THE INSTITUTION OF MECHANICAL ENGINEERS.

In our article last week (*vide* page 112 *ante*) on the recent very successful meeting of the Institution of Mechanical Engineers at Glasgow, we were able to deal fully with the first day's proceedings only, and we have now to speak of the proceedings on the remaining days of the meeting. On the second day, Wednesday, the 6th inst., the members again assembled in the morning at 10 A.M. at the Corporation Galleries, when the reading of the papers was preceded by a short address by Professor James Thomson, in the course of which he explained, by the aid of diagrams, the results of his investigations into the action of water flowing round the bends of rivers. These results were very interesting, and they were further explained by an apparatus fitted up in an adjoining room, this apparatus enabling the action of such currents to be illustrated experimentally. We hope to be able to give further particulars of this apparatus, and of Professor James Thomson's deductions, at some future time.

The Forging of Crankshafts.

On the conclusion of Professor Thomson's remarks the reading of papers was proceeded with, the first paper read being one "On the Forging of Crankshafts," by Mr. W. L. E. McLean, of the Lancefield Forge. In this paper the author gave an interesting account, well illustrated by diagrams, of the methods of forging large crankshafts generally in use, and especially of the system which had for many years been adopted at the Lancefield Forge, an establishment which, as is well known, has a high reputation for this class of work. Inasmuch as we print Mr. McLean's paper *in extenso* elsewhere in the present number, it will be unnecessary that we should analyse it here, and we may, therefore, proceed to give an account of the discussion. This discussion, at the invitation of the President, was opened by Mr. Edward Williams, the President of the Iron and Steel Institute. Mr. Williams stated that he had had no special experience in the forging of large shafts, he having been principally engaged in the manufacture of iron and steel by rolling, but it appeared to him that a weak point in Mr. McLean's system of forging was shown by the diagram, Fig. 25, exhibited (see page 137 of the present number). This diagram showed the slabs 6 in. shorter than the surface on to which they were to be welded, it being stated in the paper that these proportions were adopted to permit of the slabs lengthening and widening under the hammer so as to cover the surface on which they were laid. He (Mr. Williams), however, considered that it would be preferable to make the slabs the full length at once, and to cut off any excess which might draw out under the hammer.

Mr. Jamieson, who spoke next, said that few men had had so much experience in forging large crankshafts as Mr. McLean, and that in such matters as that referred to by Mr. Williams, experience was everything. A demand would he considered arise for much larger shafts than were at present required. He believed that at no very distant day the Atlantic steamship service would be such that it would be possible to leave Great Britain early in the week and arrive at New York at the end of it; but this of course would necessitate the employment of larger vessels and more powerful engines. He had had considerable experience in the building up of large shafts in several pieces, and the firm with which he had lately been connected (Messrs. J. Elder and Co.) had constructed in this way a shaft weighing 56 tons, this being a three-throw shaft and built up of fifteen pieces. Within the next ten years, shafts weighing 100 tons would he considered probably be required, and he believed that the proper way to construct such shafts was to build them up, a shaft so built up involving much less loss of time for repairs or renewal, in the event of failure, than would be the case with a solid shaft.

After a few words from Mr. J. Whitley, who strongly advocated the construction of shafts of steel compressed while in a molten state, Mr. Edward Reynolds, of Sheffield, made some remarks on the subject under discussion. Mr. McLean had, he observed, described the right way of putting on slabs so as to secure a sound forging. Formerly a large number of works used to make Collinge axles for road vehicles, and at one time he (Mr. Reynolds) had had a good deal to do with turning and finishing such axles. A difficulty they had with them was that they went oval during the casehardening process in consequence of the manner in which they were piled. To avoid this defect the Patent Shaft and Axletree Company introduced a mode of making such shafts by piling a series of bars of segmental section around a central bar or core. The axles so made did not go oval, but they had the important disadvantage of breaking, the fact being that it was only by accident that a shaft so piled could be made sound. Mr. McLean had, in his paper, challenged the use of steel, but in doing this he had gone somewhat out of his depth. He (Mr. Reynolds) could state that no steel shaft had been made by his firm (Messrs. Vickers, Sons, and Co.), in which the piece cut out between the webs of the crank could not be bent double cold and broken without showing a crystalline fracture. Steel shafts were necessarily more costly than iron, on account of the full weight of the shaft having to be dealt with from the commencement of the forging operations, whereas with iron shafts the forging was built up by successive additions, and more time could be taken in the operation. In conclusion, he remarked that he had been informed that in America many locomotives were running with steel crankshafts cast only and not forged.

The next speaker was Mr. George Ratliffe, of the Mersey Iron and Steel Works, who commended the practical character of Mr. McLean's paper. At the Mersey Iron and Steel Works they had, he stated, always used the system advocated by Mr. McLean, except that they made the slabs the full length of the surface to which they were to be welded, as recommended by Mr. Edward Williams. The slabs drew out under the hammer, and the excess which was cut off was of a convenient size for forging down into another "lay." He differed from Mr. McLean's opinion that puddled iron was not so good as scrap as a material from which large shafts should be forged. He (Mr. Ratliffe) considered that scrap was too variable in quality, and at the Mersey Works it was their practice to use puddled bars made from cold blast iron, such as Maddeley Wood, &c. This material gave small crystals like steel, and a $1\frac{1}{4}$ in. or $1\frac{1}{2}$ in. bar would bend double. Puddled iron, if made from cold blast pig, was not cheaper than scrap, so that it was not on the score of cheapness that they used such iron. As regarded steel, he looked forward to the time when steel shafts could be made as much cheaper than iron shafts as steel rails are now cheaper than iron rails. All cast steel was crystalline, and fibre could not be got without working, and this fibre was wanted for shafts. Steel he regarded as ingot iron, and they were now making some crankshafts of steel ingots rolled down to small bars and piled for forging. The steel so treated welded as well as wrought iron, and was vastly stronger. He exhibited a sample made from steel bars 3 in. by $\frac{1}{2}$ in. piled 12 in. high and drawn out, and it would be observed that the welds could not be seen. Mr. Jamieson had remarked that it was an awkward matter to delay a vessel for the construction of a new shaft forged in one piece; but he thought he might say that both he and his friend Mr. McLean would be happy to make either solid shafts or the parts of built-up shafts. He might observe, however, that the weight of metal cut to waste in finishing a built-up shaft was greater than in the case of a solid shaft. In reply to a question he further stated that he had sold forgings made from welded steel at 90*l*. per ton, but he believed that ultimately they would be made at the price of iron.

The next speaker was Mr. Peacock, of Manchester, who stated his experience had shown that in the case of crank axles for locomotives a greater mileage was obtained from those made of good scrap iron than from steel. But to secure this result it was necessary to have scrap of a high quality, and he had found that for this purpose Lowmoor or Bowling boiler plates cut up into strips did best. Mr. McDonnell, of the Great Southern and Western Railway of Ireland, agreed with Mr. Peacock that really good iron crank axles gave excellent results, but at the same time he did not consider them equal to steel. With steel crank axles he had got a mileage up to 300,000 miles. He had been using crucible steel crank axles for twelve years, and during this period he had only had three failures. One of these axles which failed broke through a flaw soon after being set to work, the second broke in an ordinary place after running 111,000 miles, while the third did not break but showed signs of flaws in two places, and was taken out. He had also a lot of Bessemer steel crank axles in use, and these had been made by two makers. Amongst those supplied by one maker there had been some breakages, but of those supplied by the other maker none had failed, although some of these Bessemer steel cranks had run upwards of 300,000 miles. He considered that the shape to which crank axles were turned had much to do with their endurance, it being especially desirable to avoid anything like sharp corners.

Mr. Samson Fox, of Leeds, agreed with Mr. Jamieson as to the desirability of building up very large shafts, while as regarded material he considered that good iron with plenty of work put into it would give the best results. Lastly, Mr. Howden, of Glasgow, considered that apart from the question of material the mode of carrying out the forging of large shafts was a matter of great importance, and he expressed every confidence in the system adopted at the Lancefield Forge.

Mr. McLean then replied to the remarks made upon his paper. He had, he said, no intention of competing with steel shafts except as regarded price. At the Lancefield Forge they would be happy to make forgings of steel if ordered, but scrap iron shafts were almost always specified. As regarded Mr. Williams's remarks he has found that the slabs referred to (see Fig. 25, page 137) came to a welding heat much more quickly than the body of the forging, and that when under the hammer they drew to the full length of the body while being welded. He had tried the use of longer slabs, but had found no advantage. In the manufacture of shafts he was anxious to improve the quality of the scrap by rolling it into bars in the manner which had been described. He did not believe that when subjected to the action of water on a hot-bearing steel would behave better than iron.

The President, Mr. Robinson, in summarising the discussion, remarked that Mr. John Ramsbottom had, he believed, many years ago patented a system of welding by friction, the action being somewhat similar to that which took place when the short slabs referred to by Mr. Williams were drawn out under the hammer in the manner which had been explained by Mr. McLean. As regarded the kind of scrap used for crankshafts, there seemed to be a general opinion that a high quality was desirable; but whereas Mr. Peacock and other locomotive builders secured this quality by using scrap from best Yorkshire boiler plates, Mr. McLean having to deal with vastly larger masses, was compelled to purchase scrap of a more common kind, and then to overcome the difficulty by working it up and rerolling it in the manner which had been described, thus securing the desired quality. It was, he considered, a mistake to speak of steel as *one* material. In reality steel varied in quality as much as iron, and there was good steel and bad steel. Some years ago he and Mr. James Kitson had had to examine a steel crank axle which had failed, and caused an accident, and by the aid of a microscope they discovered no less than seven flaws in it. Of course such a microscopic investigation was impossible in regular practice; but the results obtained by Mr. McDonnell showed that better axles were now in use. After a few remarks on the observations made by other speakers, the President proposed a vote of thanks to Mr. McLean, which was carried unanimously.

Water Power Engines.

The next paper read was one by Mr. John Hastie, of Greenock, "On Water Power Engines with Variable Stroke." This paper we printed *in extenso* on page 106 of our last number, while on page 363 of our twenty-sixth volume we illustrated and described fully the ingenious engine with which it dealt. The discussion on Mr. Hastie's paper was opened by Mr. Stephen Alley, of Glasgow, who commended Mr. Hastie's plans and said that the arrangement was one which he had himself tried to invent without succeeding to his own satisfaction. He had, he added, tested Mr. Hastie's engine, and had obtained results agreeing with those set forth in the paper.

Professor Kennedy also commended Mr. Hastie's plans as meeting a great want. Another arrangement for effecting the same end had, he might mention, been designed by Mr. Henry Davey, of Leeds, who caused a governor on the engine to actuate a valve admitting water from what might be termed an exhaust water chamber, the arrangement being such that during a portion of the stroke waste water only was used. Mr. R. H. Tweddell also considered Mr. Hastie's arrangement of engine a useful one, and referring to the table of results given in Mr. Hastie's paper he pointed out that these showed an increased efficiency as the length of stroke was increased, this being a result which might have been anticipated.

Mr. Arthur Paget, of Loughborough, who spoke next, asked whether the adaptability to different loads which Mr. Hastie's plans afforded had not been secured—or attempted to be secured—by the employment of variable gear between the engine and the machinery it had to drive, the speed of the engine relatively to this machinery being made greater as the power required was increased? He (Mr. Paget) was under the impression that something of the kind had been designed many years ago by the late Mr. Francis Wise. He was unacquainted with the details, but he believed that a belt capable of being shifted on opposed cone pulleys was employed, or as an alternative a driving rope working on a rope pulley which could be expanded and contracted.

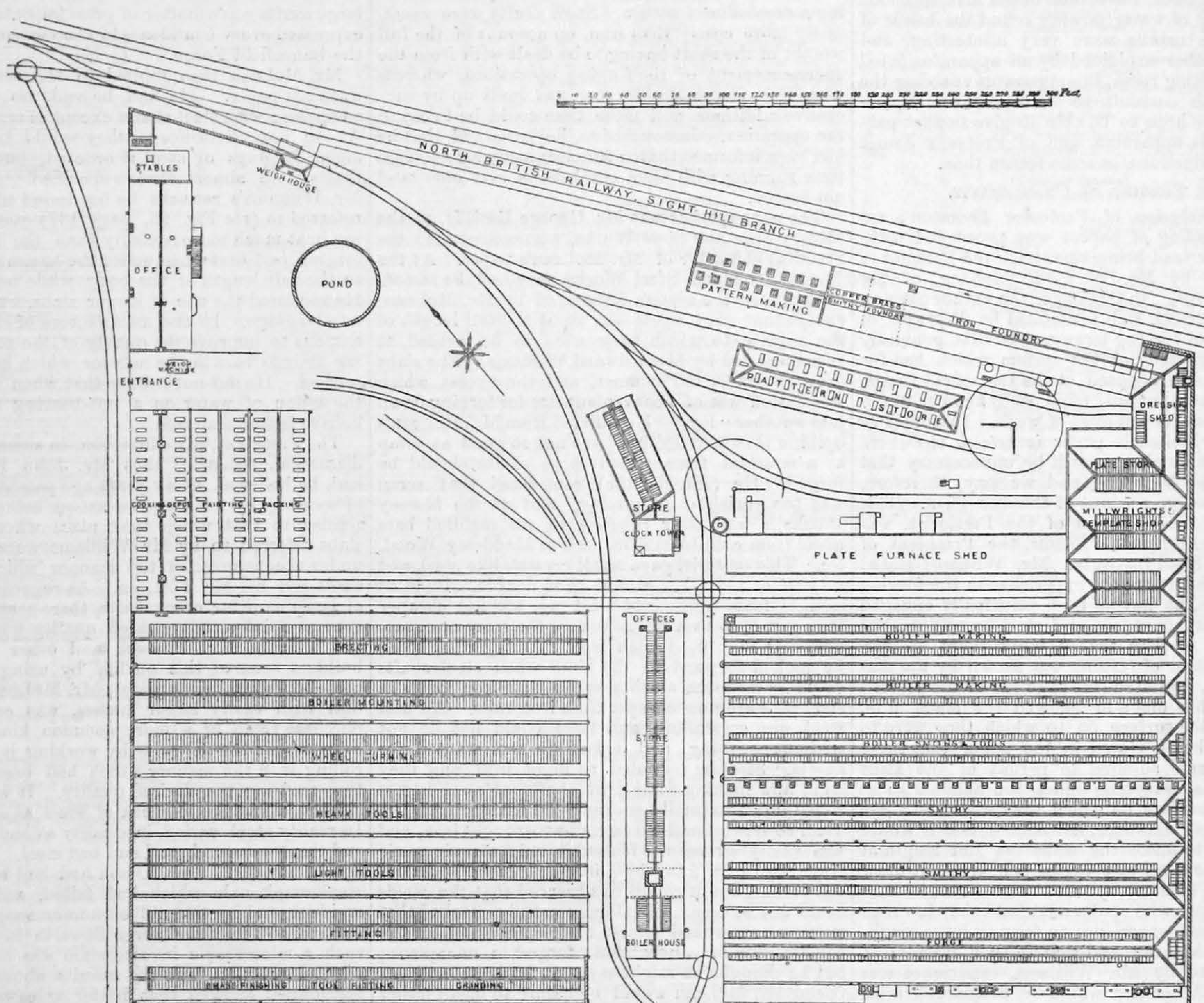
Mr. Ellington, of Chester, considered that the value of varying the power of hydraulic engines had been generally overrated. Such engines were only adapted for use under special conditions, and when these conditions existed the cost of the water used was of minor importance. For most lifts it was preferable to use a ram acting on chain pulleys rather than an hydraulic engine. Mr. E. C. Welch also considered that the value of the loss of effect due to the non-variability of water-pressure engines had been overrated. This loss was, he stated, less than that arising from the friction of shafting, &c., in cases where steam power was transmitted to considerable distances.

Replying to the discussion Mr. Hastie remarked that Mr. Davey's arrangement of engine, as described by Professor Kennedy, necessitated the employment of an extra valve, while as regarded the plan described by Mr. Paget, he had himself tried to scheme a similar arrangement, but had been unable to adapt it to work with gear, although it was available when belts could be used. With Mr. Tweddell's remarks as to the greater efficiency of his engine when working with a long stroke, he agreed. In reply to an inquiry he stated that he had had one of his engines working about two years, and fourteen such engines were now at work. A load of 1½ cwt. on the chain was sufficient to run it down. Too much stress had, he thought, been laid on what was considered complication. In reality his engine was very simple and the movement of the cam was very little, it only having to adjust itself once for each lift. The largest engine he had yet made on his plans was one developing 6-horse power when working with a water pressure of 55 lb. per square inch.

After a few words from the President a vote of thanks was proposed and voted to Mr. Hastie for his paper, and a paper by Mr. R. E. Crompton "On the Working of Traction Engines in India," was then read, the discussion, however, been postponed until the following day. We commenced the publication of Mr. Crompton's paper on page 106 of our last issue, and we shall complete it next week; meanwhile we may remark that it contains an interesting account of the working of india-rubber tyred traction engines in India, with much valuable statistical information.

For the afternoon of Wednesday two excursions were available, the one being to the Steel Company of Scotland's Works at Newton, near Glasgow, and the other to the North British Iron Works at Coatbridge, and the Coatbridge Tin-Plate Company's Works. The works of the Summerlee Iron Company, and of Messrs. Neilson and Co., and of Messrs. W. Baird and Co., at Gartsherrie, were also included in this latter excursion, but there was not time to examine them. They were, however, visited by many members during the week. For each of the excursions above mentioned, special trains had been provided and the visitors were most hospitably received at the various works. Much the larger party visited the Steel Company of Scotland's Works, of which we give a plan on page 128 of the present number, and of which, as well as of many other of the works visited, we give an account elsewhere in our present issue.

On the evening of Wednesday the majority of the members attending the meeting dined together at the Grand Hotel, the President, Mr. John Robinson, occupying the chair, and there being upwards of 200 present, including the Lord Provost and a number of guests. We have no intention of dealing here with after-dinner toasts and speeches, but we may remark that advantage was taken of the opportunity afforded at this dinner of drinking the health of the local secretaries, Mr. Millar and Mr. Gale, and acknowledging the great indebtedness of all who had taken part in the meeting, to the labours of these gentlemen and the local committee.



PLAN OF MESSRS. NEILSON AND CO.'S HYDE PARK LOCOMOTIVE WORKS, GLASGOW.—*(For Description, see Page 129.)*

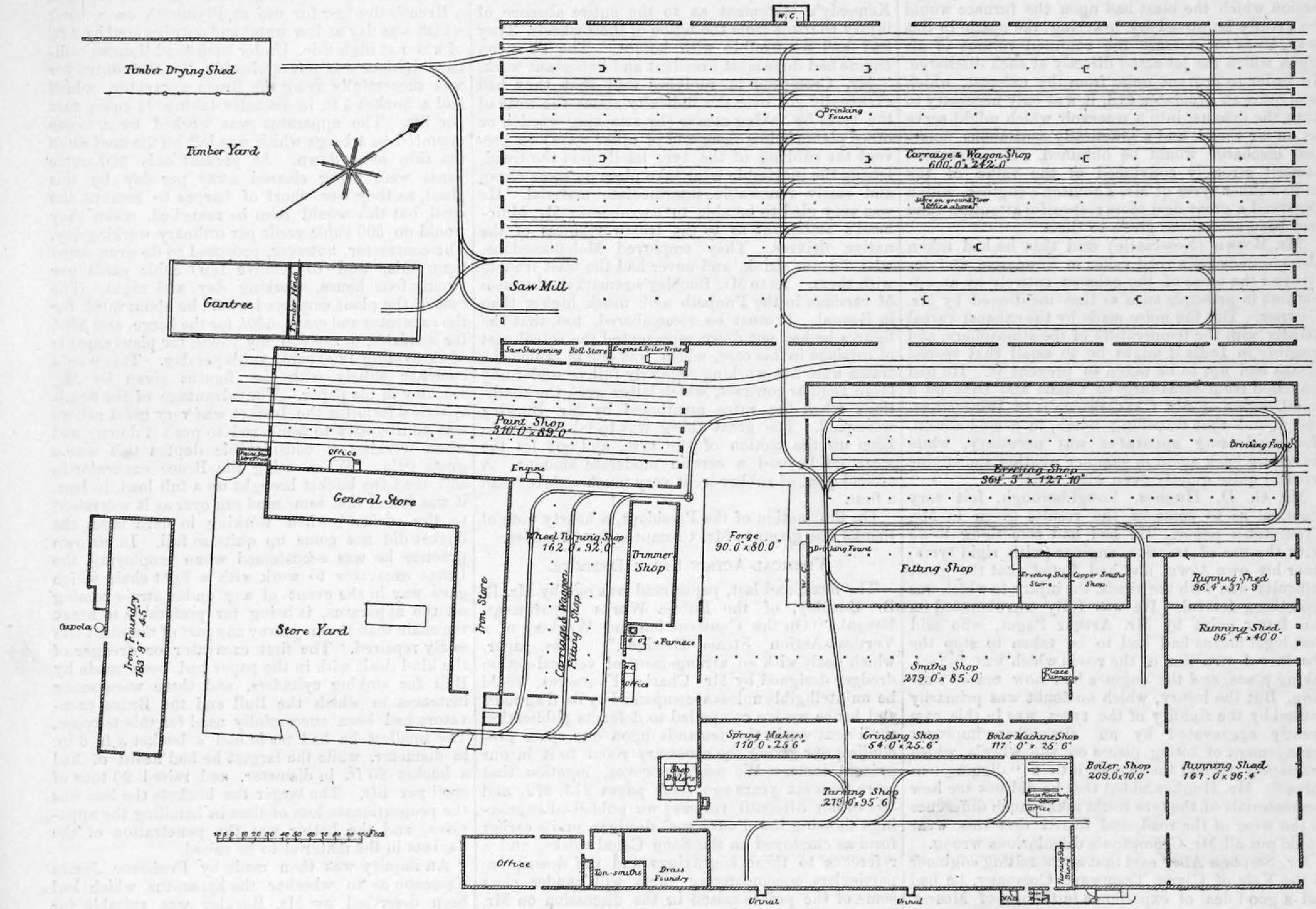
Traction Engines in India.

On the reassembling of the members at the Corporation Galleries on the morning of Thursday the 7th inst. the discussion was taken on Mr. Crompton's paper "On the Working of Traction Engines in India," which had, as we have already recorded, been read the previous day. Before the discussion began, however, Mr. Crompton gave a few additional particulars as to the cost of road carriage in India. He said that packages which were sufficiently small to be carried on camels could be taken at the rate of about 5.28d. per ton-mile, while the carriage by bullock cart of heavier packages cost 6.0d. per ton-mile as against 3.5d. for the traction engine carriage, a cost which would, he believed, be reduced to 2.8d. in England, when allowance was made for the altered and improved circumstances. The cost of carrying goods in this country by horse and cart seemed to vary from 5d. to 12d. per ton-mile; from his own experience he thought 9d. was about an average figure in the neighbourhood of London. The cost of tramway (passenger) carriage has been approximately as follows, in pence per car-mile: Glasgow Company, 10.3d. (lately, while forage has been excessively cheap, reduced to 9.8d.); North Metropolitan, 12.6d.; London, 12.45d.; Edinburgh, 14.6d., average, 12.5d., which corresponds to about 0 78d. per passenger mile. He estimated the cost of conveying passengers in India by traction engine, in large cars capable of holding 112 passengers each, and carrying on an average 44 (taking the same proportion to the capacity of the car as found to exist here), at 0.45d. per passenger-mile, the cars running at intervals of, say, 45 minutes.

M. Francq, what seemed to be an extremely detailed account of his "locomotive sans foyer," but the connexion of this with road locomotives in India or elsewhere, not being quite obvious, the President suggested that if M. Francq wished to bring his engine before the members he should make it the subject of a special paper.

