PARKHEAD FORGE, ROLLING MILLS AND STEEL WORKS.

(*Concluded from page* 131.)

FROM the furnaces, which have an output capacity of 150 tons in the twelve hours, this highly serviceable crane lifts the slabs and rapidly transports its load to the plate mills, the roughing and finishing rolls of which are served by one live-roller table in front and one in the rear of the mill, a cross-sliding motion being imparted by a special engine of Messrs. Miller and Co.'s make. These tables of live rollers are capable of carrying plates up to 25 tons weight, an example of this being the stupendous gun-shield plate which is shown being operated upon in our view of the planing machine on page 166.

The largest of the plate mills—one of the most powerful and complete plate mills in Scotland—is driven by a set of coupled reversing steam engines with 46in. cylinders, 5ft. stroke, geared $2\frac{1}{2}$ to 1, and having a working pressure of 120 lb. These engines, which are also by Messrs. D. Stewart and Co., are illustrated on page 154. The mill rolls are 32in. diameter, $10\frac{1}{2}$ft. long, and weigh 15 tons each. A small pair of 6in. cylinder engines on the housing work the screw gear, raising or lowering the top roll, which is also balanced by hydraulic pressure.

This mill is capable of turning out over 100 tons of finished plates every twelve hours, from $\frac{3}{8}$in. upwards in thickness and of all sizes and dimensions. The very largest and heaviest plates ever put into a marine boiler have been produced here; amongst others being those supplied to Messrs. J. and G. Thomson for the boilers of the International steamship Kensington built two years ago. These plates were 32ft. 11in. by 7ft. $7\frac{1}{4}$in. by $1\frac{9}{16}$in. thick, and weighed each 7 tons 10 cwt. 3 qr. The other plate mills, of which there are two—the larger having rolls 24in. diameter by $6\frac{1}{2}$ft. long—are principally devoted to ship and bridge plates and thin plates, including sheets of all sizes down to $\frac{1}{16}$in. thick.

For shearing plates after they are rolled there are several powerful steam shears at a convenient distance in the rear of the mills. The two largest of these are by Messrs. Joshua Buckton and Co., Leeds, and deal with plates up to $1\frac{1}{2}$in. thick. Messrs. Beardmore, however, impressed with the greater suitability of shears actuated by hydraulic power over those driven by steam for the heaviest class of work, are now constructing for this purpose a powerful hydraulic shearing machine. It is of massive design, capable of shearing mild steel plates up to $2\frac{1}{2}$in. thick, and as it embodies some interesting novelties in this class of machine, may be referred to with some detail. The cheeks or standards each consist of two steel plates 14ft. by $9\frac{1}{2}$ft. by 6in., which are separated by a cast steel distance piece, so as to stand about $13\frac{1}{2}$ft. apart from centre to centre. The gap is 37in. wide from the edge of the bolster, and is quite open at both ends of the machine, so that a $2\frac{1}{2}$in. plate, 6ft. broad, and of any length, can be split from end to end with ease. The motive power is supplied by two cast steel hydraulic cylinders, $20\frac{1}{2}$in. internal diameter by $4\frac{1}{2}$ft. stroke, firmly snugged and bolted to the back of the cheeks. The ram of each cylinder is in the form of a trunk piston, to which is secured a mild steel connecting-rod. The water, under a pressure of 700 lb. per square inch, acts on an area of 330 square inches on the underside of each ram, while there is a constant back pressure of 700 lb. per square inch on an annular area of 47 square inches on the upper side of the ram, thereby enabling the blade to be lifted when the pressure on the lower side of the ram is relieved. The effective pressure on the lower side of each ram is thus $88\frac{1}{2}$ tons. The hydraulic pressure is transmitted from each ram to the blade or apron through a lever having a mechanical advantage of 3 to 1. Both levers are rigidly keyed to one common shaft, 18in. diameter and 18ft. long, which passes from end to end of the machine, and is supported by cast steel brass-lined bearings passing through the cheeks and bolted firmly to them. Any tendency to thrust the blade endwise will be resisted by the torsional rigidity of the main shaft. The total pressure, therefore, transmitted to the blade at any instant is upwards of 530 tons; and as the cutting edge has an inclination of 1 in 9, the intensity of pressure per square inch on the section of, say, a 2in. plate in the process of being sheared will be approximately thirty tons, which allows an ample margin for friction in the working parts. While the plate is being sheared, it is held steadily against the bolster by three small hydraulic cylinders, which together exert a pressure of ten tons, and are bolted firmly to the front guide of the machine.

When equipped with this massive appliance, Messrs. Beardmore have it under consideration whether arrangements cannot be made whereby a mild steel plate of any dimensions and of thickness up to 2in. may be taken from the mill floor, sheared on all four edges, and deposited again on the floor, with the aid of only one man and a boy

There are two principal bar mills at Parkhead. One is a 22in. mill, with three-high roughing rolls, and lifting tables at front and rear, and two-high finishing rolls. Coupled direct to mill is the driving tandem engine, having cylinders 40in. and 30in. diameter, the working pressure being 60 lb. In this mill are rolled angles up to 7in. by 7in., bulb angles up to $8\frac{1}{2}$in. by $3\frac{1}{2}$in., channels up to 10in. by $3\frac{1}{2}$in., girders 9in. by 3in., tees 6in. by 5in., bulbs 10in., rounds and squares $6\frac{1}{4}$in., &c. The mill is served by six coal-fired heating furnaces. The other is a 10in. merchant mill with three-high roughing and finishing rolls and necessary guide rollers, driven by horizontal engine, 24in. cylinders and 22in. stroke, coupled direct to mill. This mill rolls angles with 1in. flanges up to 3in. by $2\frac{1}{2}$in., also rounds and squares, flats, channels, cop steel, nail strips, &c., of a like range of scantling, including Z-bars, 2in. by $1\frac{1}{4}$in. by $\frac{1}{4}$in. by $\frac{1}{8}$in., as supplied for the construction of the torpedo-boat destroyers.

At the present time Messrs. Beardmore are laying down a tire mill which, it is anticipated, will soon be in operation, and supplying a felt want in the Glasgow district where locomotive works abound. In connection with this class of manufacture, the steam hammer "Samson," as already stated, is being altered to serve for punching out the centre of the tires.

Coming now to speak of the production of armour-plates by the Harvey process, Parkhead has already been employed in their manufacture for some considerable time. Plates of this class, as well as plates of nickel steel, have been turned out in large numbers for many of the vessels now building or fitting out for our own and foreign navies. Casemate plates for H.M.S. cruiser Terrible and battleship Jupiter, and protective engine hatchway armour-plates for H.M.S. Venus, Diana, Juno, and Doris, have all been turned out. One of the complete casemates for H.M.S. Terrible is shown, as erected in the finishing-shop of Parkhead prior to despatching it to the builders, by Fig. 5. At the present time Messrs. Beardmore are engaged, amongst other "lines," upon the armoured casemates for the new first-class cruisers Europa and Diadem, being laid down at Fairfield and Clydebank.

The Harvey process, as carried out at Parkhead, may be briefly outlined before treating of any features in detail. A special ingot of the necessary weight—20 tons or 25 tons it may be—is cast from one of the open-hearth Siemen's furnaces. Never allowed to get positively cold, it is transported to the reheating furnace, situated alike near the cogging mill and the hydraulic press. To the latter it is conveyed on rails by steel bogie carriages. Supported in slings from an overhead crane serving the press, the ingot is rapidly, bit by bit, compressed in thickness. By bogie again it is then transferred to the reheating furnaces in connection with the plate rolling mill, where the mass is rolled out so as to allow of a clear plate being cut of the dimensions and thickness required.

From the plate mill the plate is again taken to the hydraulic press and perfectly flattened, from whence it is taken to the machine shop, and when cool, stripped of its rough surplus sides and ends. One of the surfaces of the plate is planed smooth preparatory to its being treated in the carburising furnace. There are four of these furnaces, charged from the top, and served by an overhead crane. Two plates are treated at once, being deposited with their planed surfaces facing each other, but with the bone and charcoal carbonising medium between. From a moderate temperature the heat is gradually increased until at a suitable degree it is maintained for a length of time—seventeen days, or perhaps twenty days—sufficient for the carbon to thoroughly penetrate the surface to a suitable depth. From the carburising furnace the plate is taken once more—if it should have to be bent—to the reheating furnace and press where the appropriate curvature is given, and thence to the machine shop to be planed and bevelled on sides and ends to something near its finished dimensions, and to have the necessary slotting done—if it be part of a gun casemate—and the holes bored and tapped for attaching it in its situation on boardship. Again subjected to a moderate heat, for a period probably of twelve hours or so, the plate is thereafter taken to the sprinkler or spray bath where its carbonised surface is chilled to the desired temper. The result is a surface of such hardness as to resist the cutting power of the hardest tools. The plate is afterwards trimmed to its correct dimensions and bevel by grinding under a special grinding machine. This and all the other machining operations are carried out in the machine shops which we describe further on.

The chilling bath, the reheating furnace from which the plates are taken prior to the chilling process, and the hydraulic forging press referred to in the foregoing, are all contiguous to each other, and have facilities in common for working them. The furnace has a draw-out bogie-built bottom on which the plates repose in the furnace, and are borne out to under the crane serving either the hydraulic press or the chilling bath. The hydraulic press is of 4000 tons capability, and was entirely constructed of Parkhead steel within the works. The gap admits of a 12ft. plate, and there are three hydraulic cylinders of 24in. diameter, the pressure in which—3 tons per inch—is supplied from large direct-acting pumping engines of Messrs. Duncan Stewart and Co.'s make. For serving the press, and at the same time so placed as to be capable of changing the rolls of the cogging mill, is an overhead travelling crane of 20 tons capacity of Messrs. Grieve and Co.'s make. Behind the press is a similar but heavier crane—40 tons capacity—by the same makers, which aids in the delivery side of the press, but whose principal duties consist in lifting the plates from the bogie in connection with the furnace for the reheating of the carbonised plates and depositing them in position on the supporting bars of the chilling bath.

The chilling bath proper is a shallow pit, brick encased and surrounded, bogie height, about 20ft. long by 10ft. in width. Across it, about ground level, are deep solid iron bearers for supporting the plate or plates to be operated upon. Below the level of these bearers is a bed of jet nozzles, pitched about 3in. apart each way. This bed occupies the entire space, but is fitted in sections of about 5ft. square, each section being controlled, as regards the ejection of water, by a separate valve so that the force and supply of water are concentrated through the particular section or sections above which the plate to be sprayed may happen to be placed. About head level, and running the whole length of bath, are side girders on which are carried two movable spray sections with nozzles similar to those underneath, also means for slinging the plate to be heated. The movable top spray sections or roses are supplied through flexible piping. The plate is deposited on the bearers with the carbonised side uppermost, and the spraying process is directed to both top and bottom surfaces simultaneously. The water supply to both top and bottom nozzles is from a storage tank of great capacity, supported on standards about 30ft. or 35ft. in height near the bath, and the water after use is pumped back into the tank by a powerful centrifugal pump of Drysdale's "Bon Accord" type.

Eclipsing all existing armour-plate plant, however, in interest and capability, is the hydraulic forging press of no less than 12,000 tons capacity which is now in course of erection in the works. This, it is believed, will be the most powerful press in existence, the one recently laid down by Messrs. John Brown and Co., of Atlas Works, Sheffield, being 10,000 tons. Mostly all the parts are being prepared by Messrs. Beardmore and Co. themselves, and in our issue for August 9th last, in connection with Mr. Riley's paper read before the Institution of Mechanical Engineers, we were enabled to give an illustration of the great cylinder pertaining to the press. This special casting of nickel steel by Messrs. Beardmore weighed in the rough sixty-four tons, and is probably the heaviest single piece ever cast of this material and afterwards machined to form part of an engineering production. Fig. 1 on page 140 shows this huge cylinder being cut to proper length in turning lathe. Finished, the cylinder will weigh forty-two tons, being 72in. diameter by 5ft. stroke. The height of the entire press above the ground level will be 33ft. 6in., the height under cross-beam will be 7ft., and the width between columns 15ft. The working pressure in the cylinder will be three tons per square inch, and there will be two return rams 14in. diameter, worked with a pressure of 750 lb. per square inch.

Power for this Titanic press will be provided by four double horizontal compound hydraulic pumping engines, by Duncan Stewart and Co., which will occupy a space 48ft. by 42ft. The cylinders will be 25in. and 43in. diameter, and the stroke 18in., the steam pressure being 100 lb. per square inch. The engines will run at 100 revolutions per minute, and work sixty-four single-acting pumps with rams $1\frac{1}{16}$in. diameter, made of Delta metal. For serving this mammoth press an overhead travelling crane of 100 tons capacity and 65ft. span has been prepared by Messrs. Shanks and Co., Johnstone. It will run on girders supported on massive steel built columns. The driving shafting is square, planed to gauge, and with a special scarph connection of new design. The crane is fitted with various special details for rotating the heavy ingots with which this stupendous press will be called upon to deal. A view of this crane temporarily erected is shown by Fig. 6, page 154.

For machining and finishing the various heavy items produced the Parkhead establishment, as has already been stated at the outset of this notice, is magnificently equipped; the re-arrangements and additions recently carried out, and still being made, being such as will fully cope with any likely further development of the system of supplying shipbuilders and engineers with completely finished items.

Apart from the older machine-shop, known in the works as the turning-shop, and which we briefly noticed in treating of the older forge department, to which it is contiguous, there are two new machine-shops parallel to each other, 200ft. long by 50ft. wide. They are lofty and are lined with white enamel bricks and copiously lighted from above. The first and older shop is served by a 40-ton square shaft-driven overhead crane by Shanks and Co., and the other by a 30-ton crane, with engine and boiler on the crab, by Messrs. Booth Bros., Leeds. At present we have only space to describe and illustrate some of the more powerful and interesting of the machine tools which the enterprise of Mr. Beardmore has successfully called into action.

The machines and plant recently, and at present, being laid down in connection with armour-plate production, embraces some of the heaviest and most perfect machinery of the kind yet made. To obviate needless iteration of the name, we may say in a sentence that almost the whole of the machines involved have been made by Messrs. Thomas Shanks and Co., of Johnstone. This firm were the original makers of the very massive armour-plate planing machine ordered by the Sheffield firms twenty years ago, but we are assured that this plant is entirely new, the machines having been designed and manufactured as the outcome of recent experience in France and America. While specially designed with a view to overtaking armour-plate work, the provision of heavy tools is, of course, adapted for general and lighter purposes. It will, therefore, be convenient to treat of the whole of the machines in the shops just as they occur in discharging the varied work they are called upon to undertake.

For dealing with plain shafting there are two heavy double lathes, 27in. centres, on one bed 84ft. long, and another over 60ft. long, fitted with two lathes in the same manner. These lathes—each with four cutting tools, and respectively capable of dealing with lengths 70ft. and 46ft.—were originally used, and are still, of course, capable of doing so if required, to centre-bore the long straight shafts, as well as turn them, until the special boring machine about to be described was designed for the purpose, and which has been a great success.

This special machine, which is constantly employed on shafts for the British and other navies, has two boring tools one working from each end, and by special arrangement progressing towards each other to meet in the mid-length of the shaft with the most absolute truth and exactness. This machine is capable of boring, at one cut, any sized hole up to 10in. diameter through the longest shaft ever yet designed. Amongst recent work overtaken by this machine is the propeller shafting for the Russian Imperial yacht Standart. This was in lengths of $60\frac{1}{2}$ft., and the hole bored through the centre was 9in. diameter. Inspection of the centre disc resulting from the operations of this machine tool affords striking proof of the marvellously exact work of which it is capable.

For dealing with crank shafts—articles of manufacture for which, as is well-known, Parkhead has long been celebrated—three of the heaviest patent quadruple geared double-bed lathes are used, fitted with special balancing details and Barrow's patent incutting slides. The smallest of these lathes, with 57in. height of centres, has a bed

9ft. 6in. wide and 42ft. long, the weight being over 60 tons. The largest lathe weighs over 100 tons, and has a bed 45ft. long. The middle lathe, Fig. 7, of 69in. centres—which we illustrate on page 166—has a double bed, 10ft. 6in. wide and 57ft. long, and is fitted with four massive saddles and rests, two working at the back by guide screw, independent of the two swivel compound rests at the front, which are worked by separate guide screws and shaft for surfacing. All these saddles are supplied with power movement, so that any or all may be moved either way at the rate of 10ft. per minute. A special feature in this trio of lathes is the width of the loose headstock, which in the particular lathe now under notice is 9ft. wide. This feature has been found of great value in securing round bearings, which in other lathes not steady in this respect are oval, owing mostly to the swing of the crank. The driving power is very great, and four heavy cuts are easily taken at the same time. Barrow's in-cutting slide is a massive steel casting overhanging between the crank webs, and self-acting either way, and reduces the time of finishing a crank-pin considerably. Still another feature is the ready mode of attaching L-shaped balance weights to the face-plate for balancing purposes.

This magnificent tool is capable of turning cranks and other shafts of the largest dimensions up to 40ft. in length. Our illustration on page 166, Fig. 7, shows this lathe dealing with a section of the double crank shafting for the Chilian cruiser Ministro Lenteno, now building by Sir William Armstrong, Mitchell, and Co., 19ft. 6in. in length, $15\frac{1}{2}$in. diameter, having an 8in. hole through centre. It is of interest to state further that on the occasion of one of our visits to Parkhead, this lathe was engaged upon a length of the heavy shafting for H.M.S. Powerful, of 20in. to 21in. diameter. The crank shaft for this vessel as finished and lying in the engine-shops at Barrow is shown by Fig. 8 on page 166. From this it will be seen that there are four similar and interchangeable lengths forming the complete shaft to each of the two separate sets of twin engines. The finished weight of each such sectional length was $6\frac{1}{2}$ tons, the rough forging from which they were made weighing $15\frac{1}{2}$ tons, while the ingots from which they were each originally fashioned weighed as much as 48 tons. The total length of shaft was 46ft. 8in., and a 10in. diameter hole ran through the centre. The finished weight of the complete shaft was $25\frac{1}{2}$ tons, while the total weight of ingots was 192 tons.

For slotting crank-webs there is employed one of the largest size of Barrow's combined slotting and planing machines hitherto made. The slotting stroke of this heavy tool is 6ft. and the vertical bed upon which it slides has an adjustment of some 4ft., so that the over-hang of the tool in slotting and planing is brought to the least possible limit. The planing movement is 10ft., and the total weight of the machine is over 50 tons. The two ripping tools are of section 9in. by 1in., and two grooving cuts are taken at one operation. This machine has proved of such great use in dealing with the peculiar form of the "tongue" in the casemate plates with which Parkhead has been engaged, that another and larger machine is nearly finished from the same patent and by the same makers. This immense machine has a 10ft. slotting stroke and a 12ft. planing stroke. The table is 10ft. in diameter, and the total weight 70 tons.

In planing machinery the shops are richly equipped. There are two of an exceptionally powerful description, which plane surfaces 10ft. 6in. square by 20ft. long, each having three tools. The side tool is balanced, and is moved up and down as easily as a 100 lb. weight. There are two grades of speed, and the total weight of each machine is over 90 tons. Another of these massive tools is in progress at the works of Messrs. Shanks and Co., Johnstone, 2ft. wider and weighing over 100 tons. One of these large planers is illustrated by Fig. 3 dealing with a truly stupendous item, a gun shield for H.M.S. Terrible, the rolled plate from which it was cut weighing no less than 25 tons. The bending of this plate to its conical shape with a different radius at top and bottom

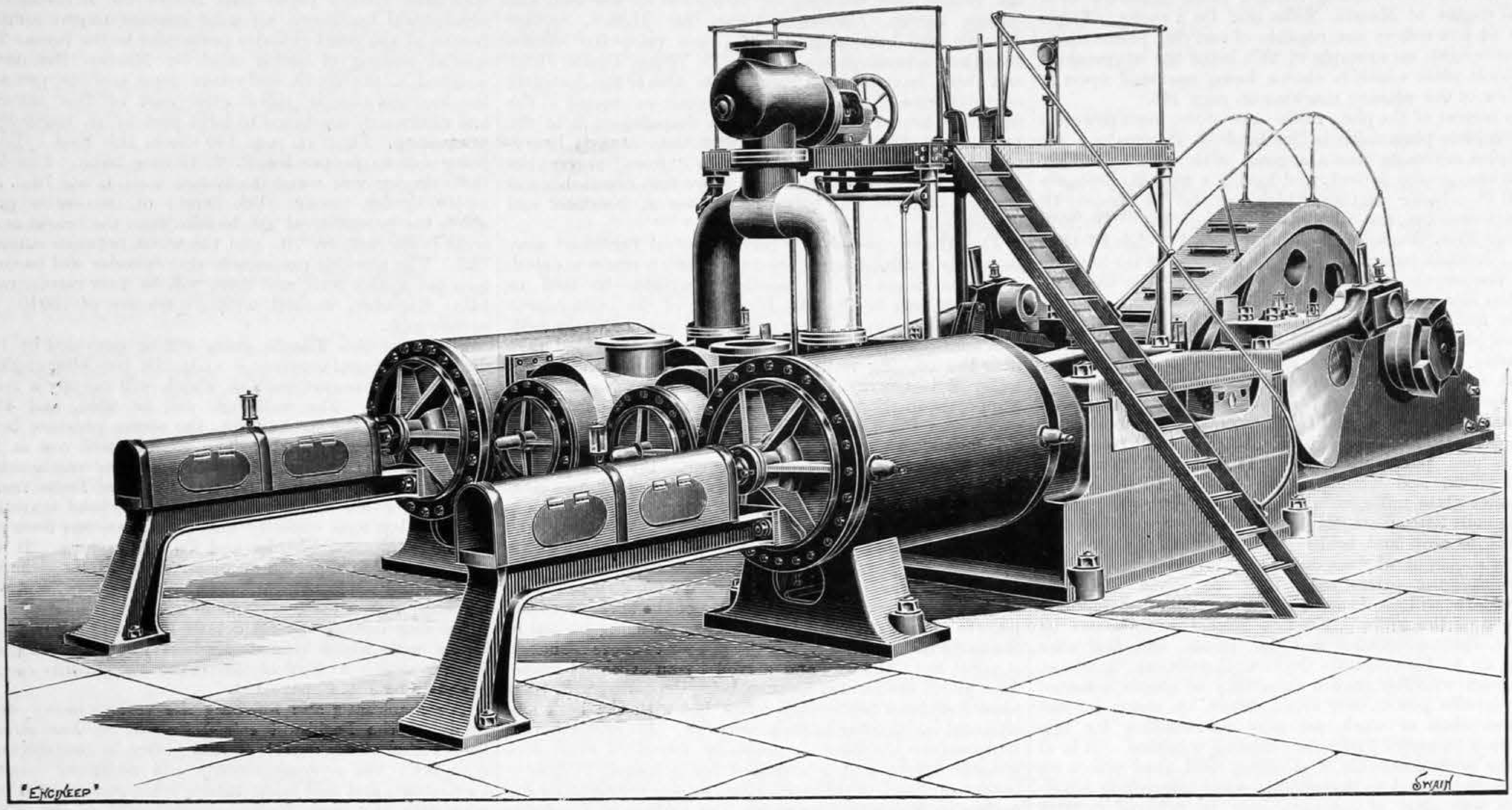


Fig. 4—REVERSING ROLLING MILL ENGINES, PLATE MILLS, PARKHEAD FORGE

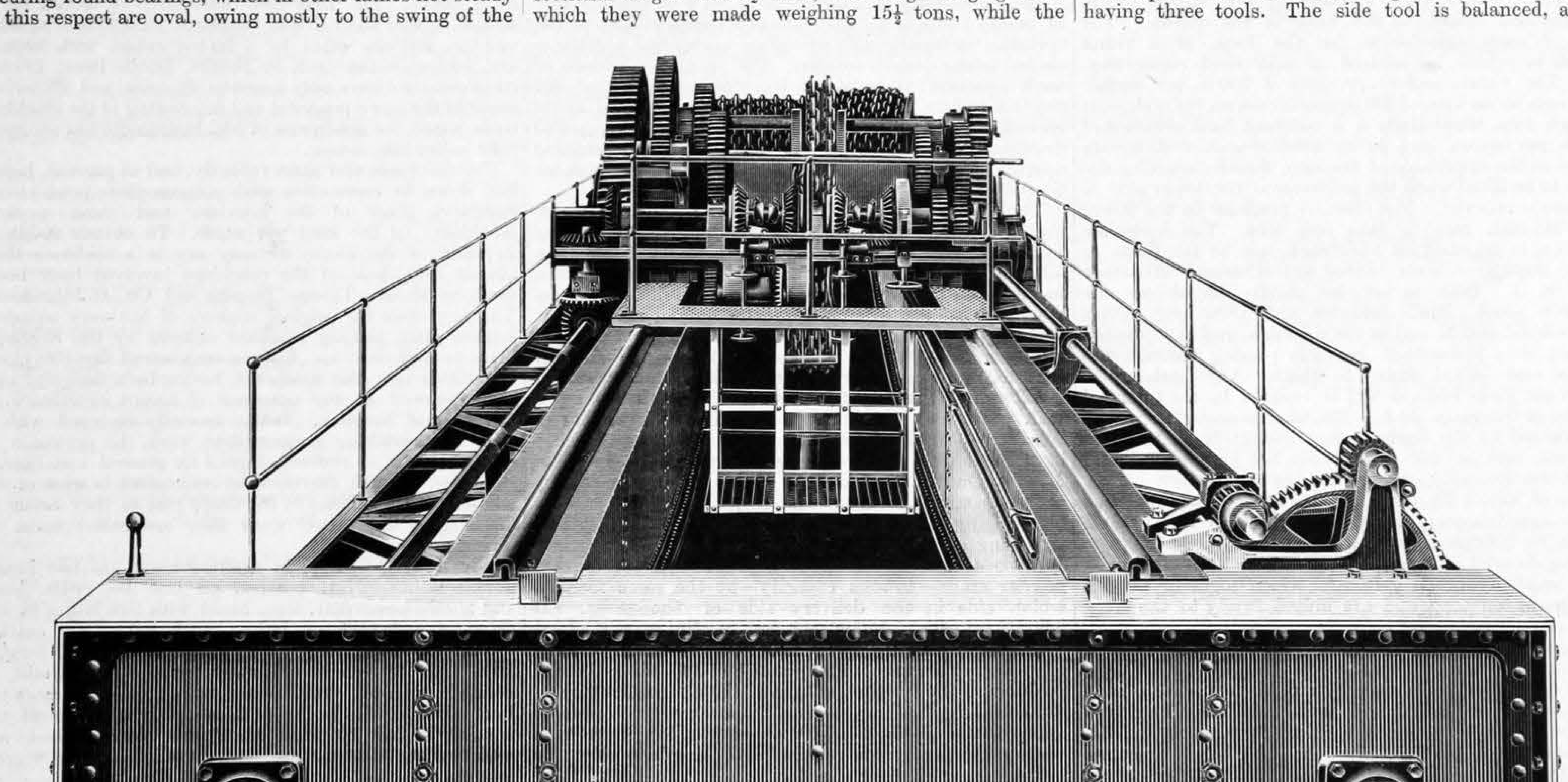


Fig. 6—100-TON TRAVELLING CRANE FOR SERVING FORGING PRESS

was done in the 4000-ton forging press, and is a striking illustration of what may be done in this direction. Besides these massive planers there is a smaller planing machine 7ft. between the uprights, and having four tools, one on each upright, and balanced as in the case of the larger planers. Sunk into the ground are massive guides, upon which two other guides are placed to receive the armour plates, while a very powerful standard and tool upon the bed is engaged in dovetail grooving, angling, and finishing the ends of the armour plates. A smaller planing machine with two tools and admitting work 6ft. square is used for planing crank webs. For boring out the holes in crank webs and the bolt holes in shaft couplings a double heavy boring machine with 5in. steel spindles is used, while for drilling and tapping the innumerable holes in armour plates a double boring machine with Barrow's patent driving gear is used, the range of the spindles being 20ft. by 10ft. high. This latter detail, it may be mentioned, has been found most effective as applied to radial drills by the same makers, and the rapidity with which these holes can be drilled may be judged from the fact that three of these machines have overtaken the whole work.

Any distortion that may be caused in the process of chilling the armour plates, or any fulness in size or shape that may remain, must afterwards be rectified by grinding machines. When it is considered that this must be done on a surface which is not only as hard as steel, but much harder, and that in some cases as much as $\frac{5}{8}$ths of an inch of this adamantine surface must be grooved away, the conditions to be met with will be understood. In accomplishing this the work is stationary, and a grindstone revolving at a high velocity moves over the surface to be ground. In addition to this there are parts to be ground away which can only be slowly done by emery wheels. The two armour grinding machines employed are of special design by the Johnstone firm. In the one for plain surfaces, the grindstone travels over 20ft. either way whilst rotating at a great velocity. The recesses and difficult parts are ground by emery grinders upon a second special machine with 30ft. bed, fitted with two work plates. The grinders are vertical and horizontal, and revolve at over 1000 revolutions per minute.

In the flanging shop, situated beyond the bar and the tire mills, there is another of the departments of Parkhead Works, in which every provision is made for dealing with the material of modern shipbuilding and engineering practice in ways which modern progress demands. For heavy plates, either for armour or for boiler building, there are to be found here a series of four ripping machines of powerful make. For dealing with the heavy plates which now enter into the construction of cylindrical marine boilers there is a set of massive vertical rolls of Craig and Donald's make. These are capable of dealing with steel plates, cold, 12ft. in width by $1\frac{3}{4}$in. thick. For flanging boiler fronts, and ends, and furnace mouths there are two of the heaviest make of Tweddell's hydraulic flanging machines. For planing the flanged ends of boiler plates there is a very capable machine, with an immense circular table, 22ft. diameter. On each side of the flanging machines here alluded to are heating fires of the most approved kind, the blast for which is provided by Root's blowers conveniently placed. The flangers and fires are served by hydraulic cranes of three tons capacity, while for serving the shop generally is an overhead travelling crane of 20 tons capability. The hydraulic power actuating the flanging machines here—the pressure being 1500 lb. per square inch—is provided for by engine pumps and accumulator in a power house adjacent to the flanging shop, the plant being of Messrs. Fielding and Platt's providing.

In addition to the branches of manufacture already indicated may be mentioned an extensive rivet works where large quantities of rivets, both iron and steel, are being turned out, of all the various sizes required in the construction of ships, boilers, and bridges, by a complete range of modern machines. There are also in the forge section special hammers and other requisite appliances for the manufacture of railway carriage axles and crank axles for locomotives, in both of which lines Parkhead does a large trade. There is an output capacity per hammer of twenty axles per day.

In the mechanical testing department, a necessity in all important modern steel works, are two of Buckton's testing machines of modern type constantly requisitioned in the determination of the qualities and characteristics of the materials produced in the works. Here also is arranged in intelligent series a most interesting and instructive collection of test pieces of various kinds, showing the wide possibility of high-class manufactured Siemens steel. One item conspicuous both for size and interest shown here is the wrecked connecting-rod taken from the engine-room of the s.s. City of Paris after the disastrous accident of August, 1893. This rod, from the extraordinary manner in which it is bent and twisted without showing the slightest sign of fracture, affords eloquent testimony not only to the severe ordeal through which it had passed, but to the high-class quality of the forgings then, as now, produced at the Parkhead works.

Needless to add, the works are lighted throughout by electricity, both on the arc and incandescent principle. The boiler power for the works is supplied by groups of boilers at various convenient situations. In all there are some 45 boilers, chiefly of the Lancashire type, of working pressures ranging from 120 lb. to 50 lb. Included in this number are two water-tube boi ers of the Babcock and Wilcox type of 100 lb. working pressure.

INSTITUTION OF NAVAL ARCHITECTS.—The annual meetings of the Institution will take place on Wednesday, March 25th, and the two following days, in the hall of the Society of Arts, John-street, Adelphi, W.C., by kind permission of the Council. The Right Hon. the Earl of Hopetoun, G.C.M.G., President, will occupy the chair. The annual dinner will be given on Wednesday, March 25th, at the Holborn Restaurant, High Holborn, W.C., at 7.15 p.m. The King's Hall has been engaged, which will afford ample accommodation. Evening dress will be worn.

CARBORUNDUM.

THE material discovered in 1890 by Mr. E. G. Acheson, and named carborundum, is now being made in quantity as a rapid-cutting, exceedingly hard abrasive. An interesting paper on the subject of its formation in the electric furnace was read some time since before the Franklin Institute, describing the discovery and the method of manufacture of this artificial material of diamond-like hardness. On October 19th last the largest electric furnace in the world was put into operation in the works of the Carborundum Company at Niagara Falls, N.Y. One thousand horse-power was at that time turned into their furnace from the power station of the Niagara Falls Power Company. The whole of the electricity produced by this power is caused to operate for twenty-four consecutive hours upon the crude materials contained in the furnace, or a total expenditure of 24,000-horse power hours. This is expended in operating on carbon and silicon. Less than two tons of carborundum is produced with the above energy, but the product is a material which will grind anything, and is now being used in diamond cutting. The production of this material was announced two or three years ago, and the Committee on Science and the Arts of the Franklin Institute, after careful and exhaustive tests on the merits of carborundum, concluded a report to the Institute as follows:—

"The results of these practical trials may fairly be summarised in the statements that the new material possesses remarkable properties as an abrasive, being the first artificial substance thus far produced which compares favourably with bort—diamond—in hardness, and which is capable of being used as a substitute for it; that when its peculiarities are better understood it should be capable of yielding cutting wheels of high efficiency to take the place of abrasives in common use; and that it should find general application in the arts wherever its price is not prohibitory. In consideration of the facts set forth, the Institute recommends the award of the John Scott Legacy Premium and Medal to Edward G. Acheson, for his discovery of a new and valuable artificial abrasive material.'

In his first experiment to find a means by which carbon could be crystallised, Mr. Acheson used an iron bowl lined with carbon, and filled with a mixture of carbon and clay. Into the centre of this mixture a carbon rod was introduced, and to it one of the wires supplying an electric current was attached, while the other wire was connected with the iron bowl. When the current was turned on the mixture was fused, and a violent chemical reaction appeared to have taken place. When the mass had cooled down it was opened and examined, with the result that a few very small crystals of a bright blue colour were found. In later experiments the iron bowl furnace was replaced with one constructed of refractory bricks, into each end of which extended a carbon rod, an electric apparatus was arranged for supplying and regulating a current of from 100 to 200 ampères, an alternating current being used. Mr. Acheson soon discovered that the crystals were not what he expected to obtain; they were not pure carbon. In colour they were usually blue, with a hardness sufficiently great to abrade the diamond. He was led to believe, from the materials, together with the colour, hardness, and general form, that the product was composed of carbon and alumina, so he coined the name carborundum from the words carbon and corundum. It was afterwards found that carborundum is a compound of carbon and silicon.

Carborundum is now manufactured from a mixture or fusion of sand, salt, coke, and sawdust, and the electric current is supplied to the furnaces of the company from the great power-houses at Niagara Falls and at Monongahela City, Pa. The furnaces are made of brick, four-sided; at the centre of each end wall there is a large bronze plate, to which four copper cables are connected. These cables convey the current. Through the centre of the mixture of sand, salt, and sawdust, a core of grains of coke is built which serves to make an electrical connection between the two terminals. When the current is turned on it soon raises this core to an enormous temperature, and a chemical change takes place, which produces carborundum. The current is kept on for twenty-four hours, and then allowed to cool down. On opening the furnace a ring of very beautiful crystals is found round the core, varying in colour from yellow to violet, and these crystals are called carborundum.

Being formed at an enormously high temperature, it is stable at all temperatures below that of its formation, and it appears to be capable of resisting many of the more powerful chemical re-agents. The only re-agents that appear to be capable of decomposing it readily are the caustic and carbonated alkalies in the state of fusion. In hardness, the substance approaches, if indeed it does not equal, the diamond, the hardest of known substances. The crystals are brittle, and are broken up into various sizes, numbered the same as emery; the numbers indicating the threads per lineal inch in the sieves through which they pass. When properly used, these grains are said to abrade any hard surface more than four times as rapidly as emery.

