closed, and provided also with a central longi-

318,978

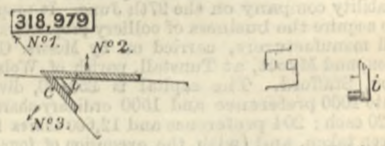


tudinal opening D in combination with a central core E fitting in said opening D, and capable of being moved therein to cover and uncover at pleasure said gas port C wholly or partially, as may be desired, said device being constructed and operating substantially as for the purpose set forth.

318,979. TOOL FOR MOULDING THE MOULD-BOARDS OF PLOUGHS, *William M. Gorry, Willimantic, Conn.—Filed September 29th, 1884.*

Claim.—A pattern—for that class of plough mould-boards in which a ledge is cast as an integral part of said mould-board—having the ledge pattern c dowelled

318,979

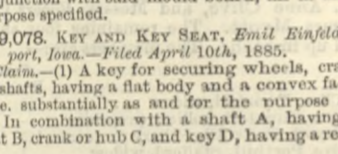


removably to the mould-board pattern, and having on its under side core prints i i, extending to the point of junction with said mould-board, all as and for the purpose specified.

319,078. KEY AND KEY SEAT, *Emil Einfeldt, Davenport, Iowa.—Filed April 10th, 1885.*

Claim.—(1) A key for securing wheels, cranks, &c., to shafts, having a flat body and a convex face on one side, substantially as and for the purpose set forth. (2) In combination with a shaft A, having concave seat B, crank or hub C, and key D, having a rectangular

319,078

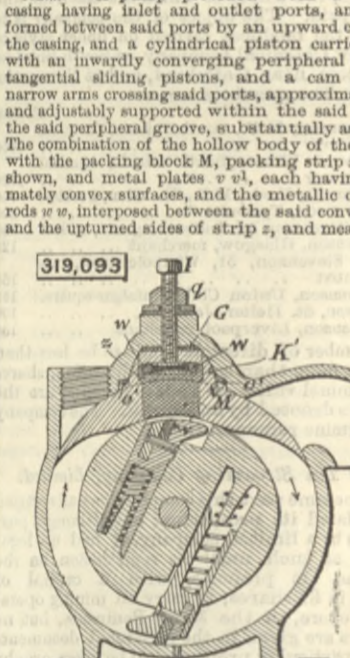


portion seated in the crank or hub, and a convex face resting in the key seat of the shaft, substantially as shown and described. (3) A key for securing wheels, cranks, &c., to shafts, having the face which rests in or upon the shaft curved on an arc of a circle of a diameter greater than the thickness of the key.

319,093. ROTARY PUMP, *Reuben F. Hassinger, Adamsburg, Pa.—Filed July 16th, 1884.*

Claim.—A pump provided with a cylindrical casing having inlet and outlet ports, and a recess formed between said ports by an upward extension of the casing, and a cylindrical piston carrier provided with an inwardly converging peripheral groove and tangential sliding pistons, and a cam block with narrow arms crossing said ports, approximately fitting and adjustably supported within the said recess and the said peripheral groove, substantially as described. The combination of the hollow body of the cam block with the packing block M, packing strip z, shaped as shown, and metal plates v v^1, each having approximately convex surfaces, and the metallic cylinders or rods w w, interposed between the said convex surfaces and the upturned sides of strip z, and means for com-

319,093

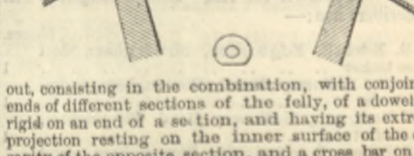


pressing said parts within the hollow cam block, substantially in the manner and with the effects specified. The combination, in a rotary pump, of the casing, having a chamber arranged between the inlet and outlet ports by an upward extension of said casing, and a revolving piston carrier provided with a wedge-shaped peripheral groove and sliding pistons, and a cam block provided with tapering arms connected by an upwardly extended hollow body portion K^1, fitting into said chamber and packed therein by compressing between it and the roof of said chambers the packing strips o o^1 G by means of screw I and nut q, and the packing block M, packing strip z, plates v v^1, and metallic cylinders or rods w w within said cam block and upon the periphery of the said piston carrier, by the means supporting the said cam block within said recess and the said peripheral groove, substantially as described.

319,410. METALLIC FELLY, *George D. Haworth, Chicago, Ill.—Filed March 9th, 1885.*

Claim.—(1) A means of providing in metallic fellies a remedy for rim-bound wheels, consisting in diminished intervening and coinciding ledges on the conjoining ends of the felly sections, substantially as described. (2) The means herein set forth for forming an iron felly of uniform strength and rigidity through-

319,410



out, consisting in the combination, with conjoining ends of different sections of the felly, of a dowel pin rigid on an end of a section, and having its extreme projection resting on the inner surface of the concavity of the opposite section, and a cross bar on the end of the opposite section, provided with a slot adapted to receive the dowel pin and effectually prevent either centripetal or lateral displacement therein.