Mr. Brodie having made a few remarks about the working of one of Messrs Aveling and Porter's road rollers at Liverpool, Mr. Buckley said that from ten years' experience of Indian work he could well appreciate the enormous difficulties which Mr. Crompton must have had to surmount in introducing a new system of this kind in that most conservative of

The next speaker was Captain Lousada, the manager of the Glasgow Tramways Company, who some years ago introduced into Glasgow the system of hauling heavy loads (boilers, &c.) from the yards to the quays by means of Thomson's engines, a system which rapidly became most successful, and has now for long supplanted all other means of haulage in the city. Captain Lousada attributed the success of these engines chiefly to the use of the flexible tyre, which gave such an enormous adhesion even on the muddy and slippery soil often to be found in the yards, just in the place where the heaviest pull had to be exerted in getting the load started. The engines used were of from eight to twelve-horse



PLAN OF THE NORTH BRITISH RAILWAY WORKS COWLAIRS, GLASGOW.—*(For Description, see Page 130.)*

Mr. Muirhead, who had been Mr. Crompton's assistant in India, said a few words about the arrangement of the blast pipe (carried downward to the baffler) and of the spark-catcher, which he said were those arrived at, and found to be the best, after many experiments. The wear of the tyres was due chiefly, he believed, to overweight resting on them, or, what was the same thing, to deficient thickness of india-rubber for the weight of engine. He also spoke very highly of the efficiency of native drivers. They had been easily trained, and had given no trouble whatever, while their original European drivers unfortunately had led them into some serious accidents through inability to resist the temptation of drink.

Mr. Jeremiah Head remarked that the road steamer was very similar in general appearance to a small shunting engine known in his neighbourhood as a "coffee-pot" engine. This engine, however, was excessively noisy in its gear, and by no means altogether satisfactory. No doubt the blast nozzle was put in quite the right position, but the arrangement would be further improved if the part of the chimney inside the boiler were made to taper somewhat to a larger diameter at its top end.

M. Bergeron commenced to give, on behalf of countries. Cheapness was everything there—a point by the way, which can hardly be claimed as a characteristic specialty of India—and unless the cost of working with new implements was very greatly less than with the most primitive of two-thousand-year old appliances, the former had no chance of supplanting the latter. As to the native drivers he was glad to hear, and to be able very fully to corroborate, Mr. Muirhead's remarks. He found that a man whose wages were only 2d. or 3d. a day learned to drive an engine fairly well in a few weeks; the natives could be entirely trusted in this respect. The system advocated by Mr. Crompton he considered excellent for India—the roads there were well suited for it, and it had a great future before it. But the figures given by Mr. Crompton at the commencement of the discussion were certainly much higher than the rates would be in Bengal; he believed they were intended to apply to the Punjaub. On the trunk road in Bengal he had found the cost of carriage to be 3.5d. to 4d. per ton-mile by bullock cart; once it had been as low as 2.43d. By canal boat, of course, the rates were very much lower. In Bengal, at any rate, the cost of conveyance by traction engine must be reduced to 1.5d. or 2d. per ton mile before the system could succeed.

power, and one of the larger size was able to go into an engineer's shop, haul out any piece of machinery, and put it just where required. With loads of 50 tons weight three engines were used, but there was no difficulty in handling them. As to the use of steam on tramways, there was first the difficulty that the existing rails were not heavy enough for steam traffic, and a heavier permanent way would have to be used. He suggested the possibility of using a road steamer or other traction engine which should run on the causeway and not on the rails, so that the strain due to the traction might not come on the rails at all. And then there came the great question of expense: the whole cost of carriage on the Glasgow tramways, including *every item in his company's balance-sheet*, he had now succeeded in reducing to 9d. per car mile. He had not yet succeeded of hearing of any one who would do the same thing with steam. He still had hopes that the Scott-Moncrieff (compressed air) system might succeed. As to horses there was no real difficulty with them generally, but where there was they must just be taught to bear whatever we required them to bear. The system of infrequent heavy cars, alluded to by Mr. Crompton, could not, unfortunately, be worked in this country; whatever steam or other system of traction was to be adopted must be made suitable for the ordinary small cars run at very short intervals.

Mr. Cowper made some interesting remarks, illustrated by sketches on the black board, on the early history and construction of traction engines, commencing with the type of 1769, of which the model is now to be seen in the museum of the Conservatoire des Arts et Métiers at Paris. This model, by the way, was one of those sent over here by the Conservatoire to the Loan Collection of Scientific Apparatus, at South Kensington, three years ago. Mr. Cowper considered that the position of the blast nozzle shown in Mr. Crompton's diagrams was certainly the right one; the kind of "pump" action which the blast had upon the furnace would be greatly improved by lowering the nozzle in this way, so as to increase the confined volume of air upon which the jet acted directly at each discharge. In order to prevent noise from the exhaust, which was quite an avoidable evil, it was only necessary to turn the exhaust into a reservoir which might serve as an air vessel, and a practically continuous, noiseless discharge would be obtained. He expressed himself strongly convinced of the value of the india-rubber tyres of Mr. Thomson's engines, which deserved a great deal more respectful attention than had been sometimes given to them.

Mr. Brown (Newcastle) said that he had taken the chimney off a road roller in Newcastle and destroyed the noise of the exhaust entirely by an apparatus in principle such as that mentioned by Mr. Cowper. But the noise made by the exhaust varied greatly with the temperature of the atmosphere, and possibly in India it might be so small that special means had not to be taken to prevent it. He had travelled from Strasburg to Calais and back on a small engine of Mr. Chas. Brown's, of Winterthur, and found that travelling north, in a cold season, the condensing apparatus was necessary, while travelling back again in summer weather the engine worked quite quietly even without it.

Mr. G. D. Hughes, Loughborough, felt very sceptical as to some of the results given in Mr. Crompton's paper. He had had something to do with the use of traction engines (with rigid tyres) near his own town, and had found that the great difficulty was with the roads, the injury to which was something fearful. He was fully corroborated on this latter point by Mr. Arthur Paget, who said that legal means had had to be taken to stop the absolute destruction of the roads which was, in fact, taking place, and the engines had now ceased running. But the injury, which no doubt was primarily caused by the rigidity of the tyres, was in this case greatly aggravated by an altogether improper arrangement of biting pieces on the wheels, which practically turned the engine into a "digging machine." Mr. Hughes added that he did not see how the materials of the tyre could make much difference to the wear of the road, and feared that this wear would put all Mr. Crompton's calculations wrong.

Mr. Stephen Alley said that as consulting engineer to the Vale of Clyde Tramways Company, he had had a good deal of experience in the use of Messrs. Hughes' engines on the lines. At first they had a good many *small* breakdowns, but more experience had put these right, and they were now working continuously without any trouble. He quite believed in the future of steam on tramway lines. The Board of Trade rules had really been a great assistance, instead of a hindrance, to the use of steam by compelling manufacturers to bring their machines to a very high state of perfection.

Professor Kennedy said that he had had a good deal of experience both in the construction and the practical working of the engines spoken of by Mr. Crompton. In regard to the three points of noise, frightening horses, and injury to roads he could speak positively. The noise, whether of gearing or exhaust, was not at all excessive. The horse difficulty was enormously exaggerated; during a number of years' working they had very seldom any trouble, and never any serious accident, while any little trouble they occasionally had was mostly due to carelessness or neglect of the man in charge of the horse. There was absolutely no injury to the roads, the flattening of the rubber distributed the pressure, and therefore the pull over so large an area, as to bring about a state of things quite different from that existing where rigid tyres were used. But in order that such a system as that described by Mr. Crompton might be remunerative it would be essential that arrangements should be made for insuring a regular traffic, and a traffic of full loads. It was a much more serious and expensive thing to keep a road steamer idle than a horse, and it could not so easily be set to all sorts of odd jobs. But with work sufficient to keep several engines going in full and regular employment, and with a stand-by engine to avoid chances of interruption to the work, he believed that on such roads as those to which we are accustomed, or those described by Mr. Crompton, such engines would do heavy haulage both economically and efficiently, in spite of their heavy first cost and expensive wear of the tyres.

Mr. Henry Chapman remarked that from a number of years' experience in France of such engines as those described by the author, and of others constructed on similar principles, he could fully confirm Mr. Kennedy's statement as to the entire absence of injury to roads from the action of their wheels. They had had no trouble with horses. The Thomson engine had done most excellent and important work.

Mr. Crompton in replying said that they had eventually got over the difficulty about the wear of the tyres by taking means (by attaching wooden or other plates below them and in other ways) to prevent the rubbing of the tyre itself upon the tread, letting the inevitable wear take place on some cheap and easily renewable intermediate material. He was very glad to be able to corroborate Mr. Muirhead's statement as to the trustworthiness of the native drivers. They employed Mahommedans, who did not drink, and never had the least trouble with them. As to Mr. Buckley's remarks; the rates of carriage in the Punjaub *were* much higher than in Bengal. It must be remembered, too, that the figures he had put down represented the actual cost of carriage in his case, which was one in which the trains were not working regularly full, or under any large regular contract, which latter were the conditions when the rates mentioned by Mr. Buckley were paid. The great thing was to take means to keep up the section of the tyre, and not let the wear go beyond a certain moderate amount. A second ½ in. of rubber went very much quicker than a first.

On the motion of the President, a hearty vote of thanks was given to Mr. Crompton for his paper.

VERTICAL-ACTION STEAM DREDGER.

The next, and last, paper read was one by Mr. R. B. Buckley, of the Public Works Department, Bengal, "On the Construction and Working of a Vertical-Action Steam Dredger." This paper, which dealt with an arrangement of vertical-action dredger designed by Mr. Charles Fouracres, would be unintelligible unless accompanied by its diagrams, and hence we are compelled to defer its publication until next week, the demands upon our space precluding our giving the necessary room to it in our present issue. We may, however, mention that more than six years ago (*vide* pages 213, 379, and 382 of our fifteenth volume) we published engravings showing the Fouracres' dredger in its earlier form as employed on the Sone Canal works, and a reference to these engravings and the descriptive particulars accompanying them will render clear some of the points raised in the discussion on Mr. Buckley's paper.

Before the commencement of the discussion Mr. Buckley made a few remarks as an addition to his paper. The statement made in his paper that in Mr. Fouracres' dredger there was "very little wear except on the cutting edges of the bucket scoops" had been found to be scarcely correct. There was, in addition, a considerable wear on the axes of buckets. Since his paper had been written he had received details of the cost of dredging in the Thames, the cost per cubic yard dredged amounting to 4.405d. for working expenses, 0.988d. for repairs, and 2.37d. for interest and depreciation, or a total of 7.76d. per cubic yard. It was to be borne in mind, however, that this cost was incurred for work that was to a great extent done intermittently, and which thus involved a much greater expenditure for working. In cases where it had been possible to carry on Thames dredging constantly, the cost was about the same as on the Tyne and Clyde. Mr. Buckley then showed, by means of a neatly constructed working model, the action of Mr. Fouracres' dredger.

At the conclusion of Mr. Buckley's remarks, and explanation, the discussion on his paper was commenced by Mr. C. J. Appleby, who observed that Mr. Fouracres' dredger was an ingenious one, but that it appeared to have been schemed without any reference to what had been done in the same direction before. Had the designer known what had previously been done, the result would probably have been different. He (Mr. Appleby) regarded the hemispherical as a much better form for dredger buckets than the semi-cylindrical form used by Mr. Buckley. The hemispherical form had first been used by Mr. Woodford for skips, and had then been adopted by the Americans for their dredger buckets. The Bull dredger was a similar apparatus to that described by Mr. Buckley, but more simple. All the earlier dredgers of this type required something to push them down, but Mr. Bruce hit upon the idea of using a hemispherical bucket divided into three parts which met at a point, and this bucket had no tendency to rise when the parts were closed together, but cut its way into the ground. He had supplied a Bruce's dredger for use at Plymouth on a bank which was dry at low water and only covered by 2 ft. of water at high tide. Under such conditions an ordinary dredger was not applicable, but the contractor was successfully using the Bruce excavator, which had a bucket 5 ft. in diameter taking 22 cubic feet per lift. The apparatus was worked by a crane mounted on a barge which was left on the mud when the tide went down. At present only 300 cubic yards were being cleared away per day by this plant, as they were short of barges to remove the spoil, but this would soon be remedied, when they would do 600 cubic yards per ordinary working day. The contractor, however, proposed to do even more than this, and to remove 1200 cubic yards per twenty-four hours, working day and night. The cost of the plant employed would be about 600*l.* for the excavator and crane, 600*l.* for the barge, and 300*l.* for sundries, or say roughly 1500*l.* for plant capable of excavating 1200 cubic yards per day. This would compare closely with the figures given by Mr. Buckley in his paper. The advantage of the hemispherical form for the bucket was very great; there was no necessity to use a rod to push it down, and when working at considerable depths this was a great gain. When using the Bruce excavator in soft mud the bucket brought up a full load, in fact, it was found that some mud ran over as it was raised to the surface; when working in hard mud, the bucket did not come up quite so full. In his own practice he was accustomed when employing the Bruce excavator to work with a light chain which gave way in the event of any undue strain coming on the apparatus, it being far preferable to break the chain than to carry away any part of the plant less easily repaired. The first excavator or dredger of the kind dealt with in the paper had been made by Bull for sinking cylinders, and there were many instances in which the Bull and the Bruce excavators had been successfully used for this purpose. The smallest he had made had a bucket 3 ft. 6 in. in diameter, while the largest he had heard of had a bucket 20 ft. in diameter, and raised 20 tons of spoil per lift. The larger the buckets the less was the proportionate loss of time in handling the apparatus, and the better was the penetration of the buckets in the material to be raised.

An inquiry was then made by Professor James Thomson as to whether the apparatus which had been described by Mr. Buckley was suitable for doing dredging work in shallow water in Demerara, where large flats have to be dealt with and where many owners are dredging these flats to open up a communication with the sea.

Next Mr. Brown, of Renfrew, criticised the figures given by Mr. Buckley in his paper. These figures he remarked did not include the cost of moving the dredger, which if taken into account would materially increase the total. The Fouracres dredger he considered valuable for use under certain conditions, but not so good as the ordinary dredger for regular work where hard material had to be dealt with. Modern large dredging machines were capable of dredging 500 cubic yards per hour in soft material, and in the case of one machine lately the cost of working had been but 1½d. per cubic yard, this including the cost of moving dredger but not repairs. It was difficult to compare the performances of machines working under different conditions; thus a machine employed in a harbour worked under considerable difficulties. The performances of dredgers working on the Clyde and Tyne was not comparable with those machines employed in India or on the Thames. In the latter case soft material had to be dealt with, and some of the Clyde dredgers if run fast could raise 1000 tons per hour when working in soft stuff. The scoop dredgers were, however, as he had said, valuable for use in some situations where ladder dredgers were not applicable.

Mr. Easton remarked that he had employed Bull excavators in depths of 50 ft. to 60 ft., and that they worked successfully without requiring a rod to secure penetration, the weight of the buckets being sufficient. Mr. Buckley then replied to the discussion. The hemispherical bucket had, he considered, only a trifling advantage over the semi-cylindrical form, and he did not see why a hemispherical bucket not held down should penetrate better than a semi-cylindrical bucket under similar circumstances. In all scoop dredgers acting by weight the performance was better the larger the buckets, but in those in which the scoops were held down by rods the difference due to size was not so noticeable. By the use of the rod or spear cutting was enforced, and a certainty of action was thus obtained. As regarded the cost it must be remembered that in India the cost of coal was from three to five times greater than here. The steel teeth (to which reference had been by Mr. Brown) Mr. Fouracres proposed to employ only when very hard ground had to be dug. Such teeth were used on a dredging apparatus called a "spider" which had been described to the Institution some years ago. The real difficulty in working large dredgers on the scoop plan was the canting of the hull of the dredging vessel when the scoop was swung round. The remarks made by Mr. Easton referred only to soft material when the weight of the scoop was sufficient to secure penetration. After a few remarks as to Milroy's excavator, Mr. Buckley concluded by stating that the advantages of the form of excavator he had described were specially noticeable when dealing with semi-hard material.

A vote of thanks to Mr. Buckley having been proposed by the President and carried unanimously, it was then announced that in consequence of want of time on the present occasion, the reading of the paper still remaining on the list, namely that "On Plate Rolling Machinery," by Mr. Edward Hutchinson, of Darlington, would be postponed until a subsequent meeting. The President next proceeded to submit to the meeting resolutions expressing the indebtedness of the members to those who had done so much to render the Glasgow meeting a success. These resolutions were as follow: That the thanks of the Institution be given to the Lord Provost and Corporation of the city for the use of the Corporation Galleries for the purposes of the present meeting, and for the facilities afforded for the meeting; to Mr. Robert Mansell, president of the Institution of Engineers and Shipbuilders, Mr. Jamieson, the chairman to the Council of that Institution, and to the general committee for their cordial invitation, and their very hospitable arrangements for the entertainment of the Institution; to the proprietors of the various works in Glasgow and neighbourhood open to members, for their kindness in inviting the members to visit their works, and for the arrangements made for their visit; to the authorities of the Caledonian, North British, and Glasgow and South-Western Railway Companies for their kindness in arranging special facilities for enabling the members to visit the works open for examination; and to the honorary local secretary, Mr. Millar, for the valuable services rendered by him in carrying out the arrangements, and in promoting the success of the meeting.

These resolutions having been put separately to the meeting, and carried by acclamation, were responded to by Treasurer Hamilton on the part of the Corporation of Glasgow, Mr. Jamieson on behalf of the Institution of Engineers and Shipbuilders and on behalf of the railway companies, and Mr. Macfarlane on behalf of the proprietors of works thrown open to the members, while Mr. Millar responded to the well-earned compliment paid to himself. Mr. Jamieson then proposed a vote of thanks to the President, Mr. Robinson, for his conduct in the chair, and in doing so referred to the great ability, tact, and judgment with which his duties had been performed. This vote having been warmly accorded, a brief reply by the President brought the meeting to a conclusion.

As on the previous days, alternative excursions had been arranged for the afternoon of Thursday, the choice in this case lying between a visit by special train to Messrs. Denny and Co.'s marine engineering and shipbuilding works at Dumbarton, where a luncheon had been provided for the members on their arrival, or a visit by ordinary train to Greenock, where various engineering factories, together with dock and harbour works, were thrown open to inspection. Of Messrs. Denny and Co.'s works, which were visited by a large party, we gave some particulars on page 114 of our last number.

VISIT TO GREENOCK.

At Greenock the party of visitors were received by Provost Lyle, Baillies Brymner and Shankland, Councillor W. B. Macmillan, and the town clerk Mr. MacCulloch, while Mr. Blackmore, of the firm of Messrs. Rankine and Blackmore, Mr. John Hastie, and other engineers of the district, aided in showing the different works. The greater number of the visitors first went to Messrs. Hastie's works, where one of Mr. John Hastie's water-pressure engines with variable stroke was shown in operation, the engine being employed lifting various loads to show the action of the adjusting cam, which worked most satisfactorily. From Messrs. Hastie's works the party was then conducted to the Glebe Sugar Refinery belonging to Messrs. Lyle, where they had the opportunity of examining the process of sugar refining. This process includes first the dissolving of the crude sugar in boiling water, then the filtering of the solution to remove mechanical impurities, and a subsequent filtration through animal charcoal to render it colourless, then a concentration of the solution in vacuum pans, and finally the separation of the crystallised product from the solution by treatment in centrifugal drying machines. The process of reburning the animal charcoal and the arrangement for packing the refined sugar in casks were also shown, these latter including a series of what we may term—for want of a better name—jolting tables, on each of which a cask in the process of being filled can be placed and subjected to a violent jolting action which of course shakes down the sugar.

From the Glebe Sugar Refinery some of the party proceeded to Messrs. Caird's works, some to the works of Messrs. Steele and Co., while others proceeded to inspect the completed Garvel Park Graving Dock and the adjoining extensive dock works which are now in progress, under the direction of Mr. W. R. Kinniple. We hope on some future occasion, when the works are further advanced, to give a complete account of these docks; meanwhile we may remark that they are of very considerable size and importance. An interesting feature in connexion with the works is the extent to which the excavations are being performed by the aid of Dunbar and Ruston's steam navvies, several of these machines being employed and doing excellent work.

EXCURSION TO INVERARY.

Friday last, the 8th inst., was devoted to a pleasure excursion down the Clyde, through the Kyles of Bute and up Loch Fyne to Inverary, at the invitation of the Institution of Engineers and Shipbuilders in Scotland, who had kindly chartered the special steamer Iona for the occasion. Altogether a party of 560 assembled on board the Iona, and the excursion was a most enjoyable one, the weather fortunately being favourable, and the whole of the arrangements excellent. It is not our duty here to speak of the charming scenery of the Clyde and its adjacent lochs, but we must say a few words respecting two large blasts which Messrs. Sim, the lessees of the Furnace and Crarae granite quarries had kindly arranged to fire at the time of the Iona's arrival opposite the mines. The Crarae and Furnace quarries are situated on the western bank of Loch Fyne, and are respectively about ten miles and eight miles distant from Inverary. The granite obtained from them is of a very hard description, and is used principally for paving setts, while the débris is now being used for macadamising. Formerly the stone was got by employing the ordinary system of small blasts, but in 1852 Mr. William Sim introduced the plan of employing large blasts fired by electricity and arranged to displace enormous quantities of material. This mode of working has proved so successful and economical compared with the former mode of procedure, that it has been continued to the present time, some very large blasts having been fired.

The proceedings on Friday last included the firing of two blasts, one of nearly three tons of powder at the Crarae quarry, and one of five tons at the Furnace quarry, and both we are glad to say were thoroughly successful, that at the Furnace quarry being especially so. At the Crarae quarry the mouth of the mine was situated 95 ft. above the quarry floor, while above it the rock rose to a height of 75 ft. The mine ran horizontally for a distance of 53 ft. from the face of the quarry, and at this point there was a perpendicular sinking 5 ft. deep, a powder chamber 6 ft. long being run inwards from the foot of this short shaft. The line of least resistance between the powder chamber and the quarry face measured 60 ft., while at a depth of 10 ft. below the floor of the mine was a natural dividing seam or sole. Under these conditions a displacement of 50,000 tons of material was expected if the powder worked down to the level of this dividing seam, as was probably the case.

In the case of the blast at the Furnace quarry the mouth of the mine was situated at a height of 100 ft. above the floor of the quarry, the rock rising to 90 ft. above it. The mine ran inwards horizontally for a distance of 65 ft., but at a point 40 ft. from a face a lateral branch was made for a short distance, and in this branch a powder chamber was formed, this being done to bring some of the powder near some natural dividing seams. At the extreme inner end of the mine a branch was made to the right, and in this branch another powder chamber was formed, the total charge of 5 tons of powder being thus divided between two chambers instead of being all in one place as in the case of the Crarae blast. A displacement of from 80,000 tons to 100,000 tons of material was expected from the Furnace blast, and the result of the explosion was magnificent, the whole upper part of the face of the quarry appearing to heave upwards and outwards. In the case of neither blast was the noise of the explosion great, nor were there signs of any fragments of rock being thrown to any considerable distance. The blasts in fact appeared to do just what they were required to do, namely, to throw down into the quarries enormous quantities of stone detached from the hill side. Messrs. Sim are certainly to be congratulated on the success which attended their operations.

The blasts at the two quarries having been witnessed, the Iona proceeded to Inverary, where the Duke of Argyle had thrown open the grounds of Inverary Castle to the visitors. A short stay having been made at Inverary the Iona returned to Glasgow, calling on her way at Wemyss Bay and at Greenock, at which latter place a special train was in attendance to take back to Glasgow those of the visitors who desired to shorten their voyage. Altogether, as we have said, the arrangements for the day were excellent, and the excursion formed a most enjoyable finale to a meeting which will long be remembered by those who took part in it.