Where it is intended to glue the grains on belts, finer numbers are used than in the case of emery, as its sharpness causes it to cut so deeply into the metal that it may be pulled from the belt. Carborundum powder is graded by floating in water, and designated by the number of minutes it floats. It is used for glass grinding, brass valve and stop-cock grinding. For the latter it is said that one-eighth of an ounce of powder, mixed with oil or soap, is all that is required by one workman for a day's work. Carborundum wheels are made with either a vitrified or cement bond.

THE ELECTRIC DRILL FOR NAVAL CONSTRUCTION.

FOR some time mechanicians have turned their attention to the possibility of applying the power generated by electrical apparatus to tools, for the purpose of rapid drilling. Messrs. Siemens have constructed portable electric motors, running at various speeds from 900 to 1200 revolutions per minute; these motors being connected up to long flexible cables, associated with a powerful current form a dynamo, and being capable of rapid application to a vertical drill, which can be worked in any position within the radius provided by the length of the cables, and moved about from spot to spot as required.

This system has been very considerably developed within the past six months, having been adopted with remarkable success in the Royal Dockyards, and its application to the exigencies of warship construction seems likely to affect in a very material degree, the rate of speed at which vessels may be completed. Of course it is very well known that the main portion of the bolt holes in the skin plating of an iron or steel vessel are punched out by suitable machines in the machine shop where the plates are prepared; but there are bolt holes whose number is countless, the precise position of which cannot be ascertained until the frames, skin and bulkheads, &c., are put together, and it is the rapid piercing of these apertures that the electric drill is eminently suited to deal with. Hitherto the old clumsy system of drilling such holes with the ordinary brace and ratchet drill has been employed. This is a most laborious and tiresome process, involving the waste of many hours in the piercing of a few holes, if the plate is at all thick, and one of the most familiar sights upon a ship in course of construction is the patient driller, in some dark, almost inaccessible corner, doubled up over his brace, whilst he painfully scratches his way through the hard steel with his inefficient tool.

By the employment of the electric portable drill, however, all this difficulty is obviated. For ordinary work, when the plate to be bored can be detached for this purpose, the electric motor is suspended by a rope from a pulley attached to a convenient beam or temporary pole above, and the rope, which runs through the pulley, has a counterweight, consisting of a few pieces of pig iron at the opposite end. This enables the artificer to lift the motor up and let it down upon his work as he proceeds. In order to steady the motor over the plate to be drilled, it is passed under a standard, which screws up and down upon an upright, and this upright is fixed to a small portable bed upon which the plate is laid. The drill works at the rate of about 200 or 300 revolutions if put at full speed, but a far lower rate of working is generally employed, we understand about 70 or 100 revolutions. The same kind of electric motor drill is also employed for piercing vertical plates which cannot be detached from their position, should there be any suitable adjoining vertical wall which can be made use of as a purchase, a special tightening-up screw being provided; only in this case the motor is suspended from the side to the pulley above, and works of course horizontally instead of vertically. The standard and bed-plate are, moreover, not required.

But by far the most ingenious and practical application of the electric motor, as now in process of development for driving the drilling tool, is in the boring of a series of many consecutive holes, one after another, for the laying of deck plating, and in the cutting out of the butterfly-shaped pieces of plating, for ports for small quick-firing guns in the sides of a vessel. In neither of these cases can any "purchase" be obtained by the ordinary means to press the drill home. Even in the case of deck drilling, the tightening screw would have to be cast loose over and over again, and shifted from spot to spot, which would neutralise the value of the speed gained by the rapid working of the electric drill. One of the dockyard electricians has adopted a most satisfactory means for overcoming the difficulty in regard to "purchase." A portion of the electric current from the generating dynamo is diverted to powerful electro-magnets attached to the electric motor, and, by making the body of the vessel itself earth, the motor is made to cling to the deck or ship's side with such tenacity that the drilling tool works away just as though it had a tightening screw at its back, only much more steadily. For the pressure of the motor with its magnets is constant, as it is associated with elastic springs acting upon the drill, whereas a tightening screw presents a pressure which is always varying. For the vertical deck-drilling electric motor a sort of truck is provided to shift it from place to place, and when required to work, a small handle is turned which switches on the current, making the magnets—which are short stumpy legs—adhere to the plate required to be pierced. Another small handle switches the current on to the drill, which starts at once. The drill is stopped and the motor detached with similar ease. For drilling holes in the vertical walls of a ship outside, the motor with magnets is suspended from a pole alongside, a rope being merely passed over the pole to support it. The leg magnets in this case are, of course, directed horizontally, and the drill works horizontally between them. The motor is pulled along the pole with a pulley and another rope, as the work advances.

But one of the cleverest features of the magnet system remains to be described. Until recently two magnet poles were employed for the two short legs, one being positive and the other negative. But it was found that the purchase was an unsteady one, as the electric motor vibrated and wobbled a good deal, and the drilling was unsatisfactory. The idea was conceived that if three legs were employed, a steady base for the drill would be obtained. But how could one pole be used without the other for the third leg? Three legs were, therefore, contrived, each having the two poles complete in itself. Thus each of the three legs of the electric drilling motor is now an independent magnet, having a positive and a negative pole. The face of each leg has three concentric spaces. The inner circle composes the negative pole, the outer ring the positive pole, a concentric portion between the two being filled with insulating material. Thus a perfectly steady tripod is afforded, and there is no danger of the drill breaking by its cutting unevenly through the plate.

All these processes are as yet practically in their infancy, but it would seem as though the electric drill had a most important future. The system might be extended, with the aid of the tripod electro-magnetic contact, to slotting and planing, and we have little doubt that this will yet be accomplished.

"THE NEW LIGHT AND THE NEW PHOTOGRAPHY" is the title of a special issue of the *Photogram*, giving articles on "Early Work on Invisible Rays," by E. J. Wall and H. Snowden Ward; "The X Rays," from an article by Prof. Roentgen; and on the work of Mr. A. Campbell Swinton and of J. W. Gifford. It is pub ished by Messrs. Dawbarn and Ward.

THE ERIE CANAL.—Mr. George W. Aldridge, Superintendent of Public Works of New York State, in his annual report on the canals of the State, recommends that the rights of millowners to use the surplus waters along the canal be not renewed when their present leases expire, as the custom leads to great waste of water, endangering navigation, while the revenue derived from this source is infinitesimal. The gross tonnage of the State canals for 1895 was 3,500,134, of which 2,327,481 tons were toward tide-water, and 1,172,833 westward; 1,762,663 tons were through freight, the remaining 1,797,651 tons being for way points. The Erie Canal alone carried 2,356,084 tons, and the Champlain 966,335, the remainder being carried by the three smaller canals. Electrician Barnes, in his report to Mr. Aldridge on the electrical towing experiments of last fall, states his belief in the practicability of th's system of towing, but considers the overhead trolley system too cumbersome and costly, and recommends a direct towing motor running on a track on the towpath, the power to be applied direct to the boats, and boat owners to be charged a stated sum for the motor service, thus relieving them of all responsibility, with the excep. tion of turning on and off the service at their needs.

COMPOUND HORIZONTAL ENGINE WITH COLLMANN VALVE GEAR AT MONSTED'S MARGARINE FACTORY, SOUTHALL

MESSRS. JESSOP AND SON, LEICESTER, ENGINEERS

(For description see page 158)

THE LIFE OF IRON RAILWAY BRIDGES.

Is the statement which has been frequently advanced, that the life of iron railway bridges does not exceed the brief span of twenty-five years true? For a certain class of bridges, under certain conditions, the answer must unquestionably be in the affirmative. For another class of bridges, under different conditions, we are not disposed to accept this very restricted limit of longevity, and shall, we trust, be able to demonstrate that in this instance the reply must be in the negative. In order better to explain our meaning, we shall divide the structures under consideration into three classes. In the first will be included all those bridges which were faulty and defective in design, built of poor material, badly constructed, of very inferior workmanship, and maintained—if at all—in the most careless and perfunctory manner, or as frequently occurred, totally neglected. Those bridges, of which there are more remaining in a tinkered and patched-up condition than the public are fortunately aware of, were erected in the early days of railways; and although we must all plead guilty, both at home and abroad, through sheer ignorance at that time, to the first allegation, yet the others do not hold, or certainly not with the same force, for the people of different countries.

It is to this class of railway bridges that the American engineers, who admit, candidly enough, how numerous they formerly were in the States, apply the phrase "flimsy construction." On the Baltimore and Ohio line, all the iron bridges erected prior to 1878 have either been strengthened by additional metal, by extra girders, or temporarily supported by scaffolding pending reconstruction. Without claiming any undue or especial merit for the English bridge builder of bye-gone days, we think we may fairly refer to our article "The Cutter Bridge at Ely," in a recent number of THE ENGINEER, as a proof that so far back as half a century ago we did not build iron railway bridges of "flimsy construction." Foreign experience has also proved that in structures of the class referred to, an existence of twenty-five years, short as it appears, was a very fair life, for as often as not bridges succumbed before the full score was attained. We may now leave any further consideration of class one, and pass on to number two.

In the second category are included all bridges which are free from the defects belonging to their predecessors of the former class, have been designed in accordance with the most approved engineering practice at the time of their erection, well and substantially built, and adequately and efficiently maintained. There remains one more condition, and a very important one, that is, that the ultimate stresses upon the bridge should not exceed—beyond a fairly reasonable limit—in character or intensity those which it has been calculated to support without detriment to itself and without danger to the public. Could all these conditions be rigorously and faithfully enforced, a very considerably longer life might be expected to attend iron and steel railway bridges than a mere quarter of a century. Unfortunately a result so desirable is impossible of achievement, though we might certainly do more than is done, especially in the matter of maintenance, to bring about a closer approximation. In addition to ordinary wear and tear, which cannot be altogether eliminated, there is the inexorable *tempus edax rerum* to be reckoned with, which denies immortality to bridges as well as to mankind. The wear and tear of iron must not be judged by that of timber or other equally perishable material. Iron and steel do not carry within themselves the germs of self destruction. They are not like timber, the production of a natural growth, and thereby subject to a natural decay, which, although it may not seriously impair the absolute strength of the material for some years, yet causes it to become deficient in fibre, and consequently less able to resist the effect of impact. Iron and steel, on the contrary, when in the form suitable for construction, are the production partly of a chemical and partly of a mechanical process, and their subsequent deterioration, and possibly ultimate destruction, are due to influences from without and not from within. If the joints of a cellular flange are all carefully riveted up and well caulked, the ends similarly closed up, and the whole box, so to speak, made completely air-tight, corrosion will not ensue. In other words, the ordinary external influences are kept at bay, and prevented from exercising their usual mordacious powers. A remarkable illustration of this immunity on the part of iron from deterioration under these conditions was afforded by the removal of an old bowstring girder over Commercial-road. The inside plates, which had not even been given a protective coat of paint, tar, or any other preservative, were as sound, both in appearance and in reality, as when they were first built up. What would be the life of a bridge under the supposed favourable conditions we have assigned to class two there are no existing examples to determine. Another condition inseparably attached to all railway bridges past, present, and in all probability future ones also, upsets all calculation. It would nevertheless exceed the limit already referred to.

The third category, which is the most general, comprises those bridges which fulfil all the conditions belonging to those of the second class, with, perhaps, a larger margin for contingencies, but which are habitually subjected to stresses considerably in excess of those for which they were designed. It may be said that, without being guilty of a waste of material, an engineer cannot help this, and there is considerable truth in the remark. Every few years a notable increase takes place in both engine and train loads; and though it may be presumed that the absolute available cross section must ultimately put a limit to the engine load, no one could take upon himself to say what that limit might be, and when it would be reached. There can be very little doubt but that all railway bridges designed within the last fifteen years, although free from all avoidable defects, are daily and hourly exposed to stresses far exceeding their original limits. About this time—that is in 1880—the consolidation engines on one of the principal American lines weighed 54 tons. The present weight of the same type of locomotive is 80 tons, and it is proposed to use on the same railway an electric motor weighing 95 tons; if it is not already running over the tracks. A similar progressive increase, though not to quite the same extent, has attended the engine or live loads of the railways of every country. It is obvious that it is not fair to estimate the death rate of bridges, designed with a margin of reasonable proportions to carry 54 tons upon the results which are obtained when those same bridges are subsequently subjected to stresses amounting to 80 tons and upwards. As well might a registrar of the public health base his bills of mortality for the inhabitants of a district blessed with all the advantages of modern hygiene, upon the data procured from a locality notoriously deficient in the very first principles of sanitary science. To some degree, the engineer is placed upon the horns of a dilemma so far as railway bridges are concerned. If he does not allow a very wide margin for future contingencies in the shape of greatly increased live loads, he lays himself open to the accusation, when these contingencies do arise, of having made his bridges too weak. If, again, he recognises the necessity, or at any rate the advisability, of providing largely for future additional demands upon his bridges, he is equally liable to the charge of incurring a great waste of material. Is it any wonder that under such circumstances, bridges were designed with either low units of stress, or with a certain margin of extra strength and redundancy of metal, and then allowed to take their chance of being able to support the 50, 60, or more per cent. of additional stress that finally was brought upon them?

It is comparatively a very simple matter to ascertain if a bridge is quite safe, and equally so to discover if it is quite dangerous, but to determine the line of demarcation exactly where safety terminates and danger commences is frequently a difficult, delicate, and anxious investigation. It is moreover one which cannot be left altogether, as a rule, to the judgment of any one particular character or class of mind. The pure theorist would point to his calculations and figures, and unhesitatingly predict the certain collapse of the structure, if the actual stresses exceeded those he had allowed and provided for. As a matter of fact, experience and practice belie this theoretical assertion on nearly every railway in the world. Again, a simple practical man in the capacity of an inspector might detect some slight deformation in some one member of a truss, and honestly conclude that the bridge was in a dangerous condition; whereas the defect might be of no consequence whatever, and the bridge in a perfectly secure state. In order to arrive at a competent opinion respecting this apparently evenly-balanced question, a searching and rigorous inspection and examination of the existing structure is, in the first place, imperative. Secondly, the ultimate decision must be founded, in addition, upon an accurate knowledge of the amount and character of the stresses upon it originally provided for, and of those subsequently imposed. Thirdly, these two sources of information must be supplemented by a perfect acquaintance with the particular type of girder or truss under investigation, with the quality of the material and workmanship, and with the amount of the maintenance or negligence, as it may happen to be, which has attended the bridge since its erection. A certain amount of practical experience and ability in dealing with the subject must also be possessed by the official upon whose fiat depends the possibly fatal prolongation of the life of an already dangerous structure, or the condemnation of one which has still some years of useful duty before it.

It is a matter for regret in connection with the subject of our article that tubular bridges are now obsolete; box girders, except under especial conditions, are in the same category; and plate girders rarely available beyond the moderate span of a couple of hundred feet. All these varieties of the continuous web type have afforded the best record for longevity, and to them may be added riveted lattice girders with several, but not too many, systems or series of triangulations. There are numerous examples of bridges belonging to one or other of these examples in our own country which have far surpassed the quarter of a century allotted to them—the Menai Bridge, for instance. One reason assigned for their superior durability is, that the stresses due to both the dead and live loads, as well as to that inseparable but indeterminate function of the latter, termed impact, are more uniformly diffused over a larger portion of the main girders, instead of being concentrated, or, perhaps, preferably speaking, located over a comparatively few points. In the former case, the whole bridge resists *en masse*, as it were, the impact of the rapidly moving load, while in the latter, the effect of the shock has to be counteracted by a very short length of the girders, for it is an axiom that the dynamical effect of a moving load decreases as the separate members of the girders are more remote from those which constitute the locus of its application. In a continuously riveted web girder there are in this sense no separate members, any more than there are in a rolled joist. In estimating the life of a railway bridge, repairs and reinforcements, such as additional plates and rivets, are not to be regarded as terminating its existence, unless they are of such a character as to destroy the peculiar type to which it originally belonged. If a bridge built with pin connections be converted into one with rivets, we hold, as in the case of the Crumlin Viaduct, that its life terminates at the time of the conversion. The patching, however, of the lattice girder bridge carrying the London, Chatham, and Dover Railway over the Thames at Blackfriars, we cannot regard as a renewal, or as an interruption of the process of decay. While it is no doubt both the duty and interest of the engineer to prolong the life of his bridges, that is, to make them last as long as possible, the safety of the public is paramount to all other considerations. Iron and steel are cheap in comparison with human limbs and lives.

LOCOMOTIVE SERVICE.*

By J. H. M'CONNELL, Superintendent of Motive Power, Union Pacific System.

TWENTY-FIVE years ago a large portion of the freight and passenger traffic in the United States was handled with 16in. × 24in. cylinder engines. On a few roads with heavy grades 45-ton 10-wheel engines and 50-ton consolidation engines were used. The maximum load in a freight car was 20,000 lb., and to prevent loading cars beyond that limit a charge of double first-class was added to the excess. With an increase of freight traffic came the 28,000 lb. capacity car; this was very shortly followed by the 32,000 lb. capacity car. As new equipment was needed the 40,000 lb. capacity car was introduced, which for a time was considered as having reached the limit for freight cars. The 50,000 lb. capacity car followed, then the 60,000 lb. capacity car, while to-day we see occasionally a car with a capacity of 80,000 lb. The modern refrigerator car with its load and ice weighs about 100,000 lb.

The 20,000 lb. capacity car carried 300 bushels of grain; the modern box-car carries 1000 bushels of grain. Every part of the railroad equipment, the track and bridges, has been increased to keep up with the advance in the freight car. The same is true of the passenger equipment. With the 20,000 lb. car we had the sleeping car weighing 60,000 lb., and considered by many people entirely too heavy for the track. It is quite common now to see coaches weighing 80,000 lb. and sleepers weighing 100,000 lb. The 56 lb. rail was followed by the 60, 67, 70, 75, 80, 90 lb. rail, and 100 lb. rail is being laid on some of the Eastern roads. The locomotive, to meet the increased service, has grown from a 30-ton 8-wheel engine to a 60-ton 8-wheel engine; the 10-wheel engine from 45 tons to 70 tons, and the consolidation engine from 50 tons to 80 tons.

Notwithstanding the greater carrying capacity of the present equipment, the constant decrease in rates made by active competition causes less revenue to be derived from hauling a car containing 60,000 lb. of freight than was received in 1870 for hauling a car containing 20,000 lb. of freight. From 1870 to 1880 there was a decrease in amount of revenue per ton per mile of 48 per cent.; between 1880 and 1894 a further decrease of 50 per cent. Comparing the rate per ton per mile earned in 1870 with 1894, there has been a decrease of 74 per cent. The revenue derived from hauling a car containing 60,000 lb. of freight in 1894 was 22 per cent. less than that obtained from hauling a car containing 20,000 lb. of freight in 1870. The train expense is greater, the general expenses greater, and the entire cost of operating a railroad is greater than in 1870. A railroad of any importance that shows operating expenses less than 65 per cent. of earnings is accused of failing to maintain the property. The ratio of operating expenses to earnings of six railroads running into Chicago shows the following percentages:—65·86 per cent., 68·37 per cent., 72·80 per cent., 62·35 per cent., 57 per cent., 74·59 per cent.

Work done by locomotives.—The question is often asked if the modern locomotive moves as much tonnage in proportion as the smaller engine did twenty-five years ago. Old engineers frequently remark that the engines of to-day do not do the work in proportion to their size that the smaller ones did twenty-five years ago. Facts show that we are getting better work with the modern engine. Every condition is more favourable to the modern engine; we have greater weight on driving wheels, larger heating surface and increased steam pressure. Some records show a consolidation engine built in 1870 to have had 20in. by 24in. cylinders, a total weight of engine of 100,000 lb., with 85,000 lb. on driving wheels, 1500ft. heating surface in the boiler, and 140 lb. steam. A consolidation engine built in 1895 shows a great difference in everything except the cylinders, which are the same. The total weight of engine now is 150,000 lb., weight on drivers 137,000 lb., heating surface in boiler 2200ft., steam pressure 180 lb. The engine of 1870 hauled 24 loads weighing 528 tons, while the 1895 engine hauled a train of 35 loads weighing 1120 tons over the same division. The increase in passenger service is almost as marked. Twenty-five years ago, with a time schedule of 22 miles an hour, it would have been considered an impossibility to make an engine haul ten cars on a schedule of 40 miles an hour, yet it is now done every day, and these engines maintain a speed of 55 miles per hour between stations with ten cars. Have we reached the limit with the modern engine, and have we determined how much a locomotive can be made to earn for the company?

Tonnage rates.—The question should only be considered from one standpoint, that is, how much can we make the engine earn? To accomplish this—that is, make it earn all it can—the idea must be given up that an engine should run from 75,000 to 100,000 miles before it is taken in the shop. When freight engines are kept in service until they have made that mileage, the company is not getting the revenue the engines could earn. An engine in freight service should haul every ton of freight it is capable of doing, regardless of cost for repairs and fuel. When the performance is considered on a mileage basis, or with reference to how cheap it can be run, and how many miles it will make between general repairs, there will be frequent complaints made by the mechanical department of overloading, and an effort will be made to have the train reduced in order to favour the engine, so there can be a better average made on repairs and coal. After four years' experience with tonnage rating on grades ranging from 40ft. to 96ft. to the mile, it has resulted in a general increase in average number of cars per train. Where 22 loads was a train over some of the heavy grades, by the tonnage system frequently 26 cars are hauled with the same engine that hauled 22 cars for a full train. In another case, where 28 cars was a full train, a tonnage rating has increased the train to 35 loads with the same engine. It was supposed that 28 loads was a full train, and trainmen were of the opinion that the engine could not pull 35 loads, but after several tests it was demonstrated that the engine was capable of doing this, and no further trouble was experienced in hauling a train of 1100 tons.

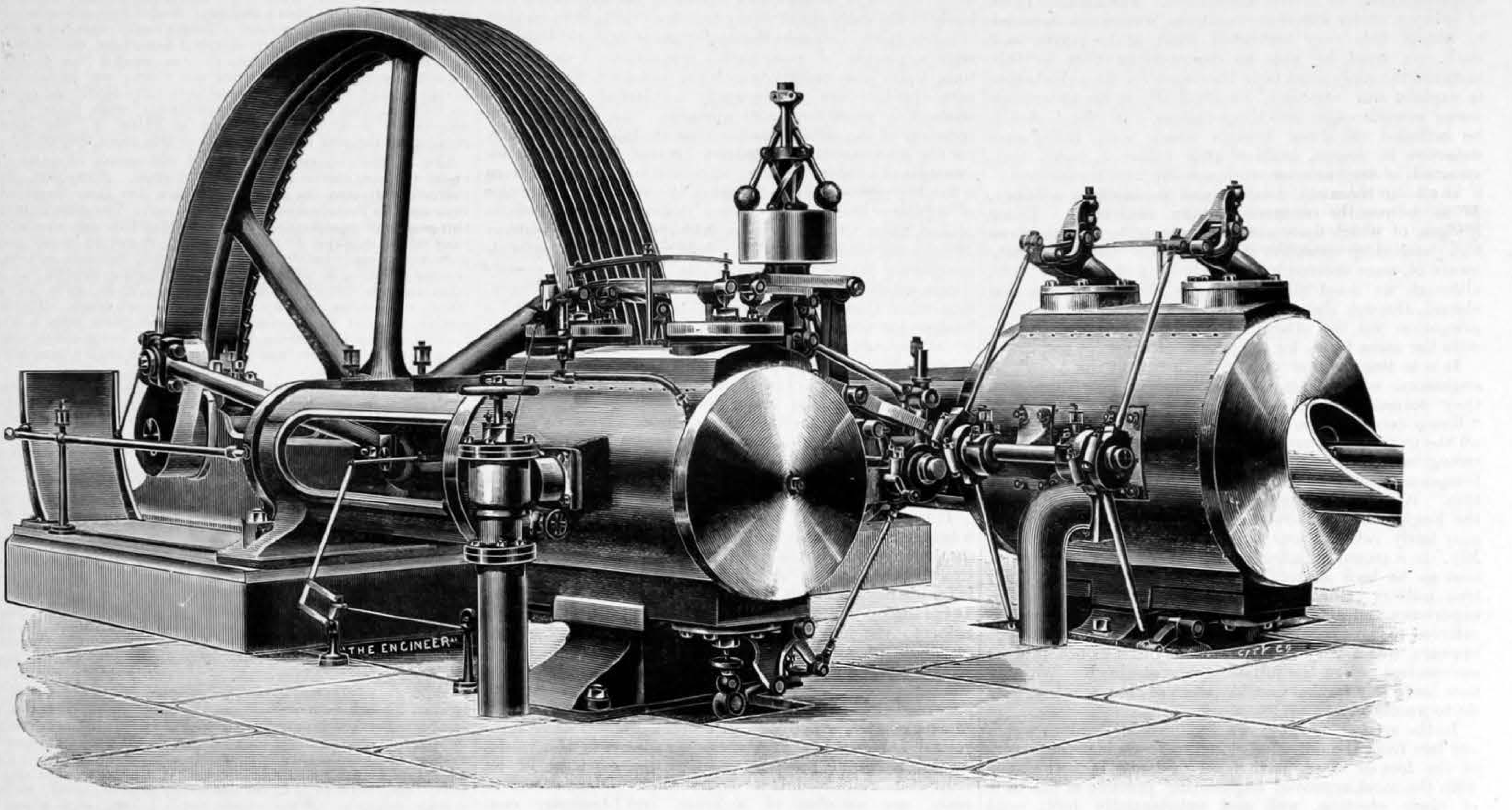
When we consider the service of a locomotive from the standpoint of what it can earn, and not what it costs per mile to run it, we will then begin to increase the number of freight cars per train and arrive at the question affecting the revenue of the company, and that is, the cost of hauling a loaded car per mile or cost of hauling a ton of freight one mile. There are very few roads in the West on which the train haul could not be increased on some of the districts. An increase of one car containing 20 tons of freight in each train will increase the earnings of a locomotive in one year 7200 dols., and the only additional expense would be 90 tons of coal. Taking the average of a locomotive at 3000 miles per month, or 36,000 miles per year, we have the revenue of 20 tons of freight hauled the same mileage at one cent per ton per mile, or 20 cents per mile per car. There has been no increase in the wages of the engineer, firemen, or trainmen, or for repairs. The only extra expense has been 5 lb. of coal per train mile. Taking the average tonnage per car for the year on six Western roads, which is 11·44 tons per car, the locomotive can earn on this basis 4118·40 dols. per year for the company more than it did before. By keeping the engine in first-class condition at all times, I believe every locomotive in freight service on our Western roads can be made to earn at least 4000 dols. more for the company per year than at present; and the expense will not be increased except for fuel at the average rate of five pounds of coal per car mile.

Reports of performance and cost.—The monthly statements of locomotive performances sent out by railroads, when compared, show a wide difference in cost, and unless the conditions of making them up are known the comparisons are unsatisfactory. Some roads allow engines only actual mileage between terminals, regardless of length of time making the trip. Should the train be delayed several hours by switching or meeting trains, no mileage is allowed. In helping service the engine is only credited with

* A paper read before the Western Railway Club.

COMPOUND HORIZONTAL ENGINE, WITH COLLMANN VALVE GEAR

MESSRS. JESSOP AND SON, LEICESTER ENGINEERS



actual mileage. While the crew will receive a day's pay, the engine may make but thirty miles in twelve hours.

It is the practice of a number of roads to allow constructive mileage to all engines in passenger and freight service. Some roads add 10 per cent. to the mileage, as it is claimed to make up for the coal and oil used in taking the engines from the roundhouse to the train and in leaving the train and being put in the roundhouse. In addition to this they are allowed ten miles per hour for switching or lay-outs on the road. Where overtime is paid the engineer, the engine is given mileage to make up for it. By this system of watering mileage a locomotive report is made to show a good average on coal and oil and low cost for repairs and a large individual engine mileage, when the actual cost is 10 per cent. to 15 per cent. greater than that shown by the report.

Taking the annual reports of some Western roads, considering the freight engine mileage with freight car mileage, they show the following percentages of freight engine mileage to freight car mileage:—

4·06 per cent.	4·24 per cent.
4·76 ,,	5·35 ,,
4·37 ,,	5·32 ,,

The combined mileage of passenger and freight trains compared with the engine mileage in same service shows following percentages of engine to car mileage:—

8·78 per cent.	7·76 per cent.
7·57 ,,	11·29 ,,
7·44 ,,	6·48 ,,

The following gives number of cars per train when figured on same basis for all the roads:—

18·80	20·09
18·66	17·73
23·60	24·66
22·86	

There is no uniformity in rating trains. One road rates two empties as one load, others three empties two loads, and others five empties three loads. A train of 10 loads and 20 empties under these systems would be called respectively 20 loads, 22 loads, and 24 loads. But the showing on paper would convey the impression that one road was hauling a greater number of cars per train than another, when there is a probability that the road showing the smaller train was moving the same tonnage.

Following this matter still further, the average tonnage for a loaded car for the year on the five roads shows:—

12·87 tons.	14·40 tons.
9·09 ,,	12·26 ,,
9·84 ,,	

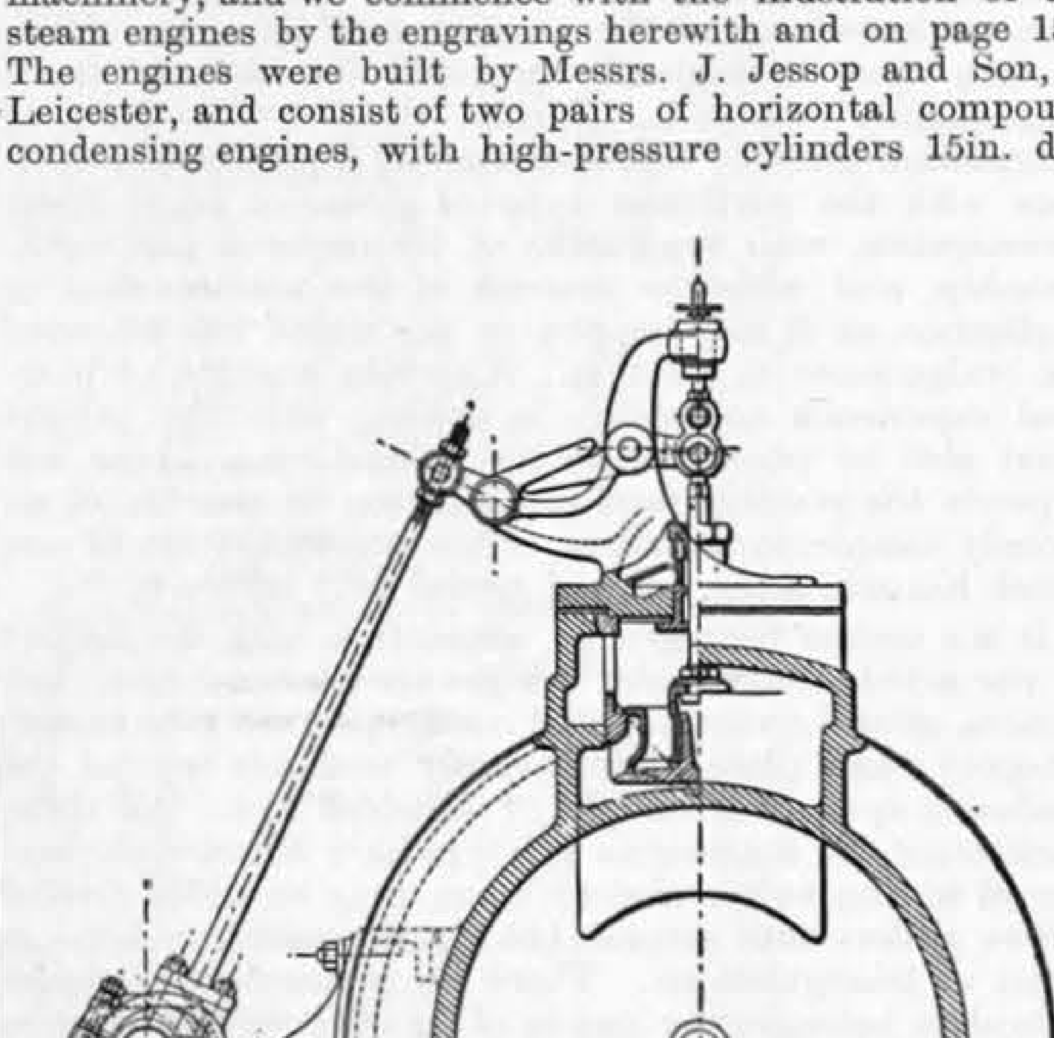
With such a variation in the manner of allowing mileage and rating trains, no satisfactory comparison can be made, and until all roads show the cost of moving a loaded passenger and freight car one mile, locomotive performance sheets will be of little value for comparison.

How to increase revenue.—The problem of to-day with decreased rates is to haul greater tonnage in each car and reduce the cost of doing it. The revenue of a railroad is derived from the service rendered by its locomotives. To increase the revenue the locomotives must do more work. The tendency is to increase their weight and size, and there is not enough attention paid to getting increased service of those now owned. The freight earnings largely exceed the passenger earnings, and by directing efforts to hauling increased tonnage the revenue is increased without any great increase in operating expenses. The weight of a train over a division is usually determined by the amount of tonnage an engine can haul over certain grades. In nearly every case increased tonnage can be hauled if the mechanical and transportation departments work together. An increase in the steam pressure of 5 lb. will, in many cases, take one more car over the grade.

When the mechanical departments of our railroads give the same attention to increasing the train haul that they do to making a showing of how cheap they can run the locomotives per mile, they will find they have obtained increased service from the locomotive, decreased the cost of hauling a ton of freight, and increased the revenue of the company. The problem of to-day is, how much does it cost to haul a ton of freight one mile, not what it costs per mile to run your locomotives.

MONSTED'S MARGARINE MANUFACTORY, SOUTHALL.

WE commence this week the illustration of the engineering features of the fine new margarine factory of Mr. Otto Monsted at Southall. The manufactory comprises many features of interest in connection with the steam and refrigerating machinery, and we commence with the illustration of the steam engines by the engravings herewith and on page 156. The engines were built by Messrs. J. Jessop and Son, of Leicester, and consist of two pairs of horizontal compound condensing engines, with high-pressure cylinders 15in. diameter; low-pressure, 28in. diameter; with a stroke of 36in. They are designed for 120 lb. boiler pressure, and run at a speed of 70 revolutions per minute, each pair indicating with an economical load 200-horse power. The cylinders are steam-jacketed with protected end covers. The air pumps for each pair have double plungers working vertically, as shown on page 156, and driven by rocking lever from tail rods of low-pressure cylinders; the plungers are 14in. diameter, and have a stroke of 16in. The condensers are jet condensers, placed vertically, and the outflow or delivery from air pumps is received in tanks placed a few feet above, whence it flows by gravity to the cooling pond some distance away. Suitable valves are fitted for working the engines high pressure when desired. The fly-wheels are 14ft. diameter by 1ft. 9in. wide, grooved for eight 1¾in. diameter ropes. The cranks and crank shafts are steel, and the crank pins of Whitworth's fluid compressed steel, with phosphor bronze steps in connecting rods. The connecting rods are 7ft. 6in. centres, and the cranks are set at 90 deg.



Transverse Section of Cylinder with Colman Valve Gear

The valve motion is the well-known Collmann patent valve gear, previously described and illustrated in our pages, and of which Messrs. J. Jessop and Son are the sole licensees in England. The arrangement of the valve gear is shown on the longitudinal elevation, page 156, and by the transverse section annexed, which is taken through the valves of the high-pressure cylinder. The action of the folding levers, the lower one of which opens the valve under the resistance of a spring, is exceedingly quiet, and in every way satisfactory. The steam valves are double-beat equilibrium valves, and are placed on top of cylinders with exhaust valves underneath. The governor is high-speed type, the automatic expansion being variable within very wide limits. The cut-off in low-pressure cylinder is variable by hand while the engine is running, and the valve gear gives excellent results in working. The wearing parts are very strong and of large area, and similar engines to those under notice have been running for many years with very little attention. Over a thousand engines fitted with Collmann patent valve gear are at work on the Continent and in England.