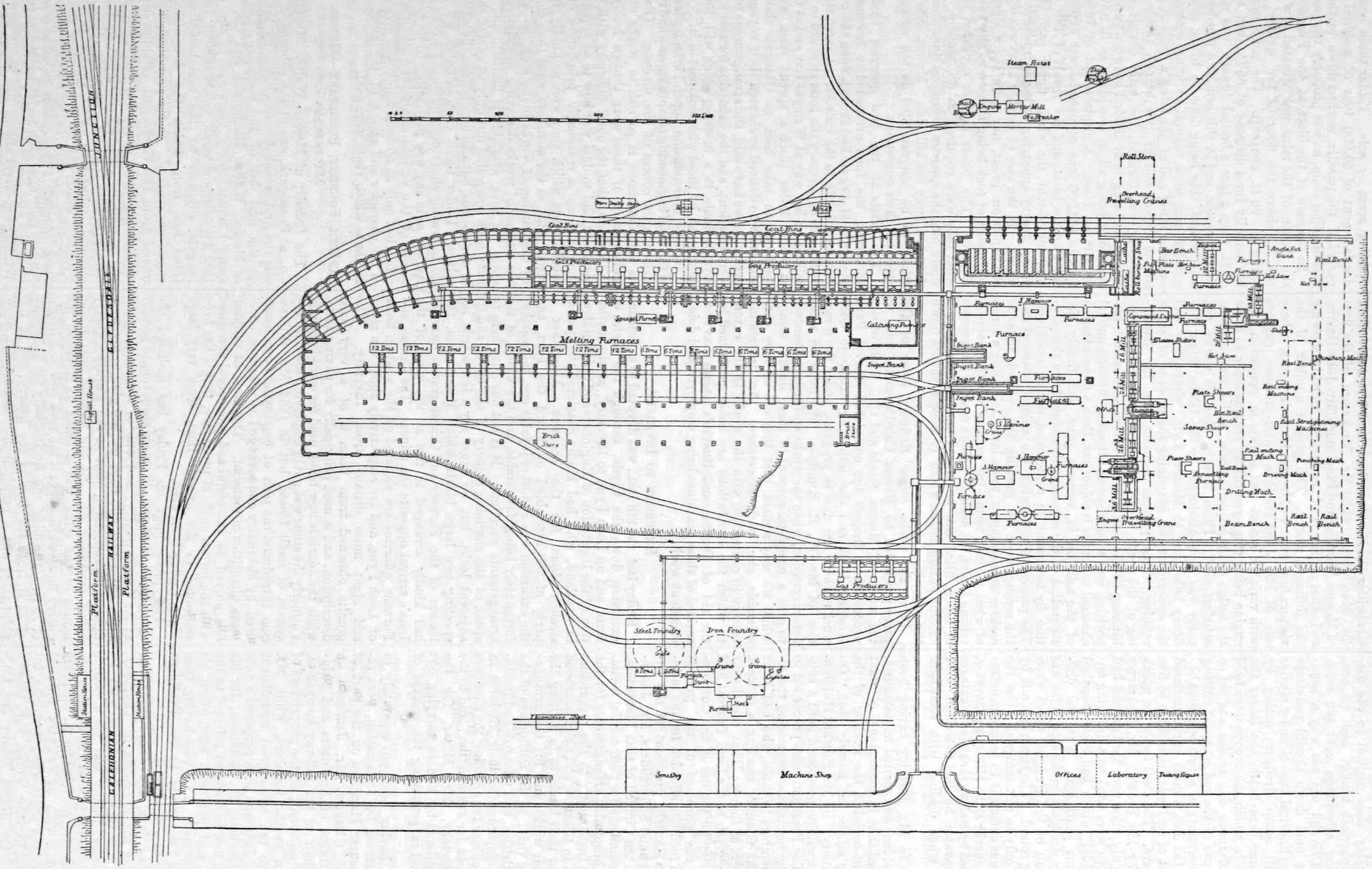
We now, in conclusion, append brief notices of some of the chief engineering establishments and iron works visited in the course of the meeting. Glasgow and its neighbourhood is so rich in works of interest, and so many of these were thrown freely open to the visitors, that the chief difficulty with which the members had to deal was how to so apportion their time as to see a reasonable proportion of the establishments which they were so kindly invited to visit. Just as the members were thus embarrassed by the number of works to be seen, so are we by the number of works deserving description, for the space we have available is limited, and hence we have been compelled not only to curtail the number of our notices, but also to condense the notices themselves. Under these circumstances we do not lay the following short descriptions of works before our readers as in any way pretending to be complete accounts of the various establishments to which they refer, but only as notices which will give a fair idea of the character and extent of the chief establishments to which visits were paid.

SARACEN FOUNDRY, POSSILPARK—MESSRS. WALTER MACFARLANE AND CO.

The foundry of Messrs. Walter Macfarlane and Co., at Possilpark, one of the suburbs of Glasgow, was the first establishment visited by the members on the first day of the meeting. The business of Messrs. Walter Macfarlane and Co. was commenced about thirty years ago in the old Brass Bell Foundry, a small establishment in the Gallowgate, adjacent to the time-honoured Saracen Head Inn, from which the designation of the works was derived. In the year 1863, the firm removed from the Gallowgate establishment to very much larger works which they had specially designed and erected for foundry purposes in Washington-street, almost exactly opposite the somewhat classical engineering works known as the Vulcan Foundry, which was for a long time the property of David Napier, and subsequently of Robert Napier, his distinguished cousin. In a very few years, however, the firm found the new Saracen Foundry in Washington-street almost too small, and they then acquired the Possilpark estate, embracing an area of about one hundred acres of ground in the northern

WORKS OF THE STEEL COMPANY OF SCOTLAND, NEWTON, NEAR GLASGOW.

(*For Description, see Page* 130.)



suburbs of the city, and on which there was the mansion occupied for many years by the late Sir Archibald Alison, Sheriff of Lanarkshire, and author of the "History of Europe." The erection of the present works of the firm at Possilpark was commenced in the year 1869, and within the ten years that have since elapsed the population of the district has increased from twelve persons to about 5000 inhabitants. In the year 1873 the entire establishment of Messrs. Macfarlane and Co. was removed to Possilpark, and the buildings embraced in the works—consisting of pattern shops, foundry sheds, warehouses, drawing offices, &c.—now cover an area of some ten acres. The works are most conveniently situated on the Glasgow and Helensburgh branch of the North British Railway system, with which there is an important siding a short distance from the extensive locomotive works at Cowlairs

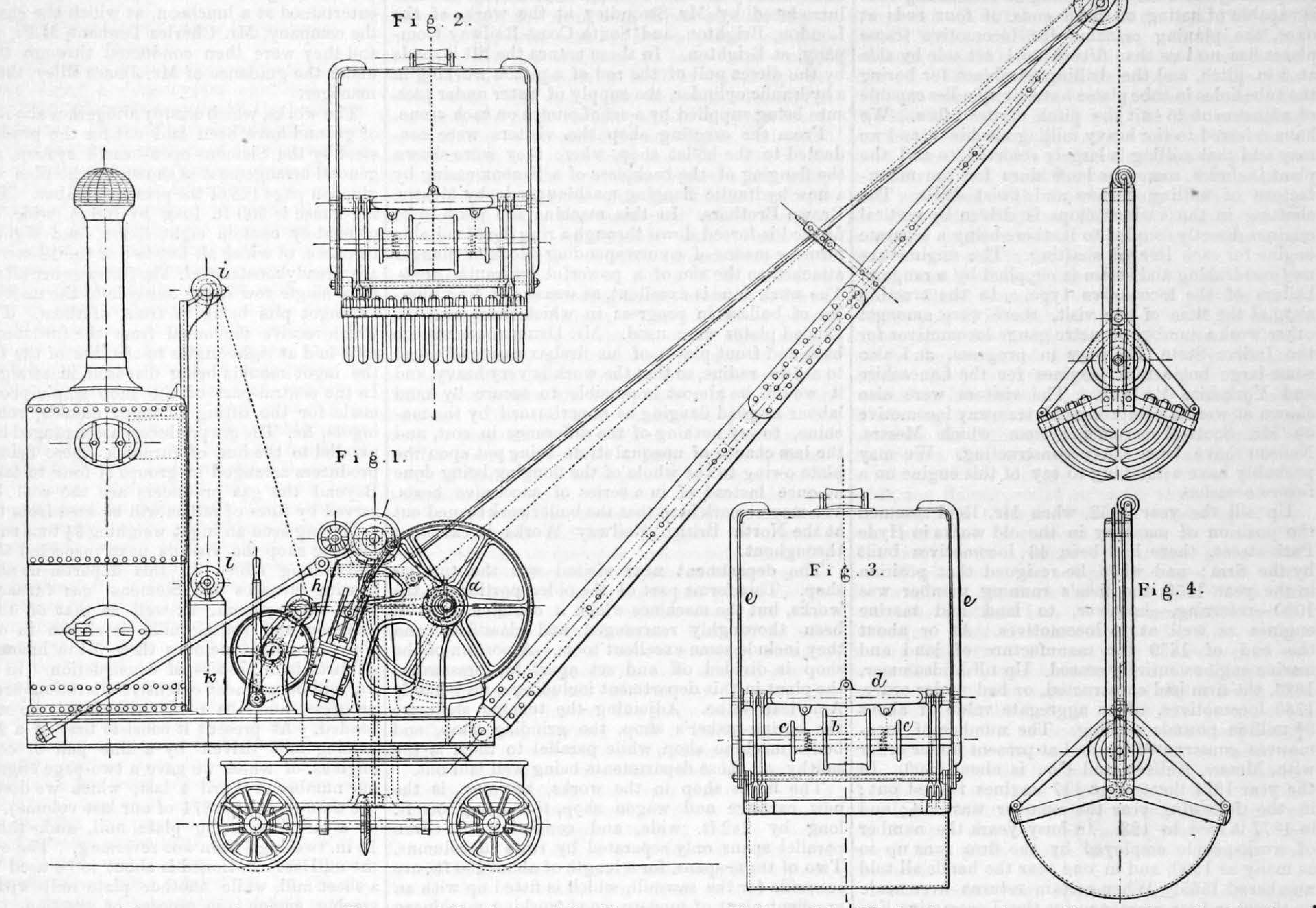
In ordinary times Messrs. Macfarlane and Co. give employment to about 1200 hands. Their manufactures are to a great extent of a very special class, being chiefly sanitary and architectural castings, and in not a few cases they are highly artistic productions in cast iron, the firm having, as is well known, a high reputation for such castings. One of the most important branches of the manufacture carried on at the Saracen Foundry is the production of rain-water pipes, which are turned out in enormous quantities and in a great variety of forms, from the plain cylindrical pipes to highly artistic patterns.

The works consist wholly of one-story buildings, and are composed for the most part of a series of

STEAM CRANE WITH SELF-ACTING BUCKET AND GRAB.

CONSTRUCTED BY MESSRS. PRIESTMAN BROTHERS, ENGINEERS, HULL.

(*For Description, see Page 136.*)



29 ft. spans separated by ranges of columns. The arrangement is such that any one department can be extended at pleasure, while the successive departments are so disposed that the work always proceeds in one direction towards completion. Thus, commencing on the south side, there follow in succession the moulding, dressing, and painting departments and stores.

On the occasion of their visit the members of the Institution were received by Mr. Walter Macfarlane, who first explained the general plan of the works, the organisation of the office department, &c., and then conducted the visitors to the foundry, where the process of casting rain-water pipes was witnessed. Messrs. Macfarlane cast these pipes on green-sand cores, the cores being formed on core bars by the side of which a ⅜ in. wire is laid. On the core being finished this wire is withdrawn, leaving a hole from end to end. No chaplets are used, but at the middle of the length of the core on the upper side there is inserted a piece of wire which projects above the core by an amount equal to the thickness of the pipe. When the core is laid in the mould this wire bears against a corresponding support in the mould, and so prevents the core from rising. The pipes are cast horizontally, and when the metal is poured, steam soon begins to issue from the hole at each end of the core. After a little has been allowed to escape, the workman plugs up each end of this hole with sand, and a few seconds later there is a mild explosion, and with a sharp puff the steam thus imprisoned blows out the greater part of the core of the pipe, leaving very little to be subsequently removed by hand.

The quality of the castings produced is admirable, and throughout the foundry are numbers of neat special contrivances for the production of the particular class of work turned out. An interesting department is that devoted to pattern-making, many of the patterns, such as those for gutters and cornices, being made of plaster-of-paris produced by the aid of profile plates used on a kind of rough planing machine especially designed for the purpose. If the article to be produced is straight, these plaster patterns are used directly to form a mould, in which an iron pattern is then cast. If, on the other hand, the article has to be curved, or if—as is the case with some classes of work—the pattern has to be curved to allow for contraction, the plaster-of-paris models are used to produce a mould in which a lead pattern is cast. This lead pattern having been curved as desired, is then in its turn used to procure a mould in which the final iron pattern is cast. Of course for a number of articles ordinary wooden patterns are used, and the collection of patterns of all kinds which Messrs. Macfarlane possess is extraordinary, and this notwithstanding that it is their practice to clear off annually all patterns out of date. In addition to examining the pipe founding, the visitors had full opportunities of seeing in progress a great variety of the works in iron, such as ornamental castings of all kinds, staircases, conservatories, railings, sanitary casings, &c., for which the firm is noted.

Hyde Park Locomotive Works—Messrs. Neilson and Co.

The business now carried on by the firm of Messrs. Neilson and Co. dates as far back as the year 1836, but as a separate and special branch of the engineering trades in the Glasgow district the construction of locomotives does not date back so far, but probably about thirty-five years. For a long time the works were in Hyde Park-street, close to the harbour of Glasgow; in the year 1860, however, the firm laid out at Springburn, in the north quarter of the city, entirely new works upon an extensive scale, and exclusively for the manufacture of locomotive engines. The buildings were forthwith commenced, and in the year 1862 the business was entirely removed to Springburn. The works at Springburn were designed by Mr. Neilson and his then partner, the late Mr. Henry Dübs. At the end of 1863 Mr. Dübs severed his connexion with the firm and started the establishment known as the Glasgow Locomotive Works, for carrying on the same branch of business, He was succeeded in his position as managing partne by Mr. James Reid, who has been closely connected with locomotive engineering almost from its earliest days in Scotland—first with Messrs. Scott, Sinclair, and Co., Greenock, then with Messrs. Neilson and Co., Glasgow, and afterwards with Messrs. Sharp, Stewart, and Co., Manchester.

Since the works were started they have been so very much extended at various times that they are about double their original size and productive power. Consisting almost exclusively of one-story buildings, the works now occupy an area of about nine acres, and have been most carefully and systematically laid out. We this week give on page 124 a plan of the works which will explain their arrangement much better than any verbal description.

Referring to this plan it will be seen that the works consist mainly of a series of parallel one-story shops separated by rows of columns, and disposed in two groups with the stores and boiler-house between them. The pattern-making shop and foundry, as well as the pattern stores, are, as will be seen, detached from the main blocks. Unfortunately, as we have already stated, the space at our disposal will only permit of our noticing briefly some of the features of the works. In the smithy the extent to which stamping is carried out is especially noticeable, some excellent work of this kind being done. Amongst other things we noticed some sections of small locomotive wheels, consisting of the crank portion of the boss, four spokes and a portion of the rim, the stamps leaving merely a thin web between the spokes, which was afterwards slotted out. In the smithy also is one of the radial steam hammers swinging round a central standard, which we illustrated and described on page 331 of our first volume, this hammer being used for "dabbing" on the outer ends of wheels, spokes, and similar work.

The machine shops contain an excellent plant o special tools adapted for locomotive work, amongst which may be mentioned some very heavy milling machines, and two "quartering" machines constructed on Mr. Reid's plans, and illustrated by us on pages 484 and 485 of our nineteenth, and pages 324 and 328 of our twentieth volumes respectively. Multiple tools are largely used; thus the machine for planing the ends of coupling or connecting rods is capable of acting on both ends of four rods at once, the planing machine for locomotive frame plates has no less than fifteen tools set side by side at 3 in. pitch, and the drilling machines for boring the tube holes in tube plates have six spindles capable of adjustment to suit the pitch of the tubes. We have referred to the heavy milling machines, and we may add that milling is largely resorted to and the plant includes some good machines for the manufacture of milling cutters and twist drills. The shafting in the various shops is driven by vertical engines directly coupled to it, there being a separate engine for each line of shafting. The engines are non-condensing and steam is supplied by a range of boilers of the locomotive type. In the erecting shop at the time of our visit, there were amongst other work a number of metre gauge locomotives for the Indian State Railways in progress, and also some large bogie tank engines for the Lancashire and Yorkshire Railway. The visitors were also shown at work a compressed air tramway locomotive on Mr. Scott-Moncrieff's system which Messrs. Neilson have been lately constructing. We may probably have something to say of this engine on a future occasion.

Up till the year 1852, when Mr. Reid assumed the position of manager in the old works in Hyde Park-street, there had been 46 locomotives built by the firm; and when he resigned that position in the year 1858, the firm's running number was 1000—referring, however, to land and marine engines as well as to locomotives. At or about the end of 1859 the manufacture of land and marine engines entirely ceased. Up till Midsummer, 1876, the firm had constructed, or had under order, 1780 locomotives, of an aggregate value of about 3¾ million pounds sterling. The number of locomotives constructed by, and at present under order with, Messrs. Neilson and Co., is about 2500. In the year 1875 there were 117 engines turned out; in the following year the number was 114; and in 1877 it rose to 123. In busy years the number of work-people employed by the firm runs up to as many as 1500, and in one year the hands all told numbered 1565. When certain returns were made up three or four years ago for the Locomotive Engineers' Association, Messrs. Neilson stood at the top of the list as to the number of hands employed in locomotive works, these hands forming, indeed, about one-seventh of the whole of the locomotive engineers in the United Kingdom, not including those in the employment of the railway companies.

NORTH BRITISH RAILWAY LOCOMOTIVE WORKS.

These works, which have recently been very considerably extended under the direction of Mr. D. Drummond, the present locomotive superintendent, and in accordance with the most recent practice, are situated at Cowlairs, about one and a half miles from the centre of the city. They are chiefly devoted to the repairing operations for the whole of the North British Company's system, the greater number of the new engines being built by private firms. The stock of engines belonging to the various railways now comprised in that system was 316 on August 1, 1865; and the total stock at the 1st of August current was increased to 497, of which 170 are six-wheeled coupled goods engines with 16-in. cylinders, 103 are six-wheeled coupled with 17-in. cylinders, and 32 are six-wheeled coupled with 18-in. cylinders. None of these existed at the time of the amalgamation of the original Edinburgh and Glasgow Railway with the North British system, which dates back, we believe, some twenty or twenty-five years. The present records of the North British Railway Locomotive Department mention 1842 as the year in which engines were first built at Cowlairs, the locomotive superintendent being then the late Mr. William Paton. (It was in the preceding year that the Edinburgh and Glasgow Railway was opened for public traffic.) The engines first turned out were the "Hercules" and the "Sampson," which were specially built to work the heavy incline leading up the tunnel from Queen-street station to Cowlairs; but they were disused in 1847, when the stationary engine and rope were again brought into operation.

We give on page 125 of the present number a plan of the Cowlair's Works, which will explain their arrangement and extent, the dimensions of the several shops being given in our engravings. On the occasion of the visit to the works last Tuesday week, the visitors first entered the erecting shop, this being an exceedingly fine shop, with three bays, each filled with hydraulic travelling cranes similar to those introduced by Mr. Stroudley at the works of the London, Brighton, and South Coast Railway Company, at Brighton. In these cranes the lift is made by the direct pull of the rod of a piston working in a hydraulic cylinder, the supply of water under pressure being supplied by a set of pumps on each crane.

From the erecting shop the visitors were conducted to the boiler shop, where they were shown the flanging of the backplate of a firebox casing by a new hydraulic flanging machine made by Messrs. Brown Brothers. In this machine the plate to be flanged is forced down through a ring die of suitable form by means of a corresponding block or plunger attached to the rim of a powerful hydraulic press. The work done is excellent, as was shown by a number of boilers in progress in which these machine flanged plates were used. Mr. Drummond has the back and front plates of his firebox casings flanged to a 6-in. radius, so that the work is very heavy, and it would be almost impossible to secure by hand labour as good flanging as is performed by the machine, to say nothing of the difference in cost, and the less chance of unequal strain being put upon the plate owing to the whole of the flanging being done at once instead of in a series of successive heats. We may remark here that the boilerwork turned out at the North British Railway Works is excellent throughout.

The department next visited was the turning shop. This forms part of the older portion of the works, but the machines which it contains have all been thoroughly rearranged and classified, and they include some excellent tools. A portion of the shop is divided off and set apart for brasswork, the plant in this department including a very handy American lathe. Adjoining the turning shop are the spring-maker's shop, the grinding shop, and boiler machine shop, while parallel to them is the smithy, all these departments being well laid out.

The finest shop in the works, however, is the new carriage and wagon shop, this being 600 ft. long by 242 ft. wide, and consisting of seven parallel spans only separated by rows of columns. Two of these spans, for a length of about 200 ft., are set aside for the sawmill, which is fitted up with an excellent plant of modern wood-working machinery—chiefly by Messrs. T. Robinson and Son, of Rochdale—specially adapted for railway carriage and wagon work. We may mention that the shafting in this department is driven by ropes, these ropes being in one case employed in the same manner as a twisted belt, to communicate motion from one shaft to another at right angles to it.

Our space will not permit us to enter here into any notice of the special features of Mr. Drummond's practice, although there are many points about his engines deserving special notice. Of some of these, however, we have spoken on former occasions, and of others we hope to treat when illustrating other engines made from his designs. At present we need only add that the Cowlairs Works afford good evidence of their having being remodelled with great judgment, while the new departments are excellent examples of modern workshops. The total number of workmen employed in the Cowlairs locomotive shops is 1639, the greatest number so employed at any one time being 1688. Over the whole of the shops on the company's system there are now employed 2653 hands, as against 2691, the greatest number ever in the company's service at one time.

Engines Built at Cowlairs since 1862.

Year.	Number of Engines.	Locomotive Superintendent.
1862	2	W. S. Brown.
1863	2	
1864	6	S. W. Johnson.
1866	3	W. Hurst.
1867	11	Thomas Wheatley.
1868	13	
1869	16	
1870	25	
1871	29	
1872	29	
1873	40	
1874	22	
1875	13	D. Drummond.
1876	12	
1877	16	
1878	15	

THE WORKS OF THE STEEL COMPANY OF SCOTLAND.

The works of the Steel Company of Scotland, which were visited by a very large party of the members on the afternoon of Wednesday the 6th inst., are situated at Newton, about six miles from Glasgow, the works adjoining the Caledonian Railway, with which they have siding communication. On arriving at the works the visitors were first entertained at a luncheon, at which the chairman of the company, Mr. Charles Tennant, M.P., presided, and they were then conducted through the works under the guidance of Mr. James Riley, the general manager.

The works, which occupy altogether about 30 acres of ground have been laid out for the production of steel by the Siemens open-hearth system, and their general arrangement is shown by the plan which we give on page 128 of the present number. The melting house is 500 ft. long by 100 ft. wide, and will ultimately contain eight 6-ton, and eight 12-ton furnaces, of which all but two of the 12-ton furnaces are already constructed. The furnaces are all arranged in a single row along one side of the melting shop, the ingot pits being in front of them. The ladles which receive the metal from the furnaces run on rails laid at right angles to the line of the furnaces, the ingot moulds being disposed in straight lines. In the central part of the shop ample provision is made for the lifting of ingot moulds, removal of ingots, &c. The gas producers are arranged in groups parallel to the line of furnaces, there being 96 gas producers arranged in groups of four to each stack. Beyond the gas producers are the coal bunkers, served by lines of rail as will be seen from the plan.

Having seen an ingot weighing 9½ tons run in the melting shop the visitors next inspected the forge and rolling mills. In this department all the reheating furnaces are Siemens' gas furnaces, and their arrangement, as well as that of the steam hammers and rolling mills, is shown in our plan. The forge plant includes three 5-ton hammers, and a fourth is in process of construction. In the rolling mill department extensive alterations are now in progress, and the plant will shortly be much extended. At present it consists first of a 26-in. reversing mill driven by a fine pair of compound engines, of which we gave a two-page engraving in our number of April 4 last, which we described at the time (*vide* page 274 of our last volume), second, of a large reversing plate mill, and, third, of a 14 in. two-high train not reversing. The engine of the mill last mentioned is about to be used to drive a sheet mill, while another plate mill with a reversing engine is in process of erection. Besides this, an 18 in. three-high train for bars and angles, and a 10-in. sheet mill are expected to be started in the course of about a couple of months.

The 26-in. reversing mill is employed in rolling rails, deck beams, and heavy angles, and last Wednesday week it was shown producing 9-in. by 7½-in. deck beams. The Steel Company of Scotland have made the production of these deck beams and similar sections in steel a specialty, and they are turning them out in excellent style. Although, as we have already stated, we have fully described the engines which drive this 26-in. mill, yet we may repeat here that they have two high and two low-pressure cylinders 31 in. and 50 in. in diameter respectively with 5 ft. stroke, and they are worked with steam at 120 lb. pressure, supplied by boilers of the locomotive type. The engines were constructed by Messrs. Miller and Co., of Coatbridge, from the designs of Mr. T. Williamson, the work's manager of the Steel Company of Scotland, and they are an exceedingly fine job. The engines are coupled to the mill direct, but it is, we understand, the intention to add gear arranged so as to enable the mill to be driven at a slower speed than the engines, and used for plate-rolling when necessary.

The mill plant includes the usual heavy shears for plates and scrap, rail-ending, and straightening machines, &c., the general arrangement of these machines being shown by our plan on page 128. The company are largely engaged in the production of steel plates for shipbuilding, as well as heavy angles and other sections for shipwork, the present output, including rails, being from 3000 tons to 3500 tons per month. We may mention that a portion of the steel used in the new torpedo vessel Polyphemus was made at the Steel Company of Scotland's Works.

Besides the mill, the works include a steel foundry, and some good examples of cast steel pinions for rolling mills produced in this department were shown on the occasion of the recent visit. There are also an iron foundry and a set of repairing shops, including smithy, machine shop, &c., and last, but by no means least in importance, a testing shop and large laboratory. In the testing shop the visitors had the opportunity of witnessing the fracture of some test pieces, and of examining a variety of samples showing the good quality of the material produced.

MESSRS. DÜBS AND CO., GLASGOW LOCOMOTIVE WORKS.

These works (which were prominently noticed in ENGINEERING about a dozen years ago) date back to the year 1864, when the erection of the buildings was commenced. Mention has already been made of the fact that the senior partner of the firm was for a number of years managing partner of the firm of Neilson and Co., Hyde Park Locomotive Works, in the designing and construction of which he played a prominent part. In designing the works now under notice, and which are situated at Little Govan, in the south-eastern suburbs of the city, and close by Govan Iron Works, Mr. Dübs set out with the determination to erect a locomotive engine factory which should be second to none, either at home or abroad, for its facilities for carrying on a large trade in that particular branch of engineering to which it was to be devoted. In that respect it has shown that it would be very difficult to surpass it. The first engine left the establishment on the 1st of May, 1865, and by the month of November, 1867, the firm had sent out 200 locomotives. Ever since they started the works have turned out engines at the rate of fully 100 per annum, or practically two per week. By midsummer, 1876, the firm had built nearly 1000 engines, of which 109 were sent out during the preceding year to their respective destinations, including several home railways, and others in Russia, India, Spain, New Zealand, South America, and Sweden, and representing a value of about 250,000*l.* From July, 1877, to July, 1878, the period embraced by the firm's financial year, there were turned out no fewer than 120 finished engines, chiefly large and powerful main line locomotives. That was certainly the largest make in any one year. Including orders for some forty-five engines now in hand, and which may be set down as work secured for nearly six months, the total number of engines on the books of the firm is 1290. At present there is in the employment of the firm about 1240 hands. Since the death of Mr. Dübs, rather more than three years ago, the business has been carried on by the reconstituted firm and now consisting of two sons of the decased, Mr. Lorimer, commercial manager, and Mr. G. G. Copestake, who was brought up with Messrs. Sharp, Stewart, and Co., under the present President of the Institution of Mechanical Engineers, and is the manager-in-chief of the designing and constructive department.

THE NORTH BRITISH IRON WORKS AT COATBRIDGE.

In spite of the attractions of the steel works at Newton, a considerable number of members last Wednesday week joined the excursion to Coatbridge, where the first works visited were those of Mr. Thomas Ellis, the well-known North British Iron Works. These works, which were started by Mr. Ellis nearly twenty years ago, on a very limited scale, seem to be in full work in spite of the dulness of business generally, and are turning out nearly 2000 tons of finished iron per month. Within the last few years Mr. Ellis has added wire-drawing to the manufacture of merchant bars, which was formerly his chief business, and this formed one of the most interesting parts of the work going on during the afternoon. The works contain over thirty puddling, scrapping, and reheating furnaces (including one puddling furnace with mechanically worked rabbles), with one forge train and four other mills, including that used for wire. All five mills were at work. One of the small finishing mills was working ½ in. round bar, in 70 ft. lengths. Both two and three-high rolls were in the train and the bar was finished with 11 passes in about 50 seconds. This was driven by a horizontal geared engine working at 130 revolutions per minute. Another mill was turning out 2½ in. round iron in lengths of about 25 ft. This was worked by a horizontal engine, acting direct, and running at 68 revolutions per minute, and finished the bar in 14 passes in about 120 seconds. A third train was working flat bars 1½ in. by ½ in., and about 15 ft. long through small three-high rolls, and finished the bar in 35 seconds with 17 passes. This mill, and that used for wire-making, were worked by a vertical engine having two cylinders inverted side by side, with the flywheel between them, running at 100 revolutions per minute. In the train used for wire-making, each pile was rolled into a coil of wire of No. 4 B.W.G. diameter, and 400 ft. or 500 ft. long, in one continuous operation. The end of the rod as it passed through one pair of rolls was carried back through the next, then back again through the next, and so on, so that at one time the bar was making seven passes simultaneously, lying on the floor in long loops—which required very considerable skill in handling—between each. The end of the wire was led away, as soon as it had made its last pass, to a rough drum, set in motion by a separate steam engine, and coiled on this as fast as it came from the rolls. The whole time occupied by the operation from the first entry of the pile to the rolls until the finished coil was taken off the drum just mentioned, was 80 seconds, on one occasion considerably less. Each coil weighed about 56 lb. All iron intended for wire is first rolled in this way to No. 4 W.G., and then carried to the wire-drawing house, where it is drawn cold in the usual fashion. The number of passes through the drawing-blocks (of which there are 18 sets, with drums, &c., complete) depends of course on the intended diameter of the wire, 7 draws being sufficient to reduce the No. 4 to No. 18 B.W.G. in diameter. Not the least interesting part of the work in progress was the action of the mechanical puddler above referred to, a design of the Kirkstall Forge at Leeds. The arrangement of this apparatus is exceedingly simple. It is of a type which has now been brought into somewhat extensive use, both here and abroad, and it is designed for working two rabbles, one on each side, and consists essentially of a large lever vibrating always in the same vertical plane, placed above the furnace, and giving motion by vertical links to two smaller ones, one overhanging each side of the furnace. Each of the links occupies the centre of a hollow cast-iron column, capable of turning about its own axis, an arm on this column carrying the fulcrum pin of one of the two upper rocking levers. The joints are so arranged that the column, carrying with it its lever, can be turned round at will without interfering in any way with the continuous vibration which the latter is receiving. A hanging link from the outer end of each of the two upper levers carries a double hook in which lies a cross-pin attached to the rabble. This machine has been at work for two years, and Mr. Ellis professes himself well satisfied with it, stating that he would put down others of the same kind if he were adding just now to his puddling furnaces.

It should be added that the members were very hospitably entertained to lunch by Mr. Ellis.

GARTSHERRIE IRON WORKS, COATBRIDGE.

On the occasion of the visit to Coatbridge on Wednesday week, these famous works were also thrown open to inspection. Considering the amount and varied interest that hovers around the Gartsherrie Iron Works, and the eminent family of the Bairds, so long occupying a foremost position in the Scotch iron trade, a very bulky volume would be required to embody what might fitly be said regarding them; on this occasion, however, we can only afford space for a very meagre sketch of the works.

The gigantic business now carried on by the well-known firm of William Baird and Co., as ironmasters, began some forty years ago; but as coalmasters it began as far back as the year 1816. The founder of the family was Alexander Baird, farmer, of Kirkwood, near Coatbridge, and in the parish of Old Monkland. He leased Woodside Colliery, near Dalserf, which he worked, in addition to his farm, for several years prior to that just mentioned; and in that year, when his son William was twenty years of age, he set him to superintend Rochsolloch Colliery, near Airdrie, of which he had taken a lease. Some ten years afterwards a number of other mineral leases were taken, including that of the coal and ironstone of Gartsherrie, on which estate the firm, embracing Alexander Baird and three sons, William, Alexander, and James, had no fewer than six pits in full operation by the year 1828. Resolved on starting as ironmasters, they had their first blast furnace in operation in May, 1830. That, it may be remembered, was just at the time when the hot-blast invention was coming into practical use. By the year 1839 there were eight blast furnaces in full operation at Gartsherrie; and by the year 1842 the Gartsherrie Iron Works, embracing sixteen furnaces in two parallel rows of eight each, were practically complete, in a great measure as they now stand. It is related of the late Mr. James Baird that he contributed much to the successful management of the works by his improvements on the hot-blast invention, and on the blowing engine first erected at the works.

Mr. Alexander Baird, Sen., the founder of the firm, went out of the business in the year 1830, and died in 1833; and William, along with four of his brothers, formed a partnership under the style and title of William Baird and Company. In the year 1840 two other brothers were admitted as partners. The late Mr. James Baird was the last remaining brother in the firm, and at the time of his death there were left three nephews as the only partners in the firm, and since then even two of those have been numbered with the dead, one of them being Mr. Alexander Whitelaw, M.P. for Glasgow, whose lamented death occurred only a few weeks ago, while he was still in the prime of life.

As their business progressed at Gartsherrie, the Messrs. Baird found it necessary to provide for a large supply of minerals within easy reach for use in subsequent years; and accordingly around Coatbridge they acquired a number of very valuable leases. They eventually extended their business connexions into Ayrshire, where they secured, near Kilwinning, a very large area of mineral lands, more especially the Eglinton coalfields. On a portion of the ground thus acquired, they erected eight blast furnaces, which along with their new mineral fields, the Bairds carried on under the style of the Eglinton Iron Company, though consisting of the same partners. In subsequent years they extended their business in Ayrshire by purchasing the Blair Iron Works (consisting of five furnaces, and since discontinued), Muirkirk and Lugar Iron Works, and lastly, the Portland Iron Works, near Kilmarnock. Including their Gartsherrie and Ayrshire works, Messrs. Baird and Company are the owners of no fewer than forty-two blast furnaces, of which seventeen are in active operation, ten of which are at the Gartsherrie establishment. Of course it must be borne in mind that several of those which are out of blast are of somewhat antiquated type of construction, and are not likely again to be blown in. Taking the whole of the iron works owned by the firm, they have a making power of about 300,000 tons of pig iron per annum; and in one year during the recent busy times almost that entire quantity was produced.

During recent years Messrs. Baird and Co. have given a great amount of attention to improvements in ironmaking, more especially in connexion with the question of the economy of fuel. Three of the furnaces now in blast at Gartsherrie have been closed in at the top without the original height having been increased, and a considerable amount of economy has been the result, all the hot air stoves on that side of the works being heated with the gas taken off. As in other cases, raw coal is used as the fuel. We need not at present even indicate the method employed, as we hope to be able on an early occasion to give an illustrated description of it. In passing, we may mention that the work of closing in the tops of at least two other furnaces is in progress. It may also be mentioned that both at the Eglinton Iron Works and the Lugar Iron Works the system of taking off the furnace gases has made decided progress.

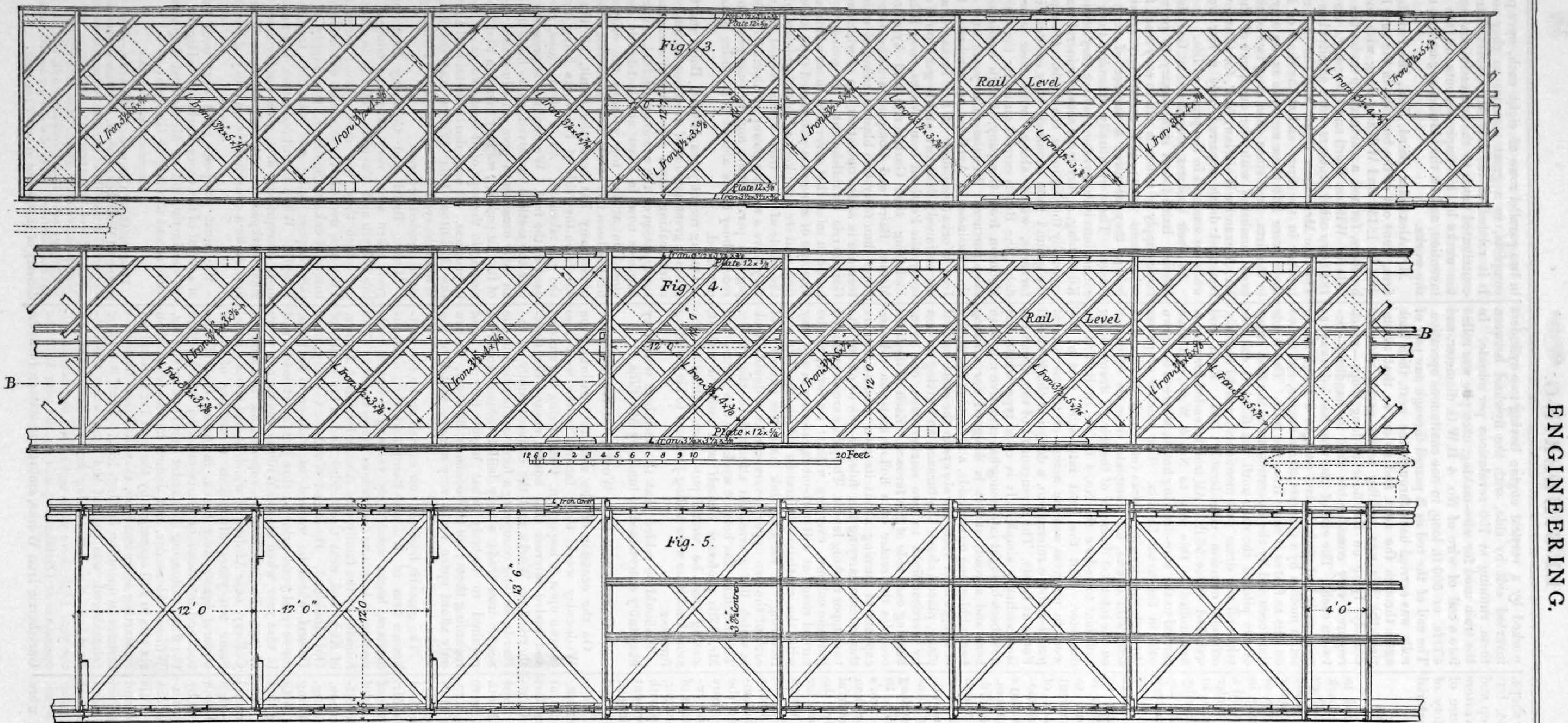
Messrs. Baird and Company have in recent years taken some very extensive mineral leases in the Kilsyth and Twechar districts in Stirlingshire, on which they are now making large demands. They are, we believe, the most extensive manufacturers of coke in Scotland, the supply of coal for the purpose being got from the famous beds at Kilsyth. When in full operation, the works of this most enterprising firm give employment to about 9000 workpeople. At their works at Muirkirk the firm make a considerable quantity of bar iron.

We must postpone until next week our notices of several of the other works visited by the members of the Institution of Mechanical Engineers during their recent meeting at Glasgow.

WESTPHAL'S COMPOUND ENGINE.—The compound engine on Westphal's system, of which we gave engravings on pages 510 and 511 of our last volume, is, we understand now employed in driving four centrifugal pumps at the Oderbruck drainage works, near Angermünde (Prussia). The pumps have discs 1.7 metres (5 ft. 7 in) in diameter, and each delivers 1¼ tons of water per second, making a tota delivery of 18,000 tons of water per hour.

BRIDGE OVER THE RIVER NILE AT KOHÉ.

MR. JOHN FOWLER, ENGINEER; MESSRS. APPLEBY BROTHERS, GREENWICH, CONTRACTORS.



WE give this week a two-page engraving, together with some detail views on the present page, of the bridge designed to carry the Soudan Railway across the River Nile at Kohé, a point about 1170 miles above Alexandria. We intend in an early number to publish further illustrations of this bridge, and for the present therefore we defer our detailed description of it.

THE BRITISH ASSOCIATION.—The following is a list of the officers appointed to the different sections of the forthcoming meeting of the British Association: A. Mathematical and Physical Science: President, George Johnstone Stoney, M.A., F.R.S., M.R.I.A., Secretary to the Queen's University, Ireland. Vice-Presidents, Rev. Samuel Earnshaw, M.A.; Professor Sir William Thomson, M.A., LL.D., D.C.L., F.R.S. L. and E. Secretaries, J. W. L. Glaisher, M.A., F.R.S., Sec. R.A.S.; Oliver J. Lodge, D.Sc.; Donald McAlister, B.A., B.Sc. (Recorder).—B. Chemical Science: President, Professor James Dewar, M.A., F.R.S. L. and E. Vice-Presidents, J. H. Gilbert, Ph.D., F.R.S., F.C.S., F.L.S.; Professor Roscoe, B.A., Ph.D., F.R.S., F.C.S. Secretaries, H. S. Bell, F.C.S.; W. Chandler Roberts, F.R.S., F.C.S., F.G.S.; J. M. Thomson, F.C.S. (Recorder).—C. Geology. President, Professor P. Martin Duncan, M.B., F.R.S., F.G.S. Vice-Presidents, A. C. Ramsay, LL.D., F.R.S., V.P.G.S.; Professor W. C. Williamson, F.R.S. Secretaries, G. Blake Walker, F.G.S.; W. Topley, F.G.S., A.I.C.E. (Recorder).—D. Biology: President, Professor St. George Mivart, F.R.S., F.L.S., F.Z.S. Vice-Presidents, Professor Gamgee, M.D., F.R.S.; Professor Lawson, M.A., F.L.S.; Dr. Pye-Smith; E. B. Tylor, D.C.L., F.R.S. Secretaries, Arthur Jackson, F.R.C.S.; Professor M'Nab, M.D.; J. Brooking Rowe, F.L.S.; F. W. Rudler, F.G.S.; Professor Schäfer, F.R.S. Department of Zoology and Botany: Professor St. George Mivart, F.R.S., F.L.S., F.Z.S. (President), will preside. Secretaries, Professor M'Nab, M.D. (Recorder); J. Brooking Rowe, F.L.S. Department of Anthropology: E. B. Tylor, D.C.L., F.R.S. (Vice-President), will preside. Secretary, F. W. Rudler, F.G.S. (Recorder). Department of Anatomy and Physiology: Dr. Pye-Smith (Vice-President) will preside. Secretaries, Arthur Jackson, F.R.C.S.; Professor Schäfer, F.R.S. (Recorder).—E. Geography: President, Clements R. Markham, C.B., F.R.S., F.L.S., Sec. R.G.S., F.S.A. Vice-Presidents, Sir Douglas Forsyth, K.C.S.I., C.B., F.R.G.S.; Sir Rawson W. Rawson, K.C.M.G., C.B., F.R.G.S. Secretaries, H. W. Bates, Assist. Sec. R.G.S., F.L.S.; E. C. Rye, Librarian R.G.S., F.Z.S. (Recorder).—F. Economic Science and Statistics: President, G. Shaw Lefevre, M.P., Pres. S.S. Vice-Presidents, Frederick Brittain; A. J. Mundella, M.P., F.S.S. Secretaries, Professor Adamson; R. E. Leader, B.A.; Constantine Molloy (Recorder).—G. Mechanical Science: President, J. Robinson, Pres. Inst. Mech. Eng. Vice-Presidents, Sir John Brown; Alderman Mark Firth; Professor Osborne Reynolds, M.A., F.R.S. Secretaries, A. T. Atchison, M.A. (Recorder); Emerson Bainbridge; H. Trueman Wood, B.A. This list of sectional officers will be completed and will be submitted to the General Committee on Wednesday, August 20. J. E. H. Gordon, Assistant Secretary.

THE BOILER INSURANCE AND STEAM POWER COMPANY, LIMITED.—At the usual monthly meeting of the Board, held at the head offices of the company, 67, King-street, Manchester, (Mr. M'Naught in the chair), the chief engineer, Mr. M'Dougall (late inspecting officer to the Board of Admiralty), reported that during the month of July 7047 boilers had been examined by the officers of the company, of which number 100 were internally, and 1206 thoroughly examined. The principal defects found in the boilers were as follows: Corrosion of plates and angle iron, 152; fracture of plates and angle iron, 47; safety valves out of order or overloaded, 129; pressure gauges out of order, 53; water gauges out of order, 38; boilers damaged from overheating in consequence of deficiency of water, 5; boilers damaged from overheating in consequence of deposit, 3. Under the management of Mr. M'Dougall, great attention is being paid to the thorough examination of the boilers entrusted to the company, and no less than 4082 have been examined completely during the past four months.—*The Manchester Courier*.

ENGLAND AND NATAL.—Messrs. Bullard, King, and Jarvis have resolved to open up direct steam communication between England and Natal. They have long had a regular line of smart clippers in connexion with the Natal trade.

BRIDGE OVER THE RIVER NILE AT KOHÉ.

MR. JOHN FOWLER, ENGINEER; MESSRS. APPLEBY BROTHERS, GREENWICH, CONTRACTORS.

(For Notice, see Page 132.)

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NOTICE TO AMERICAN SUBSCRIBERS.

We beg to announce that we have appointed Mr. Lenox Smith, 46, Pine-street, New York, the sole agent for Engineering in the United States, and all subscriptions for the United States will in future be payable to him. Mr. Lenox Smith is also prepared to receive advertisements for Engineering, and will afford full information as to terms, &c., on application. The annual subscription for Engineering delivered post free in the United States is 10 dols. U.S. currency payable in advance.

ENGINEERING.

FRIDAY, AUGUST 15, 1879.

DOCKYARD PROFESSIONAL OFFICERS.

The discussion brought about by Mr. Brassey in the House of Commons on Thursday the 30th ult., on the status and remuneration of the professional officers of the Royal Dockyards and of the Constructors' Department of the Admiralty, opens up a subject of considerable interest, and one possessing more importance to the country than is generally supposed. Mr. Brassey introduced the subject with a speech which had the merit of extreme moderation, and it was one that, if it did no immediate good pecuniarily to the officers whose cause he pleaded, could not possibly do them any harm. It ruffled nobody's feelings. Mr. Brassey might have made out a much stronger case for the professional officers if he had pressed home comparisons between their positions and responsibilities and those of other branches of the civil and naval services. In such a case, however, he would probably have aroused angry feelings and jealousies, and in the end have done harm rather than good with the House of Commons for those he aimed at benefiting. As usual Mr. Brassey had bestowed care and attention on his case, and had studied a number of blue-books containing the results of official inquiries on the subject. Indeed the First Lord of the Admiralty was evidently surprised to find there was so much literature extant on the matter.

We doubt, however, whether Mr. Brassey's researches among the reports of the various committees and Royal Commissions have entirely cleared his mind as to the real position and organisation of the professional staff of the dockyards. There was a lengthy report of his remarks and of the whole discussion in the *Times* of the 1st inst., but it is impossible for any one to gather from it any correct ideas on this subject. Circumstances have entirely changed since some of the reports from which Mr. Brassey quoted were made, and have been greatly modified, since most of them came into existence. Mr. Brassey's speech, therefore, although carefully prepared, and with an evident desire to state the case fairly, must, as reported, seem to those acquainted with the subject like an echo of other days rather than like an exposition of the state of affairs at the present date. The discussion throughout was peculiar. The First Lord of the Admiralty is made to appear as far in advance of his time as Mr. Brassey is behind. He describes the state of affairs as follows: "The constructors were selected, first of all, from the apprentices in the dockyards. These apprentices were admitted on open competition, and the best were sent to Greenwich, where they received a careful and complete training, after which they came back to the dockyards. The result of this system was highly satisfactory in producing highly trained men with a practical knowledge of their profession."

Now as the Royal Naval College at Greenwich was only established about six years ago, and those trained there are still young men in very subordinate positions, it is evident this reply was entirely misleading so far as the higher officers are concerned, and it was to these latter Mr. Brassey's remarks applied throughout. It must be said, however, for Mr. Smith that he admitted he had not had time to look up the history of the subject, and consequently we suppose he assumed that the scheme at present in force has been fully developed instead of its being, as it is in reality, only in its infancy.

Mr. Brassey urged that the chief constructors at the dockyards were the persons really responsible for the efficient management of the dockyards. "On the two cardinal points of cost and workmanship the constructors were solely responsible." He quoted a memorandum prepared by Sir Spencer Robinson for the Duke of Somerset's Committee on the Board of Admiralty, to show that the superintendent of a dockyard, the naval officer placed in authority over the chief constructor, is in no sense responsible for the quality or the cost of the work done in the dockyard. "He was the vehicle through which orders passed from the Admiralty to the heads of departments; but if a work which ought to have been done for 10,000*l*. cost 16,000*l*., he was not called upon to account for this excess. When a question was asked he directed the master shipwright to reply. All the naval superintendents who were examined by the Dockyard Commissioners in 1860 took a similar view of their position."