KING'S COLLEGE ENGINEERING SOCIETY.—On Friday, January 31st, Mr. Mowat gave his presidential address, Mr. Herroun, F.I.C., in the chair. Commencing with a few remarks as to the advantage of regularly attending the Society's meeting, the author passed on to the consideration of railways. The methods of acquiring land for railway purposes, and the requirements of the Board of Trade, was followed by a description of the permanent way, in which the different appliances, such as rails, sleepers, chairs, check-rails, fish-plates, &c., were described in detail. Passing on to the subject of signalling, the author described the working of a semaphore and the use of auxiliary and fog signals, and then dealt with the block system, taking the train staff and ticket systems as an example of the working of a single line. With regard to the rolling stock, he referred to the coupling of the wheels of the locomotive and to passenger carriages and goods trucks, pointing out the advantage of bogies and describing the carriage wheels and continuous brakes. Before bringing his remarks to a close, the author referred to the extraordinary growth of traffic on British lines, which necessitates the adoption of many precautions, often insufficiently appreciated by the public.

ENGLAND LEADS IN THIS ONLY.—"There is not perhaps a larger market for any mechanical device of which a need is felt than for a small gas and gasoline engine. The mechanic, says the *Scientific Machinist*, who will build a 1-H.P. fairly efficient gas engine, and sell it at about the cost of a 1-H.P. steam engine, will secure a trade of very large proportions. If he should be able to realize a fair profit on each sale—and otherwise it would be dangerous to engage in that or any other business—a large fortune could undoubtedly be built up in a few years. The question is often asked, why are Americans, who in most matters of enterprise generally have no superiors, so backward in the use of gas and gasoline engines? And it is a pertinent question which no one can answer. The English lead us in this line of work, and perhaps this only. They adopt our steam engine and boiler designs, machine tool designs, and have modified much of their engineering work in various branches along the line of American ideas, but they are our masters, in the design of gas engines. Not only this, but our manufacturers are either so egotistical or fossilised that they see nothing of the kind, admit no part of the truth, and apparently care nothing about doing their plain duty by their customers and to maintain America's reputation. They are even lacking in Yankee adroitness, or they would at least copy some of the good English designs." The writer of this might have added just one thing more, namely, the oil engine, and by that one point be more correct, for the American gas engines will work.

STEAM ENGINE MAKERS' SOCIETY.

THE seventy-first annual report of the Steam Engine Makers' Society is being issued this week, and Mr. James Swift, the general secretary, in his introductory address, congratulates the members on the very satisfactory results of the past year's operations. The number of admissions had exceeded those of any previous year, the total increase of members had shown a like result, and notwithstanding a depression in trade, with an extended unemployed list, several extensive disputes, and a heavier list of sickness than in any previous year, the capital value was a record that had never been attained before. All this had been achieved without any excessive tax upon its contributors; and if proof were wanted upon this point, it was to be found in the limited number who had lapsed their membership, or given up their connection with the Society.

The compilation of the report is on similar lines to those of previous years, the income and expenditure of each branch being given in detail, and carried forward to abstract tables, from which is compiled the summary balance of the Society's entire work. These show that the balance at the end of 1894 stood at £28,826, and that the expenditure for 1895 had been £17,366, leaving the Society with a cash balance on December 31st, 1895, amounting to £30,478, or an average of of £4 6s. 1d. per member. The total number of members at the close of the year was 7085, and the number of branches 101, of which 98 are in the United Kingdom, one in the United States, one in Canada, and one in Queensland. The net result of the year's work was, an increase of two branches, 405 additional members, after allowing for deaths and exclusions, and an increase of capital amounting to £1651, without taking into account the arrears owing, or any valuation of the Society's stocks, or goods, or other property. In comparing this year's report with its predecessor, the total income of £19,018 is more by £1443 than that of 1894, and this increased income has been due chiefly to the lesser number out of employment, who, not being in receipt of donation, became contributors for the time being.

Turning to the expenditure, Mr. Swift remarks that while there are points for pleasant reflection, there are others that cause matter for serious consideration for some time to come. The most satisfactory feature in the expenditure is the reduction in the amount paid for donation to unemployed. In 1894 it was £8250, or £1 4s. 8½d. per member; but this year's report only shows £6009, or 16s. 11½d. per member, being £2240 of a decrease, and Mr. Swift is sanguine that the year on which we have now entered will be even more satisfactory, as, apart from present signs that the average period of bad trade had spent itself, they might look forward with less anxiety as to employment for members than has been the case for the past three years. The total payment for sick benefit had, however, been larger than in any former year, being £4068, as against £3324 in 1894. The greater part of this sum was paid in the spring of the year, and in a great measure appeared to have been the result of the long frost, as in March the number of members in receipt of sick benefit went up to double the normal number. Fortunately the advent of milder weather restored the great majority, and death did not claim more than the average number, the sum paid for funeral allowance being £1170, or only £72 in excess of 1894.

Superannuation again showed an increase, and to such an amount that should tell them they did not take up this matter any too soon, and that if they were to be true to themselves they would have to do even more in the future. The payments last year had amounted to £3208, as compared with £2830 in 1894, and the present worth of the superannuation fund now stood at £11,648, having increased by interest £350 during the year. The payment for miscellaneous or working expenses had amounted to £12,036, being equal to 5s. 9d. per member, or 11¾ per cent. of the total expenditure, a smaller average than on any former occasion.

In former reports Mr. Swift has alluded to the suggestion by some that trade societies should confine their work to combatting the capitalist, leaving the providing of benefits for sickness, old age, funerals, &c., to the friendly societies. Turning to this question again, he says, that "although it is but some five years since this theory was advocated, its being put into practice has not shown lasting results. Few, if any, who have adopted this principle, have shown any staying power, but so soon as the first excitement appears to have passed, and contributions had to be paid with no immediate return, the membership lapsed. As evidence of this, and what may be called the rise and fall of new unionism, as run upon these lines, we may say that in 1890 there were five societies who then made returns of membership, giving a total of 266,000. By the latest returns the same five societies have fallen to a membership of 54,700, and trade unionism is weaker by over 211,000 in these cases than it was five years ago. Had, however, in our opinion these societies been financed to provide some benefits, however small, other than strike pay or management expenses alone, we believe they would still have been a power in their separate industries. Societies like our own were derided for attaching benefits of a friendly nature, but events have proved that our forefathers were wise in their generation when they adopted the principle which we of the present generation have done our best to extend and consolidate. Whilst we are prepared for peace, we are, at the same time, prepared for war. We have capital to meet our con-combatant members' claims, whilst we have it to defend our position if the capitalists become the aggressors, or causes arise that call for action to be taken."

Referring to the recent dispute in the shipbuilding industry, Mr. Swift remarks that "Much has been written within the past four months in relation to this strike and lock-out, and much of it might have been left unsaid. The statement that the action of the employers was for the purpose of stamping out trades unions is an old cry, but almost out of date. We do not think that there is more than a very limited number of employers who have even the desire to do so, much less the thought that such a result is possible. There may be exceptions in single cases, and the exception may be made in that of the Belfast employers, who arrogantly refused any return of previous reductions in wages. To this no exception could be made had they stood alone, but the Clyde employers, figuratively speaking, did not stay to inquire whether it was a free fight or a family quarrel, but rushed into the fray by closing their works in sympathy with the wealthy firms in Belfast. Having done so they can now at their leisure count the cost. Their private ledger showing the loss on production will certainly be a sealed book to themselves, but to the public it will be known that the Clyde workmen secured an advance that would most likely not have been at present asked for, seeing that only a short time before they had accepted a compromise on wages, and this had not even been paid before they were locked out. Having locked out their own men, other centres were asked to federate and make common cause with them in their own rash policy. Fortunately the other centres were more rational, and although it was understood they were full of sympathy, their inaction showed they were at least human, and would not turn adrift old employés to cover the rash action of the Clyde employers, who in the long run had to concede an advance beyond what the men had previously agreed to accept. After this experience it is doubtful if the Scotch Employers' Federation will resort to such an expensive experiment again. The disputes named have been an object lesson in other than the disaffected districts, as our list of admissions fully proves. It has had the effect of recommending combination, as the action might have been taken in any other locality; hence the desire to be prepared. The newspapers giving prominence to the question, young men have been anxious to be part of an organisation, offered themselves as candidates, paid the entrance fees, not waiting for a conflict, and then looked to trade unionists to support them. This desire is still manifest, and it rests with present members as to how far they will assist in securing a benefit to the Society by the many who are now open to be canvassed and initiated."

WATER IN HERTFORDSHIRE.

THE water supply of districts round London opens many questions of considerable difficulty, and as a contribution to the problem of the supply by wells the following letter by Professor W. Boyd Dawkins, F.R.S., F.G.S., Assoc. Inst. C.E., will be read with some interest:—

The feeling that the wells proposed to be constructed by the New River Company, and for which they are applying to Parliament for powers, will do injury to the surface in the upper valley of the Lea, is so general among the inhabitants of Hertfordshire that it will not be out of place for me to discuss the question as to whether it be well founded or not. I propose, therefore, to lay before your readers (1) what has been done in the area under consideration, (2) what it is proposed to do in the future, and, lastly, to see from the experience of other similar areas of chalk from which large quantities of water have been obtained, whether the surface has been damaged by the deep wells. For this inquiry the report of the Royal Commission on the Water Supply of the Metropolis (1893) offers a convenient basis.

(1) The daily average amount of water pumped during 1891 by the New River and East London Companies from deep wells sunk into the chalk in the area of the Lea to the south of Ware, irrespective of the supply from the river Lea itself, which does not concern us, as it cannot affect in any way the surface waters above the intakes, amounted to about 11 million gallons per day. Does this abstraction of water, coupled with the quantity drawn from private wells, affect the surface waters of the district? On this point the divergence of opinion among the witnesses examined before the Commission was so great that an assistant commissioner was sent, in company with the engineer to the Hertfordshire County Council, to collect independent evidence, and to verify the alleged facts on the spot. The result of his inquiry, as embodied in the report of the Royal Commission dated September, 1893, are as follows, viz.:—"I am unable to find in the whole of the evidence, and in the arguments produced, a single item which is at all strongly in favour of the theory of permanent depletion; while there are many most convincing arguments in support of the theory of seasonal change. Taking the oral evidence as a whole, it is shown that the source of no river which has been examined is at the present time, or was in 1891, at a point lower down in the valley than it had been at some previous period before 1875, and Mr. Topley says there was a belief in the depletion of the rivers, &c., in or about 1868, a time of great drought, and, it may be added, a time longer anterior to the date at which the Lea Valley Companies began to pump any material quantity of water. For the reasons recorded above, with the information derived from the tables of rainfall and percolation, and from the river gaugings, along with the general evidence, I am of opinion that there is no proof of any permanent depletion of any river, well, or spring, except from local causes; while there is conclusive evidence that the changes recorded, where not produced by local pumping or the undue extension of watercress beds, are seasonal; that they have occurred to at least as marked a degree in years gone by, and before 1875, and that they will occur again."

This conclusion was accepted by the Commissioners in the following terms:—"We are of opinion that we are not justified in believing that the pumping by the New River and East London Companies has actually and in fact produced as yet a permanent appreciable depression of the water levels in Hertfordshire and the upper part of the Lea Valley, although such pumping may temporarily affect to some extent the height of water in wells in the immediate neighbourhood of the companies' works. That these companies can continue to increase the quantity pumped from the chalk with equal immunity until it has reached five times the present 'take' we are not prepared to say, as will be seen later on. We think there can be no doubt, although Sir John Evans does not agree, that water is constantly passing in considerable volume from the north and north-west to the south-east under the pumping stations in the Lea Valley, and ultimately finding its way into the bed of the Thames some distance below London." It is obvious, therefore, that no mischief has been done as yet to the surface waters of the Upper Lea by pumping from the existing deep wells, and that the current idea that the general level of the water in the district has been lowered by pumping is without foundation in fact.

(2) The New River Company's Bill makes provision for obtaining a further supply of 12 million gallons from six wells in the sparsely populated area around Hertford and Ware. Will these wells injure the surface? The first point to be noted is the fact proved before the Commission, that the deep subterranean water in the chalk finds its way ultimately into the lower reaches of the Thames, and into the sea, in vast volume through the general mass of the chalk underneath the valleys and without touching the surface, and that therefore the quantity pumped out of a given deep well does not represent the number of gallons abstracted from the nearest surface stream, but that obtained from the general body of water in the chalk, of which the surface streams form a small fraction. Within the limits of a letter it is impossible to carry this line of inquiry further. It is sufficient for our purpose to quote the following conclusions from the report of the Commissioners, viz., that "During a succession of wet years no doubt more than 56 millions will be available," and that, "An average daily supply of 40 million gallons can be obtained from wells and springs in the chalk of the Lea Valley without affecting any material interests." The additional 12 millions sought for brings up the total yield to about 23 millions, leaving a margin of from 17 millions in dry seasons to 33 millions in wet years for further requirements should they arise.

(3) The last point to be considered is the effect of heavy pumping from deep wells on the surface in other districts in which the conditions are the same as in the area of the Lea. It may be measured by the effect of pumping on the valleys of the Cray and the Darenth, and the wells of the Croydon area on the surface waters. The area of chalk available for the supply of the Kent Waterworks amounts to about 132 square miles, and the actual amount pumped from it in 1891 was 13½ millions, without counting the numerous private wells established on the banks of the Thames, some of which yield as much as 1,800,000 gallons a day. The only result has been to lower the water level close to the pumps. The general effect on the agriculture of the district is nil, and Kent still remains the garden of England. The chalk area of the Lea is more than twice as great as this area, and, consequently, the percolation into it is more than twice as great. In the light of this experience, it is idle to suppose that the addition of 12 million gallons to the yield of the existing wells would affect the surface in the Upper Lea, except by lowering the water-line close to the wells during pumping.

In the case of Croydon the experience is practically the same. In that small district the amount of water obtained from deep wells has been steadily increasing during the last twenty years without any effect in lowering the general level of the water in the chalk. The observations of Mr. Walker, ranging over a period from 1883 to 1892, prove that there is only a seasonal fluctuation without permanent depression. There is no reason to believe that the sinking of the proposed wells in the valley of the Lea will cause other effects that those experienced in the two above-cited cases, and if local damage of any sort be done, it will no doubt be fairly met by the New River Company. There is, in my opinion, water in abundance, both for the local needs and for the deep wells in question. If anyone doubts this, let him refer to the report of the Royal Commission, and the evidence upon which it is based.

LEGAL INTELLIGENCE.

AT THE ROYAL COURTS OF JUSTICE, CHANCERY DIVISION.

4th February, 1896.

(*Before Mr. Justice* STIRLING.)

THE BLACKPOOL GREAT WHEEL.

GRAYDON V. BASSETT.

IN this case the plaintiff was described by his counsel as an American gentleman, who had served in the United States cavalry, and had devoted a great portion of his life to applied science. He had, in September, 1893, taken out a patent in this country for a gigantic wheel or vertical "roundabout," and was also the inventor of a dynamite gun, which, it was alleged, was a great success. It was under a licence from him that the Great Wheel at Earl's Court was erected, in accordance with his patent, in 1894 and 1895, and which was worked during the summer of 1895 and very extensively patronised. The work of erection was carried out by Lieutenant Bassett, R.N., the defendant, who was connected with the firm of Maudslay, Sons, and Field, the well-known engineers. Under an agreement of date 10th August, 1895, defendant acquired the sole right of constructing these wheels in the United Kingdom and France, on terms to be settled, from time to time, between himself and the patentee, provision being made for reference to arbitration in the event of dispute.

The plaintiff's case was that in the autumn of 1895 he found that the defendant Bassett had negotiated with a company who were owners or lessees of certain pleasure grounds at Blackpool, and had entered into a contract for the erection of a great wheel there. There had been previous communications with a view to an agreement, according to which Lieutenant Graydon was to get £5000 for his licence for the Blackpool Wheel, but those negotiations came to nothing.

Mr. BUTCHER, who with Mr. BOUSFIELD, Q.C., and Mr. KIMBER, appeared for the plaintiff, stated that investigations that had been made with regard to the Blackpool Wheel disclosed the fact that it was in all substantial respects similar to the Great Wheel at Earl's Court, and that if it were constructed it would be in violation of the plaintiff's patent. He, therefore, claimed an injunction restraining the defendant Bassett and the Blackpool Company from erecting the wheel, except in accordance with the licence of August 10th. Defendant had admitted that he had entered into the contract for the erection of a Great Wheel at Blackpool, but suggested that it was not being constructed in accordance with the plaintiff's patent; but upon comparison of the designs, as well as on the testimony of experts, it appeared to be absolutely identical with the patented design. The defendant further suggested that the plaintiff's patent was not valid, but he—Mr. Butcher—submitted that a licensee was estopped from raising a question of that kind.

Mr. JUSTICE STIRLING observed that if the plaintiff's case rested on a grant to the defendant of an absolute licence there could be no injunction, the only question being what was to be paid for the use of the licence.

The case occupied the whole day, and was adjourned to the next day, and at the conclusion of the arguments Mr. Justice Stirling postponed his decision.

On the 6th Mr. JUSTICE STIRLING delivered judgment. He said the action was brought by the owner of a patent for improvements in revolving vertical wheels for amusement and other purposes, and was brought to restrain alleged infringement, or, in the alternative, to restrain breach of an agreement between the parties, dated August 10th, 1895. In October, 1893, there had been an agreement by which Bassett, who was a partner in the firm of Maudslay, Sons, and Field, the engineers, by which Bassett was to have sole right of manufacture in the United Kingdom and France of wheels and towers, in accordance with Graydon's inventions, and on the 4th November a similar right was given through Bassett to the Gigantic Wheel and Recreation Towers Company, within the district under the control of the London County Council. That company erected the Great Wheel at Earl's Court. In August, 1895, disputes arose between Graydon and Bassett, and cross-actions were brought which led to the agreement in question, by which Bassett was to have, subject to the agreement with the Great Wheel Company, the sole right of constructing in the United Kingdom and France, wheels, towers, and other works, in accordance with plaintiff's patent. In September, 1895, negotiations took place between plaintiff and Bassett with relation to the Great Wheel at Blackpool, but the parties were unable to come to terms. Then Bassett appeared to have entered into negotiations with the Blackpool Winter Gardens, Limited, for the construction of a wheel on land of which they were owners, and after an exchange of letters this action was instituted to restrain the defendant from erecting the wheel except in accordance with the agreement of 10th August. The defendant denied that the intended wheel was to be constructed in accordance with the plaintiff's patent, and he also disputed the validity of the patent on the ground of want of utility and want of novelty. It was contended that the defendant, being a licensee, was not entitled to question the validity of the patent, and the argument had been limited by the Court to the question of construction. In his—the Judge's—judgment, the plaintiff was right in his view that the agreement gave Bassett the sole right of using the invention for the purpose of construction only; but it seemed to him that no case had been made out for the interference of the Court. The defendant had, according to the plaintiff's admission, a licence to construct wheels according to the patent; but there was no evidence that Bassett intended to use this wheel when it had been constructed—and, indeed, it seemed that he intended to get up a company to work it. The case, therefore, on the present materials failed. This issue determined but a very small item of the controversy that had arisen, and he should be glad to give favourable consideration to any suggestion for facilitating the trial of the more serious question of the validity of the patent. He dismissed the action without costs as regarded Bassett, but with costs as regarded the Company.

COMPOUND HORIZONTAL ENGINE WITH COLLMANN VALVE GEAR AT MONSTED'S MARGARINE FACTORY, SOUTHALL

MESSRS. JESSOP AND SON, LEICESTER, ENGINEERS

(*For description see page 158*)

RAILWAY MATTERS.

A DEPUTATION, under the auspices of the Light Railways Association, waited upon Mr. C. T. Ritchie, M.P., President of the Board of Trade yesterday—Thursday—at noon, to advocate the promotion of legislation for the construction of light railways under an improved system of procedure and regulations, and with the assistance, in certain cases, of financial aid from the Government.

MESSRS. RUCHONNET AND DUMUR, representing the Jura-Simplon Company, have arrived in Rome, to discuss with the representatives of the Italian Government some points which remain to be settled in the conventions for the definitive construction of the line through the Simplon, which is to be carried out by the Governments of Italy and Switzerland, each on its own territory.

MR. THOMAS ROBERTSON, general manager of the Great Northern Railway of Ireland, has been appointed to the chairmanship of the Irish Board of Works in place of Lieutenant-General Sir R. H. Sankey, K.C.B., who retires under the sixty-fifth year rule. Mr. Robertson took up the general managership of the Great Northern Railway of Ireland in April, 1890, and the railway has since advanced with signal success, and now occupies a position of great prosperity.

AN extraordinary if not unique accident happened on the 10th inst. to William Stevens, an engine-driver on the North British Railway, while driving an express train from Carlisle to Riccarton. As the train was approaching Longtown at high speed, the lid of the sand-box was blown off, and, rising in the air, was shot through the spectacles of the engine, and struck Stevens on the head with great force. He was seriously injured, and is now in the infirmary at Carlisle.

THE London and North-Western fast train leaving Carlisle at 5.38 p.m. had a narrow escape on Wednesday from being wrecked in a cutting between Grayrigg and Oxenholme. As the train was running through the cutting a huge boulder was rolled over the edge of the rocks above, and it smashed against the side of the train, two carriages being badly damaged. No passengers appear to have been hurt, but the affair caused much consternation. Detectives are investigating the matter.

AT the annual general meeting of the shareholders of the London Street Tramways Company, held at the Cannon-street Hotel on the 6th inst., the chairman Mr. A. F. Fry, said they had carried 13,987,820 passengers during the year, showing an increase over the previous year of 1,370,037, while the percentage of working expenses to receipts showed a decrease of 2·10 compared with 1894—an altogether satisfactory return. The miles run by their cars during the year totalled 1,314,711, or an increase of 50,464 miles over the miles run during the previous year. The amount earned per mile run had beeen 12·67d., or an increase of 0·08 over 1894. The cost of forage showed a decrease of £615, and they recommended a dividend of 4 per cent.

AN official notice has been given by the Bute Docks Company of their intention to withdraw the deposited Bill for next session. The Bill, which was regarded as the great Bill of the coming session, sought powers to enable the Bute Docks Company to construct over forty-nine miles of railways in connection with their docks at Cardiff. These railways were to be constructed principally along the beds of the Glamorganshire and Monmouthshire canals, and would thus have enabled the dock company to enter into direct railway competition with the Taff Vale Railway. The amount of share and loan capital required for this scheme was £1,330,000. The withdrawal of the Bill is understood to have been decided upon in order to facilitate the passing of the Bill for the amalgamation of the undertakings of the Bute Docks Company and the Rhymney Railway Company

IN the report to the Board of Trade on the accident which occurred on the 5th December last at Ballynahinch junction, on the Belfast and County Down Railway, Major Marindin says:—"Now the collision under consideration would not have occurred had the automatic vacuum brake been operative on the passenger vehicles at the tail of the train, and the inquiry has elicited the fact that the Belfast and County Down Railway Company are not only ignoring the order in regard to the proportion of brake vans in their mixed trains, but are deliberately acting in direct contravention of their undertaking (quoted). This is a matter deserving the Board's serious attention, for although such undertakings, the acceptance of which enables the Board at times to make certain valuable concessions to railway companies, are, to the best of my belief, honestly acted up to as a rule, it becomes a question, in view of this case, how far they should be accepted in the future." The undertaking referred to was given under the seal of this Irish company; no wonder at the unequivocal remarks by Major Marindin.

A BOARD of Trade report by Major F. A. Marindin, R.E., has been published on an accident which occurred on December 26th, near St. Pinnnocks Viaduct, between Doublebois and Bodmin-road, on the Cornwall section of the Great Western Railway. In this case, as the down mail train which left London for Penzance at 9 p.m. on December 25th was running down the incline between Doublebois and Bodmin-road at about 5.44 a.m., the engine, tender, and the leading carriage left the rails, the engine, after running across the 6ft. way and along the side of the longitudinal timbers of the up line, coming to a stand in a distance of 170 yards from the point where it left the rails. No person was injured, and there was not very much damage done to the rolling stock. Major Marindin says that the accident, which would probably have been a serious one if it had not been for the excellent service done by the continuous brake promptly applied by the driver, and stopping the train about 107 yards short of a high viaduct, was due to a portion of the rocky slope on the south side of the line slipping down on to the line shortly before the train passed.

AT the fourth half-yearly meeting of the Waterloo and City Railway Company on the 6th inst., held in the Board-room at Waterloo terminus, the directors' report showed that the expenditure during the half-year amounted to £62,321, making the total outlay £122,736 at the close of December last. Since the report was issued they had received a statement from the engineers which gave a most interesting account of the progress that had been made. It stated that towards the City the tunnels on July 22nd last were about 100 yards Citywards of the river Thames. They had now reached a point in Queen Victoria-street, nearly opposite St. Nicholas Church, the distance driven in six months being 530 yards of double tunnel. These tunnels had been driven under the low-level sewer, the Metropolitan Railway, and Queen Victoria-street, without mishap, in the solid London clay, and the rate of progress was 73ft. per week. The smaller, or railway, tunnels were now 400 yards distant from the commencement of the City station, which would probably be reached in June, 1896. Towards Waterloo the tunnels were, in July last, entering Stamford-street, but as they had encountered ballast and water, and had to work under compressed air, the progress was much slower. Average distance of tunnels from the crossing of the Waterloo-road, about 120 yards; present rate of progress, only about 23ft. per week; length of double tunnel driven in this direction since the last half-yearly report, 300 yards. The contracts for the Waterloo low level station had been let at the engineer's estimate, and the works had been commenced. Total length of single tunnel driven since the commencement of the works, 3036 yards, being 69 per cent. out of the total length between the Waterloo station and the City station.

NOTES AND MEMORANDA.

AT the last meeting of the Berlin Physical Society Professor Des Coudres made a communication on kathodic radiation, and demonstrated its sensitiveness to magnetic lines of force.

ACCORDING to the *Mittheilungen* of the Verein Deutscher Eisen and Stahl-Industrieller, the total outturn of pig iron in Germany, including spiegeleisen, forge, Bessemer, basic, and foundry pig, and also castings run directly from the blast furnace, amounted last year to 5,788,798 tons against 5,559,332 tons in 1894, showing an increase of 229,476 tons.

ONE of the first surgical operations in which the diagnosis has been made by means of the Röntgen rays was performed in Berlin last Sunday. The patient got a piece of needle into her hand two months ago, and suffered very severe pain. With the help of a Röntgen photograph the exact position of the fragment was ascertained, and the operation was perfectly successful.

IN a paper on "Dark Light," before the Paris Academy of Sciences, by M. Gustave Le Bon, it is described how an ordinary photographic dry plate, placed under a negative in a printing frame, and the negative closely covered with a thin plate of iron, was exposed to the light of a paraffin lamp for three hours, and after prolonged development brought out a faint but well-defined image. If a plate of lead was wrapped round the back of the frame, and bent over the edges of the iron plate so as to enclose the printing frame in a metallic box, after three hours' exposure to the same source of light, an image was obtained "which was nearly as vigorous as if no obstacle had been interposed between the light and the plate." M. Le Bon proposes to continue the study of the properties of light after its passage through opaque bodies.

THERE are about sixty-three cement works in the whole of Germany. The Rhine is the principal centre for this manufacture, but in the neighbourhood of Hamburg there are three or four in operation for the production of the article. The annual production of Germany amounts to nearly 11,000,000 barrels, giving employment to some 1800 hands, whose annual earnings amount to some £698,780. The largest customers for this article in Europe are Russia and Norway, and of transatlantic countries, the United States, Brazil, Chili, and Venezuela. The exportation to Great Britain and British Possessions is comparatively small. The following table gives approximately the quantity and value exported to European and other countries:—Norway, 58,500 cwt., £6700; Russia, 34,353 cwt., £2900: United States, 1,386,872 cwt., £168,000; Brazil, 446,340 cwt., £40,200; Chili, 131,000 cwt., £13,000; Venezuela, 103,000 cwt., £9800.

PROFESSOR NEESEN described recently to the Berlin Physical Society two interesting strokes of lightning, one of which pierced the roof of a church tower unprovided with a conductor, and stopped short at the organ. Its effects were characterised by the rents it made in the inside of the church above the organ, similar to those observed in a tree when struck. The second struck a petroleum store, whose four tanks were each protected by five-pointed conductors adequately put to earth. Two of the tanks were completely shattered by a violent explosion, the other two burnt out by fire. The speaker was of opinion that the petroleum vapours above the tanks had been ignited by small sparks during the discharge, and he had verified this view by experiment; he therefore proposed that, for the purpose of adequate protection, all openings, more particularly manholes, should be guarded by wire netting, on the principle of the Davy lamp.

GREAT BRITAIN is still the largest producing country of tin ore in Europe, although her ore only contains on an average about 2½ per cent. of metal, requiring much washing and concentration. As regards Europe, observes the report for 1895 of the Liège Chamber of Commerce:—"For a long while past tin has only been worked to a profit in the mines of Cornwall, Saxony, and Bohemia; and latterly new lodes have been proved, some of which already make considerable additions to the general production. Some deposits have been found in Spain, in Gallicia, and especially in Orense, these deposits continuing into Portugal; and, during the last few years, tin has been mined near Oporto and Braganza. France possesses a few tin mines, but their ore is poor, and the Montebras mines in La Creuse are no longer worked for tin ore." If the other countries make no more profit from the working of tin ores than is now made in Cornwall they will soon close some of their workings.

IN one of the Fine Art Society's galleries Professor Herkomer is exhibiting a series of some thirty specimens of a new process of his own invention, by means of which autograph sketches by an artist can be indefinitely reproduced by copper-plate printing. The process is simple. According to a description published in the *St. James's Gazette*, the design to be reproduced is painted by the artist upon a plate of copper surfaced with silver; the pigment used is black and oleaginous; its composition a secret of Professor Herkomer's; the painting is transparent, the silver ground being left for the high lights, and only semi-obscured in the half-tones. When completed the design is granulated by sprinkling it with a powder which adheres to the plate in varying densities corresponding with the tones of the design. From the plate so granulated in relief a matrix in intaglio is obtained by electrotyping, and this can be put into the press and printed like an ordinary copper-plate.

ACCORDING to the latest returns for the year 1893-94 regarding the expenditure of the highway authorities in rural districts in England upon main roads and ordinary highways, the sum spent was £1,992,786. The amount raised by rates to meet this outlay was slightly higher than it has been since the whole cost of maintenance was thrown on the County Councils in 1888-1889, although it is less than the old rate. The rateable value of the highway districts and separate highway parishes was £52,683,540, and as the amount raised was £1,520,510, the average charge was equivalent 6·9d. in the pound. The aggregate length of the roads under the supervision of highway boards and surveyors of highways in England and Wales—excluding 14,697 miles of main roads repaired by the County Councils themselves—was 105,330 miles. Main roads cost on an average from £45 6s. to £72 16s. per mile to keep in repair every year, and ordinary highways from £14 6s. to £19 10s. a mile.

THE topographic and hydrographic survey of Chatham county, Georgia, which was started in 1890, and afterwards discontinued, has, *Engineering News* says, recently been resumed by placing a large corps of engineers in the field. The object of the survey is to establish a basis from which the work of draining large areas of swamp land can be carried on. The whole of the county lies but little above water level—the highest point being but 60ft. above mean low water, as established by the U.S. Coast and Geodetic Survey—and with proper ditching and the construction of tide-water gates much land now valueless might be used for farming purposes, and particularly for rice growing. As a basis of operations a principal meridian and parallel were run, crossing each other at the City Exchange, of Savannah, Ga., and dividing the county into four unequal parts. From the intersection as a zero point meridians every 3000ft., and parallels every 2000ft. run, with a transit, and then levels taken. Meander lines are then run along roads, streams and swamp lines. The surveys being transferred to topographic sheets, give lines of drainage with great accuracy, and enable the location of the tidal gates. A part of the county has already been ditched and drained and further and quite extensive work will follow the present surveys. The work is done by the County Commissioners, who use convict labour mostly. M. Geo. W. Brown is chief engineer, and Mr. Hayward Ranuel is assistant engineer.

MISCELLANEA.

THE Administration of the Province of Amur is adopting measures for the development of steam navigation between the port of Vladivostock and the ports of China and Japan.

THE British Association of Waterworks Engineers has been formed, and the address of the Association is, we are informed by the secretary, Palace-chambers, 9, Bridge-street, Westminster, S.W.

THE Sheffield Gas Company has intimated a reduction in the price of gas of 2d. per 1000 cubic feet to all classes of customers. The benefit to the consumers of gas will be £15,029 per annum, and to the Corporation for public lamps £1241 per annum.

AMONG the measures which have been prepared, and will be submitted by the Government this session, is one for facilitating the construction of light railways in the United Kingdom, and for amending the law with respect to the supply of water to the metropolis.

THE death took place, on Saturday, of Mr. John Gunter, of Middlesbrough, who was at one time works manager of Messrs Dorman, Long, and Co.'s Britannia and West Marsh Iron and Steel Works, Middlesbrough, and afterwards of Sir Theodore Fry and Co.'s Riso Carr Ironworks, Darlington.

THE *Gazette* of the 11th inst. publishes an Order in Council, dated the 8th inst., rescinding the regulations of January, 1893, relating to the screening of ships' side-lights at sea, and reviving in its original form Article 3 of the regulations contained in the schedule of the Order of August 11th, 1894.

WE are requested to state that the arrangements are now complete for lighting in the evening the "Southern Galleries" of the South Kensington Museum on the west side of Exhibition-road, which contain the collections of machinery and naval models. These galleries will be open free to the public from 17th February on three evenings a week—Mondays, Tuesdays, and Saturdays, till ten p.m.—in the same manner as the main building.

IT is stated that the Niagara Falls Power Company, on January 14th, accepted the grant approved by Mayor Jewett, and that it may be expected that within a year or so, electric current, generated by the Niagara Falls, will be transmitted to Buffalo for lighting and power purposes. The contract entered into, which covers a term of sixty-six years, requires 10,000-horse power to be furnished on or before June 17th, 1897, and an additional 10,000-horse power per year for four years thereafter.

THE librarian of the Patent-office of the United States of America is making a collection of illustrated and other trade catalogues, price-lists, circulars, and other similar publications for reference by those instituting inquiries in regard to patents, designs, and trade marks, or making use of the Patent-office library. In reply to a letter from the London Chamber of Commerce, urging that a collection of illustrated and other trade catalogues, price-lists, and similar publications should be made and filed in our Patent-office library, Sir H. Reader Lack, the Comptroller, has written that the nucleus of such a collection was formed some twenty years ago, and has since that date been gradually extended. In view, however, of the suggestion of the London Chamber of Commerce, he will be happy to consider how far it may be possible to render this collection more complete, and to make it more easily accessible for public reference.

THE economy of electricity as a means of power in connection with mining engineering was well illustrated at a meeting a few days ago, at Mason's College, Birmingham, of the South Staffordshire and East Worcestershire Institute of Mining Engineers, when Mr. L. Meachen, jun., supplemented his paper, read at a former meeting, on the new electric power plant at Haden Hill Colliery. This plant has now been at work about six months. The total cost of the installation was £2289, while a steam plant would cost £1089 less; but, on the other hand, they had the advantage of light, and a saving of £73 per annum in candles, and a saving of £30 per annum in lights on the bank. Altogether there was a saving of £102 per annum. Taking other considerations into account, the result of the change was a net reduction of cost equal to 3½d. per ton, or on the output £40 per week. The cost of abour in connection with the installation was ·47d. per ton.