It should here be explained that the term "master shipwright" applies to the same officer as the term "chief constructor." The former is the old time-honoured name of the head of the shipbuilding department of the dockyard, and was well understood. The term "chief constructor" was applied only to the head of the Constructors' Department of the Admiralty. Both terms were clearly recognised and fairly applicable; but a few years ago, by the whim of somebody, the whole of the "master shipwrights" were changed to "chief constructors," and their assistants to constructors, and there are now in the dockyards, as well as in the Admiralty, a host of chief constructors and constructors, while a further grade of assistant constructors exists in the latter place, making altogether one of the most confusing and senseless arrangements of titles ever conceived and carried out in a great public department. We have never heard any reason assigned for this change, nor have we met any one able to suggest any advantage that could have been expected to arise from it. However, to return to our subject. Mr. Brassey gave further evidence from the inquiry held before the Megæra Commission to show that the naval superintendents of the dockyards, although occupying the highest positions, and drawing the largest salaries of any officers in the yards, are nevertheless not responsible for their efficient management. No argument could be more complete for their removal from such anomalous positions, and it is surprising to find Mr. Brassey almost in the same breath saying, "he wished distinctly to disclaim any desire to see the naval superintendents of dockyards superseded by civilians." Our own belief is that the naval superintendents of dockyards have, as a rule, a damaging and demoralising effect on those establishments, and that their removal is one of the most necessary steps if the professional staff is to be brought up to an adequate state of efficiency with a correspondingly improved status and social position. This, however, we propose to show more clearly hereafter.

Mr. Brassey next quoted the evidence of the late Mr. Oliver Lang, master shipwright of Chatham Dockyard, before the Dockyard Commission of 1860, to show the unsatisfactory social position of the dockyard officers. Mr. Lang said, "I do not object to a considerable infusion of the working class, and their being allowed to rise to the highest offices in the branch. I complain that the sons of gentlemen are shut out entirely."

This, however, is a piece of nonsense arising from mistaken pride, and quite unworthy to be perpetuated by Mr. Brassey. Mr. Lang meant that he could not make his own son, or a boy of equal position, a master shipwright without first putting him to learn to be a shipwright.

Mr. Lang himself is known to have had a good eye for the lines of a ship, and to have designed some beautiful models, but is not reputed for profound knowledge of the higher branches of his profession; and he probably regarded naval architecture as a heaven-born gift rather than a difficult profession requiring years of practical experience and scientific study. Any gentleman's son might at the present time, or in the time of Mr. Lang, enter the dockyards as a youth, and by the help of superior education and abilities reach the position occupied by Mr. Lang himself, or even higher, at a comparatively early age. What more could Mr. Lang require? It is no uncommon thing to see the sons of some of the largest and wealthiest shipbuilders in this country learning to work with their tools to qualify themselves for their future business, and without doing this in early life, and passing through the draughting office and other stages of the business, a shipbuilder, whether in private life or in the public service, must always remain more or less an amateur.

Mr. Brassey next gave the following quotation from the report of the Megæra Commission to show that the professional staff of the dockyards was not all that could be desired. "We feel compelled to remark that we have formed, however unwillingly, an unfavourable opinion as to the mode in which the administration of Her Majesty's dockyards is generally conducted. The officers appear to us too often to have done no more than each of them thought it was absolutely necessary to do, following a blind routine in the discharge of their duties, and acting almost as if it was their main object to avoid responsibility."

This was certainly a harsh judgment, and it was recognised pretty generally that some of the members of this particular commission were unnecessarily severe upon some of the best officers in the service. We shall show hereafter to what extent the above judgment needs qualification to make it adequately represent the present state of the dockyards. Throughout his speech Mr. Brassey speaks as a man who has carefully culled from the official blue-books to get up a case, but without really getting at the kernel of the subject.

Mr. E. J. Reed spoke with an intimate personal knowledge of the question and seconded Mr. Brassey in enforcing the claims of the professional officers, but in his anxiety to uphold the claims of his former colleagues he vastly overstated the case and did a manifest injustice to a much larger and equally able body of professional men, viz., the private shipbuilders and naval architects of the country.

The First Lord of the Admiralty, although not disposed to commit himself to rash promises, evidently looked with a favourable eye upon the case of professional officers as put by Mr. Brassey, and promised to look further into the matter. We hope he will do so, for on the one hand the professional officers have much to complain of that is not to be found in blue-books, and on the other hand the organisation of the professional staff is so defective in many respects that reform is urgently needed as well as amelioration. It was truly said in the House the other night that the Admiralty professional men have but few friends. They are indeed the Bulgarians of the Admiralty employ, a race only just rising out of servitude and oppression. From time out of mind they have been more or less sat upon. In the Admiralty itself, as in the dockyards, the constructors and their professional staff have for years had to do most of the work, while naval officers on the one hand, and clerks on the other, have been reaping most of the rewards and no small share of the credit. That this sort of thing is all wrong must be obvious, and it is pernicious in many ways. It not only perpetrates an injustice on the professional men, but it tends to deprive many of them of that tone and self-reliance which are necessary where great responsibilities have to be undertaken, while in others it engenders an air dissatisfied and defiant, equally undesirable and unbecoming. Moreover, it tends to demoralise the naval and clerical officials themselves by encouraging them to affect the ornamental rather than the useful, and to really believe that the routine of official redtapeism is higher and more important than the real work in hand.

Whatever may be the relative status of naval architects and marine engineers inside Her Majesty's service with men of the same professions in the mercantile world, there can be no doubt whatever that compared with other Government employés, such as clerks more especially, the professional men are either much underpaid, or the latter are much overpaid. We believe both errors exist to a large extent, and that a just rectification might be made without at all adding to the burdens of the public.

We believe that the present absurd inequalities date from a time when Government clerks were for the most part political nominees having influence in the House of Commons, while the professional officers were mechanical men of limited education. In the present day the professional officers are more highly educated than the clerks, and have their professional knowledge to boot, so that obviously their positions should be higher than those of the clerks, instead of being inferior to them. Somewhat similar reasons account for the subordination of the professional to the naval officers, and which contributes so much to the heartburnings and consequent inefficiency of the whole service.

To treat this subject at all adequately will require considerably more space than we can spare this week, but it is worth returning to, for it is one of much interest, and one that outside the Admiralty service is but little known or understood. We will therefore confine ourselves for the present to a few general observations, and reserve a more precise account of the growth of the present dockyard system and its results for a future occasion.

The principle on which the Admiralty have proceeded for many years in the Royal Dockyards has been to train their own technical officers from the lowest to the highest, like they train their naval officers, rather than to look outside of the service for a supply of shipbuilders or engineers whenever they might be required. In this respect they differ from mercantile establishments, who select the best men they can obtain from whatever source to fulfil the duties that may be required of them. There are advantages and disadvantages arising from both systems, and they should be carefully examined and weighed before the real position of Admiralty professional men can be realised, or can be placed on a proper footing. The great advantage of a Government training its own professional men is, of course, that the men are brought up in the ways of the service, they cling more to the service, are more amenable to discipline, and the qualifications of the different men become known to the higher authorities as they rise step by step in the dockyards or the Admiralty. The chief disadvantage is of course that men trained all their lives in this way have a tendency to settle down into grooves, which in course of years it is next to impossible to get them out of. However, the system of training their own officers, technical as well as executive, is followed in other countries, and is doubtless on the whole best, provided it is carried out properly.

Mr. Brassey said, "He would venture to urge that the Constructors of the Navy should be constituted as a distinct corps, like the Ingenieurs de la Marine, in France, and that we ought to have one or more naval architects in every dockyard capable of preparing competitive designs for new ships. In the French service, the work of the central office was limited to the specification of the qualities and the general features of the new ships which it was proposed to build. The programme having been prepared at head-quarters, the dockyards were invited to furnish competitive designs, and the most successful was selected. That plan insured a wide development of ideas, and prevented the shipbuilding of the Navy falling into a groove under the direction of a single mind."

Mr. Brassey here recognises in part the danger of getting into grooves, but he does not seem to realise the tendency which exists of a whole staff of officers trained in the same modes of thought cut off, as it were, from the outside world, and subject only occasionally to criticism of a general kind in the House of Commons, to get into grooves under the direction of precedents, service traditions, and such like influences as easily as under the direction of a single mind. Instead of urging that the Constructors of the Navy should be organised into a distinct corps, Mr. Brassey should rather urge that they be given greater opportunities of becoming acquainted with the private shipyards and engine factories of the country; and instead of seeking to confine competition in design between the royal dockyards, he should urge that the eminent private shipbuilders of the country should be more often consulted, or brought into competition with the Admiralty designers.

We have referred to Mr. E. J. Reed having eulogised the dockyard system and dockyard officers unduly at the expense of the private shipbuilders of the country. We will quote his words as reported the *Times*. "The officers of the dockyards were not open to the suspicion of being theoretical rather than practical men. He did not believe there was a more practical body of men in the country than the technical officers of the Admiralty and the royal dockyards. Nearly every man among them had begun his profession with apprenticeship, and had acquainted himself with the use of tools, and nearly every one had risen from an humble position to the position he now occupied." With all this we entirely agree, but Mr. Reed goes further than this, and says:

"What happened when a private yard wanted a manager? They came to the royal dockyards, and the men they got were those who had not been successful in the competition of the public service. The inference he drew was that the men in the royal dockyards were of the highest skill, both theoretically and practically, that could be found at present in the whole world."

Here Mr. Reed is entirely wrong in his facts, and consequently erroneous in his inferences. How many instances can he give of private yards going to a royal dockyard for a manager? The rule is entirely contrary to Mr. Reed's assertion, and the exceptions to the rule are very few, and have not ended happily. How Mr. Reed could have got such an idea in his head, or laboured under such a misconception, is astonishing. In spite of his own showing, that the vessels being designed and built in the royal dockyards possess every vice from unseaworthiness downwards, how could Mr. Reed think for a moment that private shipbuilders when they want a manager rush to the royal dockyards? Nevertheless the system of training given to professional officers in the royal dockyards is well worth study. Briefly stated the process is this:

The supply of workmen in the dockyards is kept up chiefly by the entry of apprentices at about the age of fourteen years. Each dockyard has its school and schoolmaster, and the apprentices for a certain number of years are bound to attend school at stated times, part of this time being in working hours and the remainder evenings. It is in fact a system of Government compulsory education, which existed long before the days of school boards. At these dockyard schools periodical examinations are held, common to all the yards, and prizes are distributed. This promotes emulation among the apprentices, and an additional stimulus to study is provided by the fact that those who distinguish themselves most in the dockyard schools and succeed in the competitive examinations have the chance of pursuing a still higher course of education at the Royal Naval College, Greenwich, similar to that formerly supplied at the Royal School of Naval Architecture, South Kensington, and at other still earlier establishments for the same purpose. These students are intended to fill eventually the higher professional positions in the dockyard and Admiralty.

Those who have been trained at Greenwich are for the most part yet in subordinate positions as we have stated, and nearly the whole of the higher positions in the dockyards are filled by men trained in the former schools and by men who, without the advantage of such a training, have gradually worked themselves up from grade to grade from the position of apprentices.

Each of these grades or steps has had to be fought for at a competitive examination, so that, as a rule, the tale of a dockyard officer's promotion, is saddened by a perpetual worry to pass his examination in algebra, geometry, and other subjects which it was well enough to test him in as a lad, but which are absurd as a test of his qualifications as a practical officer in middle life.

Few things indeed do more in the dockyards to vex the life and lower the tone of the officers than this perpetual necessity for keeping crammed up for competitive examinations; it is well known that many of the most efficient officers have given up all chance of promotion in despair and disgust rather than keep on going through examination after examination against an ever increasing flow of younger men comparatively fresh from school and of far less experience. And on the other hand men selected for the higher college training and read in higher mathemathics and the science of their professions, have afterwards to compete for years in elementary arithmetical examinations before they can get a step of advancement in the dockyards! But this opens up a wide field, that we must recur to on a future occasion.

THE RECENT GUNNERY EXPERIMENTS AT MEPPEN.

A SERIES of experiments were made last week at Meppen, in Hanover, on Krupp guns, with results which will not in any way serve to restore the reputation of Woolwich Arsenal, which was so seriously injured by the explosion of a 38-ton gun on board the Thunderer. On the contrary, as we will presently show by a comparative Table, our official gun-factory has been left hopelessly in the rear by a private firm, which turns out guns of all calibres, in comparison to which our service pieces are almost as antiquated as the old 68-pounders are to the armour-piercing weapons which replaced them.

A careful study of the Table on the opposite page will be found instructive, for Krupp's guns differ from our own in nearly every particular, in material of construction, in the manner of loading, in the nature of the rifling, and the rate of twist, in the proportions of powder to projectile—of calibre to length—of power developed to weight of gun, in short in no two particulars are the systems alike.

There were in all twelve guns experimented upon, varying in size from a piece of 15.75-in. calibre, weighing 72 tons, to a 3.78-in. field gun, weighing little more than 12 cwt., but of this number only five, viz.: the 15.75-in., a 14-in., a 9.45-in., a 4.13-in. and a 3.78-in. gun are of any interest for purposes of comparison with our own weapons. We have accordingly collated and tabulated all the figures of importance relating to these five guns and their performances, and also the corresponding data of those English service pieces which are nearest to them in weight and calibre.

The first point of interest which strikes the reader on looking over the Table is the enormous initial velocity attained by the Krupp guns, a result which has been achieved mainly by the use of immense charges of powder, long bores, and cartridges judiciously arranged to maintain the powder pressure till the projectile has nearly left the gun. In the case of one of these guns, viz., the 24 cm. or 9.45 in., the initial velocity reached to 1910 ft. per second, the corresponding energy was 8755 foot-tons, the penetrating figure, or energy per inch of shot's circumference was 294.8, and the figure of efficiency, or energy developed per ton weight of gun, was 486.4. Comparing this with our own service 9-in. and 10-in. guns the stride in advance is certainly amazing; but going further and comparing it with the 38-ton gun of the type mounted in the Thunderer, it will be seen that the Krupp weapon, which only weighs 18 tons, or less than half its rival, has an equal power of penetration, the energy per inch of shot's circumference being 294.8 foot-tons, as against 296.5 in the case of the 38-ton gun. As a matter of fact, during the trials at Meppen the steel shell fired from the Krupp gun pierced a target consisting of a 12-in. and an 8-in. plate separated by 2-in. of pine planking; in all 20-in. of iron, and after penetration had sufficient energy remaining to enable it to travel over a mile on the other side. The advance here indicated has an especially important bearing upon naval armaments, the reduced weight of gun necessary to secure a given penetration enabling great modifications to be made in ironclad construction, while if the present weight of guns be retained, the increased penetration obtainable renders practically useless thicknesses of armour upon which reliance has hitherto been placed.

Another gun which is well worthy of special mention is the 3.75-in. field-piece weighing a little over 12 cwt., and firing a shell of 27 lb. with a 6.5 lb. charge. The superiority of this weapon over our own 12 cwt. or 16-pounder field gun is very marked; the weights of shell are as 27 lb. to 16 lb., and the energies developed as 405 to 200 foot-tons, or rather

DESIGNATION OF GUN.	Dimensions.			Rifling.					Ammunition.				Performance.				MISCELLANEOUS REMARKS.
	Weight in Tons.	Length of Bore in Feet.	Calibre in Inches.	System.	Number of Grooves.	Width of Grooves.	Depth of Grooves.	Rate of Twist.	Nature of Projectile.	Weight of Projectile.	Nature of Powder Charge.	Weight of Powder Charge.	Initial Velocity in Feet per Second.	Initial Energy in Foot-Tons.	Energy per Inch of Shot's Circumference.	Energy per Ton's Weight of Gun.	
80-ton Woolwich ...	80	24	16	Woolwich gaining twist	...	...	...	...	Palliser with studs	lb. 1700	Cubical powder of 1½ in. side	lb. 370	1520	27,213	541	340	
40-centimetre Krupp...	72	28.5	15.75	Polygroove uniform twist	90	mm. 9.45	mm. 2	1 in 45	Chilled shell with copper base ring	1711	Hexagonal prisms perforated	452	1648	32,271	652	448.2	Gas pressure 19.85 tons per square inch.
38-ton Woolwich ...	38	16.6	12.5	Woolwich gaining twist	9	in. 1.5	in. 0.2	From 0 to 1 in 35	Palliser with studs	800	Cubical as above	130	1451	11,676	296.5	307	
35-cm. Krupp	52	25.4	14	Polygroove uniform twist	80	...	mm. 2	1 in 45	Chilled shell with copper base ring	1155	Hexagonal as above	243	1627	21,235	483	408	
18-ton Woolwich ...	18	12.2	10	Woolwich gaining twist	7	in. 1.5	in. 0.2	From 0 to 1 in 45	Palliser with studs	399	Pebble	70	1364	5160	164	286.6	
12-ton Woolwich ...	12	10.4	9	Ditto	6	1.5	0.18	Ditto	Ditto	248	Ditto	50	1420	3496	123.5	291.3	
24-cm. Krupp	18	17.7	9.45	Polygroove uniform	54	...	mm. 1.5	1 in 45	Steel shell with copper base ring	352	Hexagonal as above	165	1910	8755	294.8	486.4	This gun pierced through a 12 in. and an 8 in. plate of iron separated by 2 in. pine, and travelled on over a mile.
16-pounder Woolwich	cwt. 12	5.66	3.6	Woolwich uniform	3	in. 0.8	in. 0.11	1 in 30	Common shell with studs	16	Rifle large grain	3	1355	200	...	333	
9.6-centimetre Krupp...	12.26	7.41	3.78	Polygroove uniform	32	mm. 6.4	mm. 1	1 in 25	Common shell with copper base ring	27	Coarse grained	6½	1485	405	...	647	Gas pressure 13.8 tons.
40-pounder Armstrong	cw. 35	8.94	4.75	Polygroove uniform	56	in. .166	in. .06	1 in 36.5	Common shell lead coated	41	Rifle large grain	5	1181	378	...	216	
10.5-centimetre Krupp	20.4	8.44	4.13	Ditto	32	mm. 6.8	mm. 1.25	1 in 25	Common shell with copper base ring	35.3	Coarse grained	11					

more than 2 to 1. It may safely be said that our own field artillery could not live in the face of the fire from these guns. It is, however, understood that the War Office has been for some time alive to our deficiencies in this respect, and that our field batteries are to be re-armed with new weapons which embody every improvement; it would be well if the military authorities could allay the public alarm by publishing the results obtained with the experimental battery, which we understand has been for some time under trial.

Of the remaining guns, not referred to in the Table, two embody somewhat novel features. One of these is a muzzle pivoting gun of 6.7 in. calibre, and rifled with 36 grooves having a uniform twist of one turn in 45 calibres. The muzzle of this gun is formed in the shape of a portion of a sphere, and works in a universal joint formed in an armour-plate. The embrasure is consequently but little larger than the bore of the gun. To prevent the gun from jamming in its joint if struck by a hostile shell an external shield is provided which is furnished with a counterpoise and levers for raising and lowering it. This shield covers the whole region of the embrasure when the gun is not being fired. Recoil is of course impossible.

The second novelty referred to is a boat gun mounted on a vertical pivot, about which it can describe a complete circle. It is 3½ in. in calibre, and 14 ft. in length. It is rifled with 24 grooves, having a twist of one turn in 30 calibres. The powder charge weighs 15 lb. and the shell 22 lb. In the case of this gun, also, recoil is impossible, though in later examples provision has been made for a recoil of a few inches. The central pivot is of course fixed to some specially prepared beam or beams in the ship.

The trials throughout were principally to test accuracy and velocity, and in some cases also the range of the various guns. The accuracy attained was in all cases most remarkable. At a range of 2700 yards the 40-centimetre gun put eight shots into an area bounded by a parallelogram 68 in. by 19 in., *i.e.*, the extreme lateral deviation was only 34 in., and the extreme vertical 9½ in. At the enormous range of 10,300 yards the 10.5-centimetre field gun dropped 10 shells upon an area 40 yards wide, measured across the range, and 800 yards long, measured in the direction of the range; but of these 5 or 50 per cent. fell within an area measuring 18×44 yards. Very few shots were fired at armour plates, nor was this necessary, for in the present state of science if the energy of a projectile is known, its penetration into all ordinary descriptions of armour can be predicted with accuracy. All the guns experimented upon were steel breechloaders, the breech-closing apparatus being on the well-known Broadwell system. It is understood to have given the greatest satisfaction, no escape of gases to the rear having been observable throughout the whole trials. After the recent explosion of a 9-in. Krupp gun, on board the German gunnery ship Renown, the breech piece was found to have been absolutely uninjured. It would be difficult to conceive of a more severe trial.

It must not be supposed that the good performances of these guns is in any way due to the metal of which they are made, for in spite of the enormous charges used, the powder pressures were low throughout, and never exceeded 20 tons on the square inch. Wrought-iron tubes, in cast-iron cases, on the Palliser principle, as adopted by the United States Navy, would have stood the test equally well, and would not have cost half the money. The real merit is due to the judicious arrangement of cartridge, and the length of bore, which enable the powder gases to act with sustained pressure on the projectile during a considerable space.

It is satisfactory to know that our own private manufacturers have not been left in the lurch, for Sir W. Armstrong attained equally good, if not better results, a year ago with a 6-in. gun, and lately also with the 11-in. guns supplied to the Chinese Government.

But now the question forces itself upon us, how is it that Woolwich Arsenal, supported as it is by the wealth of the nation, has been left hopelessly behind? We fear the answer is that artillery officers, no matter how competent they may be in the fulfilment of their military duties, cannot be expected to manage one of the largest mechanical engineering establishments in the country, nor can they be expected to understand thoroughly the nature, the application, and the manufacture of materials, nor the proper applications of the laws of force to the motion of matter, unless they have undergone a special education for this purpose, and above all, have had lengthy practical experience. We might with equal reason expect the Chief Constructor of the Navy to take command of the Channel Squadron, or Sir Joseph Whitworth to command a brigade of artillery in action, as an artillery officer to design and manufacture guns, and to superintend the mechanical arrangements of a large arsenal.

Bury Local Government Board Inquiry.—Mr. John Thornhill Harrison, C.E., attended at the Council Chamber, Bury, on Friday, the 25th July, for the purpose of inquiring into the subject matter of the application of the Town Council to borrow the sum of 40,000*l*. for sewerage purposes. Mr. F. Bull, town clerk, said the population of the borough was 50,000, the rateable value 214,651*l*., the expenses of the construction of all sewers must be borne by the sewer rate, which amounts at the present time to 6d. in the pound, which would raise a sum equal to payment of principal and interest in 30 years of the amount now proposed to borrow. Mr. J. Cartwright, C.E., the borough surveyor, produced the plans, duplicates of which had been deposited with the Local Government Board, and described the scheme upon which the application had been based as follows: first, sewers for new streets, second, intercepting sewers, of which there were two, one along the valley of the Roach, the other along the valley of the Irwell, which sewers when completed would convey the whole of the sewage of the borough to one point. The former part of the scheme embraced sewers for new streets, of which there were some 10¼ miles, the estimated cost of which was 11,830*l*., being after the rate of 651*l*. 6s. per mile, to which must be added for manholes, ventilators, and street gullies a further sum of 3812*l*. 10s., making a total of 15,702*l*. 10s. The second division, the intercepting sewers, embraced over five miles of brick sewers varying in size from 3 ft. by 2 ft. to 4 ft. by 2 ft. 8 in.; the estimated cost including manholes, ventilators &c., was 30,148*l*. 15s. The sewers are designed to convey the sewage from double the present population, together with a rainfall of ¼ in. in 24 hours; the average velocity of the flow of the sewage would equal 4½ ft. per second. Storm overflows would be provided principally at the present outlets, which would convey the heavy rainfalls direct into the river, the natural brooks, of which there were several, would also be allowed to flow as now into the river. The land at the outfall was suitable for sewage purification, both as to site, levels, and nature of soil. The inspector observed that no provision was made in the estimate for sewage purification nor purchase of land, and that under these circumstances he did not think the Local Government Board would sanction the loan applied for. Mr. Cartwright urged upon the attention of the inspector the desirability of the Board granting the loan of 15,000*l*. for new streets, inasmuch as the sewage from them would ultimately be taken into any system of interception that might afterwards be adopted. The inspector again intimated that the Local Government Board would not be favourable to the grant of 15,000*l*. unless the Corporation showed their determination to proceed with some system of purification at the outfall. Mr. Harrison, in company with the borough surveyor, then proceeded to view the proposed site for sewage works, and expresed his approval of the choice.