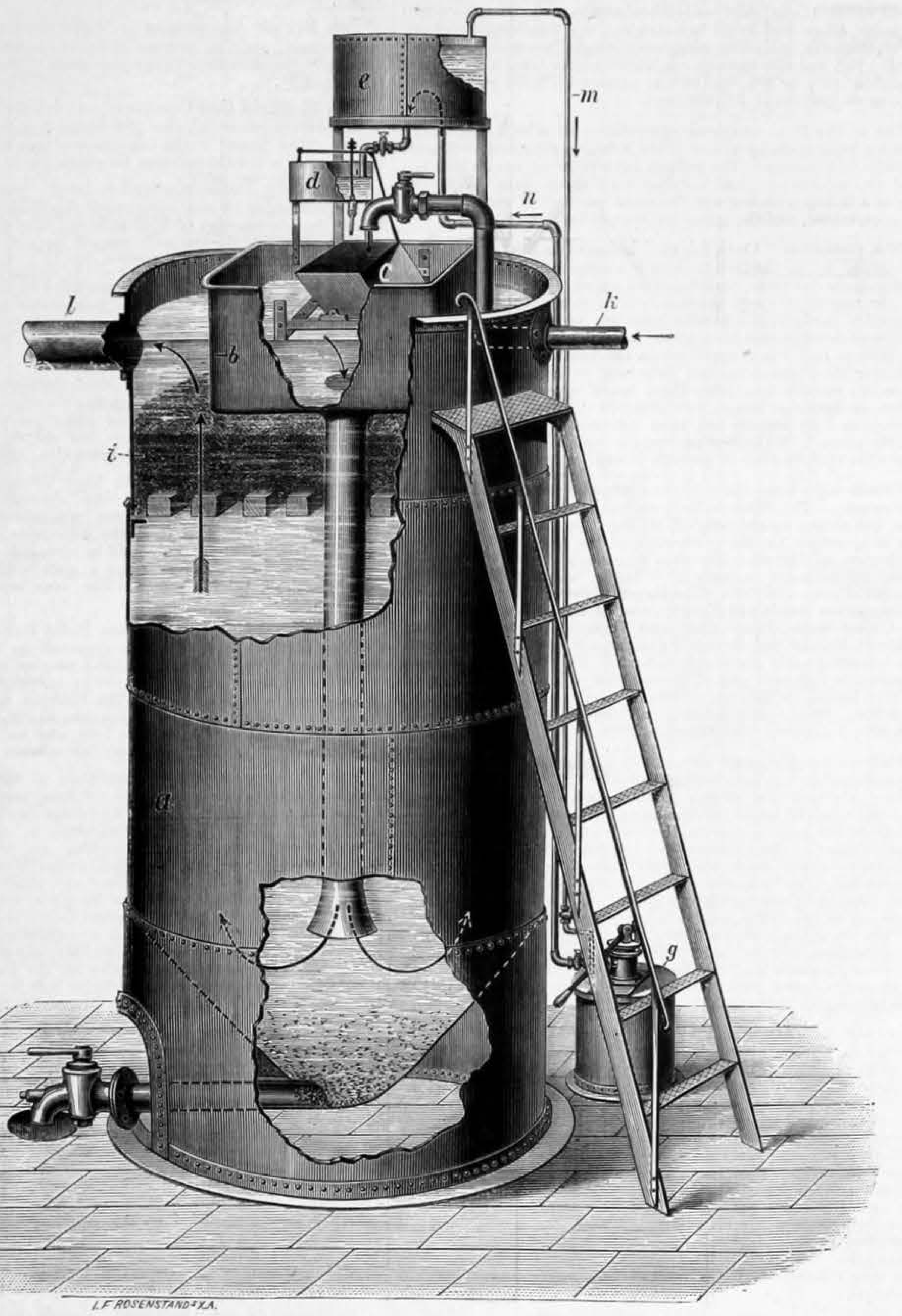
SPEAKING of the "marking" mania, the *Journal* of the London Chamber of Commerce says, "The Merchandise Marks Act of 1887 was passed with the object of protecting the purchasing public from fraud through false representations and descriptions, and it provides that any representation or description must be true. Hereupon the conclusion was hastily jumped at that the Act compelled the marking of all imported goods capable of being marked with the name of the country of origin. The Act compels nothing of the kind. The Customs have no power, because the Act does not confer it, to interfere with imports of 'blank' goods, whether these be textile stuffs, hardware, or what not. Where no marks appear, therefore, there is no room for qualification, and Parliament has not yet considered it desirable or necessary to introduce wholesale and all-round compulsory marking. So far, therefore, as trade has been lost to German houses by unnecessary disclosures of origin, the loss is due to the over-anxiety either of the producing house or of the agent here."

IN concluding an article on the late so-called "water famine," the *St. James's Gazette* says:—"The Progressives threaten to reopen the question in the House of Commons. No course could give greater satisfaction to the other side, for the more the facts are investigated the more uncompromising will they appear. If a dozen inquiries were held they could lead to no other conclusion. But in the House of Commons there would be an opportunity of going into a point which is lightly passed over by the Government inspectors, which came out at the inquiry. A most damning indictment, to which no answer was attempted, was laid against the County Council for its share in this business. It was proved, point by point, that this public body not only opposed the necessary works, which would have averted the scarcity of water, but in doing so acted with deliberate dishonesty. It concealed a certain important document from its own engineer, who must otherwise have materially modified his own expert opinion on the question. This will be a very pretty story to air in the House of Commons, and it is to be hoped that the Progressive threat will be carried out and the requisite opportunity given."

THE Swansea Corporation has decided to adopt a scheme of refuse destruction, electric lighting, and tramcar propulsion. It was decided, before the work was begun, to take the opinion of Mr. Preece, C.B., and he has reported:—"I have carefully considered all that has been said against the proposals of the town council, but I have come to the conclusion that the corporation would be quite safe in adopting Mr. Manville's several recommendations on their own individual, intrinsic merits. Each part of the so-called triple scheme is practical and promising. They mutually support each other for the benefit of the ratepayers. The price charged for the light could be reduced to a figure below that of any other town in the United Kingdom. The demand for the light must consequently increase and the number of lamps fixed would soon exceed the comparatively small number proposed to be installed by the town council. Swansea would become a pioneer town. Its inhabitants would benefit by having better transit, purer air, and cheaper light. Its finances would be improved by the profits that would arise from the successful administration of those purely local and municipal industries which the Legislature has decreed should be in the hands or under the control of the ratepayers themselves."

BRUNN'S AUTOMATIC FEED-WATER SOFTENER

MR. P. SCHAU, MANCHESTER, ENGINEER



AUTOMATIC FEED-WATER SOFTENER.

THE accompanying engraving illustrates a form of water softener, with automatic arrangements for delivering and mixing the softening materials in the water to be treated. The water to be treated is led through the pipe *k*, into one of the chambers of the oscillating receiver *c*, and when this chamber is filled the centre of gravity is removed, and the receiver tips over in such a manner as to pour its contents into the mixing tank *o* below, bringing the other chamber of the receiver below the orifice of pipe *k*. To the receiver is fixed a system of levers, which at every oscillation actuates a valve fixed on the bottom of the holder *d* in which the chemicals are contained. As the movement of the valve at *d* can be regulated, any given quantity of chemicals is by this arrangement mixed with the water. The impurities are precipitated to the bottom of the tank *a*, while the pure water ascends through an intermediate filter *i*, consisting of wood-wool, and leaves the apparatus through the pipe *l*. The precipitated impurities are removed by the cock *f* every four to six weeks, and the filter material is taken out at the same intervals to be cleansed, and can be used repeatedly. The chemicals are, by means of the pump *g*, pumped to the top of the apparatus, thus saving time and labour. The apparatus is also made in a smaller form by the manufacturer, Mr. Paul Schou, 6, St. Mary's-gate, Manchester, and they are made under Brunn's patent.

STORAGE OF COAL IN HOPPERS AT BATTERSEA.

THE coal storage hoppers illustrated by the engravings on page 163, and by the engraving annexed, have been erected from the designs and under the superintendence of Mr. Percy W. Symmons, Assoc. M. Inst. C.E., London, for the Sea Coal Company, at Ransomes Dock, Battersea, for the purpose of receiving and discharging house coal brought from canal-side collieries by sea-going lighters. The lighters are constructed to carry about 350 tons, and are capable of navigating canal or river as well as putting out to sea. The widening of locks in the Aire and Calder Navigation, West Yorkshire, has made it possible for the lighters to be berthed alongside the colliery staiths or screen-shoots to receive their cargoes, thereby saving the serious breakage made at the ports of shipment by steamers. When loaded the lighters are towed back to sea to be picked up by a steam collier bound for London. The disadvantages in the use of sea-borne coal are, that owing to the four trans-shipments it receives from the pit's mouth to the consumer's cellar, the size is much reduced, and the condition altogether deteriorated. By direct shipment into sea-going lighters these drawbacks are avoided, and river-side merchants are able to deliver to the consumer coal equal in size to that conveyed by rail. The past twelve months' working of the lighters proves that there is a great future before them, that their adoption was no reckless venture, but a bold attempt to solve a difficulty which has troubled the seaborne traders and rendered it hard for them to compete with their railway rivals when the size of coal was the chief factor in the business. It must, however, be borne in mind that the successful working of the lighters depends entirely upon a sufficient number of quick steamers fitted with towing apparatus to take them to and fro. A powerful steam tug was employed to bring the lighters round the coast when they were first started, but the towing colliers were found to be superior. Another fact worthy of mention is that it is hazardous to bring coals from the Durham collieries by lighter during the winter months owing to the exceptionally rough weather experienced north of Spurnhead.

The hoppers.—They are wooden structures made up of 12in. by 12in., 12in. by 6in., and 14in. by 7in. creosoted pitch pine timbers for the framework, which stands on forty-four cast iron columns 10ft. high from the ground, the bottom and sides being made up of 4in. and 3in. planking. The hoppers have three divisions 33ft. 6in., 23ft. 6in., and 16ft. in length, with a uniform breadth of 29ft. and are capable of holding 1000 tons of coal. The columns stand on brick piers, which are built of London stock bricks set in cement, and are secured by four 1¼in. bolts 2ft. 3in. long attached to cross bearers built into the brickwork of the piers. These piers stand on a bed of concrete 5ft. square and 3ft. deep, consisting of eight parts of ballast to one of Portland cement. The framework of the hoppers is braced together with old iron rails, and the inside receives additional support from two tiers of angle iron stays, which are bent round and securely bolted to the uprights. The bottoms of the hoppers slope down to a point from the sides at an angle of 30 deg. one side and 20 deg. on the other, and are supported by two 14in. by 7in timbers, to which the 4in. planking is secured. These timbers are fastened to the 12in. by 12in. uprights, and they also rest on a bracket made out of a 14in. by 7in. timber, which is secured by bolts to the uprights. This sheet iron is fastened along the bottom of the hoppers to enable the coal to run with freedom, thus doing away with any trimming of the coal towards the mouths of the shoots by the aid of men inside the hoppers. There is a crane road running along the top of the hoppers parallel with the dock frontage, upon which is placed a steam locomotive crane, which unloads the coal from the lighters and discharges into hoppers. Openings, ten in all, are constructed at the bottom of the hoppers, and a combined shoot and screen is fixed below each. The screens—which were specially designed by Mr. Symmons—are fixed underneath the shoots, being 5ft. long by 2ft. 6in. wide, and can be altered as required from ⅝in. to ⅞in. mesh. A loading bench in two tiers is constructed beneath the hoppers, the back bench being closed with match-boarding to keep the coal dust from spreading. Underneath the mouths of the shoots is a bench for the scales, and the lower bench is for the man who takes the sack from the scales into the carts, which are backed up to this bench in between the columns. There is a space for thirteen carts to be loaded at a time, and this can be done at the rate of 120 tons per hour. The loading into the hoppers from the lighters—by the aid of the one crane—can be done at the rate of 30 tons per hour. The actual saving per ton by using these hoppers is small, but they have the advantage of turning out five times as much work, and work can be carried out in any state of weather.

Steam crane.—This crane was constructed by Messrs. Grafton and Co., of Bedford, and is nominally of five tons power. The carriage—which is built up of rolled steel girders—is mounted upon four steel tired wheels, 2ft. 4in. diameter, spaced for 7ft. gauge, and the centres of axles are also 7ft. apart, so that the crane is equally stable in all four directions. The superstructure or revolving portion is of a new type, inasmuch as it has no central pillar, but revolves on four friction rollers placed on axles radiating from the centre. The centre pivot is a massive steel bolt 5in. diameter, provided with a steel nut and gun-metal washer under the head, which anchors down the revolving portion to the under carriage. The engines have two cylinders 7in. diameter by 10in. stroke, placed horizontally and driving on to a steel double-throw crank; they are fitted with link motion and gun-metal straps. The crane has four motions, namely, hoisting, slewing, derricking,

COAL STORAGE HOPPERS, BATTERSEA

and travelling; they can all be worked simultaneously, although it is very seldom required to do this, as the crane is usually placed in such a position that it will plumb both the lighter and the hopper in some portion of the circumference of the circle described by the jib. The jib—which measures 33ft. long—is made of light steel girders, trussed and braced, and is arranged for working at a radius of 30ft., or any shorter radius that may be found convenient. The boiler is of the vertical cross water-tube type, 7ft. 6in. high by 3ft. 6in. diameter. Placed beneath it is a tank which contains about five hours' supply of water, the boiler being fed by a pump driven direct from the crosshead of one of the engines; there is also a donkey pump as a standby or auxiliary, when the engines are not being worked; the exhaust steam is taken into the chimney. The working pressure of the boiler is 80 lb. The whole of the levers controlling the various motions of the crane are brought into a convenient position immediately in front of the driver, so that he can, without taking his eye off the load, move any lever in any direction required and with the least amount of effort. All the shafts of the crane are steel, the derrick and travelling gear wheels are also of steel, as well as the pinions for the hoisting and slewing gear. The speed of lift is 200ft. per minute, and the speed of slewing 600ft. per minute, and by a special arrangement of loose frictional roller path, the crane can be stopped or started without any surge or jerk. The total net weight of the crane itself is 18 tons, coal and water about 2 tons, and receptacles are provided for ballast of scrap iron to the extent of 4 tons or 5 tons, or 25 tons in working order.

THE MAINTENANCE OF ROADS AND STREETS IN SUBURBAN TOWNS.

IN a recent paper read before the Township of East Orange, U.S.A., Improvement Society, Mr. W. S. Bacot, C.E., called attention to the great expense and poor results of the present system of cleaning and maintaining the roads of suburban districts, and described a systematic plan for efficient and economical work, which he recommended for adoption by the East Orange Township.

There should first of all be an energetic man and a good engineer appointed as commissioner of streets and sewers, with full power and ample means, and he should be held responsible for the expenditure of the money and the work done therewith, but he should not be hampered by political considerations. No breaking up of the street to excavate for sewers, gas pipes, water pipes, &c., would be allowed except upon his permit, and the permit would only be granted upon a deposit being made to ensure the proper restoration of the road and the road surface. He would have under him an assistant engineer to do the engineering and surveying work of the department, and an inspector of roads who would supervise the repair and construction work, inspect the condition of the entire system of roads, direct the work of the block men, and generally supervise the outdoor work of maintenance, cleaning and renewal, besides keeping the necessary records and making periodical reports to the commissioner.

The township authorities are charged with the maintenance of 30 miles of improved streets and roads with Macadam and Telford paving, and it is recommended that 10 miles should be maintained

COAL STORAGE HOPPERS, RANSOME'S DOCK, BATTERSEA

MR. P. W. SYMMONS, ASSOC. M. INST. C.E., LONDON, ENGINEER

(For description see page 162)

on the block system, while a central force—divided into small gangs for street cleaning and light repairs, and into larger gangs for reconstruction work—would attend to the maintenance of the other 20 miles, and to the periodical renewal of road paving on the entire 30 miles.

There would be fifteen block men, each having a beat or section of two-thirds of a mile, which he would patrol, keeping it clean and in order, making continual light repairs to prevent ruts or holes, &c. Each man would be equipped with a wheelbarrow or push-cart, a short square shovel, a street broom, a large hoe, a rake, a pickaxe, and an iron tamp or rammer. The annual cost would be as follows :—

	£
Fifteen men at £72	1080
250 cubic yards stone at 6s. 5¼d.	80
Incidentals	40
Total per year	1200
Total per mile per year	120

The average width of the paved part of the roads is 24 yards, giving 15,000 square yards per mile, which must be renewed every five years, the wear being estimated at ½in. per year, and the limit of wear not being allowed to exceed 2½in. As the 2½in. of wear would require to be renewed with 3in. of stone—as rolling compresses the loose material 20 per cent.—the amount of material required per mile for reconstruction would be 1250 cubic yards. The cost may then be estimated as follows :—

	£
1250 cubic yards of stone delivered, at 6s. 5d.	400
Picking or "stocking" the surface, 15,000 yards	15
Rolling 15,000 yards, at ½d.	30
Spreading stone, screenings, and binding material, at ½d. ..	30
Incidentals	25
Total for repairs for five years	500
Total for repairs per mile..	50

In addition to this, the cost would be increased £120 per mile for ten miles, so that the total estimate is as follows :—

	£
10 miles cleaned and repaired at £220	2200
20 miles general repairs at £100	2000
20 miles cleaning by central force at £20..	400
Incidentals: Gutters, basins, ditching, drains, &c.	400
Total	5000

The central force would be equipped with the proper outfit of tools for the men, and also with a 10-ton steam roller, and a sprinkling cart of 600 gallons capacity.

ELECTRIC MOTORS FOR SHOP TOOLS.

During the annual meeting of the American Society of Civil Engineers, held in New York in January, a visit was paid to the new works of the Crocker-Wheeler Electric Company, on the Delaware Lackawanna and Western Railroad, where the tools and machines are driven by independent motors, thus eliminating shafting and long belts.

As described in the society's programme, the principal engineering feature is the electrical power transmission system which is employed throughout, whereby the power required to operate the works proper is reduced to 25-horse power from 100-horse power estimated. All of the machinery is operated by individual motors built into each machine, or by separate motors, each driving a single length of shafting, which in turn drives as many of the old-style machines as can be conveniently belted to it. The result is, first, that all power used in connection with these machines is stopped whenever the machine is out of use ; and second, that the works are free from belting, leaving them remarkably light and clear for handling material. As most of the tools are fitted with their own motors, it is easy to shift them from place to place if required, as it is unnecessary to line them up to any system of shafting. In addition to the remarkable reduction in power required for operating the plant, this method of driving gives a shop system of great flexibility. This was well illustrated during the past summer, when many of the company's machines were operated in their original positions in the ruins of the old works which were burned, under temporary covers, by means of temporary wires run to the motors built in them. The machines were afterward, from time to time, moved from one position to another, as the work on

FIG. I.

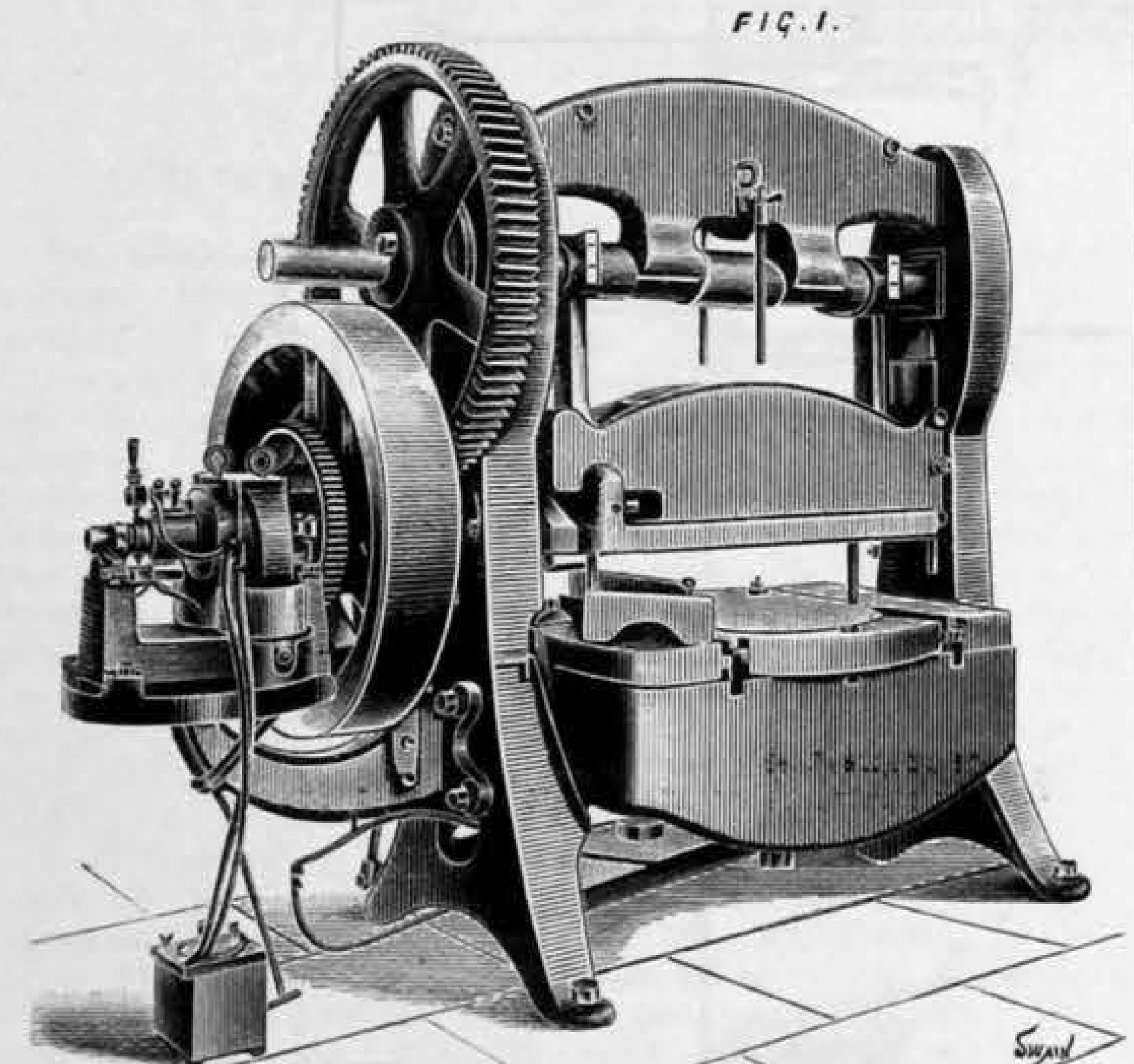


Fig. 1—HEAVY PUNCH PRESS, WITH ELECTRIC MOTOR

the new buildings required, being kept, however, in continuous operation day and night. By this means the company turned out 20 per cent. more product last year than ever before in its history, in spite of the fact that for three months the entire plant was in ruins.

The lighting and power for the plant are supplied by a 150-horse power Corliss engine driving an 80-kilowatt dynamo in the detached power-house. The current is conducted from the power-house by a pair of cables through an underground tunnel—which also carries the heating pipe and the cables for experimental work—through the cellar of the office building, thence rising from a manhole under the floor of the main shop and running along under the roof on ordinary trolley line insulators to about the centre of the shop, where they terminate on suitable slate panels. From these branch out four sets of wires carried in a similar manner along the roof trusses, and extending through and feeding the four quarters of the main building. By this arrangement the supply of power for either section of the shop can be readily discontinued by opening a small switch.

From the switchboard run also the circuits for supplying the other buildings. The branch connections from the main circuits are carried down the inside of the cast iron columns of the building to a point about 6in. below the surface of the floor; thence they are carried along through small wooden troughs, which were laid for this purpose in the concrete, straight across the shop close to the bases of each pair of columns, or 10ft. apart. The wires are brought up from the troughs through the floor wherever connections are desired, through 1in. holes bored through the flooring. The wires pass into and out of the centres of the columns through small hand holes cast in them near the top and bottom. The columns are supported on cast iron bases resting on suitable masonry foundations, but the joints between the columns and their bases are about 1ft. above the shop floor, to facilitate the levelling of the columns by wedging, if it should ever become necessary to preserve the level of the overhead crane track.

The king posts of the roof trusses are extended upward so as to furnish posts for the roof sign. The main building is 100ft. wide, and 450ft. long, the office building adding another 50ft. to the length.

In the construction of the buildings it was decided to use a floor heavy enough for the foundations of any machinery it was desired to put down at any part, and which would also permit the carrying of heavy loads on roller trucks, rather than to introduce hand car or industrial railway tracks, since this would greatly cut up the floor, and could not be arranged to reach every part and avoid interference of two cars on one track. The floor consists of 4in. by 6in. chestnut sleepers laid in Portland cement concrete, with a finishing coat laid on by trowel and treated on top with tar. On this is laid 2in. spruce planking, and on this 1¼in. finished maple floor boarding.

The ordinary construction for the side trusses of a roof was also departed from, in order to furnish trusses the lower members of which would be strong enough to support trolleys for travelling hoists of a capacity up to four tons, and it was found by Messrs. Post and McCord, the engineers of the building, that by the use of 15in. light I beams—or rolled joists—for the under members of the lean-to trusses, and a very light angle iron for the upper members supported by vertical pieces of angle iron, the roof trusses could be made with very little increase of weight, and with a lower member that would easily carry a large and powerful hand hoist. These roof trusses are 10ft. apart. The same principle was applied to the roof of the engine-room in the power-house, where it was desired to support a six-ton travelling crane on the roof trusses, and extend over a stretch of 45ft., or four trusses, as this would avoid the presence of any columns. The main shop has a fifteen-ton electric travelling crane.

The office building is designed with special reference to facilitating the work of the engineering department and the management of the company. The general offices and the office of the chief engineer and assistants are on the main floor, with connection directly to the floor of the shop. The workmen's entrance, also on this floor, is so arranged as to make the men pass through the book-keeper's department. The second floor contains the drawing office, blue print and photographers' rooms, library, and the toilet and locker rooms. The third floor will be for

FIG 2

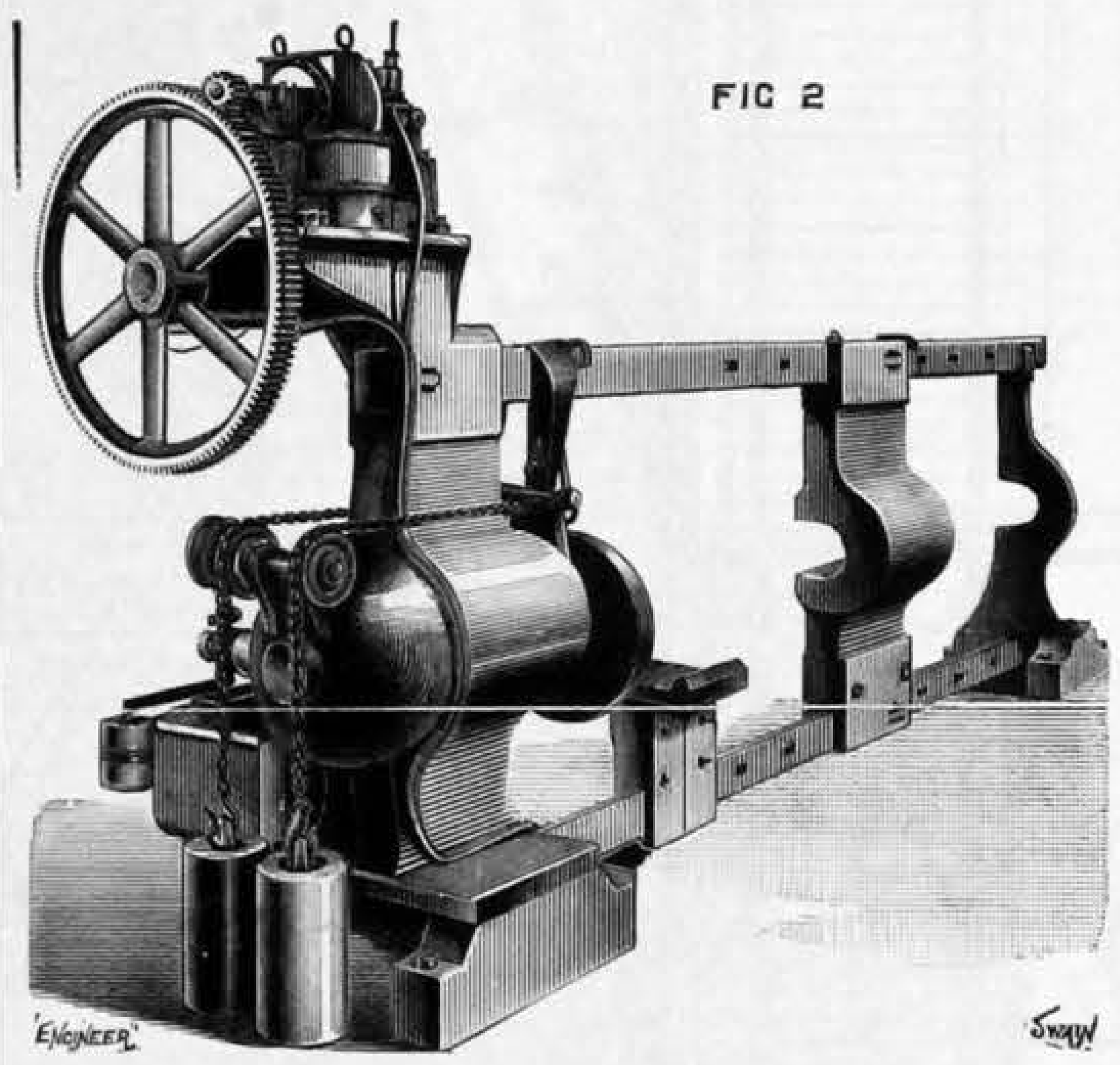


Fig. 2, HYDRAULIC ARMATURE PRESS, WITH ELECTRIC MOTOR

assistants and storage. One-half of the basement is arranged for a laboratory for such experimental work as it is desired to carry on without disturbing the shop ; the other half is for bicycles used by the employés. Up through all of the floors extends a fire-proof vault about 10ft. square, with arched brick floors and air spaces on all sides for the reception of the records on each department.

The entire plant is new, having been rebuilt last summer on the site of the old works occupied by this company. The new buildings are of the modern "slow-burning mill construction," and have been erected practically in accordance with the plans of the New England Mutual Insurance Companies.

Two of the larger machine tools we illustrate. Fig. 1 is a heavy punch press, with the electric motor mounted at the side, the controller being shown on the floor. Fig. 2 is a hydraulic press for forcing together the plates of armatures, and the pump is driven by the motor mounted on top of the machine and geared to the spur wheel as shown.

HORSELESS CARRIAGE NOTES.

A display of motor carriages and other road vehicles will be made in the North Gallery of the Imperial Institute to-morrow afternoon, under the auspices of the Motor Car Club.

A deputation, including members of the Self-propelled Traffic Association and others, on Wednesday waited on the President of the Local Government Board in a room at the House of Commons. Their object was to urge upon the right hon. gentleman the desirability of amending the Locomotive Act, or of introducing a new Bill to facilitate locomotion on highways, and it is satisfactory to find that the deputation adopted and supported the suggestions we have made as to the form the Bill should take.

Sir David Salomons, in introducing the deputation, said that they wished to amend the Acts which had been framed with a view to restricting the traffic of traction engines in the country roads. There had recently arisen on the Continent a system of horseless carriages. Such vehicles, it was believed, would be of great advantage in this country, particularly in agricultural districts, where they might be used to convey produce to the railways. The restrictions of the existing law prevented the development of this trade. He pointed out also the large industry which would grow up in the making of such carriages.

Mr. Thornton, of the County Council, stated that the Highways Committee was in favour of the proposed reform, and said that if there was one place more than another where these horseless carriages might be tried, it was in the metropolis. The Committee felt that some controlling power should be vested in the local authorities as far as London was concerned, though that might not be necessary outside the metropolis.

Mr. Shaw Lefevre said that his presence on that occasion showed that this was not a party question of any kind. He should be very glad indeed to render any assistance he could in forwarding a measure such as the one suggested. He believed that they were much behindhand in this important industry, and that continental towns were much ahead of them. The parts of the country most concerned in the matter were undoubtedly the rural districts. One must consider this a branch of the light railway question. Anything which would facilitate transit in and out of the country and the supply of the towns could not fail to be of enormous importance and value to the agricultural labourers.

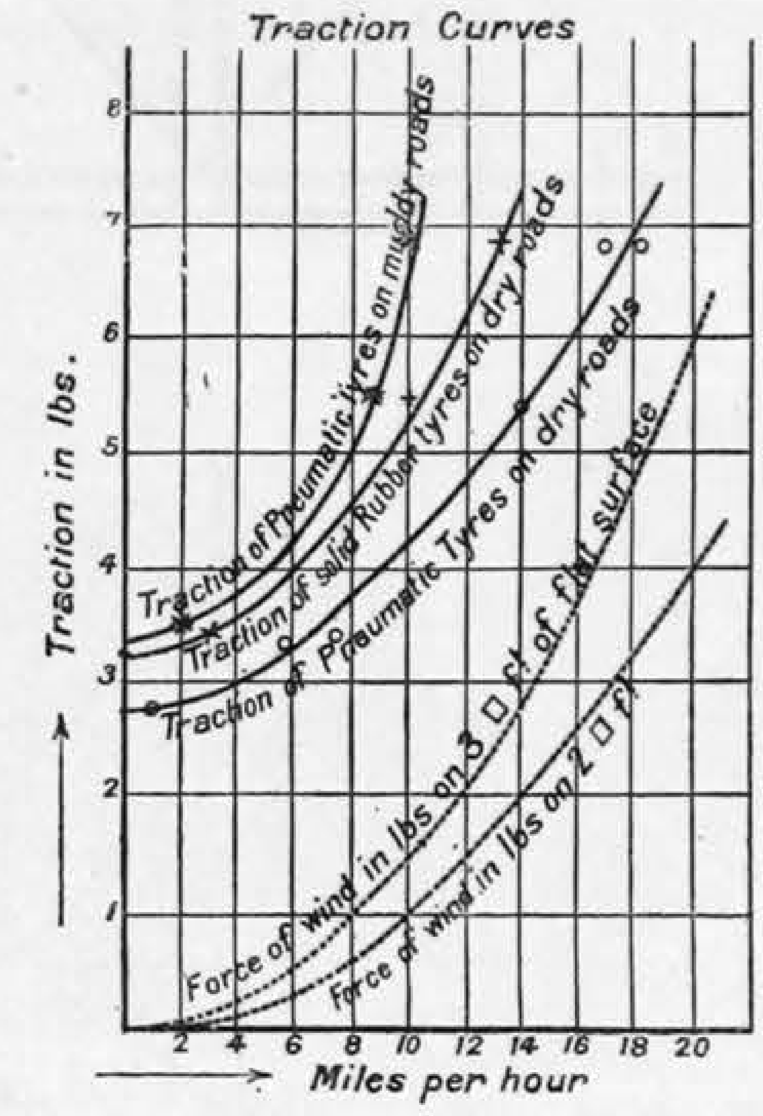
Mr. Chaplin in reply said, with regard to the object of the deputation he would not detain them long. He was in sympathy with everything which had been said. A Bill on the subject was now in an advanced stage, and he was quite in sympathy with it, and intended, with the assistance of Mr. Russell, to carry it through the House during the present session. With regard to the statement made as to the advantage these vehicles would be to agriculturists, he quite agreed. The Bill suggested possessed certain advantages which did not exist for the light railways. For instance, the vehicles referred to could go to every farmer's door, and this would be a decided advantage not only to agriculturists, but to other classes of the community. He hoped at an early period to introduce a measure which would meet the views of all the gentlemen who had been good enough to wait upon him.

The deputation withdrew after thanking Mr. Chaplin.

The computation of the power necessary for working motor carriages will occupy the attention of some of our readers just now, and the following account of experiments sent us by Mr. Louis Barrow, of 61, Stirling Road, Edgbaston, will interest them :—

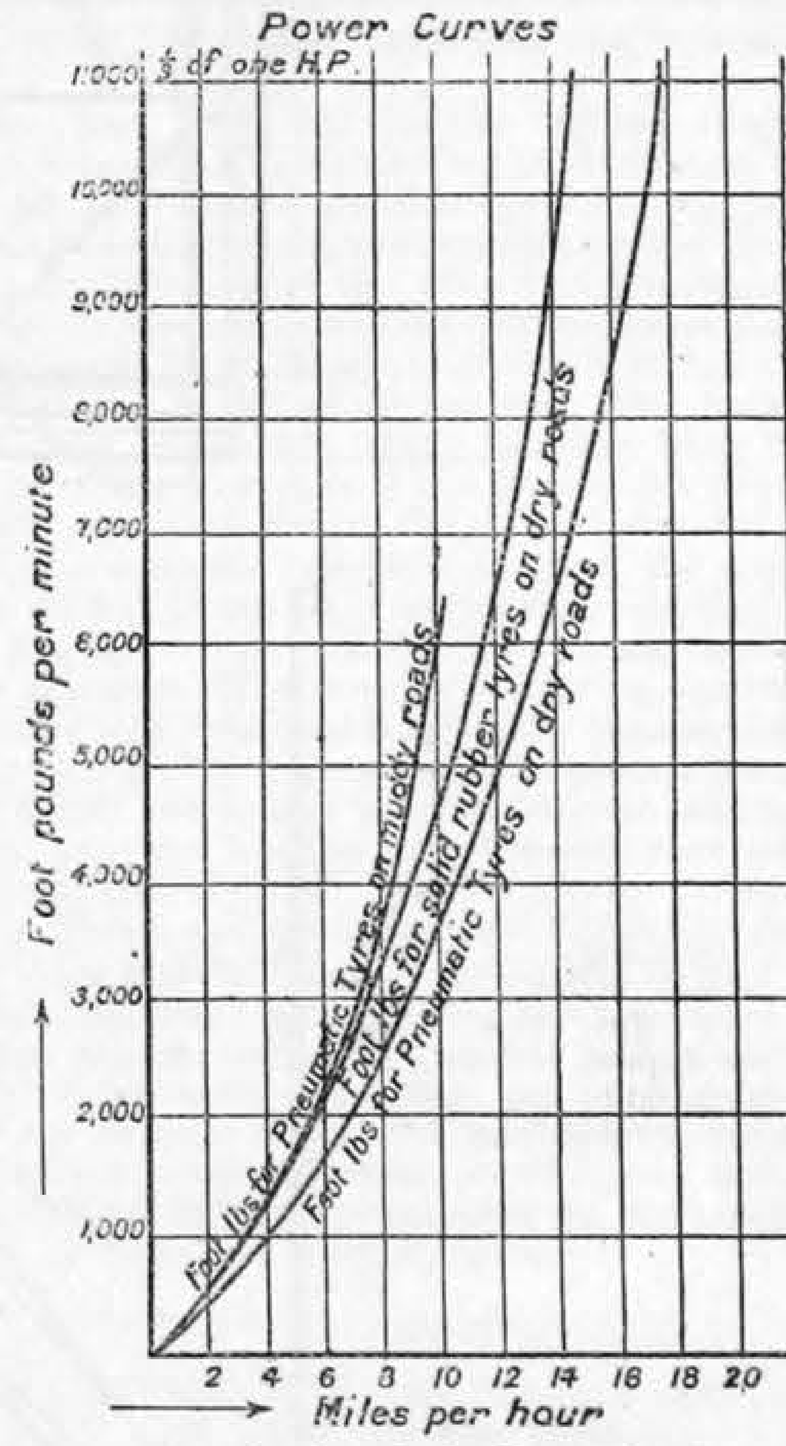
The curves shown herewith are derived from some experiments made a year ago upon half-a-dozen bicycles fitted with pneumatic, solid, and cushion tires, each weighing with their rider about 200 lb. The machines were run "free" down hill with feet on rests at a constant speed, and the traction was found by multiplying the gradient by the weight.

The method of conducting the experiments was as follows :—Suburban roads of even gradient were chosen having bench marks at convenient positions. Now if the incline is a long one, and the machine is started from rest, the velocity will accelerate until the resistances exactly balance the traction, after this point the revolutions of the crank were duly noted.



Curves showing Cycle Traction and Wind Resistance

In the next experiment, instead of the machine being started from rest, a flying start was made with the cranks revolving at the same number of revolutions as was attained in the previous experiment, the hill would then be descended at a constant speed. The time was now taken by stop watch for a certain distance.



Curves showing Cycle Propelling Power

General experiments were made on the same incline and the mean time taken—differences of more than 5 per cent. were rare. Distances and gradients were found from the new 6in. Ordnance maps. A second machine of the same kind of tires has sometimes given slightly different results. These points have been duly marked on the above curve. All the roads had a uniform gradient. Each point on the traction curves is the result of at least three separate tests on the same machine. Cushion tires were not perceptibly faster than solid, but the difference between these and pneumatics is considerable. Two curves for wind pressures—from Molesworth—for 2 and 3 square feet of flat surface are also shown, for the purpose of comparison with the traction curves.

If the traction is proportional to the weight, it would appear from the curves that the power required to drive a motor carriage of one ton—including passengers—along level roads at ten miles an hour would be 1·2-horse power if fitted with pneumatic tires, 1·6-horse power for solid rbbuer tires, and 2-horse power where a pneumatic tired vehicle is used on muddy roads. If it is required to ascend gradients of 1 in 20 at the same speed, the horse-power required is respectively 4·2-horse power, 4·6-horse power, and 5-horse power. The power required to drive the mechanism would have to be added to these results to obtain the total horse-power wanted.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

BULLHEAD RAILS AND FLANGE RAILS.

SIR,—I hope before long to present some new and interesting information on the comparative merits of the bullhead and flange section for rails, but in the meantime will answer one or two remarks in the correspondence column of THE ENGINEER of January 17th. It is, of course, true that deficiency in rail stiffness cannot be compensated for by close spacing of sleepers; but as even heavy rails will and do deflect, it is well to have such comparatively close spacing. As already noted, the modern type of American standard section is designed for a combination of stiffness and durability. As to the question of colonial railways, the traffic and the finances should enter into consideration; and it would be economically and morally wrong to expend money on the elaborate construction of a short length of railway that would have better served the interests of the community by being spent in opening up the country by greater lengths of railway. It is not right to impose an unnecessary capital cost for work whose benefit will be reaped only by "posterity," while the originators and first-comers have to pay the interest on this cost. It would certainly be wrong, for instance, to build the Mombasa Railway suitable for express trains and heavy traffic. As Sir Arthur Cotton says, in his "Public Works in India:"—"What is most wanted is speed; not in travelling on the railways or canals when executed, but in executing them." In other words, the underlying principle of colonial railways should be the construction of the greatest mileage at the least cost, and in the least time; "least cost" being, of course, considered in relation to the prospects of immediate or delayed increase in traffic. It is simply a matter of economics—not economies.

As to the remarks of "Railbed," if he will read my former letter on the rail question he will see that it is distinctly pointed out that the tie-plate is entirely different from a chair. The tie-plate is simply to protect the tie, and may be considered in the same light as creosoting or other preservative methods. It is not necessary with light traffic or with hard ties, but with the bullhead rail a chair is required in any case to support the rail, the rail having no stability in itself. Thus the standard track of the South Australian Government Railways consists of 80 lb. flange rails, on wooden sleepers so hard as to require the boring of the spike holes, and rendering tie-plates unnecessary.

In regard to the reference of "Sextus" to the question of stiffness, I may say that while the London and North-Western Railway 90 lb. bullhead rail is 5½in. high, there are here in use 80 lb. rails 5⅜in. high, and 100 lb. rails 6in high. Height, however, is, of course, only one consideration, but I have not yet had time to more closely compare actual sections. I may say, however, that with a somewhat extensive observation of railway track, I have never found any track—certainly not in England—to compare with the remarkably smooth and easy riding track having 100 lb. American flange rails. It is, as one engineer has said, like riding on a billiard table. Your correspondent says that flange rails have been tried in England and have failed. That, however, judging from the sections, has been due to the fact that the sections were not of such good design as to give the best results. The same is true of many of the older American sections, but in this discussion I have been dealing with the modern sections.

E. E. RUSSELL TRATMAN, C.E.

New York, January 31st.

SEWAGE DISPOSAL AT SALFORD.

SIR,—Having read the article in your issue of the 17th ult., upon "Sewage Disposal at Salford" and Mr. Corbett's scheme for the purification of the sewage of the borough, and having studied the question of sewage purification for a number of years, permit me to make a few observations upon the mode intended to be pursued in the proposed new works at Salford.

First, Mr. Corbett proposes to use chemical precipitants which will cost 31s. 5d. per million gallons. This is a very serious item, and in addition there is the cost of the washing machinery, and the working expenses attached thereto, used for the purpose of cleansing the filtering media, &c. The effluent he will get from this costly chemical and mechanical mode of working will, I venture to say, be far from satisfactory, either to himself or the Corporation.

Let us here examine the question of precipitants. In all sewage there is an ever-varying amount of matter in suspension, and which it is important to get rid of; in order to do this he proposes to add so many grains of a precipitant costing, as before stated, 31s. 5d. per million gallons; but in doing this he not only adds to the weight and bulk of the sludge to be dealt with, but makes it worse to deal with than if it were left alone, and also destroys any manurial value that may be in the sludge.

Secondly, Mr. Corbett proposes in his filters to use a material that would need constant attention, and when foul require to be washed in the sand-washing machines, and thus all foul matter that has been arrested by filtration he gets back again; it is working in a circle. Mr. Editor, what becomes of the "washings" from the filters? Do they not go back again into the sewage tanks, and thus the sewage becomes worse and harder to treat than before?

Mr. Corbett is right when he throws cold water upon filtering media, such as polarite, magnetic carbide, magnetite, and the like; but why not carry this reasoning a little further, and do away with chemical precipitants as well as the other "media"? I will endeavour to point out a material made from town's refuse that will obviate all this washing, and at the same time deodorise and decolorise the sewage without any precipitant whatever. I refer to the "carbonised refuse system of sewage purification, combining therewith the disposal of town's refuse." This is a method of purification unequalled by any other as yet devised, and consists in making the town's refuse purify the town's sewage; or in other words, using one nuisance to abate another. At first sight this would appear to be well-nigh impossible; but it is well known that all town's ashpit refuse contains a large percentage of animal and vegetable matter, to carbonise which is to convert it into charcoal, and thus not only is a cheap and efficient filtering medium obtained, but the first and annual cost of destructors and such-like methods of disposing of refuse is entirely obviated.

The process may be briefly described as follows:—The refuse is deposited in specially-constructed carbonisers and brought to a red heat, so that no matter how foul the material may previously have been, it will by this process not only become thoroughly purified, but be converted into the most valuable filtering material that can be produced. It is screened into four grades, the second, third, and fourth sizes—consisting principally of small, medium, and large cinders—are used in two ways, viz., (1) as preliminary filters or screens, by means of which the sewage is deprived of the bulk of its suspended matter; (2) as the under-layers of filter beds supporting a top one of the first screenings, being the carbon powder used in the filtering—deodorising and decolorising—medium, and in, to, and through which the previously clarified sewage is run; a clear and inodorous effluent issuing therefrom, capable of sustaining fish life.

The filters are capable of dealing with every description of polluted fluids, domestic or factory. As no lime or other precipitating agents are employed, the sewage is not robbed of any of its fertilising properties, nor is the effluent poisoned by noxious chemicals, and what is of still greater importance, there is no increase in the volume of sludge, which consists of settlings only. The impurities in the sewage are arrested either in the preliminary filters, or on the surface of the filter bed, and when the former become choked they are allowed to drain, and the contents re-carbonised. When the filter bed becomes choked, the flow is diverted, the bed drained, the impurities deposited are scraped off, and after resting awhile a fresh layer of carbon powder is laid on, and there is practically a new filter ready again for use. The scrapings are in a comparatively dry and portable condition, and can be either used for fertilising purposes or re-carbonised and used over again.

In conclusion, I put works down on the above system for the—then—Baildon, near Bradford, Local Board, and the results obtained cannot be surpassed for efficiency and economy.

Leeds, February 6th. W. SHAW DUNCAN, Civil Engineer.

SLIDE VALVE FRICTION.

SIR,—Referring to my letter on the above subject in your last issue, and your remarks with reference to the presence of steam between the slide valve face and its seating, I beg to thank you for honouring me by an editorial note to my letter.

I was aware at the time I wrote that steam does insinuate itself between the valve and steam chest facing, but considered that such steam would be squeezed out owing to the superincumbent pressure and the motion of the slide; in fact, Professor Unwin in his 1877 edition of "Machine Design," page 266, refers to this question as follows:—"But it is possible that the steam may insinuate itself partially or over the whole extent of the faces of the valve which are in contact with the surface of the valve chest; and in that case the downward pressure of the steam on the back of the valve at those parts would be neutralised by the upward pressure of the layer of steam between the surfaces, and the friction would be due to the pressure on the remainder of the valve only. According to some experiments of Mr. Thomas Adams, steam does so insinuate itself so long as the intensity of pressure between the valve and steam chest faces is less than the steam pressure, but when the pressure is greater, as must be the case with ordinary slide valves, this layer of steam is squeezed out, and then the coefficient of friction is found to have a much higher value, so that in the formula above we ought to take $\mu = 0{\cdot}2$ to $0{\cdot}35$, the value being greater as the pressure and temperature of the steam is greater." The formula referred to by Professor Unwin was $F = \mu\, p\, a$, where $\mu = 0{\cdot}15$ for smooth surfaces, such as slide valve surfaces not well lubricated. In his latest edition, Professor Unwin does not mention anything with reference to the presence of steam between the valve and steam chest faces, only quoting the preceding formula, but substituting for the value of μ, $0{\cdot}10$ instead of $0{\cdot}15$ as given above. He also refers to Mr. Aspinall's experiments, as stated in my previous letter. From this I concluded that the presence of steam between the valve and steam-chest faces might be ignored, and therefore based my calculation on this assumption.

It may be of interest to mention that a method of lubricating slide valves with water has been proposed by Herr C. von Lüde, and was published in the *Organ für die Forschritte des Eisenbahnwesens*, 1884, page 4. His proposition was to use as a lubricant water taken direct from the boiler and forced under the steam pressure between the valve and steam-chest faces. It would then be distributed over the whole surface, so that the valve would roll, as it were, on drops of water, which are themselves subject to the boiler pressure, and thus in the simplest way equalise the pressure on both the upper and lower faces of the valve. The claim put forward on its behalf was that the lubrication would be independent of the driver, and, therefore, require no attention; it would also be independent of the working of any lubricating gear; the lubricant would always be present in unlimited quantity, and would always be distributed automatically over the surfaces by the steam pressure. Diagrams were given showing the application of the arrangement to both passenger and goods engines. A small stop-cock fixed in the side of the fire-box admits water through a copper pipe to the valve chest, and is only closed when the engine is standing. The water passes through small holes in the slide valve to narrow grooves cut in its face; these are alternately emptied and filled as the slide valve passes to and fro, four times during each double stroke, and this takes place, whether the regulator is open or closed, without any possibility of interruption. It was also claimed for the arrangement that it was simpler than other lubricating devices in use. EDWARD J. M. DAVIES.

24, Harrington-square, London, N.W.,
February 8th.

SIR,—In commenting on Mr. Davies' letter in your issue of the 7th, you state, as far as I can gather, that in the case of a slide valve, no matter how well fitting, the steam pressure acts not only on its back but also underneath the valve, so that the only pressure holding it on to its seat is that due to its weight. Now what puzzles me here is the inconsistency between this theory and such facts as scored and worn slide valve faces and seats, and the advantageous use of balanced slide valves and piston valves. Surely its weight alone cannot be enough to cause the deep scores and heavy wear of pretty well every slide valve? I should be very glad if you could explain this inconsistency, and so enlighten a puzzled reader. E. A. G.

2, Willes-terrace, Leamington,
February 10th.

[The total area of the back of the valve on which the pressure acts is very much larger than that of the faces in contact.—ED. E.]

SIR,—If your correspondent will take two plates of cast iron, and plane up the surfaces carefully, and then put one plate on the other, and squeeze them hard together, he will find that he cannot exclude the air from between the two, and they will fall apart. This they ought not to do if they fitted air-tight on each other. A properly made surface plate, however, will float on the film of air between it and its fellows, but the air may be excluded by sliding. No such conditions can occur in a slide valve, the surface being comparatively rough. FRITTOIR.

Paris, February 10th.

THE TRUSTY GAS ENGINE.

SIR,—In reply to a letter in your issue of the 7th inst., signed J. A. Drake, it is true this gentleman was in the service of Weyman and Hitchcock, Ld., from 1890 to 1895, as works foreman or manager, and in that capacity was employed both on the gas and oil engine. There is no need for other comment.

J. E. WEYMAN.

Cheltenham, February 8th.

[This correspondence must now close.—ED. E.]

THE INSTITUTION OF CIVIL ENGINEERS.

MANUFACTURE OF ALUMINIUM.

AT the ordinary meeting on Tuesday, February 11th, Sir Benjamin Baker, K.C.M.G., the President, in the chair, the paper read was on "The Manufacture of Aluminium by Electrolysis, and the Plant at Niagara for its Extraction," by Mr. Alfred E. Hunt, M. Inst. C.E.

The author, after briefly stating the situation of the Pittsburgh Reduction Company's works, and of those of the Niagara Falls Power Company, described the ores of aluminium best fitted for electrolytic reduction to the metallic state, and gave an account of the general principles governing the extraction of the metal from its compounds.

The Hall process, which was that adopted by the Pittsburgh Reduction Company, involved the direct electrolysis of the sesqui-oxide, alumina, dissolved in a molten bath of the mixed fluorides of aluminium, calcium, and sodium. One cubic foot of the solvent would serve for an hourly production of one pound of metallic aluminium, the bath used being capable of dissolving one-third of its own weight of alumina. The electrical energy required for extracting this amount of metal was 3730 watt hours for the decomposition of the alumina, with a further supply to maintain the bath at the temperature necessary for the molten condition. The fluorides remained unchanged, so that the operation was continuous. The bath was made either from a mixture of fluorspar and cryolite, or from the artificial fluorides; and it might be fused in a separate vessel when starting work, or in the bath by the current itself. Alumina was added at frequent intervals to prevent too great a variation in the resistance of the bath, and the aluminium, as it was produced, was siphoned from beneath the layer of fluoride, where it collected without interference with the progress of the operations. The oxygen of the alumina was liberated at the carbon anode, which at the temperature of the bath—980 deg. C.—oxidised to carbon monoxide. Outside the bath this was burnt at once to carbon dioxide, and was allowed to escape into the working apartment. The carbon anodes were consumed at nearly the same rate as the aluminium was produced, the amount being about two-thirds of the quantity actually used. The difference of potentials theoretically necessary for the separation of the constituents of alumina was about 2·8 volts, but a greater difference was due to the resistance of the bath. The pots employed were of iron with carbon linings, but these could be dispensed with if a high degree of purity was not required.

The chief impurities in the finished product were silicon and iron. These were derived from the alumina as well as from the carbon anodes. Aluminium could be produced containing 99¾ per cent. of the pure metal, and was regularly delivered with 99 per cent. The electrolytic baths were joined in series, the positive bar of the switchboard being joined to the carbon anode of one of the baths, and the last pot of the series being joined to the negative bar of the switchboard. All the copper connections were necessarily very heavy, on account of the large currents employed. The sources of the loss of energy were enumerated, as well as the requirements to be met by a suitable solvent and the ore for use in the Hall process.

The electrical energy was generated at the works of the Niagara Falls Power Company, and was conveyed, without the intervention of transformers, over a distance of about half a mile by stranded copper cables 1¼in. in diameter. The loss in transmission was about 1½ per cent. of the energy conveyed. The cables were carried in a subway, 5ft. 6in. high and 3ft. 10in. wide, formed of concrete with masonry protection, and with a wooden floor. The two circuits were kept distinct, and were connected at the further end by a switchboard to step-down transformers. These were arranged in sets of two, of which the secondary coils were in circuit with one commutating machine or motor generator, the entire set of three machines dealing with 500-horse power. The transformers were of the ordinary type, with closed magnetic circuit, and gave an efficiency of 97 per cent. on full load. They reduced the potential of the secondary circuit to 115 volts. The conductors from the low potential side of the transformers were formed of 4in. by ½in. copper bars, insulated on slate slabs. They connected the two transformers with the twenty-pole motor generator, driven by the two quarter-phase currents at 150 revolutions per minute and producing a continuous current of 2500 ampères, by means of a second and independent winding and commutator on its armature. The currents from the motor generators were joined in parallel to large "omnibus" bars passing directly from a switchboard to the reduction pots. The author discussed the several methods of measurement for a basis of charge for the energy supplied.

At the New Kensington works of the Pittsburgh Reduction Company the dynamos were driven by steam power. The best steam coal cost only 5s. 3d. per ton at the stokeholds, and evaporated 10 lb. of water per lb. of coal at 100 deg. C. in actual practice. Natural gas was obtainable at even a lower equivalent rate during part of the year, when it was used instead of coal.

At the works of the Niagara Falls Power Company water was taken through a canal, 188ft. wide and 12ft. deep, from the Niagara River, on the United States side, and at a point about half a mile above the celebrated Falls. It was then conducted by vertical iron pipes, 7ft. 6in. in diameter, to the turbines, at present three in number, of 5000-horse power each. These were placed at the bottom of a pit, which it was intended ultimately to enlarge so as to accommodate ten turbines. The flow of the water was controlled by gates and penstocks, placed at the top of the vertical pipes. The turbines were of the Fourneyron type, with two wheels each, and with buckets divided into three tiers. The axes were vertical, and the centre line of the case, midway between the two wheels, was 136ft. below the level of the water in the canal. The speed was controlled by external annular gates, by which the buckets could be partially or wholly throttled. The turbines discharged into a tunnel of horseshoe section, 21ft. high, 18ft. 10in. wide at its upper portion, and 14ft. 9in. on the floor. It was about 9500ft. in length, the average gradient being 36ft. per mile, and it was expected to give a velocity of discharge of 26ft. 6in. per second, and to have a capacity as a tail-race to turbines developing 100,000-horse power.

The 5000-horse power turbines had vertical shafts, carried up to the surface without the intervention of gearing between the bucket-wheels and the dynamos. The weight of each of the shafts and of the machinery attached to it amounted to about 152,000 lb. The load was supported as far as possible upon the disc of the upper bucket-wheel by arranging it as the top cover to the case of the guide-wheels, the disc of the lower bucket-wheel being at the same time shielded from the pressure of the water. The resultant end pressure, when the load was light, therefore, amounted to about 2000 lb. upwards; but when the load was increased the upward pressure diminished slightly and became a downward one of the same amount at full load. These variable resultant pressures were taken up by water-cooled thrust blocks, arranged on the shaft. The latter was 11in. in diameter at its journals, where it was solid, and 3ft. 2in. at its intermediate portions, where it consisted of a steel tube. The turbines were arranged to deal with 430 cubic feet of water per second, and to develope 5000-horse power, with an efficiency of 75 per cent. Their normal speed was 250 revolutions per minute. Each turbine drove a single dynamo, built upon a heavy masonry arch thrown across the top of the turbine-pit. The field magnets revolved, and the armature was arranged wholly within the revolving field-magnet system. There were twelve pole-pieces mounted within a nickel steel ring 4$\frac{7}{16}$in. thick, 4ft. 3in. high, and 11ft. 6in. in diameter. The field magnets were excited by a continuous current, representing 0·2 per cent. of the energy developed by the machine. The armature was built on the outside of a large annular foundation casting, and was entirely wound with $\frac{5}{8}$in. by 1¼in. copper strips placed in pairs in grooves made in the core, and insulated by mica. The winding was arranged to give two separate but similar alternating currents, each with twenty-five complete cycles per second, and with a maximum difference of potential of 2500 volts. The two currents differed in phase by an angle of 90 deg. The efficiency of the machines was 97¼ per cent.

In an appendix a detailed account was given of the several ores of aluminium.

SPEAKING of the construction of H.M.S. Andromeda, the Pembroke correspondent of the *Naval and Military Record* says:—"A noticeable feature of the frames at the two ends are the bracket plates to receive the beams of the various flats, which were all riveted in place before the frames were erected. Such a proceeding, which is perfectly safe when the frames are treated on the scrive board, would not be so if resorted to under other circumstances. It has, therefore, never been attempted on any previous ship."

THE PARKHEAD FORGE

(*For description see page* 153)

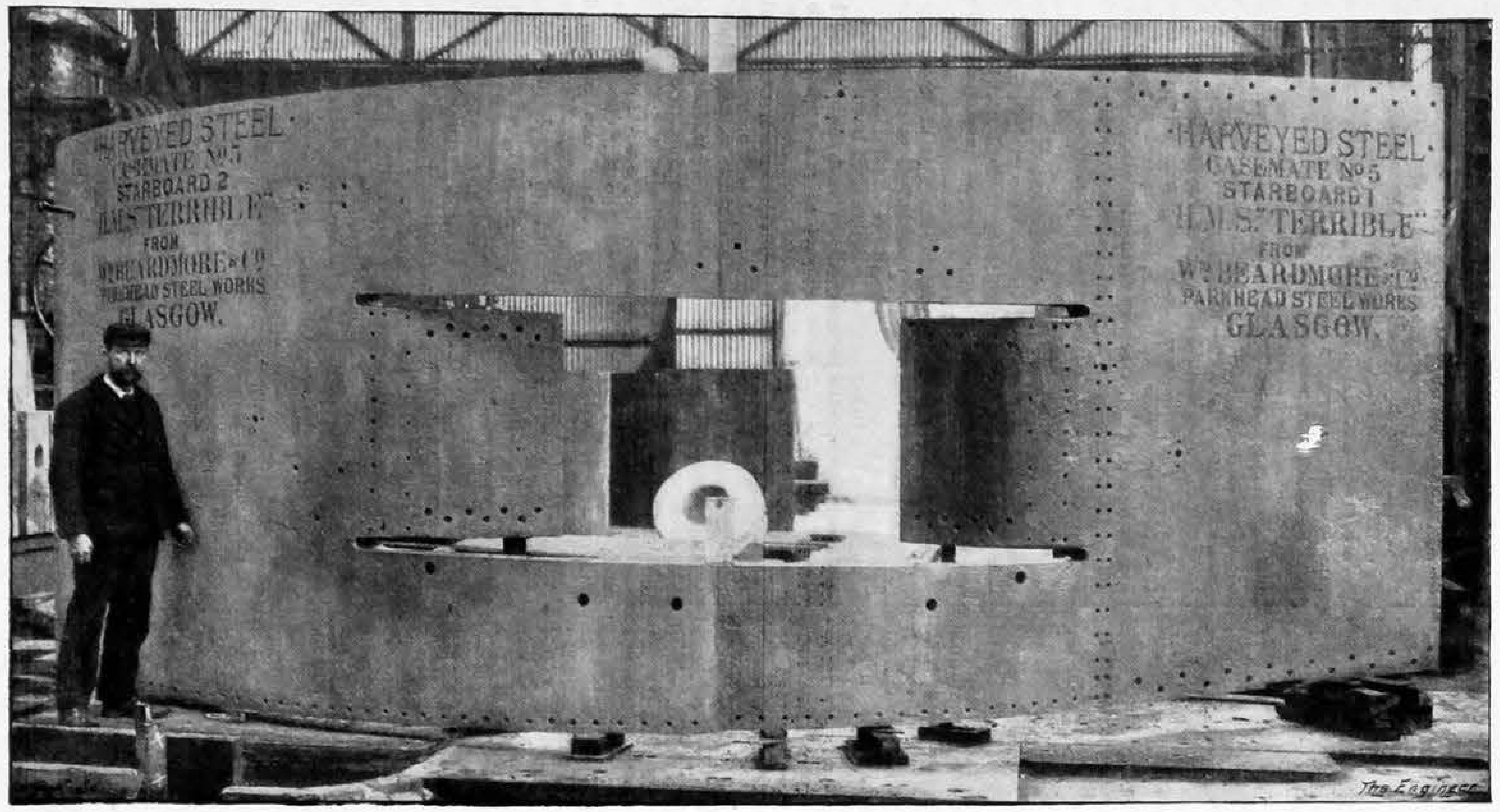


Fig. 5—HARVEYED STEEL CASEMATE, 6in. THICK, FOR H.M.S. TERRIBLE

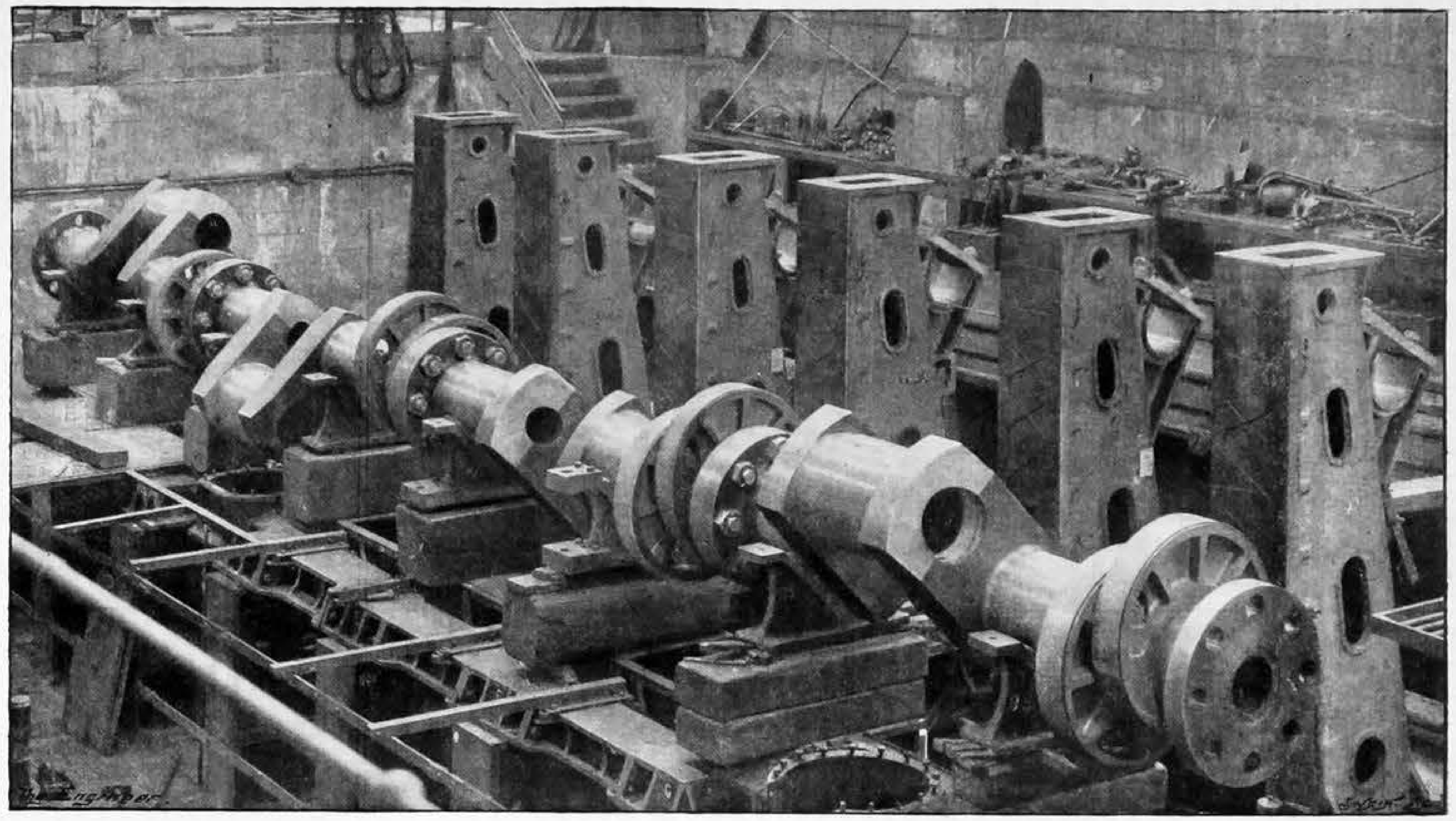


Fig. 8—CRANK-SHAFT OF H.M.S. POWERFUL IN BARROW ENGINE WORKS

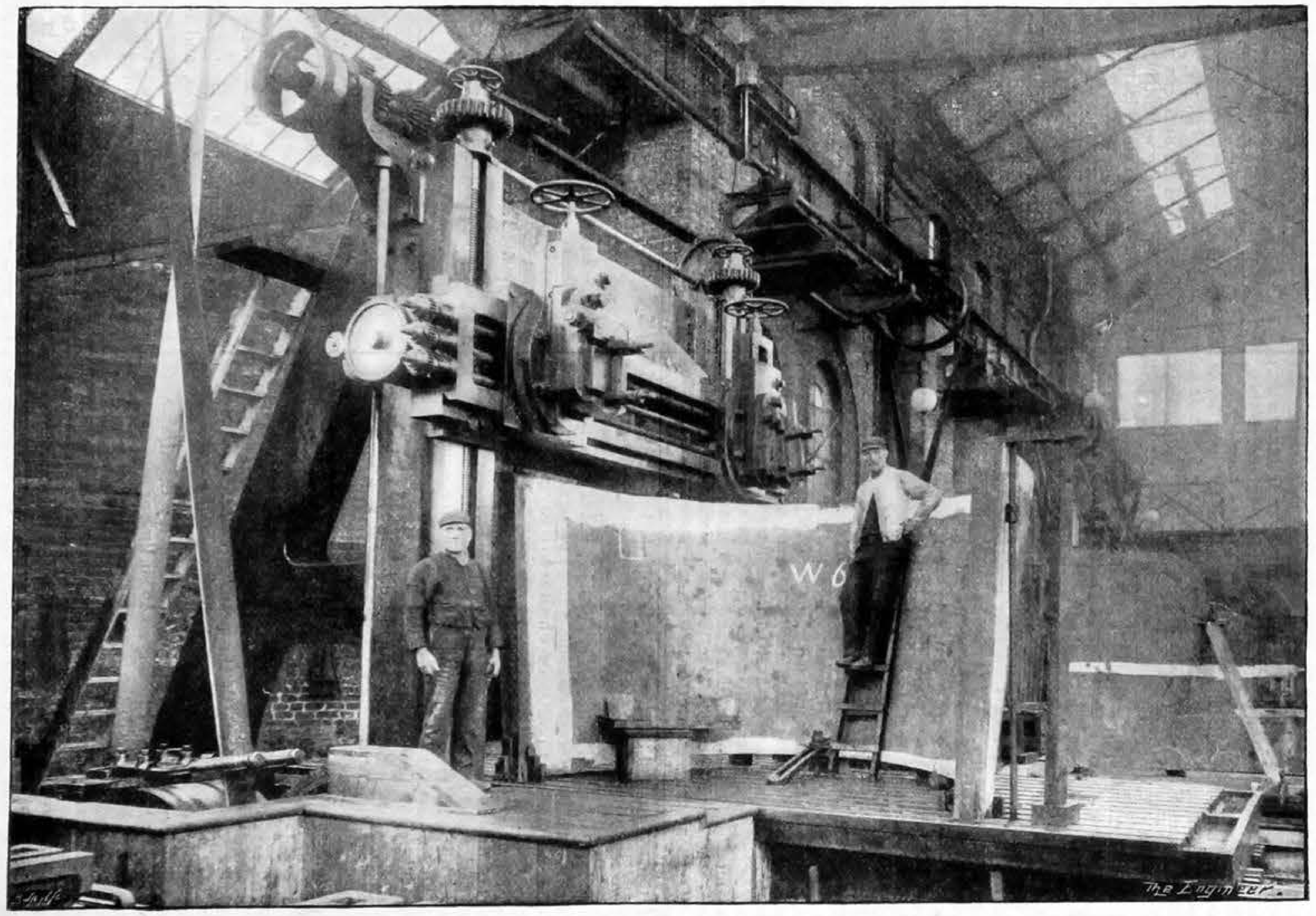


Fig. 3—PLANING MACHINE OPERATING UPON GUN SHIELD, 6in. THICK, FOR H.M.S. TERRIBLE

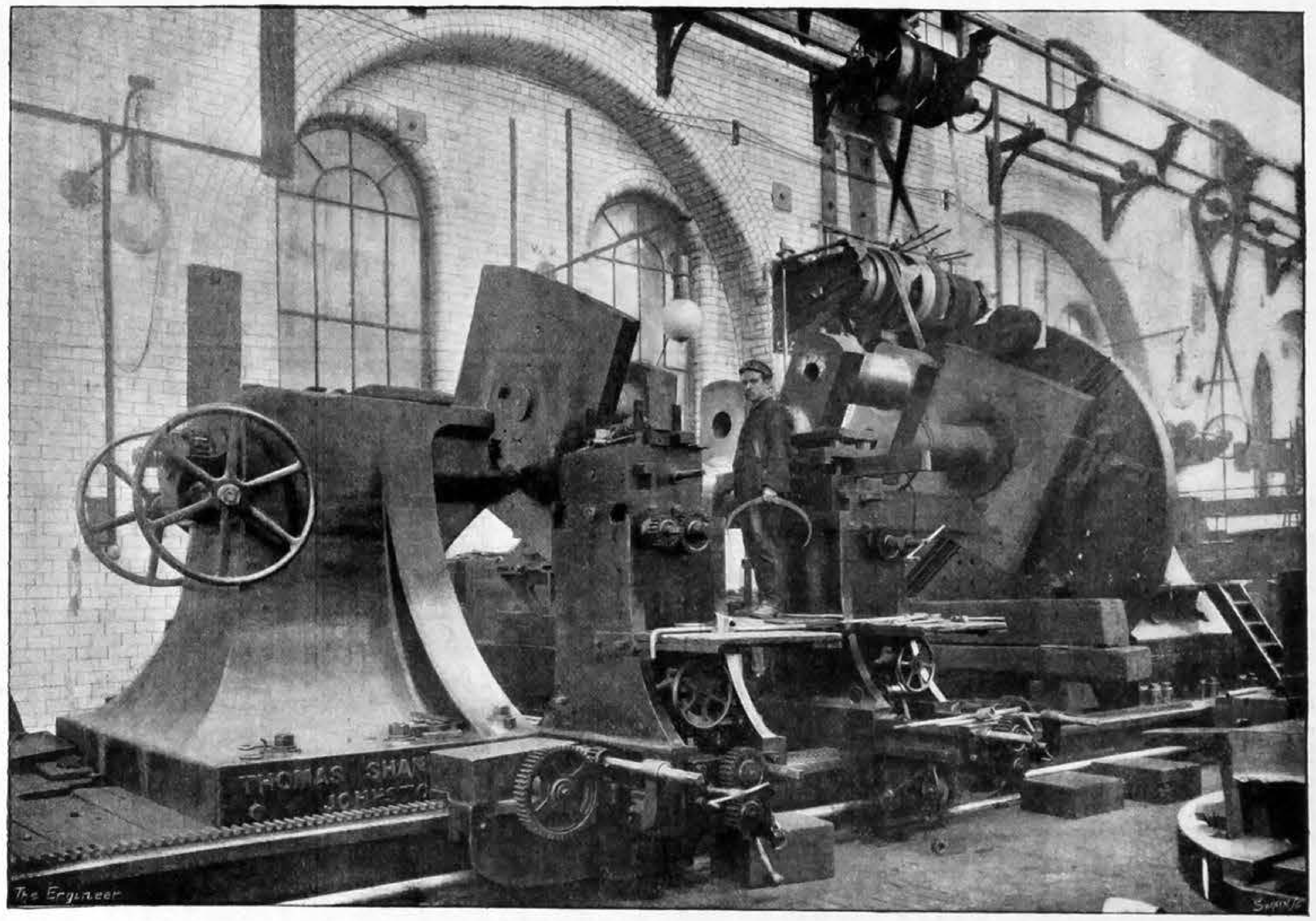


Fig. 7—LATHE, 69in. CENTRES, WITH DOUBLE CRANK-SHAFT OF CHILIAN CRUISER MINISTERO LENTENO

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THE ENGINEER, February 14th, 1896.