BOILER-DRILLING MACHINE.

CONSTRUCTED BY MESSRS. G. AND A. HARVEY, ENGINEERS, GLASGOW.

FIG. 1.

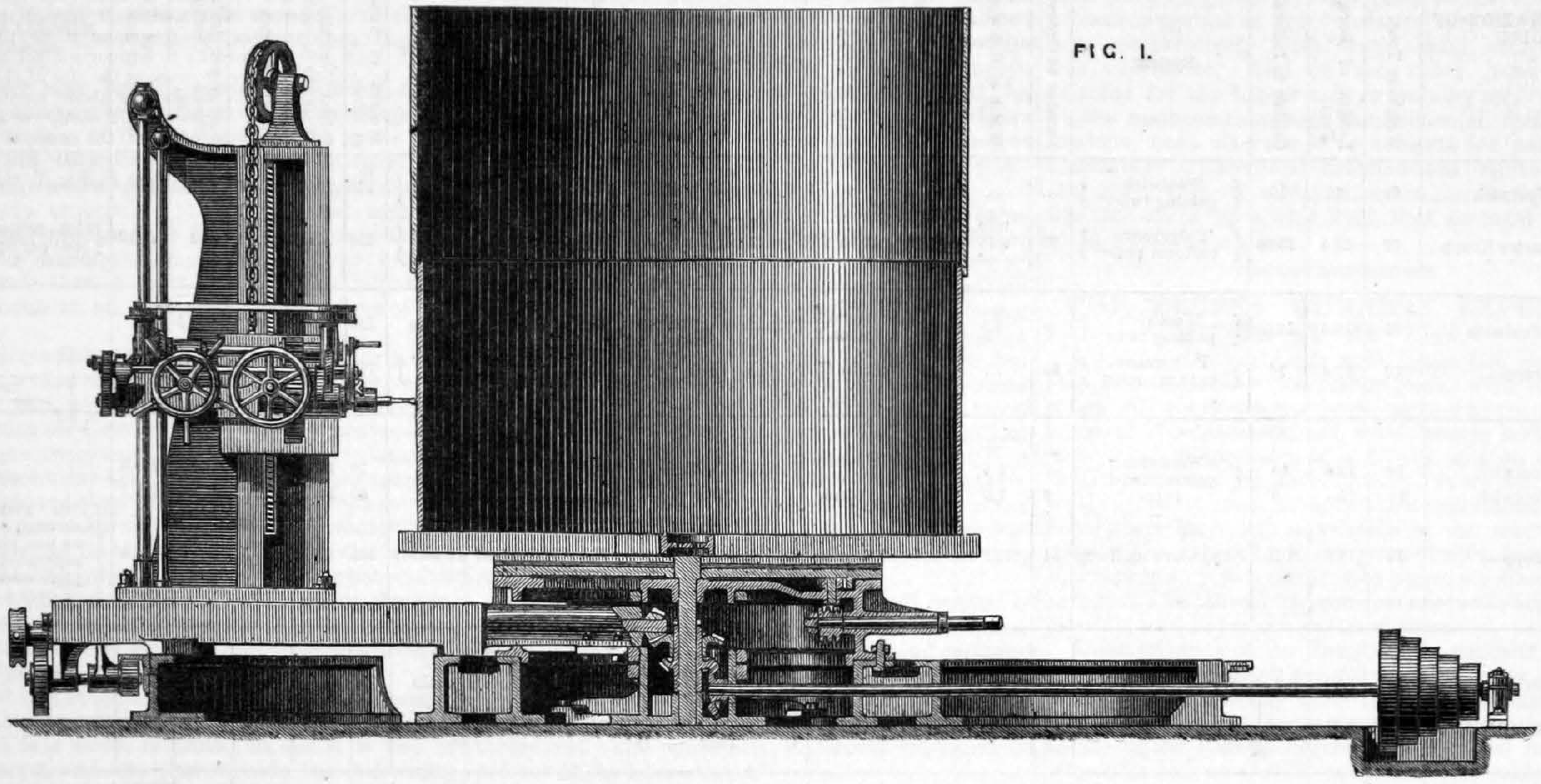
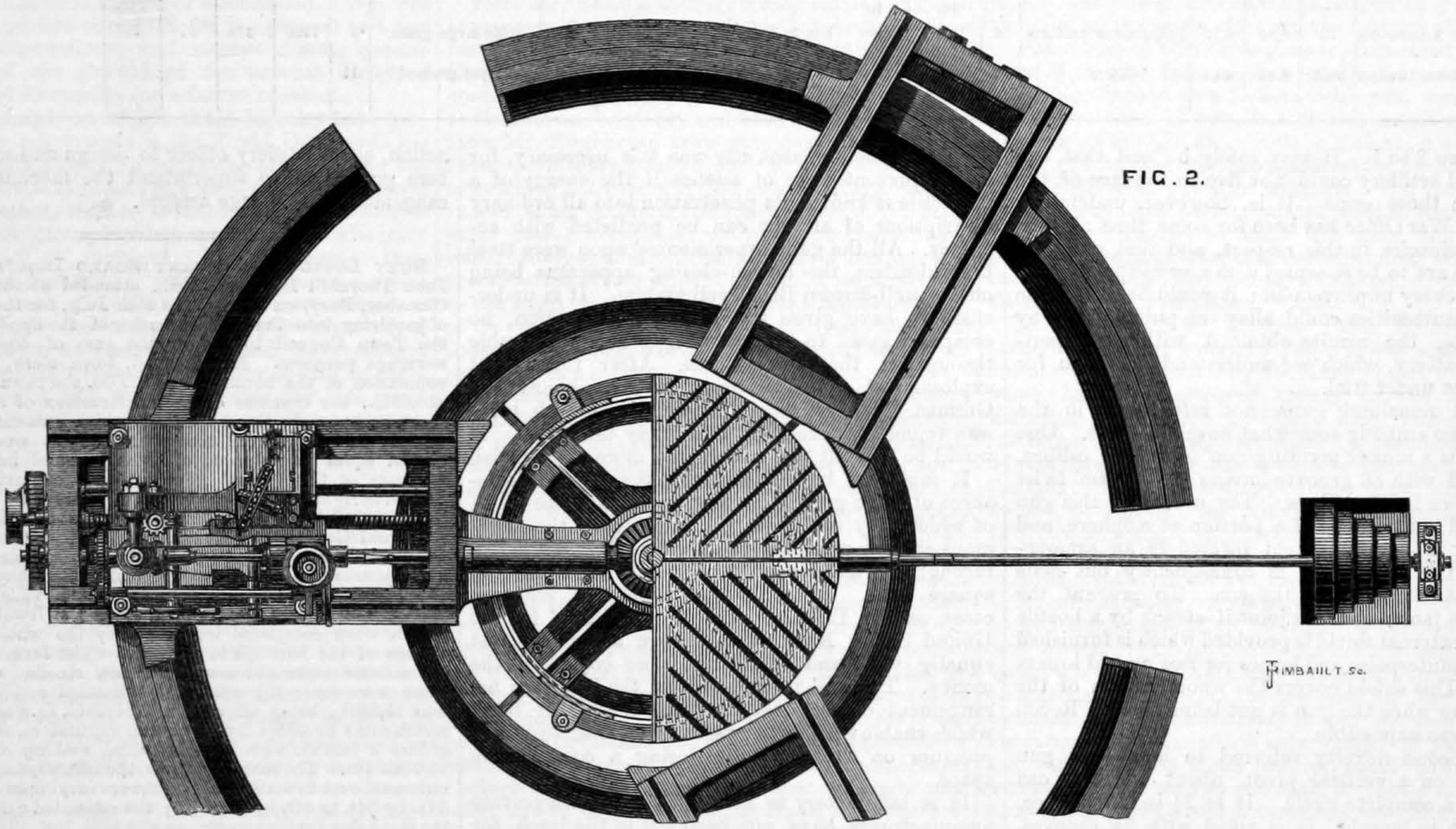


FIG. 2.



We annex engravings of a boiler-drilling machine, designed and recently constructed by Messrs. G. and A. Harvey, of the Albion Machine Works, Glasgow, this machine embodying some special features. As will be seen from our illustrations the machine is mounted on a double annular baseplate or double annular rail, as it is termed by the makers, there being fixed outside this three segmental outer rails fitted with racks. On these segmental rails and the outer flange of the inner annular rail are mounted three radial bottom frames, each of which is clasped to a central bearing, and carries a standard with a boring saddle or headstock. The spindles of the three headstocks are driven from a central bevel wheel through the shafts shown in our engravings, the arrangement being such that the three pinions which gear into the central wheel cannot come into contact in any position. The boiler to be drilled is carried, as shown, by a central circular table, gear being provided for conveniently turning the table when required.

In working the machine it is intended that each drilling headstock shall drill one-sixth of the circumference of the boiler, the three thus finishing one-half of a ring seam. When this has been done the table carrying the boiler is revolved one-sixth, bringing the other parts of the seam in the position to be operated upon. The headstocks have, as will be seen, a vertical traverse on their standards for drilling longitudinal seams, and the whole arrangement is very convenient.

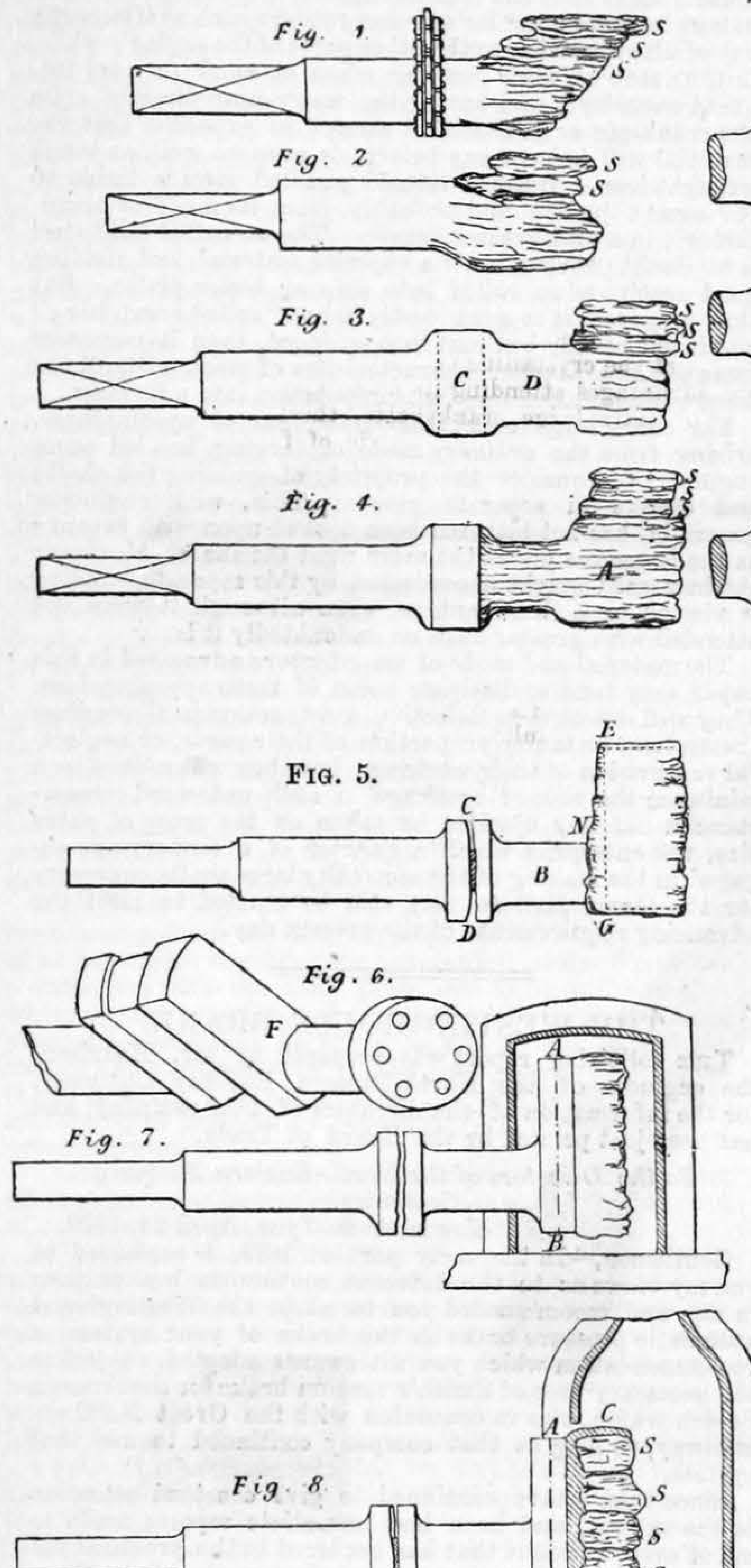
STEAM CRANE WITH SELF-ACTING BUCKET.

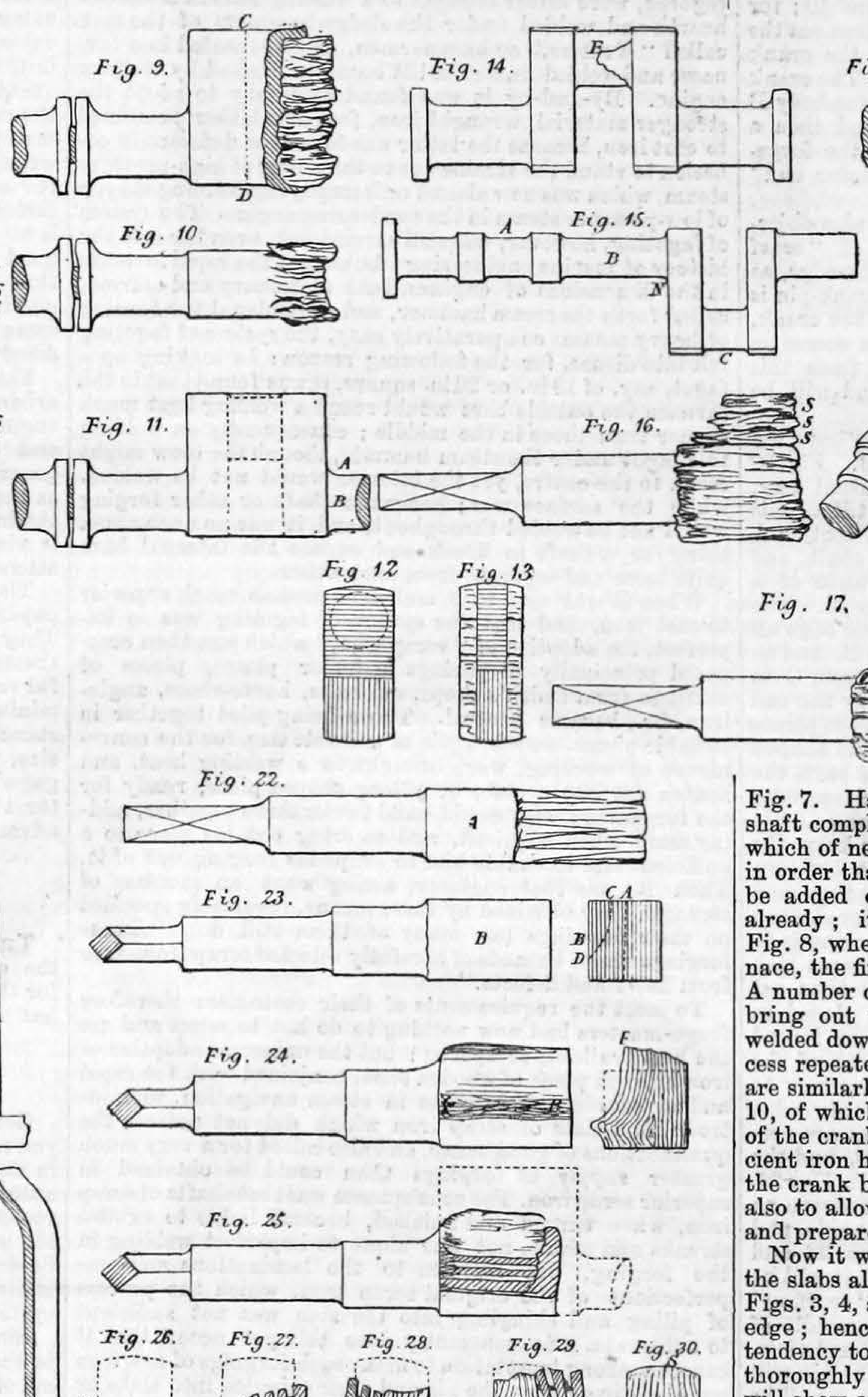
We give this week on page 129 an engraving of the steam crane with self-acting bucket and grab which was exhibited by Messrs. Priestman Brothers, of Hull, at the recent show of the Royal Agricultural Society at Kilburn. In our engravings, Fig. 1 is a general elevation of the crane with the grab suspended from it, and Fig. 2 a front view of the grab, while Figs. 3 and 4 are views of the self-acting bucket by which the grab can be replaced. The self-acting grab is used for raising stones and similar bodies, which can be effectually held by its arms, while the bucket is employed when soft materials have to be dealt with. The mode of closing the bucket is identical with that of closing the grab, and our description of the arrangement will thus apply to each.

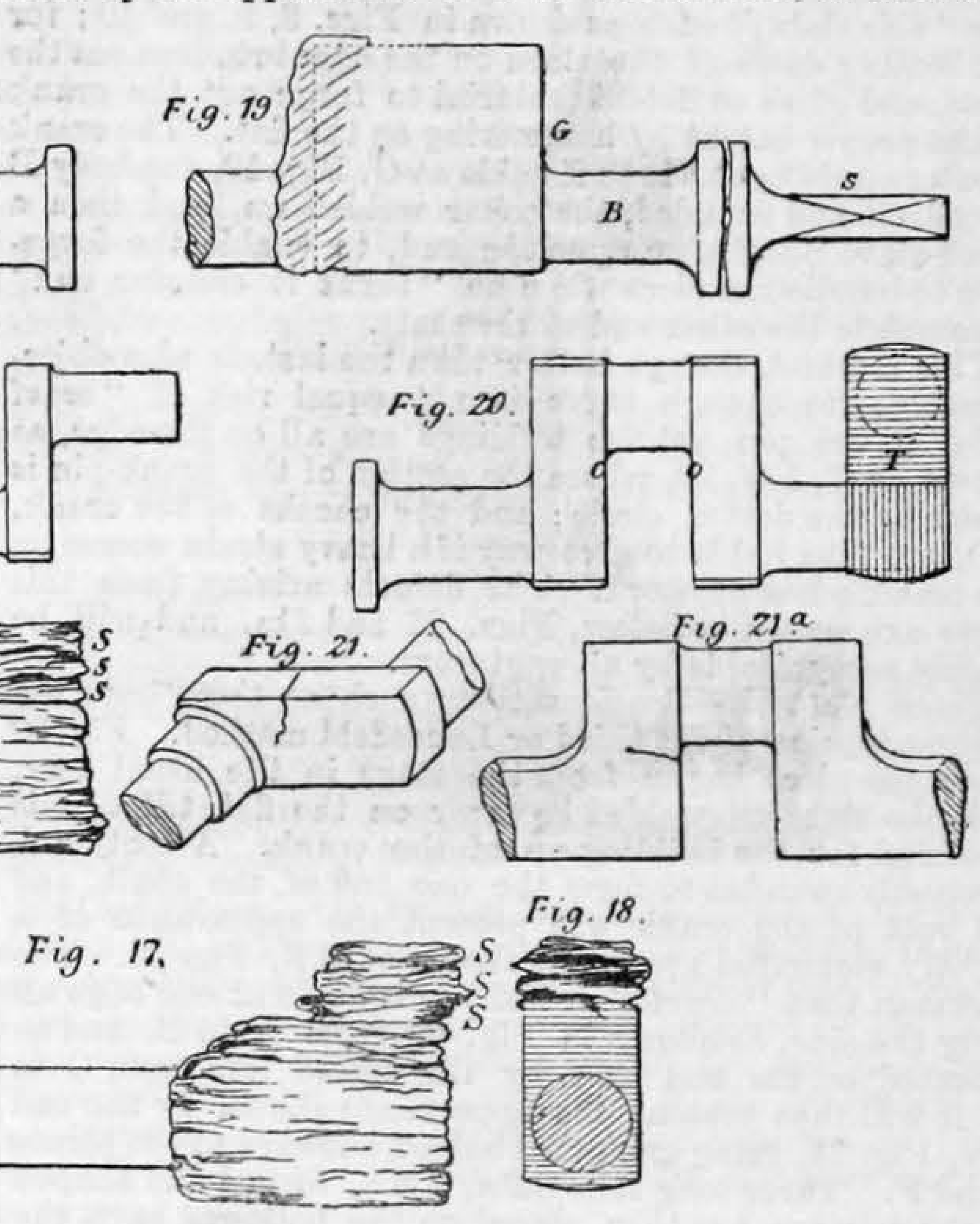
Referring to our engravings it will be seen that two chains are employed, one, the lifting chain, being led from the drum *a* over the pulley at the head of the jib in the usual way, and attached to a drum *b* (see Fig. 3) mounted on the frame attached to the grab or bucket. Cast in one with the drum *b* are two smaller drums *c c*, on which chains are wound in the contrary direction to that in which the chain first mentioned is wound on the drum *b*. The chains for the drums *c c* are led upwards and attached to the crossbar *d*, the ends of which slide on the frame *e*, *e* and which has hinged to it the links by which the two parts of the bucket are forced together. As will be seen from an inspection of our engraving, the arrangement is such that the hauling down of the bar *d* towards the drums *c c* closes the bucket or grab.

To the centre of the bar *d* is attached another chain, which is led up over a pulley at the head of the crane jib, and then down to the drum *f*, around which it passes to the guide pulley *h*, and then up to and around the pulleys *i i*, the lower of which carries a heavy weight *k* capable of rising and falling, but suitably guided. On the same shaft as the drum *f* is a brake pulley, as shown.

The action of the arrangement which we have described is as follows: Supposing the grab or bucket to be in its highest position, the chain passing from the drum *a* is left slack, and the weight of the apparatus sustained by the chain coupled to the centre of the bar *d*, this chain being held by the brake on the shaft of the drum *f*. Under these circumstances the crossbar *d* is, of course, kept near the top of the frame *e e*, and hence the jaws of the bucket or grab are fully open. The bucket or grab is then lowered at any desired rate by manipulating the brake controlling the drum *f*. When it has arrived at the bottom of its course, and is in a position for taking hold of the material to be raised, the friction wheel which drives the drum *a* is put into gear, and the engines being started a strain is put on the chain leading to the drum *b*. The first effect of this is to uncoil the chain from this drum, causing the latter to rotate, and







so making the drums *c c* wind up the chain and haul down the bar *d*. In this way the jaws of the bucket or grab are closed, and when this has been done, the drum *b* being no longer able to rotate, the chain on which the engines are hauling lifts the whole apparatus. During the lift the brake on the shaft of the drum *f* is released, and a counterweight attached to the lever pulley *i* then causes the stalk of the chain to be taken in as the bucket rises. When the full lift has been made, the chain attached to the crossbar *d* is held by the brake, the chain drum *a* set free, and the load being thus transferred to the bar *d*, the frame *e e* slides down, opening the bucket or grab, and depositing the material which has been raised.

The operations here explained are somewhat lengthy to describe, but in practice they are performed very rapidly, and at Kilburn the whole apparatus worked admirably. By means of a lever acting on an eccentric bearing, the large friction wheel on the shaft of the drum *a* can be readily thrown out of gear with the pinion which drives it, and the engine can be used for slewing or travelling the crane in the ordinary way. The whole arrangement is a very handy one.

GREAT NORTHERN TELEGRAPH COMPANY. — The number of telegrams forwarded by the Great Northern Telegraph Company in the first seven months of this year was 483,258, as compared with 493,453 in the first seven months of 1878. The company's revenue presented a falling off of 1766*l*. this year.

FORGING CRANKSHAFTS.*

By MR. W. L. E. MCLEAN, of Glasgow.

THE following paper describes the method of forging marine crankshafts adopted at the Lancefield Forge, Glasgow. It will be better understood if a short account is first given of the ordinary methods in use for the same purpose.