TO CORRESPONDENTS.

Registered Telegraphic Address, "ENGINEER NEWSPAPER, LONDON."

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

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

THE COST OF LOCKS AND WEIRS.

(*To the Editor of The Engineer.*)

SIR,—Can any reader give me a rough estimate of the cost of a lock and weir across a river about 60 yards wide with a rocky bed?

Monmouth, February 8th. E. P. J.

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, February 18th, at 8 p.m. Paper to be discussed: "The Manufacture of Aluminium by Electrolysis, and the Plant at Niagara for its Extraction," by Mr. Alfred Ephraim Hunt, M. Inst. C.E.

THE INSTITUTION OF JUNIOR ENGINEERS.—Monday, February 17th, at 7.30 p.m. Lecture II. of special course on Marine Engineering Design, by Mr. H. M. Rounthwaite, M.I. Mech. E., M.I.N.A.

THE INSTITUTION OF MINING AND METALLURGY, LONDON.—Wednesday, February 19th, at 8 p.m. Paper: "Mining in the Wollastonite Ore Deposits of the Santa Fé Mine, State of Chiapas, Mexico," by Mr. E. T. McCarthy, Member.

ROYAL INSTITUTION OF GREAT BRITAIN.—Tuesday, February 18th, at 3 p.m. Lecture: "The External Covering of Plants and Animals: Its Structures and Functions," by Professor Charles Stewart, M.R.C.S., F.L.S. Thursday, February 20th, at 3 p.m. Lecture: "Some Aspects of Modern Botany," by Professor H. Marshall Ward, D.Sc., F.R.S., F.L.S., Professor of Botany in the University of Cambridge. Friday, February 21st, at 9 p.m. Discourse: "The Past, Present, and Future Water Supply of London," by Edward Frankland, Esq., D.C.L., LL.D., F.R.S., M.R.I. Saturday, February 22nd, at 3 p.m. Lecture: "Light," by the Right Hon. Lord Rayleigh, M.A., D.C.L., LL.D., F.R.S., M.R.I., Professor of Natural Philosophy, R.I.

ROYAL METEOROLOGICAL SOCIETY.—Wednesday, February 19th, at 7.30 p.m. Papers: "Report on the Phenological Observations for 1895," by Edward Mawley, F.R.H.S., President. "Notes on the Recent Unusually High Barometer Readings in the British Isles," by Robert H. Scott, M.A., F.R.S. "Turner's Representations of Lightning," by Richard Inwards, F.R. Met. Soc., F.R.A.S.

SOCIETY OF ARTS.—Monday, February 17th, at 8 p.m. Cantor lecture: "The Chemistry of Certain Metals and their Compounds used in Building, and the Changes Produced in them by Air, Moisture, and Noxious Gases, &c.," by Professor J. M. Thompson, F.R.S.E. Tuesday, February 18th, at 8 p.m. Foreign and Colonial Section. Paper: "The Development of Electrical Traction Apparatus," by H. F. Parshall, General Electric Company, U.S.A. W. H. Preece, C.B., F.R.S., Vice-president of the Society, will preside. Wednesday, February 19th, at 8 p.m. Paper: "Report of the Royal Commission on Secondary Education," by H. Macan. Sir Owen Roberts, M.A., will preside.

DEATHS.

On the 7th inst., at 32, Carleton-road, Tufnell-park, suddenly, of syncope, FRANCIS PICKERSGILL COCKSHOTT, late Superintendent of the Great Northern Railway, in his 72nd year.

On February 7th, at 35, Cambridge-gardens, North Kensington, GEORGE ROBERTSON, M.I.C.E., F.R.S.E.

THE ENGINEER.

FEBRUARY 14, 1896.

COAST DEFENCE SHIPS.

A VERY large addition will be made, no doubt, to our naval strength. We shall have line-of-battle ships, cruisers, and torpedo catchers, but we fear that a special type will find no favour with the Admiralty. At all events, no hint has been dropped, no sign has been made that coast defence ships will be built; indeed, the term coast defence ship is regarded as a term almost of opprobrium. When a ship is held to have gone out of fashion, instead of being broken up she is used as a coast defence vessel. One would imagine that the part which such ships might have to play was wholly insignificant. In this respect Great Britain does not pursue the policy of other countries; Germany and the United States, for example, attach great importance to vessels for coast defence. It seems to us that it is impossible to consider the problems of modern naval warfare without seeing that the coast defence ship might on occasion prove simply invaluable; but the coast defence ship, to be of the greatest utility, must be specially constructed for the purpose. The battleship is in all cases a thing of compromise, and in the craft we have in view certain things indispensable in a sea-going vessel or a cruiser would be absent. Indeed, any attempt to combine a number of qualities all good in themselves would prevent the attainment of the intended object.

The coast defence ship whose construction we suggest would have for headquarters any suitable port; as for instance, Liverpool, Leith, or the Tyne. The number of ships appertaining to each port could be easily settled, probably on a basis of length of coast line to be protected. In war time the duties of the vessels would be that of patrols. Each would be attended by scouts in the shape of torpedo catchers. Only under the most exceptional circumstances would any one of them be withdrawn far from the base of operations. The ranges or beats of them would overlap, so that a constant chain of intercommunication might exist round our shores. It will be seen that ships working under such conditions can dispense with much that is essential in sea-going craft which may be for days, if not weeks, out of sight of land, or at least far from any port where coal, stores, ammunition, &c., can be obtained. Consequently on a reasonable tonnage very great opportunities for providing armour and guns become available. But, on the other hand, the draught of water must be moderate; we shall go so far as to say that the ships must be built each with more or less regard for the particular station on which she is to be employed. It is probable, however, that a draught of 18ft. is about the most that could be allowed; certainly the most on the east coast, and in many places in the Channel. The speed of the ship should be considerable, but we do not think that in this class of craft a very high speed is at all essential. As a rule 17 knots would do very well. The object of such a ship is neither to run away nor to chase, and she could always traverse the distance covered by her beat in sufficient time to be useful if she could steam 17 knots. The attempt to make her faster would defeat the object in view, by overloading her with machinery. It would not be of the smallest use for such a ship to arrive in a hurry where she was wanted, and then find that she was wholly overmatched. Our coast defence ship would have comparatively moderate engine and boiler power. Her boilers would be of the "express" type. Her machinery light, and adapted for running at a high speed. A breakdown would be a matter of secondary importance, because the vessel would never be far from her base; and for the same reason, the quantity of coal carried would be small—enough for a couple of days' hard steaming at most would suffice. Special arrangements, would, however, be made for taking in coal quickly, and coal derricks could be provided either in the river, in the case of the Mersey, let us say, or on shore. In Portsmouth the arrangements for coaling would be such that she could always fill her bunkers in a couple of hours. There is no mechanical difficulty in the way of doing this, all that is needed are special coaling appliances. Thus, then, the ship when short of coal would be able to run into harbour, fill her bunkers, and go out again in an exceedingly short time. Her utility would largely depend on the power of doing this.

While we are at peace, it would be unnecessary to maintain a full crew on board the coast defence ship, and even when she was in fighting trim, it would not be necessary, perhaps, to carry a crew for more than three days at a time without a day on shore. But, in any case, it is clear that the accommodation to be provided on board for the crew might be much less complete and comfortable, not to say luxurious, than that to be found in modern battleships and cruisers. The great mass of superstructure, in the shape of deck-houses, which are more or less necessary in regular sea-going ships, would not be needed in a vessel working near home. In peace times there would be plenty of room for the very small crew, and in war times the men would have to rough it a little. In no case, however, would wooden deck-houses and a multitude of wind trunks and cowls be tolerated. Our man-of-war is intended for fighting, not as a residence. It will be seen that by carrying small quantities of coal, and providing very light boilers and machinery, sacrificing deck-houses, and so on, a very considerable weight is rendered available for other purposes, and our coast defence ship may be at once heavily armed and well protected by armour. The first essential is that she should not be sunk at all, or sunk with difficulty; the second is that her crew should not be killed nor her guns disabled by the fire of the enemy. The first end would be attained as far as may be by bulkheads, the second by disposing the whole of her armament in a central citadel over an armour deck running fore and aft, and a belt along the water-line of such a thickness as would keep out the shells of quick-fire guns. This would not be difficult, because hard-faced armour is capable of great things in this way. We hear of plates being punched, and projectiles going through almost uninjured; but the damage which even a 6in. solid shot can do inside a large ship is quite trifling compared to the havoc which can be wrought by a shell bursting between decks. The United States pin their faith to a large extent on their monitors for coast defence—and properly so. They would, no doubt, prove extremely formidable craft, especially in fair weather, or in inland waters or sheltered bays. They present a very small mark to shoot at, and there is very little to damage even if they are hit; but they are too low in the water, and carry their guns too near the sea, to be really dangerous in a breeze, and they are, besides, very, very slow. It would not be at all a difficult task for such a ship as our own Empress of India to run right over and sink an American turret ship. Our coast defence ship would have to carry her guns well above water; the more so as a light forecastle would be necessary for steaming head to sea. But in all this there is no insurmountable difficulty so long as too much is not attempted. Her armament would consist of quick-fire guns of moderate weight and dimensions, and we are disposed to think that it would be better to use only a single size of gun throughout, say 8in. Elswick quick-fire. This would very greatly simplify all the ammunition arrangements, and avoid a source of confusion. The number of guns to be carried would depend on the tonnage available. Half a dozen such guns, carried two to fire ahead and two on each broadside, would constitute a most powerful armament. Of course there would be provided a considerable number of small machine guns intended to repel torpedo attacks, and the ship would be fitted with a couple of torpedo tubes; but her guns would be her strong point.

It is of not the smallest use to provide a great number of guns—the crews of which would be destroyed by shell fire in a few minutes—or even shielded guns, which could be carried away shield and all; nor guns on a deck which would be choked with the ruins of boats and deck-houses, all in flames in five minutes. It needs no magical perspicacity to see that a ship with two guns, which she can continue to use as long as her ammunition holds out, must in the long run beat a ship with a dozen guns, none of which can be fired ten minutes or less after a battle begins. If we have a given amount of tonnage allowed us, it is better to use that up partly in armour and partly in guns, than all in guns. Very great protection can be afforded to guns and gunners in a central citadel with suitable traverses. Of course we shall be told that we propose to sacrifice we know not how many good qualities, but this is precisely what we intend to do; and we answer that in every warship something must be given up, and that it is unwise—most unwise—to crowd a coast defence ship with things which, even in sea-going ships, are of doubtful necessity.

We shall have, then, in the ship whose description we have sketched a more or less impregnable floating fort rather than a ship of war in the ordinary sense in which the word ship is employed, and it will be seen at a glance, we trust, that this floating fort would be a thing about which the captain of even a first-class battleship might think twice before he attacked it. In the first place, our ship could manœuvre in water that the battleship dare not enter. The French Navy could do nothing with the German Navy in 1870-71 because the French ships drew seven or eight feet more water than did those of their foes. The well-directed fire of a few 8in. quick-firers would play havoc with the upper works of the warship, and in return the warship could do little unless she succeeded in landing a heavy shell inside the citadel of the coast defence ship. The principal duty, however, of our suggested craft would be to prevent the making of raids on our coasts by armed cruisers. Numerous examples of these raids were supplied a few years ago during the Naval Manœuvres. It would be an extremely audacious cruiser, for example, that attempted to loot Brighton, let us say, while there was one of our coast defence ships within fifty miles of that town. In a fair fight there are not half a-dozen cruisers afloat that would not have to seek safety in flight, and the cruisers that would not are in the British Navy. It is, of course, extremely difficult to convey anything like an accurate idea of details within the limits of an article like this, we can but suggest the outlines. Our programme after all comes to this, that a number of ships should be constructed specially to defend our coasts and those of our Colonies and our coaling stations; that they should abandon a number of qualities needed in a cruiser or a battleship, on much the same principle that policemen do not carry knapsacks; and that availing ourselves of the sacrifice of certain characteristics, we should secure in their place a very powerful battery, which could be fought behind armour to the very best advantage. There is much in such craft to recommend them; something worth consideration, we think, in the proposal that they should be built.

LOCOMOTIVE GRATES.

PERHAPS our American railroad contemporaries will pardon us for saying that their pages present us with an endless series of puzzles, some of them amusing, all interesting. The puzzle sometimes lies in a direct statement of fact; sometimes in the difficulty of reconciling contradictory arguments or assertions; sometimes in the apparent impossibility of explaining an event on any rational scientific basis. The last number of *The American Engineer and Car Builder* contains an article which presents us with a very favourable example of the second type of puzzle. Of course all our readers know that railway men in the United States, far from having anything to learn from English engineers, are in a position to impart very valuable instruction. If we were to venture to assert anything to the contrary we should be called very hard names, yet we find the following passage in our contemporary. He advocates the carrying out of a series of experiments by some intelligent person to ascertain the relative value of large and small grates in locomotive engines, and then goes on to say:—"Unfortunately most of our railroad managers seem to be wedded, or at least in love, with ignorance. They are always ready to spend any amount of money in contention or litigation, to protect themselves and advance their interests, but if it could be known, it is believed that the amount of money which is expended annually for the advancement of knowledge is very small." We tremble when we think of the chastisement we should receive if we had written and printed and published such a statement. Fancy an English journal daring to say that American railway managers were in love with ignorance, not even wedded to it; the delicate significance of the distinction will be generally appreciated, we think. As a puzzle, the query how came such a passage to appear in an American railroad journal is excellent. We pass on to the consideration of another.

Tremendous speeds have been attained in the United States. We have admired, wondered, and not unnaturally asked how the thing was done. We cannot do it at this side of the Atlantic, or at least we do not do it, and we seek for explanation and information. In reply, we are told by one railway engineer that he has no fast engines, but that he can provide "some first-class liars." This statement does not advance matters much, and may be regarded as beside the question. But as an explanation is seen to be necessary, our contemporaries tell us that the resistance of rolling stock on American railways is quite trifling, 15 lb. or so per ton at 73 miles an hour. If this be so, it is easy to see that no very extraordinary power is required, and so we find that a locomotive developing 600 to 700-horse power is quite competent to do the work said to be done. Here we may do a little sum. Let us assume that the rate of combustion is 30 lb. a mile. In an hour there was burned $73 \times 30 = 2190$ lb. of coal, and, dividing this by 700-horse power, we have 3·1 lb. of coal per horse-power per hour. This is just what we should expect with an English engine. If we suppose, further, that the grate area was twenty square feet, then coal would have to be burned at the rate of about 109 lb. per square foot per hour. That is a very high rate of combustion, much higher than rates usual in this country; but, on the other hand, no English locomotive has ever run 86 miles at the rate of 73 miles an hour. The engine which, in the United States, made the run in question had, we understand, about 28 square feet of grate surface for 700-horse power. At the 30 lb. a mile rate, this would represent a consumption of 78 lb. per square foot per hour. We would be content to accept this figure as representing what took place, but for the article which we are considering. From this we learn that the maximum rate of combustion in the United States locomotives is 200 lb. per square foot of grate per hour. We may say here at once that we do not believe that it is possible under any conditions obtaining in a locomotive boiler to *burn* coal at this rate. It may be put through the fire-door, but it is not all burned, a large proportion being carried up the chimney by a draught which is of necessity so strong that the fireman "has to keep tight hold of his shovel lest it should be pulled into the fire." It is, perhaps, not unfair to assume that coal was burned during the run on the Lake Shore line at 40 per cent. less than the maximum rate. This would give us 120 lb. per square foot of grate per hour, an estimate which is probably not far from the truth. Another simple little sum tells us that under these circumstances the total weight burned per hour on a 28ft. grate was 33,600 lb. Now, if we divide this by 3, we have 1120-horse power, in which case the theory that the resistance of the train was only 15 lb. per ton collapses; and if we divide by 700 we find that the engine used 4·8 lb. of coal per horse per hour; if by 73 that the consumption per mile was 44·6 lb. We must leave our friends at the other side of the Atlantic to take their choice. Probably the truth lies somewhere between the two. At all events, it is a perplexing puzzle to reconcile the statements made on the one hand concerning train resistance, and on the other about the rate at which coal is burned by American locomotives. We need scarcely say that it is a matter of extreme importance to decide whether the resistance of American rolling stock on American roads is or is not really less than that to be overcome on English daily practice. Mr. Tratman, in his letter which will be found in another column, more than implies that it is very much less. It is a difficult matter, no doubt, to carry out any really useful direct test of the stress on a drawbar at high speeds, and to get diagrams from the engine cylinders would be yet more difficult. But there ought to be no trouble in ascertaining within a little what was the total weight of coal burned during the 86 miles "record" run, and with this before us we should be able to form a good idea as to what the train resistance was.

The reason why our contemporary has written about grates is that a paper was read by Mr. J. Snowden Bell on "Wide Fire-box Locomotive Boilers" before the Western Railway Club last November. *The American Engineer and Car Builder* tells us that the discussion which followed was by "No means conclusive with reference to the primary question whether a large locomotive grate and fire-box is better than a small one. In fact, this debate reminds one of a boy's composition on the seasons, in which he said that 'Some loves Spring, some loves Summer, others Autumn, and others Winter; but as for me give me Liberty or give me Death.' That is, the participants in the discussion seemed to desire most to maintain a non-committal attitude with reference to the question under consideration, so as to be free to use big or little fire-boxes as they might choose." Our contemporary manifests some surprise that there should be any difference of opinion on the subject. But there is really nothing surprising about the matter. To use the words of the late Charles Beyer: "Anything will do for a locomotive;" and it is well known that engines manage to get along somehow, and do their work under very various conditions. In this country locomotive superintendents are so tied up for width that the grates of express locomotives at all events are nearly all the same size; the minimum dimension is about 18 square feet, and the maximum seldom touches 21 square feet. If we could use larger grates we would, and the reason why is obvious. The smaller the grate the less is the area through which air can find its way for combustion, and the sharper must be the draught to pull it in. Furthermore, a small grate always means a thick fire when the engine is fully loaded, and a thick fire requires a smart draught to force air through it. But this entails a contracted blast pipe, and a contracted blast pipe is contrary to all the best traditions of English practice, and is an offence to drivers and locomotive superintendents alike. It is sometimes argued that the size of the grate is of the less consequence, because so much air can be admitted through the fire-door. This may be right in theory, but not in practice. It is well known that when there is a difficulty in keeping steam, it is often due to too large an air admission over the fire. It seems to check the rate of combustion. In the United States coal is burned under very different conditions from that which obtains here, and the scoop is not used to anything like the extent it is employed in this country. Our contemporary does not supply much information as to the results obtained with grates of varying size. He argues in favour of a large fire-box, no matter what the grate area; and in this we think he is right, but it must not be forgotten that some locomotives built many years ago by Mr. McConnell, for the London and North-Western Railway, with very large and lofty fire-boxes, could not be made to steam satisfactorily until the grates were raised nearly a foot. Radiant heat is a very peculiar thing, and seems to lose itself in an inexplicable fashion, if it has to travel very far.

THE HARBOURS OF INDIA.

THE question of the present insufficiency of harbour accommodation throughout the coast line of India appears likely shortly to receive the consideration it undoubtedly demands. The importance of this matter will certainly receive accentuation owing to the construction now progressing of the coast line railway between Madras and Calcutta along the western shore of the Bay of Bengal. Up to the present time all the inland districts of India have been practically shut off from the numerous towns—many of them important—situate on that coast. To all intents and purposes the only ports available for the shipment of the produce of such of those districts as lie north of Madras on the eastern side of India have been Madras and Calcutta. Nearly 800 miles of surf-beaten coast stretch between these two ports. In the absence of all railway communication with the interior, this gap in the harbour accommodation of the Bay of Bengal has not been so seriously felt as to make it imperative on the Government of India to incur the expense of constructing a midway harbour. But as the coast line progresses it is sure to become linked up at various points throughout its length with the great interior system of railways. Through this connection a large amount of freight-seeking traffic will ask a readier outlet than is now available for it. This chance of adding to the expected revenue of the new line must, however, be sacrificed if there be no port at which that freight can be obtained. This fact must render it imperative upon the Indian Government to stir in the matter, even if there existed no other reasons for its doing so.

To deny that such other reasons exist would, however, be to concede too much. The total harbour accommodation of India is, and has long been, quite insufficient for its needs. Representation on this point has been urgent for very many years past. Nor have such representations failed of a considerable amount of effect. We have within the last few decades seen Karachi, Colombo, and Madras converted at a vast outlay into safe harbours; all of these, prior to such a term, having been but open roadsteads. As to the two ports first named, we hear nothing but satisfaction expressed. Unfortunately, however, this is not the case as regards the third, Madras. The writer of a letter to the *Times* recently described this port as being yet one from which all prudent shipmasters must fly on the first threatening presage of one of those cyclonic storms which are so frequent and so disastrous in the Bay of Bengal. If this assertion may be accepted, it remains therefrom that between Colombo, in Ceylon, and Calcutta at the head of this "storm-vexed" bay, a distance of about 1400 miles, there exists no safe shelter for shipping. This fact, coupled with the approaching facilities of railway communication that we have named, must surely induce the Government of India to adopt remedial measures; and there have not been wanting suggestions in this direction to which attention might well be given. It is, however, not to be denied that there is hardly a coast line in the world that is so bare of facilities for the construction of a harbour as that which is now under particular reference. South of Madras these disabilities are not so severely felt. In both Tuticorin and Negapatam the traffic of Southern India possesses outlets the natural advantages of which might, perhaps, lend themselves without difficulty to improvement. But both of these ports lie relatively adjacent to the magnificent harbour of Colombo before referred to, and it is confidently anticipated that when union shall have been effected between that place and the railway system of Southern India, it will become the port of export for all the districts of that Indian region.

We need, therefore, primarily only to consider the question as it affects the 800 miles of coast between Madras and Calcutta—the efficiency of the port first named being assumed. Doubtless the Government at Calcutta has in its possession surveys and reports upon all such localities along this coast line as may possess features for safe harbourage. But if so the public has not been taken into confidence respecting them. Nor must the fact, perhaps, be too readily assumed, for a harbour on the east coast of Ceylon now used as a safe resort for shipping during the height of the north-east monsoon, was only accidentally discovered a few years back by a member of the Public Works Department of the island. It is, therefore, possible that there may remain undiscovered possibilities along the 800 miles of unsheltering coast line that we have named. But this is merely conjecture. What we have heard asserted is that at Vizagapatam, a town on the coast situated about midway between the ports of Madras and Calcutta, an outlay of some £300,000 would construct a harbour ample for the accommodation required for the shipping plying in the Bay of Bengal. We do not understand that this estimate has been made professionally, or as the result of any detailed survey of the marine features of the locality. Consequently it is not pretended that the suggestion can be anything more than barely tentative. Still, the information has been made upon information locally acquired, and may therefore be possessed of material value. Vizagapatam is, as we have said, centrally situate in the sense of our discussion. It is one of the points that will not only be directly served by the coast railway now in progress, but it is one that, from its importance, must become one of the ports of debouchment for the trade of the interior, from which it is now shut off by the want of railway communication. In our foregoing remarks we have abstained from mention of the needs of the Western coast of India. The Indian Ocean, however, is relatively free from the cyclones that are almost seasonal in the Bay of Bengal. The demands of the West Coast, therefore, for extended harbour accommodation, do not in the least degree approach in gravity those of the coast to which we have confined our notice, and its claims may be held over without prejudice to the needs of the present generation.

A FEATURE OF THE NEW NAVAL PROGRAMME.

THE most remarkable feature in the new naval programme, if the forecasts of it are in any degree correct, is the proposed construction of a large fleet of torpedo boat destroyers. It seems not improbable that between a fifth and a sixth of the entire sum voted to the Naval Estimates of the ensuing financial year will be appropriated to the construction of a large number of these vessels. The cost of each may be estimated at between £60,000 and £70,000. The speed aimed at is 30 knots, and in some cases, from makers who are prepared and able to undertake the task, 33 knots will be asked. There is no doubt whatever that such a speed can be obtained; there are at least three makers who will willingly undertake to give it, but in fairness to themselves they will probably insist on being allowed a comparatively free hand in the matter. Fortunately, the British Admiralty, though faulty and misguided on several points, is wise enough, as a rule, to leave the design and construction of highly-specialised types in the hands of those most competent to deal with them, and to slacken, though not infrequently under pressure, the government trammels. In the coming orders it is sincerely to be hoped that the Admiralty will deal wisely and generously with the builders. In doing so they will certainly have the approval and sympathy of the public, for in this way can they alone realise their ambition. To those who have watched with attention the gradual change of opinion on naval matters, this large order for high speed, lightly armed, and totally unprotected craft will come with little surprise. When, a few years ago, a revulsion of feeling against huge unwieldy fighting platforms set in, it might have been foreseen that as our knowledge and capability increased, a smaller, high speed, readily manœuvred vessel would replace the old and massive form, just as surely as the lighter quick-firing, high velocity guns would replace the cumbrous 110 tonners when science had made it possible. There will doubtless be various opinions about the wisdom of the order, there will be some who will contend that unarmoured vessels are useless in these days of quick, accurate fire and penetrating projectiles; there will be others who consider it impossible to keep vessels intended for such high speed permanently efficient; others perhaps who will see no place for them in warfare, and not comprehend their method of attack; and finally, and amongst them ourselves, those who foresee great things from the torpedo boat destroyer, as it is now called—a name which will need revision—and believe that, as in the days of the Great Armada the small handy vessels of the British fleet were able to swarm round and rout the great Spanish ships, so in the future the little boats that can come and go with swiftness and precision will have an immense power over more unwieldy craft. We do not underrate by a fraction the value of battleships of a size not exceeding that of the new ships, magnificent fighting machines in all respects, nor of the first-class cruisers—both these elements are exceedingly necessary to an efficient navy—

but we expect when the trial comes to see great things done by the skilful combination of the smaller vessels. From one point of view, an order for such a large quantity of a particular type, and a great expenditure of money, require the most careful consideration. The whole difficulty appears in the question, Has finality, or an approach to finality, been reached in the construction and design of torpedo boat destroyers? We can very safely answer No, and that gives the pause to a stat ment of opinion. We are, it must be understood, firm in our belief that a large fleet of small ships is greatly to be desired; but we think that to construct it too rapidly would be a fatal error. Unfortunately wars and rumours of wars make it imperative that the country should be expeditious in her movements. If the country were more settled, we should like to see the construction of this fleet of torpedo destroyers spread over several years, to the constructions of each new year the experience of the previous year being added. There are very many points that require improving. Chief of them, steering qualities, both in men and machines. Perhaps the men have been quite as much to blame as the machinery in the many petty collisions and mishaps which have marred our naval manœuvres. It is very much to be deplored that men should be at fault, but that can and must be corrected by drill, discipline, and knowledge. That the machinery should go wrong is also to be deplored; that also can be and must be put right. The whole machinery of warships, of all sorts, for the future must be simplified. A completely fitted vessel now-a-days is as intricate in its internal arrangements as a spinning jenny. This should not be, and will not be. Means and methods of simplifying can and will be found. Many have appeared in the last few years, and there are men ready and able to make many more. We do not think we are unreasonably optimistic in this. Our experience has always been that where simplicity has been demanded it has been found, and that only where unnecessary complications have been tolerated they continued to exist. Might we prophesy of the craft of the future the direct lineal descendant of the torpedo destroyer, we should say it will attain a speed approaching 40 knots, will have a thin but very resisting armoured deck and whaleback, will be armed with two or three torpedo tubes, and one quick-fire automatic 4·7in. or 6in. gun, protected. Steering gear will be perfected, and the vessel will have magnificent possibilities in manœuvring. Such things we may hope to see while the twentieth century is still young; what our children may see, and foresee, we do not dare to anticipate. We leave untouched the subject of the tactics of the new flotilla. It is the province of the admiral, not of the engineer. It is the engineer's duty to produce the handiest, swiftest, most dangerous craft he can, and in the present instance we may say it is the duty of the Admiralty to break the remaining shackles and leave him quite free to do his utmost.

IRISH RAILWAY WORKING.

THE railway companies of Ireland seem to have had some of the benefits in working that have been common here in the last half-year. Companies such as the Great Northern of Ireland have had increased receipts throughout most of the sections of the revenue, but passengers exhibit the largest recovery; and they have the benefit which is not so common here of a moderate expenditure on new works, so that there is only a limited additional interest to pay. The Great Northern, for instance, last half-year, expended £32,286 only. Out of this sum, £9812 was spent on the new line to Ardee, in course of formation—a short branch on which £16,409 have been spent up to the end of last year, and which is expected to take the further sum of £19,500 to complete it. Beyond that amount already alluded to the expenditure on the capital account in the past half-year has been £9256 on new working stock, and £13,217 on new works at many parts of the line; and when it is remembered that the line owned and worked by the company is over 500 miles, it will be seen that the additional capital expenditure is very limited. The cost of working the traffic, too, is moderate—the receipts for the past half-year being £420,000, and the expenses in the total only £202,251, so that the proportion is below that of most of the arterial lines of this country. In the case of another of the Irish lines of a different type, the Cork, Blackrock, and Passage Railway, the past half-year seems to have brought about a decision that is rather unusual—a Bill is to be promoted in Parliament to enable the company, amongst other things, to convert the existing line to one of 3ft. gauge; and to make a line of that gauge from Passage to Crookhaven. The little line from Cork has been one that has attempted to introduce the "zone" system of railway fares, but with only limited success; and it is now intended to alter the gauge of the line to a narrower one. Apart from such variations, the working of the Irish railways seems to proceed smoothly, and yields on the whole better results as the years pass on, though some of the items of expenditure show that growth which is very familiar on this side of the Channel.

LITERATURE.

Gas Manufacture: The Chemistry of. A Practical Handbook on the Production, Purification, and Testing of Illuminating Gas, and the Assay of the Bye-Products of Gas Manufacture. For the use of Students, Chemists, and Gas Engineers. By W. J. ATKINSON BUTTERFIELD, M.A., F.C.S., Head Chemist, Gasworks, Becton. London: Charles Griffin and Co., Limited. 1896. Large 8vo., pp. 375.

IT has always been a matter of surprise that this particular and vast chemical industry has not attracted greater attention among chemists, and that its exposition and development has been left almost entirely to engineers; it is therefore gratifying to record a move in the right direction in the appearance of a volume emanating from a chemical source. Therefore, we welcome the present handbook, and have perused it with interest, and our only cause for regret is that it is not more chemical, and even exclusively chemical. The matter is treated in eleven chapters. The first chapter deals with the raw materials of gas manufacture, which are considered under the following heads:—(1) For the production of coal gas; (2) for the production of water gas; (3) for the production of oil gas; (4) for enriching gas of low illuminating power. It is one of the best chapters in the book. Various coals and oils are described, their chemical characters set forth, and methods of examining them recorded. The next two chapters treat of coal gas, and contain some of the worst matter in the book, where the author enters very superficially into the engineering department of the gasworks and leaves chemical problems of high technical interest unsolved, and this is all the more regrettable because the chemical matter that fortunately does form the preponderating proportion of these two chapters is good. The next four chapters treat of water gas, oil gas, gas enrichment, station gas meters, station governors, and the gasholder. Again we feel that more might have been said chemically; for instance, about oil gas processes that are before the public at the present day.