First Method.—The most common method is technically termed by the forgeman "finishing the piece before him." He begins with a staff or stave, as shown in Fig. 1, suspended by a chain from the crane, and made round for the convenience of manipulating under the steam hammer; this stave is used over and over again for many forgings, as it is merely the "porter" to carry the piece, and enable it to be worked. The forging is begun by two or three slabs being placed on the stave as at S S S, and then inserted in the furnace. These slabs are flat blocks made up of pieces of scrap iron, which have been piled and heated, and then welded together. After being brought to a welding heat in the furnace, the slabs are withdrawn, placed under the steam hammer, and beat down solid. The piece is then turned upside down, and two or three similar slabs placed on the opposite side, as shown at S S, Fig. 2. When sufficient iron has been thus added to form the collar of the shaft (assuming it is to have a collar), it is rounded under the hammer, as at C, Fig. 3, and the body of the shaft next to the collar is roughly formed, as at D. More slabs S S S are added to bring out the body, and afterwards the crank itself is proceeded with, as at E, Fig. 3. The piece will begin to assume the appearance of A, Fig. 4. Then more slabs are welded on the top, as at S S S, Fig. 4, till the depth of the crank is obtained, after which the forgeman proceeds to finish the collar and body of the shaft, as shown in Fig. 5. The collar on being finished is cut all round, as shown at C D, so that it may be more easily detached from the stave when the shaft is completed, leaving only sufficient connexion to carry it till then. The forgeman then cuts the gable of the crank as at E G, and rounds up the body and neck as at B N.

This it will be observed is a speedy process, and would invariably be adopted if it were not attended with a very serious drawback; it is very hazardous to the solidity of the forging. For it will be easily understood that not above a third of the crank itself can be thus formed, because the iron at the neck N would not carry a greater mass; if the whole mass of the crank, or even the half of it, was formed before the body and neck of the shaft were finished, a proper heat could not be taken on the body and neck for finishing, without the neck giving way or rupturing. Indeed, as it is, the undue proportion often causes the shaft to be strained at this part, where most strength should be, so that it is rendered weak, and a flaw is developed which by-and-by causes it to be removed from the steamer as dangerous and useless, if indeed it does not break outright; so that the forgeman if he adopts this method, must be very careful to proportion the amount of iron he has massed in the furnace to the size of the body he is finishing, otherwise the weakening above mentioned will take place. All marine engineers will easily recognise this defect, which frequently occurs, but the cause of which is probably not well understood. Such a flaw will present a similar appearance to that shown at F, Fig. 6, taken from an actual example.

This difficulty of proportioning the part of the crank first forged to the size of the neck, will be still better understood by the appearance of it in the furnace, as shown in Fig. 7. Having reached this stage, with one end of the shaft completed, as also that portion of the crank itself which of necessity was completed before the collar was cut, in order that the neck might be finished, no more iron can be added on the top edge, as it is up to the full depth already; it must therefore be added on the flat, as in Fig. 8, where the piece is shown on its flat side in the furnace, the finished portion being outside the furnace door. A number of slabs S S S are then placed side by side to bring out the width of the crank further; these being welded down, the piece is turned upside down, and the process repeated on the other side. Afterwards other slabs are similarly placed on both sides, as shown in Figs. 9 and 10, of which one is the flat, and the other is the edge view of the crank at this stage; and this is continued till sufficient iron has been massed to allow of the other gable of the crank being cut down, as at A, Fig. 11, and sufficient also to allow of the other part of the body B being rounded and prepared for further piecing out.

Now it will be observed that the first gable finished has the slabs all welded on the edge of the crank, as shown in Figs. 3, 4, and 5, and the hammering has all been on the edge; hence the subsequent hammering on the flat has a tendency to open up the weldings, if they have not been thoroughly made. A section taken at A B, Figs. 7 and 8, will show as in Fig. 12, the weldings being across the web of the crank; the circle indicates the section which the crank-pin would present if cut through there. But when the slabs are placed on the flat afterwards, some of the joinings of the ends of the slabs, or "scarf ends," are certain to fall within the crank-pin, as seen in Figs. 8, 9, and 10; therefore the section through C D, Figs. 8 and 9, will show somewhat like Fig. 13, where the circle indicates the position of the crank-pin. The flaw thus produced, called "a scarf end in the pin," is readily recognisable by all marine engineers; at E, Fig. 14, is a sketch from an actual occurence.

When the second gable is cut, and the other end is rounded, there is only the other collar to put on (if a double-collared shaft), and the forging is completed.

This method is so speedy as compared with any other, that it is often resorted to even at the risk of making a bad forging; and too many broken shafts testify to the fact. Besides, it may be observed that in making a double crankshaft, while the one crank may be made in this way, the other must; for, the first crank A (Fig. 15) being completed, and the body B, between the two cranks, also completed, the second crank C must of necessity be pieced off this body, even at the risk of the neck N being strained. This may account for the many instances in which one of the cranks of a double crankshaft gives way, rendering the shaft useless; and also for the plan now almost universal of making the two cranks separately and coupling them together; a further object being, no doubt, to have the means of replacing a defective half, if need be, without losing the whole shaft. At Lancefield, when a double crankshaft is to be made, the after crank A is first made by the method afterwards described, so as to insure that this crank, through which, as being next the propeller, all the power of the engine passes, is perfectly sound; and in piecing the other crank off the body, it is worked with slabs on the flat instead of on the edge, as afterwards described.

The writer's own opinion is that the crank is the most

* Paper read at the Glasgow Meeting of the Institution of Mechanical Engineers.

important part of the shaft, and therefore, at all costs, should be made first. Others, no doubt, may take the same view, and to avoid the risks just mentioned may adopt the following method.

Second Method.—This method builds the middle first, and is called "turning the shaft end for end." The shaft is begun from a stave, by the addition of slabs, as shown in Figs. 1 and 2. Fig. 16 shows it with iron added in slabs, till a butt is formed as at B, to form the nucleus of the crank; slabs S S S are then piled on it to bring the crank up to the height. These are beaten down, and welded, and more are added, as at S S S, Fig. 17, till the full height of the crank is reached. Should the web (or edgeway of the crank) be thick, two slabs are frequently used to make up the breadth, placed edge to edge, as shown in Fig. 18; the width of these slabs being limited by that at which the shinglers can conveniently work and turn them under the steam hammer. The crank however is completed without any "side slabs," such as shown in Figs. 8, 9, and 10; for the beating down of the slabs on the edge broadens out the mass, and gives sufficient material to forge out the crank to the proper height by hammering on the flat. The crank is afterwards cut at the off gable at G, Fig. 19, the body B pieced out and rounded, the collar welded on, and then a small stave S is drawn upon the end, to enable the forgeman to handle the piece when he "turns it end for end" to complete the other end of the shaft.

This method, though better than the last, is also objectionable; for though there is not equal risk of "scarf ends" in the pin, yet the weldings are all on the edge, as shown at T, Fig. 20, where the section of the crank-pin is shown by the dotted circle; and the cheeks of the crank, O O, are thus liable to give way if a heavy strain comes on the crank when at work. The defects arising from this cause are shown as below, Figs. 21 and 21a, and will be readily recognisable by all engineers.

Third Method.—Considerations such as these have led to the adoption of the third or Lancefield method. Fig. 22 shows the piece begun from the stave in the usual way, with the slabs all welded however on the flat, till a basis is formed for the building up of the crank. A portion A is roughly rounded to form the one end of the shaft, and the butt of the crank will present the appearance of a slightly elongated square, as shown at B B, Fig. 23. The workman then "scarfs" or hollows it down at one edge all along the side, as shown in Fig. 24 from A to B, and as indicated on the end view by the dotted line from C to D; it will then present the appearance shown by the end view, Fig. 24, being somewhat bulged outward at the points E and F. Three long thin slabs, S S S, forged and shaped for the purpose, are then placed on the hollowed part, the piece lying flat in the furnace. These slabs are tapered a little the breadth way, not on the length, and little pieces of iron are interposed between them, to keep the surfaces apart, and allow the flame free access between them. The object of making them thin is that they may be all equally heated, which is not so readily achieved when the slabs are thick; and the object of the tapering is to allow the slag to flow out freely when the uppermost slab is struck by the steam hammer. The surfaces thus get solidly welded. Fig. 25 presents the slabs thus placed in elevation, and Fig. 26 in section. The slabs are forged long enough to go right across the whole width of the crank, excepting about 6 in.; this margin is necessary to allow of the lengthening out of the slabs to the whole width under the process of forging. After these slabs are perfectly welded, the piece is turned upside down, and the process is repeated on the other side, as shown in Fig. 27. When welded down the mass has increased in depth as well. Another scarfing takes place on the first side, and then another on the second side, as shown in Figs. 28 and 29, and so on, till the full size is obtained; and it will be seen, as in Fig. 30, that by this process of "scarfing" equally from both sides, the iron from the very middle of the body of the shaft (originally as at H I in the end view, Fig. 23), is drawn up quite to the crank-pin. The pin will show in section as the dotted line, Fig. 30, and it will be seen that by no possibility can there be a "scarf end" in the crank-pin, as the slabs in all cases go right across the crank, and also that the cheeks of the cranks have no edge weldings crossing them, as in the previous cases; for the tail of a slab may be at R, while the other end may be at S (Fig. 30). The fibre is also developed by the continuous drawing up of the iron consequent upon the repeated flat scarfings across the whole width of the crank. When the crank has been thus massed sufficiently large, it is cut at the gable, with sufficient material left to piece out the other body of the shaft. This is now done, the coupling welded on, and a small stave drawn on the end to enable the forgeman to manipulate it, when it is turned end for end, to complete the other end, as shown already in Fig. 19.

These proceedings occupy longer time than either of the other two methods, and consequently cost a little more; but the advantage is well worth all the difference, as greater confidence can be entertained that the forging is every way satisfactory. In brief, by making the crank first, is avoided the liability to weakness at the neck, characteristic of the forgeman's making the shaft before him, as in the first method: by the repeated "side scarfings" is avoided the liability to fracture across the cheeks, consequent upon the edge weldings of both first and second methods; while by having the slabs the whole length of the width of the crank any "scarf end" in the length way of the crank-pin is impossible (such as may occur in the first method); and the welding of the mass of the crank being wholly on the flat must tend to form a more solid forging than if hammered otherwise. Thus, if the forging is well heated and properly hammered, the system promises to insure that no weak part will be found in the shaft after it is finished and put to work. The writer believes, from the success which has already followed in every case the adoption of this method, that it will eventually be found that almost more depends on the mode in which a crankshaft forging is constructed than on the material of which it is made.

This leads him to some observations regarding the material for such shafts. It is of course well known that in the early days of engineering, before the time when steam navigation had received its great impetus by the invention of the screw propeller, the connecting rods, cranks, shafts, &c., of land engines were all formed of cast iron; except indeed where the connecting rods were made of wood, strapped with plates of wrought iron, as frequently was the case with pumping, winding, and blowing engines. In fact all the parts that could be made of cast iron were so made, and the piston rods, bolts, keys, straps, and other smaller parts were alone made of malleable iron, the smaller pieces being made from rolled bars direct, as at present, and the larger made of similar bars, but placed side by side and bound together or "fagoted," as they were called, from their resemblance to a bundle of fagots. These bars, thus fagoted, were either brought to a welding heat in a smith's hearth and welded under the sledge-hammers of the men called "strikers," or hammermen, or else heated in a furnace, and welded under the tilt hammer worked by a steam engine. By-and-by it was found necessary to adopt the stronger material, wrought iron, for parts hitherto confined to cast iron, because the latter was found too deficient in cohesion to stand the strains due to the power of high-pressure steam, which was now almost universally superseding the use of low-pressure steam in the condensing engine. The system of fagoting, however, was still carried out, even far into the history of marine engineering; but when the rapid increase in the dimensions of engines, both stationary and marine, called forth the steam hammer, and so rendered the forging of heavy masses comparatively easy, the system of fagoting fell into disuse, for the following reason: In making up a fagot, say, of 18 in. or 20 in. square, it was found that in the furnace the outside bars would reach a welding heat much sooner than those in the middle; consequently on welding this fagot under the steam hammer, though the blow might reach to the centre, yet the interior would not be welded, while the surface was; hence the shaft or other forging would not be welded throughout, and it was no uncommon thing for a shaft to break and expose the internal bars quite loose and separate from each other.

When it was seen that malleable was so much superior to cast iron, and that the system of fagoting was so imperfect, the adoption of "scrap iron," which was then composed principally of parings of boiler plates, pieces of cuttings from smith's shops, old bolts, horse-shoes, angle-iron, &c., became general. These being piled together in suitable pieces, and in a pile of suitable size, for the convenience of working, were brought to a welding heat, and beaten out into a slab, or oblong-shaped piece, ready for the forgeman; who would build two or three together, adding more when required, and so bring out his piece to a sufficient size to enable him to shape his forging out of it. Then it was that engineer, seeing what an increase of strength they obtained by these means, invariably specified on their drawings (as many of them still do), "These forgings are to be made of carefully selected scrap iron, free from flaws and defects."

To meet the requirements of their customers therefore forge-masters had now nothing to do but to select and use the best available scrap iron; but the universal adoption of iron hulls in place of wooden ones, conjoined with the rapid and unprecedented increase in steam navigation, soon introduced a class of scrap iron which did not possess the qualifications of good scrap, and also called for a very much greater supply of forgings than could be obtained in superior scrap iron. The consequence was that shafts of scrap iron, when turned and finished, became liable to exhibit streaks and seams, not due alone to imperfect welding in the forging, but likewise to the laminations and imperfections of the original scrap iron, which the process of piling and shingling into the slab was not sufficient to obliterate. So constantly does this yet occur that it causes a strong temptation to make such forgings of new iron puddled direct from the pig and then shingled into slabs or blooms, under the idea that these streaks and seams will thus be avoided, and that the iron will be improved almost to the condition of scrap iron, while being forged under the steam hammer. This, however, is found not to be the case. The forging is certainly free from the streaks of the scrap iron, but this is obtained at the expense of strength; for the material is too raw; it wants cohesion, and has not had the proper kind or amount of working to bring it to the condition of superior wrought iron. This method is still further tempting, inasmuch as it is far cheaper than the other; the material costs less than scrap iron, and, as it welds at a lower temperature, a forging can be much more quickly and easily made. Still, for whatever class of machinery it may be fitted, it should certainly be eschewed in every case for a crankshaft or propeller shaft.

From these considerations it has been the custom at Lancefield, in the preparation of the iron for crankshafts, to improve upon the ordinary condition of the scrap iron in the following manner. The pile is made up of carefully cleaned and selected scrap; it is brought to a welding heat, and then hammered under the steam hammer. But instead of being beaten into a flat slab for the forgeman, it is beaten into a square billet, which is afterwards rolled in the rolling mill into a flat bar, as if for "best best" merchant iron. By this additional heating, hammering, and rolling, all the different qualities of the scrap iron composing the pile are merged into one homogeneous material, having the fibre given to it that was lost in the separated portions of the scrap iron; and this, when cut up into proper lengths, and again piled and shingled into the slab, results in a material possessing somewhat the closeness and density of steel, while retaining all the toughness and tenacity of superior malleable iron. The improved method of constructing the forging, previously detailed, is worthy the use of this superior material; and both having been adopted at Lancefield with results which have commended themselves so unmistakably to many engineers, that they now not only specify the material but stipulate for the mode of manufacture, it is thought the system has only to be more widely known in order to be universally adopted. It is certain to give greater confidence in the endurance of such important parts of the machinery, although this confidence may have to be obtained by a small increase in the cost, due to the extra workmanship both on the material and on the forging.

When we take into consideration the vastly accelerated speed of the marine engine in late years, and the many disastrous effects which follow the breaking of a shaft at sea—also that the tendency of the age is still towards much higher pressures, and further lengthening of stroke—it is not surprising that improvement in such an important part as the crankshaft should be eagerly sought after; but it has hitherto been sought in the direction of the material alone. Cast steel has been advocated, and brought to some extent into use; but its expense renders such shafts costly out of all proportion to the other parts of the engine; while, in the event of their heating when at work (a very frequent casualty), and having the water-hose directed upon the crank-pin or journals, it cannot be expected that the material will behave any better, or even so well, as tough wrought iron. What is termed puddled steel is liable to the same objection, and probably, from its mode of manufacture, in a still greater degree. The so-called mild steel is no doubt proving itself a superior material, and yielding good results when rolled into ship or boiler plates. But thus prepared, it is more costly than "rolled scrap bar;" and if not rolled, but cast into an ingot, then it possesses some of the crystalline characteristics of steel, with all the disadvantages attending its manipulation into a forging.

For extra large crankshafts, the fear of unsoundness, arising from the ordinary mode of forging, has led some engineers to consider the propriety of building the shafts and cranks in separate pieces. This, with engineers generally, has not hitherto been looked upon with favour; as the fewer the pieces the more rigid the shaft. Moreover the increased weight necessitated by this separate building is viewed as a disadvantage, even although it were not attended with greater cost, as undoubtedly it is.

The material and mode of manufacture advocated in this paper may tend to dissipate some of these apprehensions. They will not obviate defective construction in the engines themselves, or faulty proportion of their parts, or neglectful supervision of their working; but they will reduce to a minimum the risk of breakage in such untoward circumstances. If any ojection be taken on the score of extra size, the enterprise which a quarter of a century ago engaged in the making of the unusually large shafts necessary for the Great Eastern may still be trusted to meet the advancing requirements of the present day.

THE WESTINGHOUSE BRAKE.

THE following report was prepared by Mr. Harrison, the engineer of the North-Eastern Railway Company, for the information of the directors of that company, and has been just printed by the Board of Trade.

To the Directors of the North-Eastern Railway Company.

Newcastle-on-Tyne, April 24, 1879.

Gentlemen,—In the early part of 1878, I explained to you my views as to the different continuous brakes then in use, and recommended you to adopt the Westinghouse automatic pressure brake as the brake of your system, a recommendation which you afterwards adopted, subject to the necessary user of Smith's vacuum brake for the through Scotch traffic, run in connexion with the Great Northern Railway, so long as that company continued to use that system.

Since then I have continued to give constant attention to the subject, and have had immediate reports made to me of every incident that has occurred in the practical use of this brake, with a view to see what weak points there were in it, and to consider the remedy to be adopted.

I may state at once that these investigations have confirmed more strongly than ever the opinion I then gave you in favour of the Westinghouse automatic brake, for though in its principle no alterations have been made, or found necessary, many small and simple modifications have been made in details, which have greatly added to the uniformity and certainty of its action.

I did not at the time you decided on adopting this brake, press on you its immediate application to the whole of your trains, but only to some of your fast trains, to which it was of importance, as I was anxious to watch all defects, and have the necessary remedy supplied; and I may state that as they have from time to time been pointed out to Mr. Westinghouse, he has in every case, if he had not anticipated the suggestions, been able without difficulty to supply a complete remedy.

The Westinghouse automatic brake continues still in use in America, and has proved itself to be well suited to that particular traffic, and has required little or no modification, but when applied to railways in England, the circumstances were so different that many alterations were necessary in the details.

Looking at the continuous brake system as a novel invention, whether vacuum or pressure, it must be obvious to any one acquainted with such inventions, that perfection could not be expected at once, and the Westinghouse automatic system has been no exception to this rule, and I purpose briefly to call your attention to some of the most important modifications which have been introduced by Mr. Westinghouse since the brake trials at Newark in 1874, some of these being of a recent date.

Triple Valve.—As the most important I will particularly draw your attention to the "triple valve" which has been made a regular bugbear by the opponents of the system, and has been called complicated, delicate, and liable to get out of order, &c. The original "triple valve" used at the "Newark experiments," a drawing of which I have now before me, had three distinct valves, and hence its name "triple valve," and it might, in its original construction, have to some extent deserved the term complicated, but the valve, as altered shortly after the Newark trials, and as now constructed, differs so entirely from the original valve, that although I think it desirable to continue the term "triple valve," its present construction would not have suggested or justified that term; it is, in fact, as simple a piece of mechanism as well can be imagined, certain in its action, of durable materials, easily accessible to an ordinary workman for examination or cleaning, and there is nothing about it that can justify the term complication; on the contrary it is a model of ingenuity and simplicity.

Leakage Valve.—In order to prevent the possibility of the brakes going on by a leakage from the reservoir on the carriage to the brake cylinder, Mr. Westinghouse introduced a "leakage valve" between the triple valve and the brake cylinder, but this has since been done away with by the simple expedient of cutting a short groove at the inner end of the brake cylinder so as to allow an escape of air under the piston when in a state of rest.

Hose Couplings.—A great improvement has been made in the couplings of the carriages. There used to be a cock at each end of each carriage, and before removing a carriage from a train it was necessary to turn four cocks to completely shut off communication, and cases have occurred where, from carelessness, a cock has not been reopened, and thus the air-pressure was shut off from the hinder portion of the train. To meet this, Mr. Westinghouse has introduced valves into the couplings, and the mere act of disconnecting closes the valves and retains the air, and the act of reuniting the couplings opens the valves and makes again a free passage for the air through the main pipes. By this arrangement two cocks on each carriage are dispensed with, and the leakage valve being superseded as above mentioned, there only now remains on each carriage two ¼ in. cocks of the simplest construction, one to be used when it may be necessary to shut off the brake action on any particular carriage, the other in the same case to let the air out of the brake cylinder.

The Driver's Brake Valve.—The driver's brake valve gives the engineman the means of applying the brake with any degree of power, and retains in the main reservoir a pressure equal to 20 lb. per square inch above the ordinary pressure in the brake pipes, and this extra pressure is at the command of the driver at any time, and enables him more rapidly to release the brake blocks and recharge the main pipes and the carriage reservoirs.

Automatic Regulation for Donkey Pump.—Another important point is the introduction, on the donkey engine, of an automatic regulator for the donkey pump, which has a connexion with the main pipes, and is so adjusted that whenever the pressure in the main pipes falls below a fixed standard, which may be varied to any extent to suit the nature and circumstances of the train, the donkey engine is set to work, and this will insure a sufficiently constant uniformity of pressure in the main pipes, a point of very great importance.

There are other minor improvements, such as welding all the reservoirs instead of rivetting them, but they are not of sufficient importance to demand separate notice.

It may here be remarked that there is no difficulty in arranging an automatic pressure brake to act without valves, but all such brakes must of necessity have the one inherent and fatal disadvantgge of slow action; and when rapidity of application of the brakes is measured by one, two, or three seconds in time, representing in some cases 30 to 100 yards of difference in stopping distance, the objection is fatal.

I have had carriages so fitted up, and tried them mixed up with carriages fitted with the Westinghouse brake, and the difference in time in applying and releasing the brakes is so marked that they could not be worked together, though alone they worked quite well.

I have, therefore, arrived at the conclusion that no pressure brake, which has not a valve which will produce the same effect as the Westinghouse triple valve, can be used as a general brake, and it will be found very difficult to find anything more simple and reliable in its action than that valve as now constructed.

It is hardly necessary for me to repeat to you what I have frequently said, viz., that I entirely agree with the Board of Trade in the conditions they have laid down as being necessary to constitute a good continuous brake, all of which the Westinghouse brake complies with.

I have heard it constantly stated that the vacuum brake is cheaper than the Westinghouse brake, both in first cost and to maintain. I have lately had the brake gear of a similar carriage fitted with the vacuum and Westinghouse brakes as now in use on your railway, taken to pieces and accurately weighed, and also a complete set of each made in the shops, and taking into account the amount paid in each case to the respective patentees for what they supply, the first cost is decidedly in favour of the Westinghouse, and the weight of wrought and cast iron necessary for the brake gear is 10 cwt. per carriage heavier in the case of the vacuum than in the Westinghouse.

Should it be decided to adopt a vacuum automatic brake there must be some considerable additions both to the first cost and maintenance.

As to the annual cost of maintenance, there being no strictly so-called perishable material in the Westinghouse brake, except the couplings, which are common to both systems, whereas in the vacuum brake the sacks must always be liable to great wear and tear from their perishable nature, and the fact of the larger amount of brake gear in the vacuum brake to be maintained, I have no doubt that the Westinghouse brake will be more cheaply maintained than the vacuum, and all the information I have got confirms this view.

I have thought it desirable to lay this report before you, having taken the responsibility of recommending you to adopt the Westinghouse automatic brake as the brake of your system, and every day's experience further confirms my views, and I am confident that there is no brake which will beat it in stopping power, in economy of first cost and maintenance, or in certainty of action.

I remain, &c.,
(Signed) THOS. E. HARRISON.