The next two chapters treat of gas analysis and photometry very completely, and although much is old and much contained in another book recently published, and mentioned by the author, yet it forms an appropriate part of the present volume. In the gas apparatus, we are surprised to find the old Frankland and Ward apparatus with the old steel facets still holding its own at Becton. In Chapter X. we come to the application of gas, with which the manager of a gasworks should be acquainted in order to produce a suitable material; to burners, including the incandescent gas burner, which the author considers one of the greatest triumphs of chemical research of the century; gas fires and gas engines are briefly treated. Bye-products and methods of examining them form the subject of the concluding chapter. An incomplete bibliography and an excellent index complete the book, which should prove of use to those connected with the gas industry.

The defects of this book are the poorness of the engineering portions, which anyway seem somewhat superfluous in a chemical handbook, and the lack of diagnosis in many chemical points. This want of confidence on the part of the author seems quite unwarranted when the character of the more complete portions of the book is considered. We should think, too, that, holding the high position he does, he cannot be new to the work, and therefore we suppose his reticence is due to his modesty; for instance, he tells us gas engineers are by no means united in opinion as to the best variety of brick to use for retort stacks; and, again, that gas engineers are not unanimous in opinion as to the most economical carbonising temperature; and further, that they are not decided as to the correct dimensions, shape, position, and material for retorts, nor quite at one as to the relative merits of various scrubbers and washers. This does not surprise us in the least, but we think readers of the book would like to know what the author's chemical erudition would lead him to say on these matters. So, too, in the paragraphs treating of the quality and quantity of gas produced, we notice no mention of the effect of the size and shape of the retort, of the effect of the size of the coal charged in, the effect of packing, or the effect of quantity of coal. Then it is pointed out that the carbonic oxide burns at the top of the shaft when the furnaces are not working properly, but that this is not sufficient to form the sole guide to the engineer on the proper amount of primary and secondary air to admit to the furnace. The introduction of a little of the chemistry of regenerative firing would, in this case, help matters through better than the abrupt suggestion of an analysis, and the subsequent comments on the composition of the gases. We may, however, in conclusion, remark that as an addition to the literature of the gas industry, this volume is decidedly valuable, and that with a few judicious expurgations on one hand and amplifications on the other, its value will be very greatly increased.

The Law Relating to Factories and Workshops, including Laundries and Docks. By MAY E. ABRAHAM and ARTHUR LLEWELLYN DAVIES. London: Eyre and Spottiswoode. 1896.

IN books which are the result of collaboration it is sometimes rather difficult to determine the point at which one author begins and the other leaves off. No such difficulty exists, however, with regard to this work, as it is divided clearly into two parts, the first of which is written by Miss May E. Abraham, and has for sub-title "A Practical Guide to the Law and its Administration;" while Part II. is styled, "The Act with Notes," and is from the pen of Mr. A. L. Davies. The book is wound up with an appendix dealing with the special rules laid down for dangerous employments, and containing copious indices. Miss Abraham is a lady Government factory inspector under the Act, and her portion of the book extends to some eighty pages. It consists of a very business-like and readable *résumé* of the various Acts of Parliament which control the inspection of factories at the present day.

The average owner of a factory or workshop has but a hazy notion of the law on the subject, and when it is borne in mind that no less than fifteen Acts, passed at various dates, must be studied and sifted by him if he wishes to master the details, his ignorance may be excused. Hitherto he has known that at odd times the factory inspector will make his appearance on his premises, and that if this latter gentleman is not treated with civility and his suggestions carried out, he can make things very unpleasant for the unfortunate proprietor. Miss Abrahams simplifies matters for him by pointing out clearly what the factory inspector has a right to do, and what he has not, so that any one armed with her book might, after a couple of days' study of it, be in a position to judge as to whether or not the inspector with whom he has to do is exceeding his legal powers.

The various chapters of Part I. deal with a general view of the Acts, sanitary provisions, means of safety from machinery and fire, employment, alterations of hours, overtime, periods of employment for men, women, and children, certificates of fitness for employment, education of children employed, holidays, accidents, special rules for dangerous occupations, laundries, docks and building operations, bakehouses, tenement factories, outworkers, particulars of work and wages, the Truck Act and its administration, and legal proceedings and penalties. The whole may be said to give a very fair outline of the law as it stands at present, and forms, so to speak, a suitable introduction to the statistics and legal technicalities which follow. The impression it leaves on the reader is that the existing Factory Acts, while, like all other laws, may be open to improvement, yet are not so terribly unreasonable as is usually imagined by those whose knowledge of them is merely superficial.

The hard reading, however, comes in in Part II., where the text of the fifteen Acts relating to the subject since 1878 is given. Mr. Davies, who is a barrister-at-law, has amplified the Acts and facilitated their comprehension by very full foot-notes. Not only is the law laid down, but its carrying into effect is demonstrated by reference to no less than thirty-seven cases which have been fought out legally under these Acts.

The subject is not altogether of an inviting nature to the ordinary reader, but it is emphatically one in which a great many industrial people are bound to take an active interest from time to time. To such this book is to be recommended, as it will greatly facilitate a grasp of the matter. The dimensions of the book, too, are not such as to alarm the business man who is short of time. This may be looked on as a distinct advantage.

SHORT NOTICES.

Laxton's Builders' Price Book for 1896. Containing above 72,000 prices. Originally compiled by William Laxton. Seventy-ninth edition. London: Kelly and Co., Ld. Price 4s.—This well-tried price-book has lately been growing much in bulk with each revision of prices. A new feature in this edition is the rule of procedure in cases to be brought before the Tribunal of Appeal appointed under the London Building Act, 1894; also a new form of "agreement and schedule of conditions for building contracts" lately issued by the Royal Institute of British Architects, which supersedes a form of "heads of conditions of builders' contract" originally agreed to between the Institute and the Builders' Society, but now withdrawn from general use.

Gleanings from Patent Laws of all Countries. With Information as to Points of Practice, Area, Population, Production, &c. By W. Lloyd Wise, J.P. London: Cassell and Co. 1895. Small 8vo, 208 pp.—This is the first portion of the "Gleanings," and comprises information concerning patent laws in twenty-two countries, beginning with the Argentine Republic and ending with Germany. The quantity of information given concerning each country varies, but the heads are much the same. For Germany they are: Application, procedure, grant, area, population, production, assignment and transfer, date of law, fees, international arrangements, kinds of patents, miscellaneous, remarks, revocation, subject matter, who may obtain, and working. It is a useful little book and systematic in arrangement.

BOOKS RECEIVED.

Traité Théorique et Pratique des Courants Alternatifs Industriels. Par F. Loppé and R. Bouquet. Ouvrage en deux volumes. Deuxième volume. Partie Pratique. Paris: E. Bernard et Cie. 1896. Price 15f.

Life and Letters of the late Admiral Sir Bartholomew James Sulivan, K.C.B., 1810-1890. Edited by his son, Henry Norton Sulivan. With an introduction by Admiral Sir G. H. Richards, K.C.B., F.R.S. With portrait, map, plans, and illustrations. London: John Murray. 1896. Price 16s.

THE VALUE OF INLAND WATERWAYS for the conveyance of goods is, perhaps, not fully realised outside of Germany. By the waterways of the Upper Elbe, nearly 2,000,000 tons of merchandise are transported inland, and a similar quantity, and some 20,000 tons of timber in rafts are brought into Hamburg from the interior. The principal articles conveyed to the interior over these waterways are grain in the proportion of 26 per cent. of the whole volume; manures, 15 per cent.; coal, 5 per cent.; raw iron, 4 per cent.; and petroleum, oils, and colonial produce. Those brought into Hamburg consist principally of sugar, 43 per cent. of the total volume; manures, 13 per cent.; and stone, grain, salt, and flour. Similarly large quantities of goods find their way into Berlin, amounting to close upon 3,000,000 tons, and several thousands of tons of timber in rafts inwards in the course of the year. Of this traffic stone forms 65 per cent.; fuel, 14 per cent.; articles of consumption, 9 per cent.; timber, 6 per cent.; and merchandise, 6 per cent. Another centre of this water traffic is Mannheim, into which nearly 2,500,000 tons of goods enter in the course of the year, but as in the case of Berlin the return trade is not nearly so considerable. The principal articles thus imported into Mannheim are coal, in the proportion of 53 per cent. of the total volume, grain, petroleum, oil-seeds, raw and worked iron. The return trade consists of salt, timber and cement.

DURHAM SEWERAGE DISPOSAL SCHEME.—On Thursday, February 6th, a Local Government Board inquiry was opened in the Town Hall, Durham, into the sewage disposal scheme of the Durham City Corporation. The inquiry was held before Major-General Crozier, one of the inspectors of the Local Government Board, and there were in attendance others interested either in promoting or opposing the scheme. The Town Clerk, Mr. Fred Marshall, and Mr. Charles J. Lomax, A.M.I.C.E., represented the Corporation. The Dean and Chapter of Durham, the Master of University College, the Principal of Hatfield Hall, Durham, and the Ratepayers' Committee were also represented. In opening the inquiry, Mr. Marshall said that the scheme had for its object the prevention of sewage entering the river Wear. The corporation were compelled to prevent this pollution owing to an action brought against them by the County Council. In consequence they advertised for schemes to be sent in, for which premiums were awarded. The scheme sent in by "Valves," the *nom de plume* of Messrs. Lomax and Lomax, engineers, Manchester, was the scheme awarded the premium, and, with a slight exception, was the one which would be laid before the inspector. In the original scheme there was no destructor. The corporation took this matter into consideration, and, having regard to the great difficulty of dealing with the refuse from the city, they instructed Messrs. Lomax to add a destructor to their schemes. The estimated cost of the proposed works amounted to, exclusive of land, £25,222. In addition to that, there was the estimated expenditure of £1500 for the land. The Local Government Board were asked to sanction the borrowing of £30,000. Mr. Lomax then explained the details of the scheme, which included main concentrating sewers following the course of the river Wear to the outfall site near Kepier, at which point the sewage will be elevated 32ft. high, and treated first in precipitation tanks, and afterwards through polarite filter beds, the effluent being passed over prepared land filtration areas. The estimated cost of the precipitation tanks and filter beds was stated to be £4453. The destructor, engines, and pumps, together with the buildings, £6257. Mr. Coldwell, the city surveyor, was called, and said that the amount of refuse collected from the city, as stated by Mr. Lomax, was correct. He stated that the existing sewers were all laid with pipes. There was great difficulty in obtaining refuse pits in Durham, and no other method of disposing of the refuse would be advantageous. The inquiry was then closed. The inspector will report to the Local Government Board in due course.

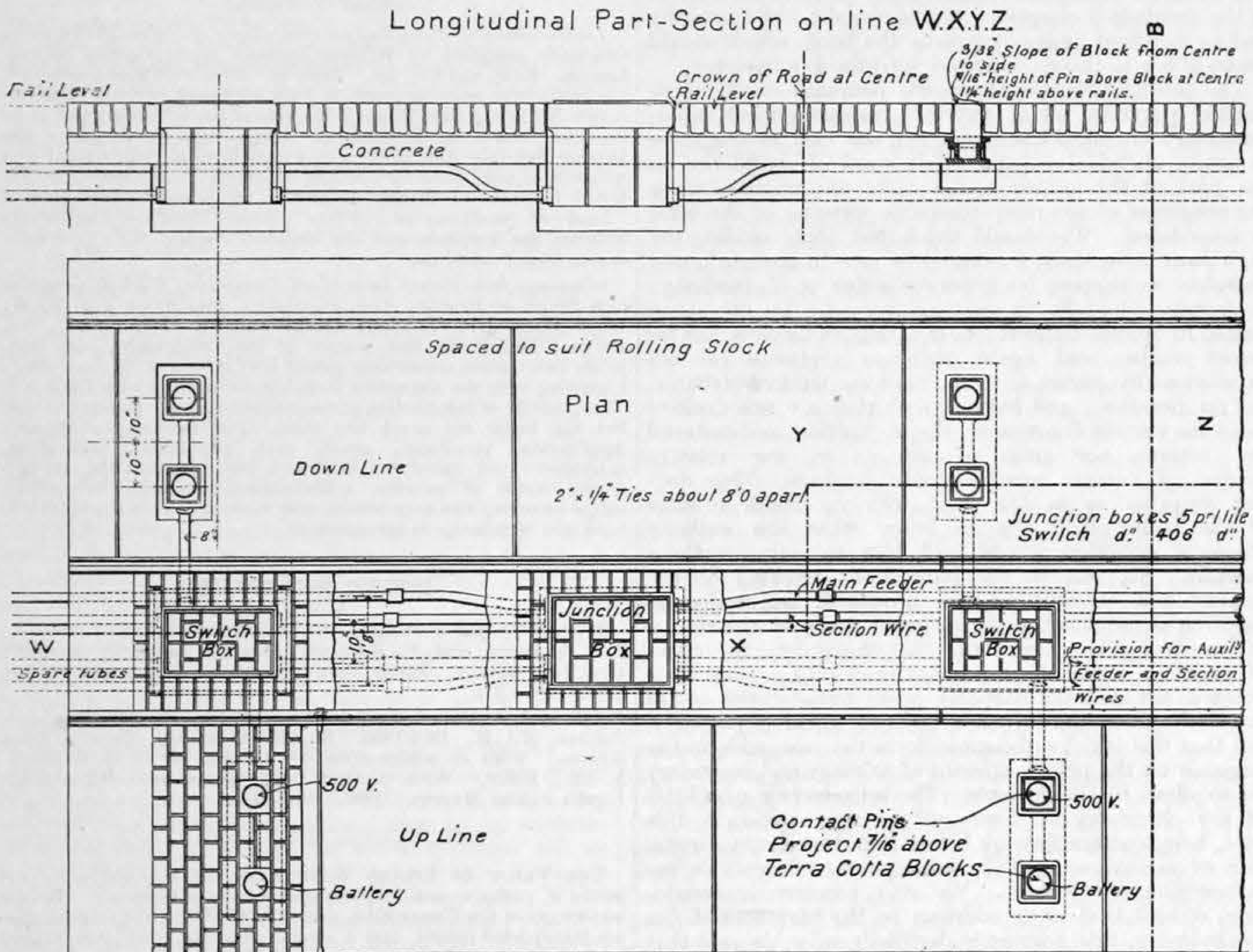
THE WESTINGHOUSE ELECTRIC TRAMWAY.

The overhead wire system for tramways has been to the present time far more widely adopted than any other, although conduit systems have been successfully used in a few places. The former system has manifold disadvantages, and objection on the score of cost chiefly is urged against the latter.

The report of Dr. Hopkinson on the Leeds electric tramway proposals calls attention to the system in use in Washington, as described in The Engineer, December 7th, 1894, and as now shown by the Westinghouse Electric Company, in Victoria-street. In this new system the ordinary electric car such as used in either of the other systems is employed. This car carries a small battery the poles of which are connected to bars placed under the car, which make contact with cast iron, flat, bun-shaped projections or buttons standing about ½in. to ⅝in. above the roadway. These bars are approximately the length of the car, so that as long as the car covers a set of buttons they are connected to the battery above referred to. These buttons form the terminals of the wires of a small electro-magnetic switch, placed in a box buried at the side of the roadway in the case of a single track, and between the tracks in a double line system. When the current from the small battery carried by the car passes through one of these switches, its armature is attracted, and which receives the current from the small battery carried by the car, the other of larger wire, which takes the current from the main required to supply the motor on the car. The action of this second coil is simply to reinforce that of the first coil, and to strengthen the pull of the electro-magnet in order to secure a firmer contact. On this electro-magnet being excited by the battery in the car its armature is attracted, thereby bringing into contact two sets of double carbon blocks.

The carbon blocks in one of these sets are connected together, while those in the other set are separately insulated. In the latter case one of the carbons is connected to one of the points in the road, through the thick wire of the coil, and the other is connected to the main. It will thus be seen that when the four carbon blocks go together the connection is made between the main wire and the third contact point. Carbon contacts are used because they will not stick together by the action of the current. This switch, as will be seen in the engravings, is mounted in a bell, similar to a diving bell. The base on which this diving bell fits has a circular groove, which is filled with oil. The construction of these boxes and the switches will be seen in the engraving, page 171.

The mouth of the bell itself contains a somewhat smaller groove, so that when the two are placed together an S-shaped channel is formed, and a complete oil seal is obtained, which prevents the entrance of dirt or moisture. The base has



THE WESTINGHOUSE ELECTRIC TRAMWAY SYSTEM

the current from the main is then switched on to the third contact point, forming part of the group of three in the roadway. This third contact point is rubbed by a corresponding bar, carried by the car, which thereupon becoming charged from the main, conveys current to connections from the motor on the car in the usual manner.

It will thus be seen that this third point is only connected with the main as long as current is flowing through the other two contact points from the battery carried by the car, so that when the car has passed over them the current ceases in the electro-magnetic switch, and leaves the three contact points "dead," so that traffic can pass over them without the possibility of a shock to either passengers or horses. In other words the entire system is insulated except at those points which are covered by the car.

Each button is about 4in. in diameter, and presents a convex face to the traffic, the edge being level with the road and the centre about ½in. above. They are corrugated on the surface so as to lessen the chance of horses slipping on them. They are placed somewhat closer together than the total length of the car, in order that the bars carried by the car make a contact with one set before they leave the previous set, and thus a continuous supply of current is obtained. The number of buttons, or points as they are for some reason called, in a group may be reduced to two by using the rails as a return, which in no sense lessens the safety of the system.

The construction of the electro-magnetic switch is novel. An electro-magnet is used having two coils, one of fine wire, knobs on it carrying insulated pins, which are permanently connected to the various wires on the surface of the road and the main wires.

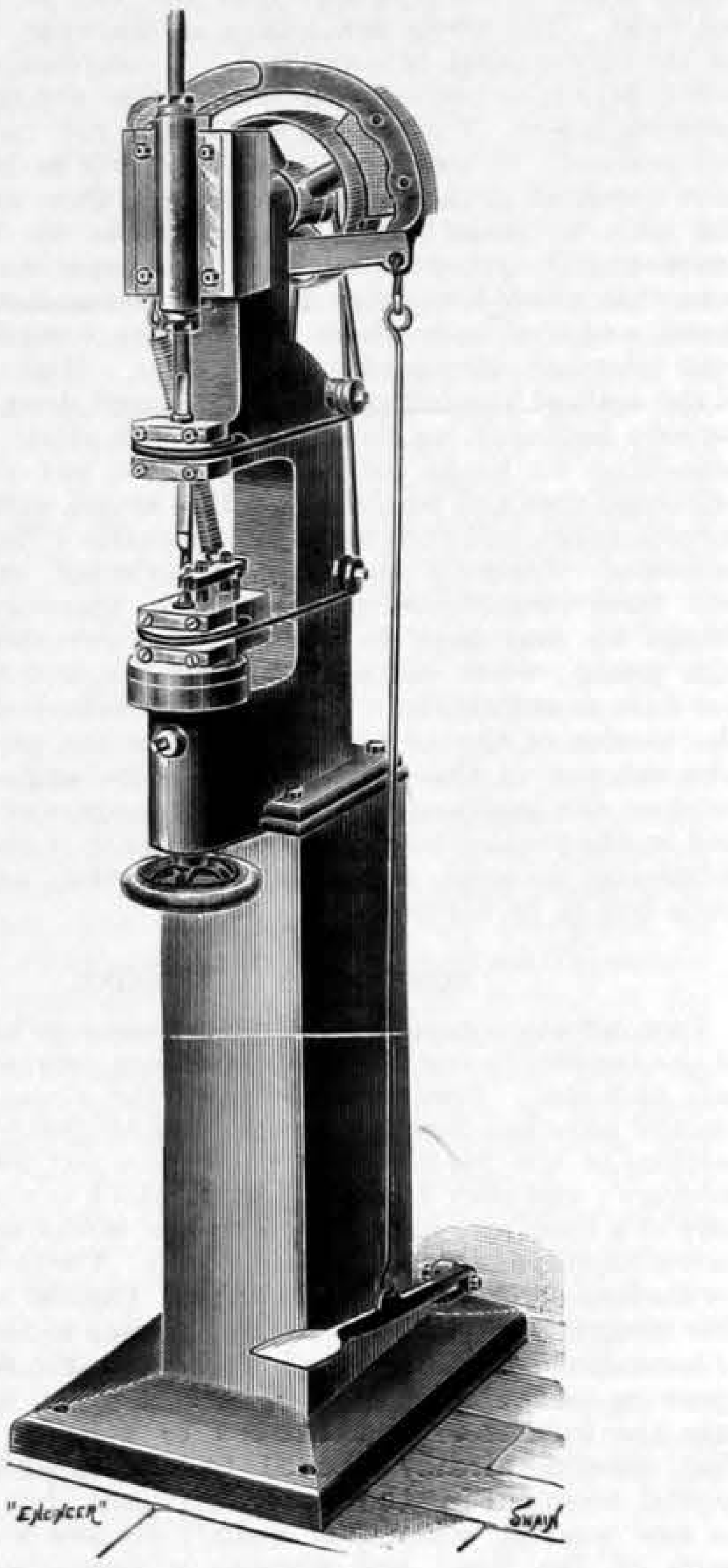
The pins have their heads split and fit into holes, the openings of which are tapered, so that the mere effect of placing the bell into position on its base will make all the contacts necessary for the switch, and in the event of the switch becoming defective the bell can easily be lifted off and a new one placed in its position, the operation occupying but a minute or two.

The diving bell construction and oil seal make an absolutely water-tight case for the switch, which will remain dry even if the whole surface of the road is covered with water. Two of these bell switches are generally placed in one manhole in a 6ft. way, one controlling the up-line, and the other the down-line. It can therefore be readily seen that the chances of leakage and accident to the wires is very much reduced, as by the construction of the switch shown the insulation of the mains can be practically made as high as may be desired, and everything being buried underground, no accidental damage can be done to the wires.

There is conduit to maintain, and the safety of the public is absolutely ensured. This system is well adapted for use on railways, where the length of trains enables very much fewer contact points to be used, and the much larger surface offered for contact makes it much easier to carry a far larger current than has been hitherto done; and as the contacts are only active at the time that the train is on them, the danger to workmen in tunnels or cuttings is reduced to a minimum.

A BICYCLE CHAIN RIVETING MACHINE.

Builders of bicycles have adopted, for the manufacture of their chains, machines for hammering the heads of rivets over instead of spinning them. By spinning, the *Scientific American* says, the friction of the spinners against the rivets causes the metal to adhere to the spinner, thus marring and tearing the heads of the rivets. Also, with the spinning machine, it is a very difficult matter to spin over the hardened rivets which most of the bicycle dealers require to be used in their chains. The rivets are hammered by means of a reciprocating rotating hammer, also by a rotating anvil held against endwise movement, in an anvil carrier bolted to the table or support between which the chain passes. The illustration represents an improvement in that class of riveting machines designed to simultaneously head the opposite ends of the rivet, the object being to produce a simple, convenient, and effective machine, containing few parts, having a large capacity for accurate work, and not liable to derangement, at a small cost. The machine shown in the illustration, made by John Adt and Son, New Haven, Conn., is arranged for heading the rivets of bicycle chains. By removing the lower revolving fixture it is adaptable for the riveting of articles which require riveting. The distance between the revolving hammer and the table is sufficient to allow the placing of fixtures thereon for the purpose of holding the work, thus expediting its manufacture. The largest chain manufacturers in the United States are now using this machine, which has had several years' prior use as a plain riveting machine,



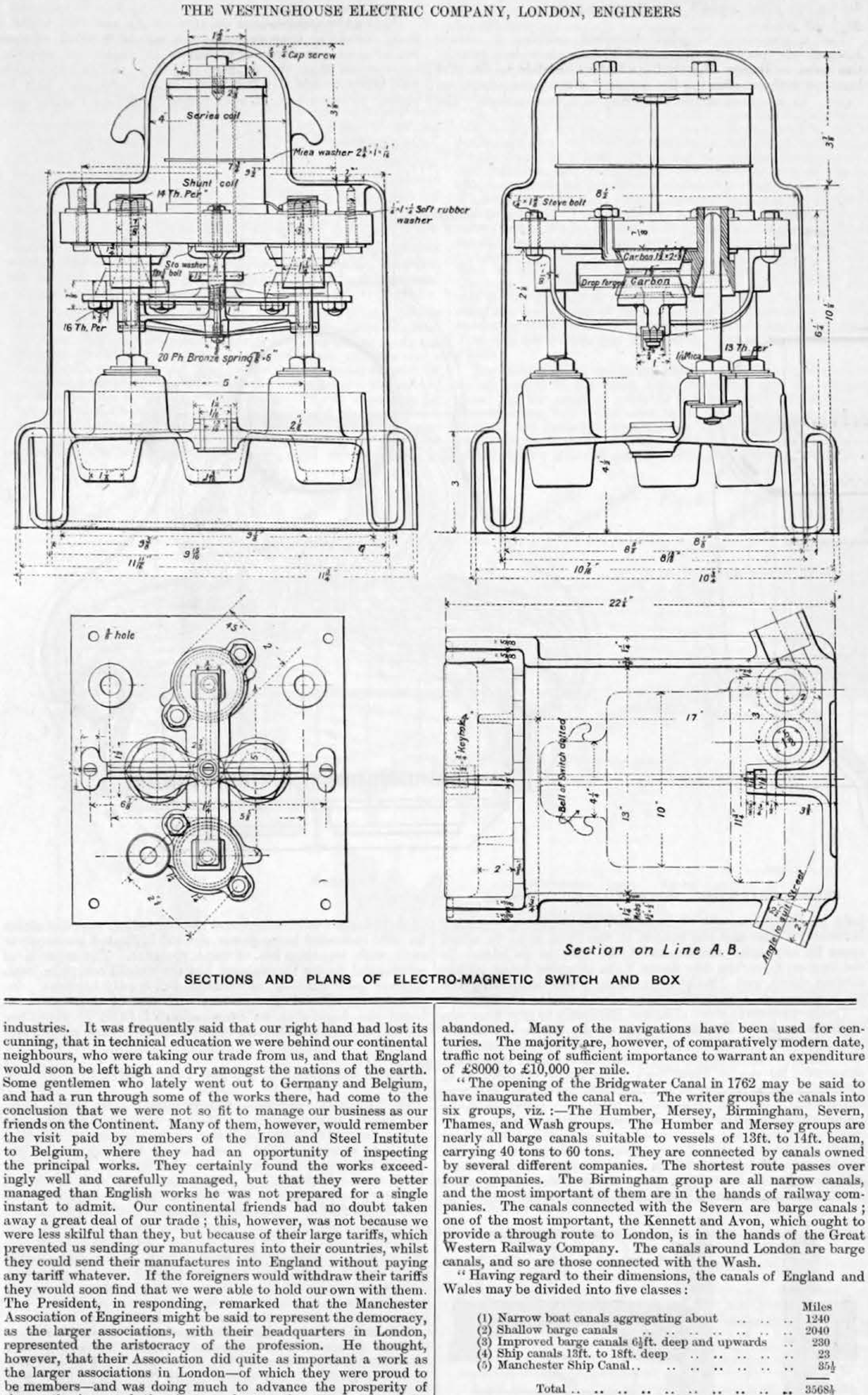
i.e., without lower revolving fixture. It is also largely used by skate manufacturers to rivet the runners of skates to the foot pieces. Messrs. John Adt and Son—F. B. Shuster, proprietor—also make an automatic wire straightening and cutting machine a large one of which has just been completed, weighing nearly six tons and being about 32ft. in length. It is capable of cutting and straightening wire from ⅜in. diameter and under, and 21ft. lengths down to 1in. in length.

MANCHESTER ASSOCIATION OF ENGINEERS.

On Saturday last the members of the above Association held their fortieth anniversary dinner at the Grand Hotel, Manchester, Mr. Joseph Nasmith, the president, occupying the chair. The loyal toasts having been duly honoured, Mr. M. Ingram proposed "Our Municipal Corporations." Whilst complimenting the corporate authorities on the important works and improvements which had already been accomplished, he urged that much remained to be done—especially in sanitary matters—before an ideal condition would be attained. Alderman Hoy, who responded, spoke at length of the important work accomplished by the Manchester Corporation in the direction of improved means for technical instruction, and remarked that the engineering and electrical students were the backbone of their technical school. There was no doubt we needed all the advantages that could be got from scientific training, and such training would become a more and more important part of the education of any person who was going to any one of the staple trades of the district. Mr. Frank Hazelton, the secretary, next read the annual report, which stated that to the membership roll during the year had been added thirteen honorary annual members, and thirteen ordinary members; and after taking into account the loss by death, resignation, and erasure, the total number of names of all classes on the roll amounted to 368, as against 360 in the previous year, viz., twenty-seven honorary life members, 126 honorary annual, and 215 ordinary members. From the financial statement it would be seen that the balance standing to the credit of the Association, after payment of all accounts due up to December 31st, 1895, was £3645 15s. 1d., as against £3469 3s. 6d. the previous year, thus showing a surplus of £176 11s. 7d. on the year's working. The payment to the superannuation members had been at the rate of 7s. per week, and during the coming year this allowance would be increased to 8s. 6d. per week. It was with profound regret, the report added, the Council had to record that during the year death had removed the following members:—Messrs. L. Burnet, Glasgow; C. Farmer, Salford; James Hall, Salford; Robert Kilgour, London; F. Meixner, Manchester; and George Vickers, of Salford. Mr. E. Windsor Richards, President of the Institution of Mechanical Engineers, proposed "Prosperity to the Association." It was, he said, very gratifying to know from the report just read that their Association was in so sound and healthy a condition, and another gratifying circumstance was the reform just brought about in the Institution of Civil Engineers, to whom a supplementary charter had been granted, largely through the efforts of their late president, Sir E. Leader Williams. A great deal had been said of late as to foreign competition and technical education, and it had been the fashion for some time to decry our own

THE WESTINGHOUSE ELECTRIC TRAMWAY SYSTEM

THE WESTINGHOUSE ELECTRIC COMPANY, LONDON, ENGINEERS



SECTIONS AND PLANS OF ELECTRO-MAGNETIC SWITCH AND BOX

industries. It was frequently said that our right hand had lost its cunning, that in technical education we were behind our continental neighbours, who were taking our trade from us, and that England would soon be left high and dry amongst the nations of the earth. Some gentlemen who lately went out to Germany and Belgium, and had a run through some of the works there, had come to the conclusion that we were not so fit to manage our business as our friends on the Continent. Many of them, however, would remember the visit paid by members of the Iron and Steel Institute to Belgium, where they had an opportunity of inspecting the principal works. They certainly found the works exceedingly well and carefully managed, but that they were better managed than English works he was not prepared for a single instant to admit. Our continental friends had no doubt taken away a great deal of our trade; this, however, was not because we were less skilful than they, but because of their large tariffs, which prevented us sending our manufactures into their countries, whilst they could send their manufactures into England without paying any tariff whatever. If the foreigners would withdraw their tariffs they would soon find that we were able to hold our own with them. The President, in responding, remarked that the Manchester Association of Engineers might be said to represent the democracy, as the larger associations, with their headquarters in London, represented the aristocracy of the profession. He thought, however, that their Association did quite as important a work as the larger associations in London—of which they were proud to be members—and was doing much to advance the prosperity of the profession, and thereby to advance the prosperity of the country generally. Mr. W. H. Hunter, M.I.M.E., engineer to the Manchester Ship Canal, proposed "Our Guests," which was responded to by Mr. Oscar Hall and Mr. James Platt. "The Trade of the District" was next proposed by Mr. T. Daniels, and responded to by Mr. Elijah Helm, secretary of the Manchester Chamber of Commerce, and the toast of the "Chairman" concluded the proceedings.

CANALS AND NAVIGABLE RIVERS.

THE following is an abstract of a paper read by Mr. L. B. Wells, M. Inst. C.E., before the Manchester Geographical Society, on the 3rd inst.:—

"The writer considers that the inland waterways question is a serious one which has to be faced, for whereas from the middle of the 18th to the middle of the 19th centuries the average cost of transportation was cheaper in England than abroad, the reverse is now the case.

"In 1850 the ordinary cost of land carriage for goods in Europe was 8d. per ton per mile; the railway rates were now:—United States, 0·40d.; Germany, 0·82d.; Italy, 1·25d.; Holland, 0·78d.; France, 1·10d.; Great Britain, 1·40d.; Belgium, 0·80d.; Russia, 1·20d.; and the average 0·97d. per ton per mile, showing that the rates on English railways are 350 per cent. higher than those of the United States, and 75 per cent. higher than those of Belgium. Railway companies do not compete in rates; the only genuine competition is from independent waterways and the sea. As shown by the canal map prepared by the writer and more clearly seen as enlarged for the purpose of this paper from York southwards there is a network of canals, the total length of which approximates 4000 miles. 2550 miles are owned by independent companies; 1400 miles are owned by railway companies; 140 miles have been converted into railways; 300 miles are derelict or abandoned. Many of the navigations have been used for centuries. The majority are, however, of comparatively modern date, traffic not being of sufficient importance to warrant an expenditure of £8000 to £10,000 per mile.

"The opening of the Bridgwater Canal in 1762 may be said to have inaugurated the canal era. The writer groups the canals into six groups, viz.:—The Humber, Mersey, Birmingham, Severn, Thames, and Wash groups. The Humber and Mersey groups are nearly all barge canals suitable to vessels of 13ft. to 14ft. beam, carrying 40 tons to 60 tons. They are connected by canals owned by several different companies. The shortest route passes over four companies. The Birmingham group are all narrow canals, and the most important of them are in the hands of railway companies. The canals connected with the Severn are barge canals; one of the most important, the Kennett and Avon, which ought to provide a through route to London, is in the hands of the Great Western Railway Company. The canals around London are barge canals, and so are those connected with the Wash.

"Having regard to their dimensions, the canals of England and Wales may be divided into five classes:

	Miles
(1) Narrow boat canals aggregating about	1240
(2) Shallow barge canals	2040
(3) Improved barge canals 6½ft. deep and upwards ..	230
(4) Ship canals 13ft. to 18ft. deep	23
(5) Manchester Ship Canal..	35½
Total	3568½

The narrow canals provide for boats carrying from 18 tons to 30 tons; the small barge from 40 tons to 60 tons; improved barge canals 90 tons to 350 tons; ship canals are short and of no present importance.

"The map shows that railway controlled canals are well situated for traffic, yet, out of a tonnage of 34,000,000 tons, they only get 6,500,000, less than one-fifth. Of the barge canals the most important ones are the Weaver, Aire and Calder, and the Severn, all of which are independent. The improved sections of these three waterways aggregate 107 miles, and the united traffic in 1888 amounted to upwards of 4,000,000 tons, the tonnage carried being one-eighth of the total carried by the remainder of the canals, and five-eighths of the total carried by railway controlled canals. The latter on nine and a-half times the length of waterway carried only 65 per cent. more traffic. Certain of the narrow canals, especially around Birmingham, are largely used. The Birmingham and Warwick Junction, which has six locks in a total length of 2½ miles, carries 195,000 tons per annum. In many of the canals the sills are well below the navigable draught of the canal, so that an additional load could be carried without structural alteration. The same horse will haul a narrow boat loaded with 20 tons on a narrow canal, a barge loaded with 40 tons to 50 tons on a small barge canal, and one loaded with 100 tons on a 10ft. waterway at the same speed. Two horses haul 200 tons and upwards on the Weaver, and on the Continent barges carrying 250 tons to 300 tons are hauled by two horses. When railways were first made the canals were handed over to them wholesale. In the year 1846 seventeen Acts of Parliament were obtained transferring 776 miles of canals to railway companies. This was one of the great mistakes in canal legislation. In France the Government bought the canals at a cheap rate and afterwards made them toll free.

"We now have forty-three navigable waterways controlled by thirteen different railway companies, including some of the main routes north and south, east and west. The railways have secured their positions by amalgamation. Nothing comparable with this has been attempted by canal companies; they remain isolated, and in many instances amalgamation is rendered impossible owing to the interposition of a railway owned canal. To proceed from London to Birmingham the canals of five different companies must be traversed. The importance which attaches to freedom of movement of material in the kingdom is seldom realised. The weight annually transported within the United Kingdom by railways equals 309,596,000 tons; by canals and navigable rivers, 36,300,000 tons; or for internal transport, 345,896,000 tons; shipped coastwise, 25,000,000 tons; total for home tranportation, 370,896,000 tons. This compared with 84,000,000 tons of cargo moved in ships trading to the Colonies and foreign ports. The coastwise and oversea traffic together reach 109,000,000 tons. Thus we find the weight transported by railway and canals is more than three times the united volume of our boasted oversea and coasting trade.