The Directors of the North-Eastern
Railway Company.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—Last Thursday's pig-iron warrant market opened dull at ½d. per ton less than at the previous day's close, but a steady improvement set in, and the close was 2d. over that of the previous day. There were transactions during the forenoon at 41s. 0½d. to 41s. 2½d. cash, and at 41s. 2d. to 41s. 4½d. one month, closing buyers 41s. 2d. and 41s. 4d. cash and one month respectively, and sellers 1d. per ton dearer. In the afternoon the quotations were 41s. 2½d. to 41s. 3d. cash, and 41s. 5d. to 41s. 5½d. one month, and at the close there were buyers at 41s. 3d. cash and 41s. 5d. one month, and sellers asking 1d. per ton more. On the following morning the warrant market opened very strong, and prices mounted up rapidly, and closed at an advance of 8d. on the day and 1s. 3½d. over the previous week's final quotation. Business was done in the forenoon at from 41s. 7d. to 41s. 11d. cash, and from 41s. 9d. to 42s. 1½d. one month, closing with buyers at 41s. 10d. cash and 42s. 1d. one month, and sellers near. There was no market in the afternoon. Monday's market opened firm, and an advance of 5d. was at one time paid; a reaction, however, set in, and all that advance, together with 1d. more, was lost. Iron changed hands during the forenoon at from 42s. to 42s. 4d., and subsequently down to 41s. 10½d. cash, and at 42s. 1d., 42s. 3d., and 42s. one month, sellers at the close asking 41s. 9d. cash and 42s. one month, and buyers offering 1½d. per ton less. The afternoon quotations were 41s. 10½d. and 41s. 10d. cash, and the market closed with buyers at 41s. 10d. cash and 42s. one month, and sellers asking 1d. more per ton. The warrant market opened yesterday at Monday's closing price, and then improved 2d. per ton, which sum, however, was lost towards the close. Business was done during the forenoon at 41s. 10d. to 42s. cash, and at 42s. to 42s. 2d. one month, closing with sellers at 42s. cash and 42s. 2d. one month, and buyers 1d. down. In the afternoon 41s. 11d. to 41s. 10d. cash and 42s. one month were accepted. At the close of the market there were buyers at 41s. 10d. cash and 42s. one month, and sellers near. The market was steady this forenoon, when business was done at 41s. 9d. to 41s. 10½d. cash, also at 42s. and 42s. 1d. one month, closing rather buyers at the higher quotation, and sellers asking a shade more. There was also a steady market in the afternoon—buyers at 41s. 10½d. cash, and sellers asking 1d. more per ton. The firmness and high prices prevailing at the close of last week, and which were due partly to speculation and partly to reports of improvement in trade in America, have not been continued this week; but there is a very general feeling that the worst has really been past, and that there will soon be evidences of improvement in this country. Last week's shipments of pig iron from all Scotch ports amounted to 7504 tons as against 5993 tons in the corresponding week of last year. Iron is still being sent into store, and the total stock with Messrs. Connal and Co. up till last Friday night was 290,323 tons, showing an increase for the week of 1778 tons. The number of blast furnaces in actual operation still remains at 90, as compared with 96 at the same time last year.

The Board of Trade and the Forth Bridge.—The Board of Trade has just issued its formal sanction of the proposed works of the Forth Bridge, subject to the following conditions: 1. That the said bridge be completed within the time specified in Section 5 of the Forth Bridge Railway Act, 1876, or within the time specified in any future Act of Parliament the company may obtain. If, before the expiration of such time the bridge be not completed, this assent shall, unless renewed, be void and of no effect. 2. That no temporary works in connexion with the said bridge across the Forth shall be commenced below high-water mark by the company without the consent of the Board of Trade in writing, and then only according to such plans, and in accordance with such restrictions and regulations as the Board of Trade may require. 3. That both of the two navigable channels of the Forth, viz., the channel to the north and the channel to the south of the island of Inch Garvie shall not be closed or interfered with at the same time. 4. That three months before commencing any portion of the suspension part of the bridge, *i.e.*, the portions between the piers and over the navigable channels, the company shall give to the Board of Trade, and to the Commissioners of Northern Lighthouses, three months' notice in writing of their intention to commence the said works or any temporary works in connexion therewith. 5. That the company shall, during the whole time of constructing the said bridge, exhibit such signals, and keep burning from sunset to sunrise such lights, if any, as the Board of Trade shall from time to time require. It may be remarked that as the result of public inquiry held in Edinburgh last year, the Board fixed the height of the two great central spans of the bridge at 150 ft. above high water of spring tides.

Forth Bridge Tenders.—At a meeting of the directors of the Forth Bridge Railway Company, held in Edinburgh last Wednesday afternoon, the tenders for the different sections of the Forth Bridge undertaking received from the different firms whose estimates had been invited were opened and examined. In view, however, of the necessity for preliminary inquiries in connexion with the different contracts, no final decision as to the acceptance of any other was come to. In the event of the completion of satisfactory arrangements with suitable contractors, it is intended to take immediate steps to raise the necessary capital, with the view to vigorous prosecution of the works. It is generally understood that the only firm in Scotland tendering for the whole of the construction in iron and steel above high water is that of Messrs. William Arrol and Co., Glasgow, the firm that built the new bridge over the Clyde leading to the Caledonian Central Station, Gordon-street, Glasgow.

The Coal Trade.—During the past week there has been a good deal of excitement in the Glasgow coal market, consequent on the movement amongst the miners in several districts to restrict their "darg" or day's output, thereby bringing the supply into keeping with the demand, and on account partly of the willingness of certain of the coalmasters to submit to the tactics of the miners. Already the price has in a number of instances been advanced from 3d. to 6d. per ton, and in one or two cases even 9d. per ton of advance has been gained. The natural effect is, that in some mining districts, including Hamilton, Larkhall, and Wishaw, a number of the miners had got an advance of 6d. per day on the rate of wages. There are, however, one or two cases of miners being on strike against a threatened reduction of wages. The agitation now engaged in by the miners extends not only to most of the mining districts of Lanarkshire, but also to the adjoining counties of Renfrew, Ayr, Dumbarton, and Stirling.

The Shipbuilding Trade.—There are reports this week of several new shipbuilding contracts having been booked by Clyde firms, and of others being under consideration.

NOTES FROM THE SOUTH-WEST.

Improvements at Swansea.—The Swansea Town Council met especially on Wednesday to execute a mortgage for the repayment of a loan of 15,000*l.* from the Public Works Loan Commissioners, in connexion with an improvement scheme to be carried out under the provisions of the Artisans' Dwellings Act of 1875. The total cost of the entire scheme is estimated at 91,564*l.*

Milford Docks.—On Friday Mr. E. J. Reed, M.P., presided at the half-yearly meeting of the Milford Docks Company, and made an interesting statement with regard to the position of the company and the progress of the new docks, which are to be completed within the specified time of contract—the 1st of March next. In the report which was adopted, it was proposed to make an issue of preference capital up to a certain amount for the purchase of the graving dock, warehouses, &c.

The Tin-plate Workers.—A meeting of the delegates from South Wales, Monmouthshire, Gloucestershire, Worcestershire, and Staffordshire tin-plate workers was held at Swansea, on Saturday, when it was resolved to resist the reduction of wages determined upon by the masters, which in some instances amounts to 20 per cent. It was also agreed to ask the masters to restrict the make, so that each mill working 12 hours shall only do 36 boxes per turn, and 30 boxes for eight hours.

The Severn Bridge.—On Thursday the last big span of the Severn Bridge was lowered to its final bearings, and the removal of the scaffolding will be proceeded with, with all practicable speed. As several applications have been received to visit the bridge, it has been arranged that it shall be open to the public on Mondays, from August 11th to September 15th.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Exodus of Workmen.—Last week it was noted that large numbers of engineers tempted by high offers from American firms were leaving the country. We now find that the cutlers and other workpeople of Hallamshire are following the example thus set them. Already 22 families numbering 102 persons, all cutlers from Sheffield, recently in the employment of Mr. Benjamin Eyre, have gone to Bridgwort, Connecticut, U.S., and there is a movement in the town for sending out large numbers more. The question is a serious one, for though at present there is surplus labour in the old staple trades of the district, these emigrants will in the future be competitors with those at home.

The Duration of Tramways.—When the Sheffield tramways to Attercliffe and Brightside were laid only a few years ago, in Mount Sorrel sets, it was stated officially that with few repairs they would last for thirty years. Now, however, the borough surveyor states that they are in many places dangerous to carriage traffic. The wrought-iron rails are more or less the worse for wear, but the chief defect is in the mode of fastening, which is by vertical spikes driven through a slightly countersunk hole in the groove of the rail into a wooden plug fixed in the top of the cast-iron chairs. The heads of the spikes get worn by the traffic and fail to answer their purpose. Wherever the foundation is not sound and hard, every heavily laden vehicle passing along the rail causes it to act as a lever, and springs the fastenings out entirely. The play of the rail is very damaging to the permanent way. The granite sets on these routes have been laid on a bed of engine ashes and grouted with ground mortar, but the water having permeated to the foundations has caused unevenness in the roadway. The remedy proposed is the relaying of the rails on another foundation set in hydraulic lime concrete, the sets to be grouted with pitch or tar.

Opening of the Ilkestone and Bulwell Railway.—The new railway from the Bennerley Junction, Ilkestone to Bulwell, has been opened for luggage and mineral traffic. The line, about six miles in length, joins the Nottingham and Mansfield Railway at Bulwell, and the Erewash Valley Railway at Bennerley. The most costly and formidable obstacle met in the construction of the line was the making of

PRICE LIST OF MATERIALS.

Thursday, August 14, 1879.

METALS.

	£	s.	£	s.
Antimony Ore (per ton)—	10	0	11	0
Regulus (star)	47	0	47	10
Brass (per lb.) –	s.	.	s.	d.
Sheets, 48 × 24	0	7¾	0	8
Yellow metal	0	6½	0	7
Castings Tyne and Cleveland (per ton)	£	s.	£	s.
Girders	4	10	5	10
Chairs	2	15	3	10
Pipes	4	5	5	0
Copper (per ton)—				
Chili bars	54	0	54	0
Australian	61	10	62	0
English tough, best	60	10	61	10
„ ingots	61	0	62	10
Sheets, &c.	63	10	65	0
Bottoms	74	0	75	0
Iron Ores (per ton)—	s.	d.	s.	d.
Red hematite, blast	12	0	13	0
„ „ puddling	11	0	12	0
Iron Pig (per ton) —				
Barrow No. 1	51	0	53	0
„ „ 2	48	0	50	6
„ „ 3	46	0	48	0
Cleveland No. 1	36	0	37	0
„ „ 3	33	6	34	0
„ „ 4 (Forge)	32	6	33	0
Foundry	31	0	32	0
Welsh (South Wales)	65	0	75	0
„ (North Wales)	60	0	65	0
	No. 1.		No. 3.	
Scotch Pig –	s.	d.	s.	d.
G.m.b., at Glasgow	42	6	41	0
Gartsherrie	46	0	43	0
Coltness	52	0	43	6
Summerlee	44	6	42	0
Langloan	49	6	43	0
Carnbroe	44	6	42	0
Monkland	42	6	41	0
Clyde	44	0	41	0
Govan, at Broomielaw	42	6	41	0
Calder, at Port Dundas	46	6	42	6
Glengarnock, at Ardrossan	44	6	42	6
Eglinton, ditto	43	0	42	0
Dalmellington, ditto	42	6	41	6
Carron, at Grangemouth	60	0	57	6
Ditto, specially selected	65	0	—	
Shotts, at Leith	47	6	44	0
Kinneil, at Bo'ness	—		—	
(The above all deliverable alongside).				
	s.	d.	s.	d.
Shropshire	55	0	80	0
North Staffordshire	45	0	75	0
South „	55	0	70	0
Yorkshire Thornaby pig No. 3.	49	0	53	0
Iron, Wrought -	£	s.	£	s.
Cleveland angles	4	17	5	0
„ bars	5	0	5	2
„ puddled bars	3	7	3	12
„ boiler plates	6	0	6	10
„ rails	5	0	5	5
„ ship plates	5	0	5	5
„ sheets	7	0	8	0
„ hoops	7	5	7	15
Scotch bars	5	0	6	0
„ nail rods	6	0	6	10
Staffordshire bars	6	0	7	10
„ plates	6	10	9	10
„ boiler	8	0	9	10
„ hoops	6	10	7	0
Welsh rails S.W.	5	0	5	15
„ bars „	6	0	6	5
„ boiler plates, S.W.	9	0	11	0
„ hoops, S.W.	8	0	8	10
Lead (per ton)—				
Soft English pig	13	15	14	0
„ „ W.B.	14	0	14	10
Spanish	13	12	13	15
Sheet	17	0	18	0
Phosphor Bronze – (per ton)	105	0	125	0
Quicksilver (per bottle)	5	12	5	17
Scrap (per ton) -	3	10	4	0
Spelter (per ton) –				
Silesian, ordinary	16	0	17	0
Spiegeleisen (per ton) —				
Best	6	0	0	0
Common	5	0	5	10
Steel (per ton) —				
Best cast	34	0	50	0
„ double shear	45	0	65	0
„ single „	32	0	50	0
English spring	14	0	22	0
Blister	00	0	00	0
Milan	28	10	30	0
Bessemer rails	4	9	5	0
„ tyres	8	5	8	15
„ axles	9	0	9	5
„ billets	6	0	7	0
„ plates	10	0	0	0
„ angles	9	0	0	0
Steel Castings (per cwt.) –				
Hydraulic cylinders in the rough not to exceed 6 ft. in length, guaranteed	s. 26	d. 0	s. 28	d. 0
Do. do. finished	30	0	34	0
Pinions and cog-wheels	25	0	28	0
Hammer tups, faces, swages, 5 cwt. and above	20	0	24	0
Holders-up for rivetting machines, &c., 1½ to 5 cwt.	25	0	26	0
Steel Castings—*continued*	s.	d.	s.	d.
Side cranks, cross heads, crane wheels, engine slides, &c.	4	0	30	0
Tumbler bars and other castings for dredging purposes	20	0	26	0
Swedish Iron (F.o.b) at Gottenburg (per ton)	£	s.	£	s.
Pig	4	5	4	10
Bar rolled	9	0	11	0
„ hammered	11	0	11	10
Tin (per ton) -				
Straits	66	0	67	0
Billiton	64	10	65	0
Banca	00	0	65	0
English ingots	65	0	66	0
English bars	65	10	67	0
English refined	66	10	68	0
Australian	66	0	67	0
Tin Plates (per box) -	s.	d.	s.	d.
I.C. charcoal	20	6	22	6
I.X. „	25	0	28	0
I.C. coke	17	0	20	0
I.X. „	22	0	25	0
Zinc (per ton) –	£	s.	£	s.
Sheets, English	18	0	19	0
Wire, fencing	10	0	12	10
„ Telegraph (galvanised)	14	0	18	0

COALS AND COKE.

Coals (per ton) –	s.	d.	s.	d.
Barrow	9	0	11	0
Bristol	9	0	10	6
Derbyshire	8	0	10	6
Lancashire	8	0	10	0
Newcastle and Durham	8	6	12	0
Scotch	7	0	10	0
Staffordshire	8	6	11	6
Welsh	9	0	10	0
Yorkshire	8	0	12	0
Coke –				
Cleveland	9	0	9	6
Durham	15	0	17	0

OILS, GREASE, & LUBRICATORS.

Oils (per tun) –	£	s.	£	s.
Seal, brown	23	0	23	10
„ pale	28	0	29	0
Sperm body	55	0	56	0
Whale, pale	25	0	25	10
„ yellow	24	0	25	0
Lard	36	0	36	10
Glue	30	0	50	0
Petroleum -	s.	d.	s.	d.
Fine (per gallon)	0	6	0	0
Coal oil, refined	0	7	0	7¼
Rangoon engine oil	2	6	2	9
Linseed oil	27	6	28	0
Pitch (per cwt.) –	s.	d.	s.	d.
British	5	6	5	9
Archangel	7	6	8	0
Plumbago (per cwt.) —				
Ceylon lump	13	3	14	6
„ chips	9	6	11	0
„ dust	7	3	9	0
Railway Grease (per cwt.)—Rose's	28	0	00	0
Pritchard, Offer and Co.'s concentrated	60	0	00	0
Resin (per cwt)	4	0	4	3
Tallow (per cwt.)				
N. American	00	0	00	0
S. American beef	00	0	00	0
„ sheep	00	0	00	0
Australian beef	31	0	31	6
„ sheep	32	6	34	0
St. Petersburg, Y.C.	34	9	36	0
English, town	32	0	33	0
Rough, English	12	0	13	0
Tar—Stockholm (per barl.)	20	6	22	0
Archangel	15	6	00	0
Turpentine - Spirit—				
American (casks)	21	3	21	6
Wipings, engine (per cwt.)	20	0	35	0

CHEMICALS, &c.

Acids—	s.	d.	s.	d
Aquafortis (per lb.)	0	4¼	0	0
Sulphuric acid (per lb.)	0	0¾	0	0
Sulphuric acid, brown	0	0½	0	0
Ammonia – Muriate (per ton)	£ 29	s. 0	£ 35	s. 0
Arsenic –	s.	d.	s.	d.
White, lump (per cwt.)	24	0	26	0
Powdered (per cwt.)	8	6	9	0
Bleaching powder per cwt.	5	9	6	0
Borax – refined (per cwt.)	35	0	38	0
Brimstone (per ton) –	£	s.	£	s
Rough	5	10	6	0
Flour	11	0	13	10
Roll	8	10	9	0
Copperas – green	45	0	50	0
Copper — Sulphate (per cwt.)	s. 18	d. 6	s. 20	d. 0
Leads, Salts, &c., (per cwt.)				
Acetate, best	18	0	19	0
Brown „	22	0	23	0
Red	14	0	16	0
White	18	0	19	0
Litharge (per cwt.)	19	0	20	0
Potash—Bichromate (per lb.)	0	4	0	4½
Saltpetre (per cwt.)				
English refined, kegs	19	0	20	0
Bombay	00	0	00	0
Bengal	19	0	19	6
Soda Caustic	12	6	13	0
„ Crystals (per ton)	£3	5	£3	10

a long tunnel under the Lawn Hills. The new railway has a number of side lines and branches connecting it with collieries, breweries, iron works, &c., and presents increased facilities for the transmission of goods. It is expected that the line will shortly be open for passenger traffic.

Boring for Water at Retford.—The town authorities at Retford have given instructions that new boring operations for water should be commenced on the west side of the town, where it is hoped the red sandstone rock may be struck without encountering overlying strata of gypsum. If the boring proves satisfactory the Corporation is to acquire the land at 300*l*. an acre.

FOREIGN AND COLONIAL NOTES.

M. Beral.—Among the members of the new French Council of State, we observe the name of M. Béral, a civil engineer of ability and experience, who was for some years well-known in Constantinople as director of the department of bridges and roads (ponts et chaussées) in the Turkish Ministry of Public Works. Shortly after the outbreak of the Franco-German war, he returned to France, and was appointed prefect of his native department of the Lot, for which he was returned as deputy to the chamber at last general election.

Danish Railways.—The King of Denmark has just opened an important link in the Danish railway systems, viz., a large bridge across the Lymfiord close to the Jutland Town of Oalborg, by which direct communication is now established right through Jutland to the northernmost town of Fredrikshaven and with the continental lines. At Fredrikshaven is in daily communication, by means of steamers, with Gothenburg travellers are now able to reach Sweden and Norway without having to pass through Copenhagen. The construction of this bridge, which is about 1000 yards long, was entrusted to the Fives Lille Company (France), and the work has been carried out under great difficulties on account of the strong tide flowing, the shifting of the bottom of the sea, and floating masses of ice during the winter. On several occasions the work had to be recommenced nearly from the beginning, and not a few lives have been lost during the five years which have been spent in building the bridge. The cost to the Danish Exchequer is somewhat like three million crowns, but perhaps another million has been spent by the Fives Lille Company, to whom the enterprise has caused a heavy loss.

American Small Arms for Turkey.—The Providence Tool Company has been for more than five years executing a contract for rifles for Turkey, the last cargo of which they are now sending. Their contract called for 650,000 rifles, valued at 17.50 dols. each, or nearly 11,500,000 dols. altogether. The Winchester Repeating Arms Company had also a contract for 300,000,000 cartridges, valued at 9,000,000 dols. This company completed their shipments several months since. The value of the two contracts aggregated over 21,000,000 dols., and they are believed to be the largest of their kind ever made by any Government. In February, 1874, the first shipment was made in the brig Gloria. This was followed from time to time by twenty-nine cargoes in steamers and sailing vessels. Sixteen cargoes went by steamers and thirteen by sailing vessels. Two of the former and three of the latter took shipments in 1874, five sailing vessels took cargoes in 1875, and three of each class of vessels sailed for Constantinople loaded with arms and ammunition in 1876. Owing to the exigencies of the Turco-Russian war in 1877 eight cargoes were carried out in steam vessels in that year. In 1878, three cargoes were despatched for the same destination, but one in the John Bramhall was lost on Little Gull Island, in Long Island Sound. The most valuable cargo was forwarded in the Lotus, in January, 1877, the insurance on the shipment having been based on an appraisal of 1,875,000 dols. The other cargoes averaged 750,000 dols. each.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

Middlesbrough, Wednesday.

The Cleveland Iron Market. — Yesterday there was a good attendance on 'Change at Middlesbrough, and the tone of the market was rather better. Pig iron makers quoted No 3 Cleveland at 34s. per ton, but merchants offered that quality for less, and indeed large parcels could have been bought at 33s. 6d. and 33s. 3d. per ton. Messrs. Connal and Co., the warrant storekeepers, held yesterday a stock of 81,950 tons. They are receiving very little iron just now. In Glasgow they have a stock amounting to 290,900 tons. Shipments are rather better.

The Finished Iron Trade.—Employers complain that this branch of industry continues in a most depressed condition. They say that the men will have to accept the proposed reduction of wages or they will be obliged to close some of their works. On the other hand it is hoped that some of the iron rails required for America will be placed with Cleveland firms, and that the iron rail trade, almost dead, will be reinstated. Several works in the north remain closed for want of orders.

Engineers and Shipbuilders.—In general engineering there is a fair amount of work in hand, but difficulty is experienced in obtaining fresh orders. There is the keenest competition in all branches. Shipbuilders find it no easy matter to replace the vacancies caused by the recent launches on the Tees and Tyne.

The Coal and Coke Trades. — All kinds of fuel is plentiful and cheap. Steam coal for exportation is in rather better demand, and nuts are more in request, but coal for manufacturing purposes is not urgently required, and until there is more activity in the iron trade there will be no alteration of any moment in this branch of the fuel trade.

The Late M. Charles Couche.—The Corps of Mines in France have recently sustained a considerable loss in the death of M. Charles Couche, Inspector-General, Professor of the School of Mines since 1848, President of the Committee of Technical Working of Railways, and President of the International Jury for Railways at the Paris Exhibition last year. M. Couche was the author of a large standard work on railways, and which has already been translated into several languages. He was a man of great force of character, and all who knew him recognised that he possessed the higher order of talent, but without ambition.

The London Water Supply.—On the 6th inst. a meeting was held in Exeter Hall, ostensibly on the part of working men, to take into consideration the present state of the London water supply, especially in the poorer districts. Mr. Thomson Hankey, M.P., presided. Among the speakers were the Bishop of London, Cardinal Manning, Dr. Lyon Playfair, M.P., &c., all of whom strongly urged the necessity of a constant supply, and that this should be placed by Government in the hand of a sole authority, in place of the division now existing between the various companies supplying the metropolis. Resolutions were passed unanimously on these questions. An interesting feature of the meeting was found in the addresses of some working men who described the state of matters within their own personal knowledge. The Bishop of London especially urged the moral aspects of the cases from his own experience gathered over a period of about forty years. Cardinal Manning, whose extensive experience among the poor classes gave great weight, expressed similar views. Mr. Fawcett's motion, and the debate thereon, we shall treat in a separate article. On Saturday last the Water Expenses Indemnity Bill was reported. It was intended to provide for the payment out of the rates of the expenses which the Metropolitan Board of Works had incurred in bringing Bills before Parliament for the purchase of the existing water companies. Sir J. McGarrel Hogg stated that the Board had been compelled to take action in the matter, as the Government had declined to do so. Eventually the Bill was read a third time, and the past action of the Board was thus sanctioned on their promise not to offend in a similar manner again.