"The ocean tonnage of the world has been estimated at 140,000,000 tons; the railway tonnage carried 100 miles at ten times that amount. The average cost of railways in the United Kingdom has reached £47,000 a mile, but throughout the world it is only £15,500 per mile. The United States affords the cheapest railway carriage, having reduced their rate of late years on seven of their trunk lines from 1·40d. in 1865 to 0·32d. in 1890, but the carriage by water is 0·20$\frac{1}{10}$d. per ton per mile, and the agitation for increasing the length and enlarging the capacity of the waterways with greater rapidity is growing year by year. The railways on which reductions were first made competed with water carriage through the Great Lakes, and these have proved among the most prosperous of the railways. It has been found impossible to regulate railway rates by law in America, and we have recently learnt a somewhat similar lesson. The Belgian railways are State owned, and the charges are made to cover the cost of maintenance and bare interest on the capital. It is reported by the Minister to require ·488d. per ton per mile to enable this to be done. Sir G. Findlay stated that the cost of full train loads of coal, and returning empties between Wigan and London, was 0·21d. in 1870, and had risen to 0·24d. per ton per mile in 1875. This rise, together with the charge of 0·4d. quoted from America, gives ground for taking 0·5d. as the lowest possible rate for general goods traffic by rail. The rate of freight from Liége to Antwerp is from 1s. 9½d. to 1s. 11d., or less than 0·25d. per ton per mile, and the canal carries 570,000 tons a year in spite of two competing lines of railway. Of the traffic into Paris by rail and water 41 per cent. is waterborne. At Berlin one-half of its imports is carried by water, and in both France and Germany the percentage carried by water has increased in much greater proportion than by railway of late years. German iron and hardware is carried by rail to Antwerp at one-half the price similar goods are carried from Wolverhampton to London, the distance being about equal. In the United States 27½ per cent. is waterborne, notwithstanding cheap railway rates. In France, 30 per cent.; in Germany, 23 per cent.; whereas in the United Kingdom it is less than 11 per cent.

"The cheap cost of conveyance by improved canals such as the Aire and Calder was given before the Committee on Canals in 188?. The question of haulage is a most important one. From the Midland brickworks in the Midlands to Brentford-on-the-Thames is 149 miles.

	£	s.	d.
Taking 24 tons as a boat load, the toll on 24 tons at 2s. 6d. amounts to	3	0	0
Haulage and navigation cost 0·83d. per ton per mile for 149 miles..	4	19	4
	£7	19	4

If the haulage be taken at the rate of steam haulage ruling on the Aire and Calder thirteen years ago, the account would stand as follows:—

	£	s.	d.
Toll	3	0	0
Haulage cost 0·33d. per ton per mile for 149 miles	0	8	9
Total cost of steam haulage	£3	8	9

A difference of £4 10s. 7d. per trip. Canals with few exceptions remain what they were before railways were made, and are still worked by horses, and we have only to compare the neglect with which they have been treated with the efforts so successfully made to develope railways to see one great reason for the decay of canals in England. Most of them require to be enlarged. Between 1887 and 1891 the number of barges 126ft. long suitable for the first class of French canals increased from 933 to 2016, or 216 per cent. At the latter period 7500 barges were in use capable of carrying 200 tons and upwards.

"The writer then quoted the Report of the Joint Committee of Parliament, 1872, which stated that canal competition with railways had been defeated and the canal system discouraged by the purchase of important lengths by railway companies. That facilities should be given for the amalgamation of adjoining canals. That no canal should be henceforth placed directly or indirectly in the control of any railway company, and pointed out that except in one or two instances these recommendations had not been acted upon. If the canal system was to take its proper place as a factor in the prosperity of the country by some means or other it must be placed on a new footing. Either the whole system must be joined into one great public trust or canals must be grouped, so as to obtain the means and benefit of organisation. Without good organisation no business could be carried on successfully in the face of the severe competition of the age. Whether any movement of real value could be made without the financial aid of Government or Corporations is a question which could only be decided after full inquiry by a Royal Commission. The writer hoped he had convinced the meeting that there was need for both inquiry and action."

KING'S COLLEGE ENGINEERING SOCIETY.—On Friday, the 7th inst., Mr. C. F. Mott read a paper on "Petroleum." He commenced with a sketch of the rise of the petroleum industry, and described earlier attempts at obtaining oil from wells. He next outlined the geological distribution of petroleum deposits, and indicated various theories as to the origin of the oil, also giving probable explanations of its tendency to "spout" violently from new wells. He then proceeded to describe the crude material, and the methods of obtaining, storing, and refining it. Finally, he touched upon the present uses for petroleum products, describing in some detail the legal method of testing lamp oil. At this meeting Mr. Wolfe Barry, C.B., and Mr. Walter Smith, were elected patrons of the Society.

TRADE AND BUSINESS ANNOUNCEMENTS.—The prospectus has been issued of the Greig Roadways, Limited, formed with a capital of £25,000 to acquire and work the patent of A. Burness Greig for improvements in the construction of paving, a new roadway material constructed chiefly of wood and asphalte made into bricks. The offices are at St. Dunstan House, Idol-lane.—The prospectus has been issued of the Daimler Motor Company, with a capital of £100,000, formed to work the patents of the Daimler motors and carriages, and to construct these motors in England. The offices of the company are Billiter-buildings, Leadenhall-street.—Messrs. Samuel Fisher and Co. inform us that owing to the lapse of lease of their premises, Nile Foundry, Birmingham, they have dissolved partnership by mutual consent as from the 31st December last. All liabilities will be discharged by Mr. C. J. Dore and Mr. R. W. Deacon, who will also receive all accounts owing to the partnership. The business and goodwill, together with all patterns, drawings, and books, have been transferred under an amalgamation agreement to Messrs. E. Humphries and Co, of Pershore, who will in future manufacture all the specialities that have for so many years been associated with the Nile Foundry.—Messrs. Fell and James give notice that the practice as patent agents and the business as consulting engineers, which have been carried on for the last seven years by them, under the titles of Fell and Wilding and Fell and James respectively, will be carried on from this date under the one style of Fell and James.

THE REED WATER-TUBE BOILER.

HER MAJESTY'S torpedo boat destroyer Lightning, delivered last year at Chatham by Palmer's Shipbuilding Company, Jarrow, went through her official trials in a remarkably creditable manner. The contract called for a speed of 27 knots per hour, maintained for three consecutive hours, and this the builders have exceeded by practically one knot per hour. The average for the three hours gave 27·944 knots per hour. In the best of the runs over the Maplin, the Lightning ran the mile in 1 min. 55 sec., being equal to 31·3 knots, or over 36 miles per hour. She had all her weights on board, being loaded down to contract conditions. The entire absence of flame from the funnels, and the absolute freedom from vibration which made her sister ship the Janus—also Palmer's build—so conspicuous, were just as marked in the case of the Lightning.

The Lightning is a duplicate of the Janus, the propelling machinery consisting of two sets of three-cylinder triple-expansion engines driving aluminium bronze propellers, and supplied with steam by four of Mr. Reed's patent water-tube boilers. The whole result was obtained with the greatest ease, and the working of the machinery, also the steaming of the boilers, was all that could be desired. The amount of coal consumed during the three hours was 14 tons. The steam pressure during the trial averaged 195 lb. per square inch, and the average revolutions 368 per minute.

After the three hours' speed trials had ended the vessel was put through an elaborate series of other trials, including full speed circles in both directions, circles astern at a little under full speed, also circles and general steering by hand gear. The handling of the engines with regard to stopping and starting was very severely tried, and seeing that with the hand gear only about seven seconds were necessary to go from full speed ahead to full speed astern, nothing better could be desired. The vessel was in command of Lord Charles Beresford. Mr. Welch and Mr. Emdin watched the trial on behalf of the Admiralty. The trial was conducted on behalf of the contractors by Mr. J. W. Reed, their engine works manager. Mr. W. J. Anstey represented the interests of the Engineer's Department of the Dockyard, and Mr. E. Cornish that of the Steam Reserve. It may also be stated that the Lightning on her run round from the Tyne occupied only about 13½ hours in covering the distance, running about 20 to 21 knots, practically under natural draught. This is probably the greatest speed at which a vessel has gone from the Tyne to the Thames. Altogether the builders are to be congratulated on the successful results.

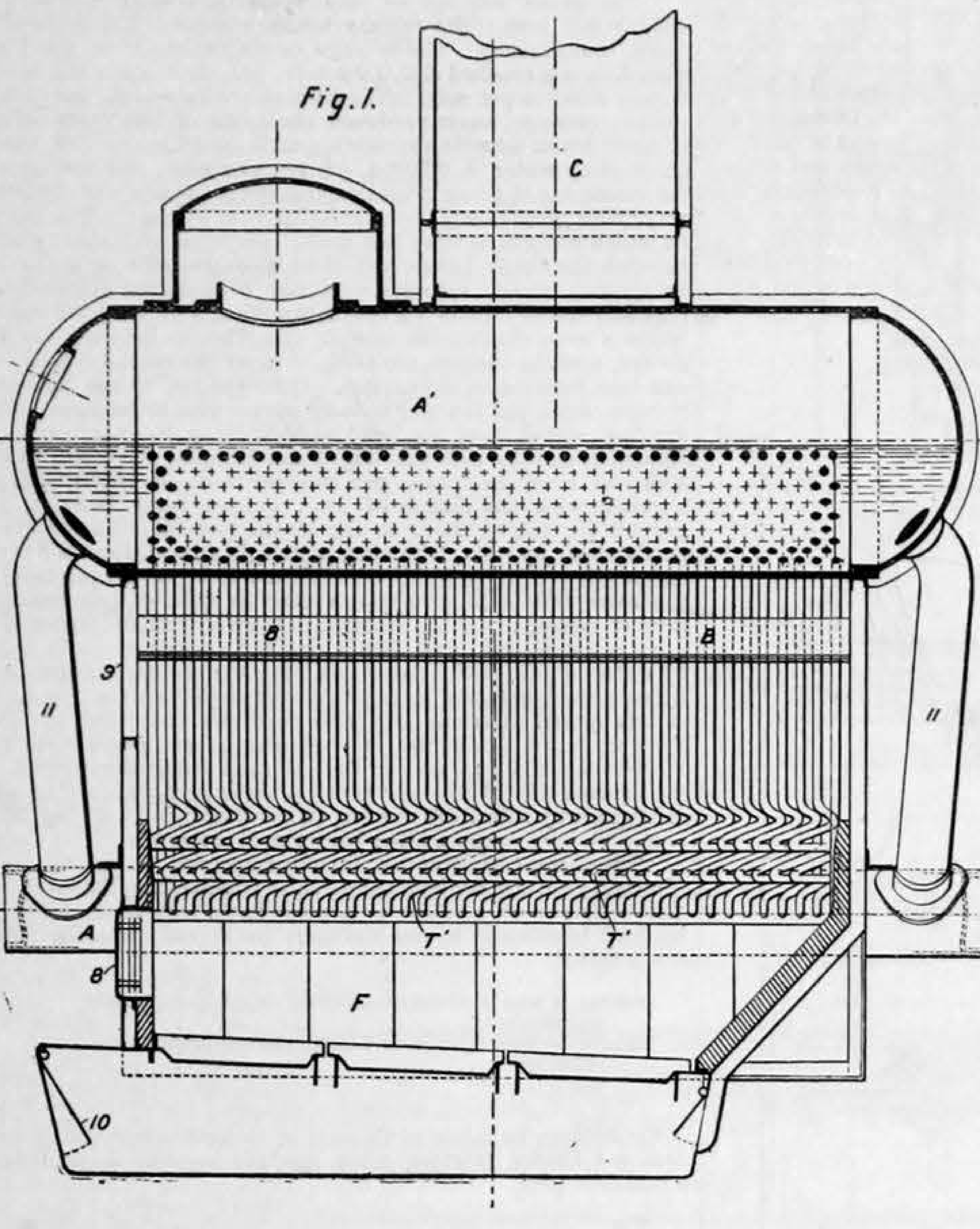
We illustrate the boilers of the Lightning, which are of the three chamber class, with four large external downcast pipes. Probably Mr. Reed will find that these are superfluous after some further experience. Fig. 1 is a longitudinal section; Fig. 2 a cross section; Figs. 3 and 4 are details showing the particular arrangements of the tubes; Fig. 5 shows the method of fixing the tubes. A more or less semi-spherical screwed washer or ferrule 3 with a canted surface 3^a thereon is screwed tightly on to the tube 4, and the tube-plate 5 is dished as shown to a radius corresponding with that of the ferrule. By screwing up the nut N the ferrule can thus be drawn into close contact with the tube-plate, so as to make good the joint.

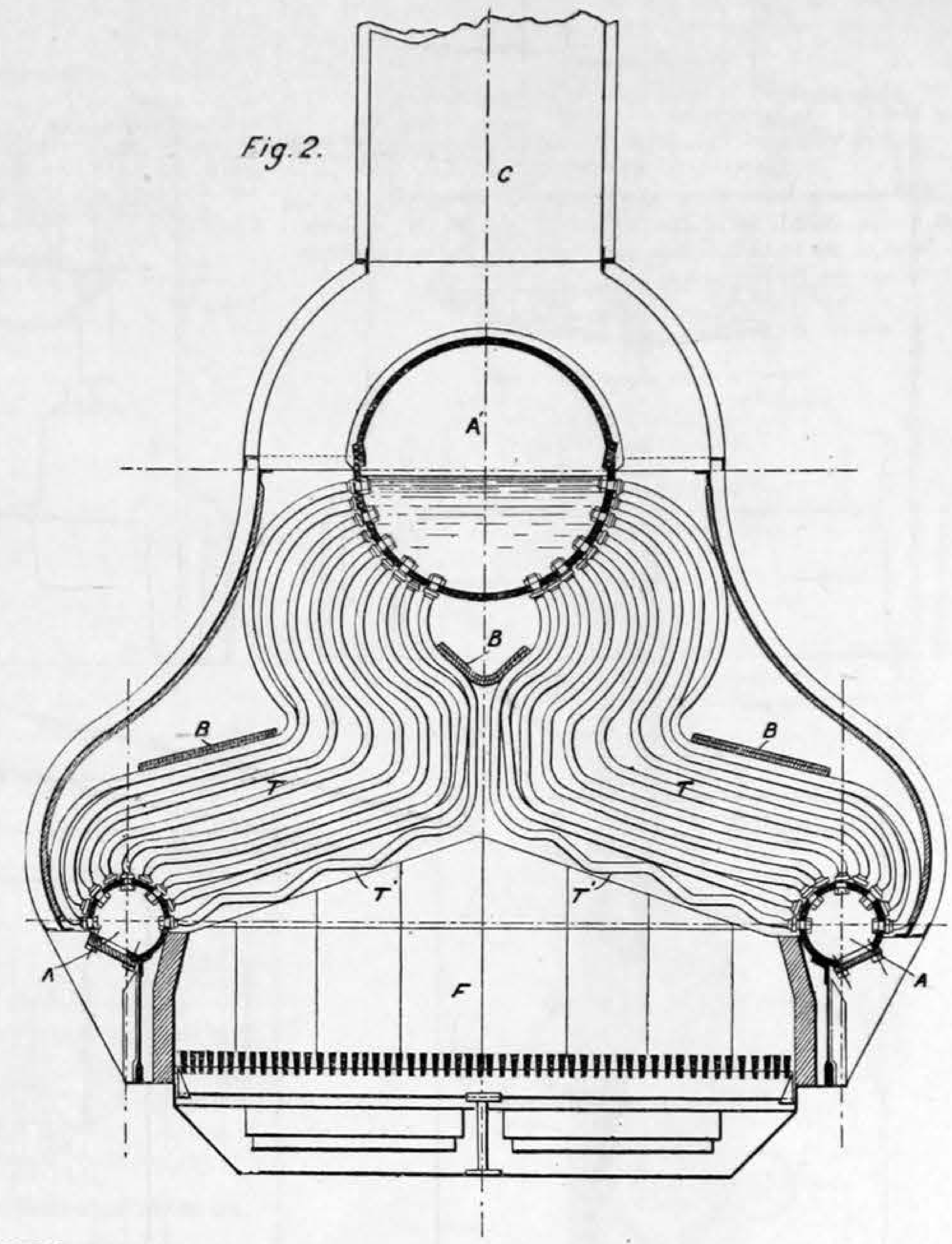
The arrangement of joint described enables a certain amount of "play" or movement to take place in a tube or the tube to diverge slightly from the correct line in the first instance without effecting the security of the joint, which can "give" to a certain extent according to circumstances. The hole in the plate will be large enough to give a clearance between its sides and the outside of the tube so as to afford space for any small movement of the tube at its joint. In the figures, 8 are the fire doors, 9 the cleaning doors, 10 the ashpan doors, and 11 the circulating pipes connecting the lower chambers A with the upper chambers A^1.

The downcomers were arranged primarily to give a certain supply of water to the bottom ends of the tubes, but at the same time they form a substantial part of the framework of the boiler. The tubes are of solid drawn steel galvanised externally by electro-deposition. The lower chamber is of cylindrical cross section with a flattened lower side, and provided with handholes for access; a manhole is provided in the upper chamber. The tubes are readily secured, and in the event of damage can be removed and replaced in a very short time; at the same time a very secure joint is made, for in the vessels referred to there are in all upwards of 30,000 joints, and though they have been many times under steam, not a single leak has occurred. Baffle plates B are provided, as shown, to assist in directing the flow of the gases. The furnace and tube casings are double, with an air space between, the fire side being lined in an effective manner with an asbestos composition, the outer casing being quite cool; even when under heavy forced draught, the hand can be borne comfortably on the boiler front. The lower part, near the grate, is lined with fire quarls. The furnace has three doors arranged to close and fasten automatically. The arrangements are such that all air supply to the furnace passes through automatic doors, all precautions being taken to prevent flame being forced into the stokehold, in the event of an accident to a tube. These precautions were considered desirable at the time of designing the work, owing to the unfortunate accidents that had then occurred in some other parts of the country. In this case the necessity for such precautions has never arisen, for although the twelve boilers in these three vessels, the Janus, Lightning, and Porcupine, have been many times under steam under forced draught, some up to as far as 5½in. of water, there has not been a single accident or leak of any kind.

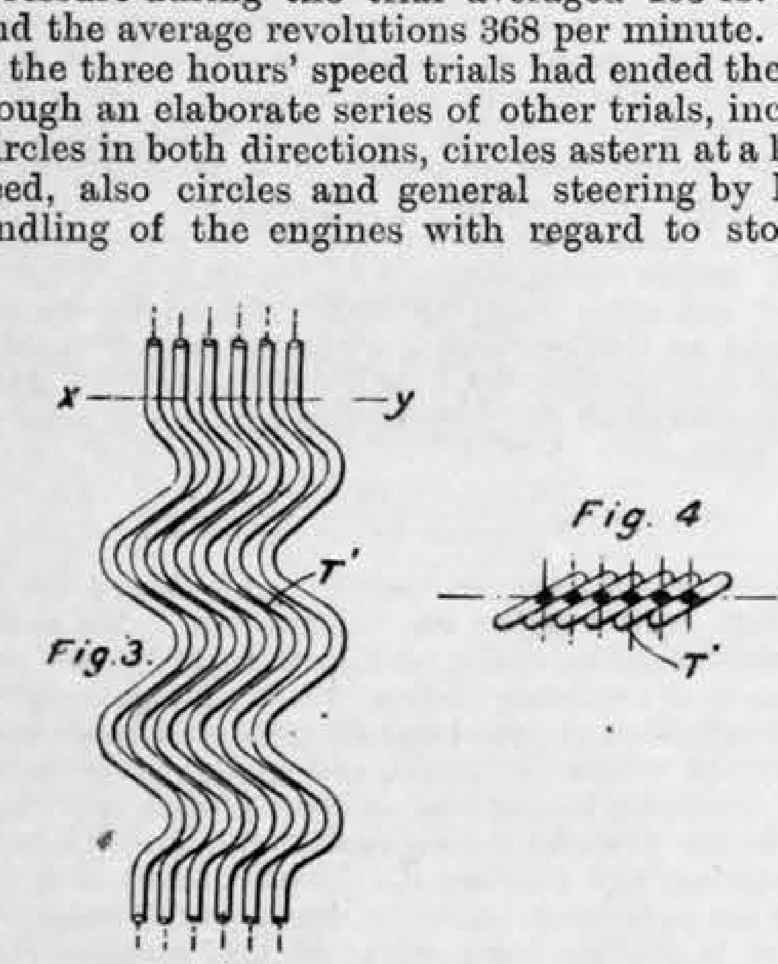
There are four boilers in each vessel, each having its separate main feed pump, the feeding being controlled by Reed's automatic feed regulator. In the upper chamber and dome a simple but effective form of separator is fitted, which ensured freedom from priming even at the highest rates of evaporation.

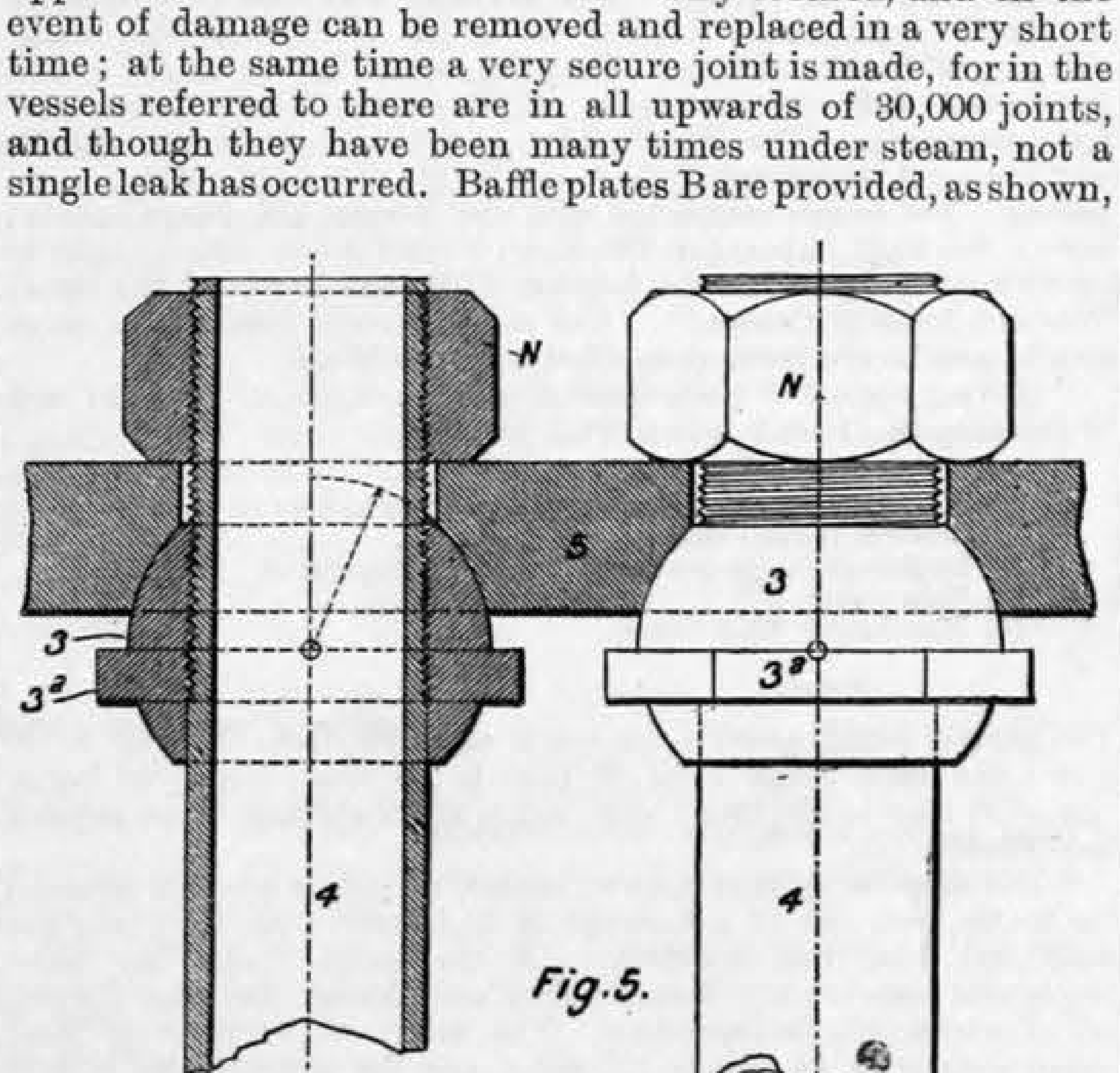
During the experiments on shore with the first boiler of these vessels, an evaporation at the rate of 28,300 lb. of water per hour was obtained. The boilers are capable of supplying more steam than the engines can take, and an opportunity was taken to try the Porcupine at sea with only half her boilers in operation. Under these conditions a mean speed of 23·79 knots was obtained, and the two boilers supplied steam for 2800 indicated horse-power, or 1400 indicated horse-power each, with less than 4in. of water pressure. The boiler is of substantial design throughout, but the weight complete, with furnace gear, clothing, mountings, &c., is only 13¼ tons. On an evaporative trial of six hours with one of the boilers on board the Lightning, an evaporation of 12 lb. of water per pound of coal was obtained, we understand, using Welsh coal.





REED'S WATER-TUBE BOILER, H.M.S. LIGHTNING





GENERAL OWEN ON "DRIFT."

ON Thursday, February 6th, General C. H. Owen, R.A., best known as the author of "Modern Artillery," read a paper at the Royal Artillery Institution on the question of "Drift," which he considered had been allowed to lapse into a less satisfactory condition than when he left the service. He dwelt on the doubtful and casual treatment of it in recent artillery works, such as the official treatise of gunnery by Major Mackinlay. He went through the records of the experiments on which his conclusions had been based, and invited discussion. His main position was that pointed projectiles with a right-handed twist carried to the right under most service conditions, and flat-headed ones to the left. This he attributed to the position of the resultant of the air pressure, and illustrated it by the gyroscope, as he had previously done by the flight of a model projectile.

The audience, as might be expected, consisted of such artillery officers as were interested in mathematical questions affecting the flight of shot, but while it included several well known specialists it was much larger than might have been expected. Major MacMahon, in the discussion which followed, abstained from any application of high mathematics to the treatment of the question, but urged the use of photography to determine the actual position of projectiles towards the end of the trajectory. Professor Greenhill followed very much the same line, urging that there are forces acting on the shot that require investigation in addition to those dealt with by General Owen; for this reason he supported Major Mackinlay's treatment of the question in the present state of our knowledge. Captain Cooper exhibited a curious effect by means of a model devised by himself and Mr. Greenhill. By this it was shown that a spinning gyroscope, enclosed in a card box running over a switchback course, turned towards the right on a concave part of the track and to the left on a convex. As the gyroscope was protected from the action of the air, this was not the effect dealt with by General Owen; moreover, its action was in the opposite direction. Altogether it was generally felt that while General Owen had investigated and dealt with the action of certain forces with great ability, there were others of which account must be taken, and that the most hopeful means of pursuing the question lay in the application of photography to a well arranged programme of firing.

THE Students of the City and Guilds' Technical College, Leonard - street, Finsbury, are holding their biennial conversazione on Thursday, February 20th, for which Professor Silvanus P. Thompson, D.Sc., F.R.S., has been induced to prepare a lecture on "Invisible Light and its Photography," a subject suggestive of recent discoveries and current scientific topics. The lighter portion of the programme consists of a concert and dance, while the whole of the College not used in the entertainment is to be given up to exhibits of model machinery, electrical appliances, and chemical manufactures.

RIVER PARRETT IMPROVEMENT SCHEME.

In THE ENGINEER of November 1st, 1895, we published the report which accompanied the first prize designs by Mr. E. D. Stoney for proposed scheme for the improvement of the navigation of the river Parrett by the formation of a ship canal to Bridgwater. We now give the report which accompanied the scheme, of Mr. H. G. Foster Barham, Assoc. M. Inst. C.E., to which was awarded the second prize by the Bridgwater Port and Navigation Board. It was suggested that the first and second prizes should be divided between these two competitors, but Mr. Barham felt so strongly that the river improvement rather than a canal was the proper course to pursue, that he preferred to take the separate prize for a separate thing. Subsequent events have proved the correctness of thit view, as the Bridgwater Port and Navigation Board have now abandoned all ideas of carrying out a ship canal, and have consulted Mr. W. H. Wheeler, of Boston, as to the advisability of carrying out improvements to the river Parrett:—

In compiling this scheme for the improvement of the Parrett Navigation, I have been influenced not only by a desire to advise the best from an engineering point of view, but also to study the interests of Bridgwater. There appear to be two alternatives:—(1) To cut a canal between Bridgwater and Combwich Reach; (2) to improve the present river course. I shall advocate the second of these because I consider a canal inadvisable, and unsuitable for reasons which I here give:—(a) It would not be a financial success, and I doubt whether the trade and prospects of Bridgwater warrant the expense that would be incurred. (b) There would be considerable difficulty in obtaining an adequate water supply. (c) Certain difficulties connected with the making, use, and maintenance of the canal, which I shall deal with hereafter.

In my opinion the canal would not pay, because I believe it would be quite the exception for vessels to use it. Ships of 300 tons and over might, it is true, prefer not to run the risks of the present channel, and smaller vessels might use it in order to avoid the neap tides, but large vessels and neap tides are the exception, not the rule at Bridgwater. I have assumed that the existing docks owned by the Great Western Railway Company will be connected with the canal, and that no fresh ones would be made. Co-operation with this company is, I consider, an essential in any canal scheme. In my estimate I have allowed no sum for the use of the docks or of the present canal as a conduit for the water supply.

Dealing next with the quantity of water necessary for the proper working of the canal, and assuming its top water level to be at 26·0 O.D., which is about 1ft. higher than the highest flood since 1883—that there are two locks, one at each end of the canal, each 230ft. long, by 35ft. broad, with an average drop in water level of 12ft. at the Combwich end, and 6ft. at the Bridgwater end, the former to be opened for calculating purposes at the most, say, five times, and the latter four times daily. Then I estimate the quantity of water necessary for the maintenance of the canal will be as follows:—

At the Combwich end	483,000	cubic feet per day.
At the Bridgwater end..	193,200	,, ,,
Which makes	676,200	,, ,,
To this I add 25 per cent. for waste, leakage, and evaporation	169,050	,, ,,
Making a total of	845,250	,, ,,
Or	5,282,812	gallons per day.

Such a demand would be very exceptional under present conditions, but provision ought to be made for its supply. There appear to be three available sources of supply:—The Cannington Brook, the Durleigh Brook, the river Tone.

The drainage area of Cannington Brook is approximately 12,032 acres. Calculating on a minimum dry weather discharge of 0·25 cubic feet per second per 1000 acres, which I believe the streams in this neighbourhood might well fall to, then the minimum dry weather discharge would be 1,624,320 gallons per day. Of this I consider a quantity of 1,120,000 gallons ought to be retained as a drinking supply to Bridgwater, assuming that the population might be trebled during the next hundred years. This leaves a surplus of 504,320 gallons per day for the canal. I understand, however, that Lord de Mauley has the right to pump water from the brook outfall, in order to irrigate the Pawlett Hams, which are 3050 acres in extent. Indeed, his agent told me that during dry weather the whole available discharge is used for this purpose. In order to utilise this supply, the stream would have to be dammed back for a considerable distance, and the banks raised from 4ft. to 5ft. at the outlet end. A bye-wash would also have to be provided for the storm water. From gaugings I have taken, I should say that during the summer months there would be a present average discharge of about 2,500,000 gallons per day at the mouth of this stream, not reckoning any deduction for pumping on to the Pawlett Hams.

The drainage area of Durleigh Brook is approximately 4480 acres. Calculating as before, there is a minimum discharge of 603,348 gallons per day. Of this the Bridgwater Swimming Baths take a weekly supply of 133,000 gallons, and in addition a daily supply of 4000 gallons to keep them fresh. We may, therefore, reckon on a minimum available quantity of water from this stream at, say, 570,000 gallons, and an average summer supply of, say, 1,400,000 gallons per day. I understand from Mr. J. H. Waddon, of Bridgwater, that he has the absolute mill rights over the Durleigh Brook, but that he would relinquish such rights for the sum of £100, and an annuity of about £7 for seventeen years, at the end of which time his lease expires. It is probable that the freeholders would also have to be compensated. There is from this brook an available fall for gravitation of 18in., assuming that the water was taken along the towing path of the present canal. I should recommend the laying of an 18in. cast iron pipe, with spigot and socket joints. This, at a cost of 33s. per yard in the ground, would amount to £2200.

The Patnell Rhine and Hamp Brook are both small streams and do not permit of the water being gravitated into the proposed canal, and for practical purposes are not worth considering. It appears, then, that if the water rights were purchased on the Cannington and Durleigh brooks, there would be a sufficient water supply for the locks for ordinary purposes, but a totally inadequate supply during times of extreme drought, combined with heavy traffic through the locks. The only certain source seems to be the river Tone. If arrangements could be come to with the Great Western Railway Company to use the present Bridgwater and Taunton canal as a conduit, and either to buy up the water rights, or to do as is done now and pump water when necessary from the Tone at Creech St. Michael, where there is a lift of 26ft., and again from the present canal into the proposed canal at Bridgwater, a rise of about 5ft., then I consider a canal is quite feasible as far as its water supply is concerned.

I am of opinion that the subsoil is not very favourable for cutting a canal. Clay with layers of sand and peat intermixed, although easy to excavate, are about the worst materials to stand at a slope. During construction water permeates through the most pervious beds, acts as a lubricant, and allows the stiff clay and top-soil to slide down the slope, while the peat and lower silt squeeze laterally into the cutting, with the result that the whole mass settles down. I have had considerable experience in this class of work, and know only too well that as a rule the lower one excavates through the alluvial deposits of this district, the softer and milder the clays become. Near the Bridgwater end, the bottom of the canal would be in peat, and sheet piling would probably have to be driven in order to keep the banks up. I do not believe anybody could say to what extent this might not be necessary without making trial pits along the canal. Bore holes are notably misleading, and my opinion is that in many places the banks would not stand at a slope of 3 to 1 without considerable support, either from stone pitching or by means of stakes or piles. The brown clay and the top of the blue clay at the Bridgwater end of the canal would be worth something to the brick and tile yards of the neighbourhood. It could probably be sold at 7d. a cubic yard, but it would take many years to get rid of it. I have deducted £4600 for the sale of the clay in my estimate of the cost of a canal. The clearing away of the silt which would accumulate at the bottom of the canal at the Combwich end would be a constant cause of expense, just as it is in the present Bridgwater Dock. It is impossible to avoid the silt entering the canal, as the salt water charged with sediment is of considerably greater specific gravity than the canal water, and fills up the lower part of the lock immediately the gates are open.

The question of vessels entering canal is a matter which wants some attention. The flood tide passes up Combwich reach at a rate of from three to four miles an hour. If, therefore, ships leave Burnham much before three-quarter flood, they will reach the lock gates at a time when the current is so strong as to make entering those gates most difficult. Waiting for the fuller tide would involve serious delay in reaching Bridgwater, and would make the captain of any vessel hesitate before adopting such a course.

I estimate the cost of constructing a canal 19ft. deep, 50ft. wide at the bottom, with slopes averaging $2\frac{1}{2}$ to 1, as follows:—

	£	s.	d.
Excavation and embankment	44,605	0	0
Land	9400	0	0
Locks	13,410	0	0
18in. pipe from Durleigh Brook	2200	0	0
Parliamentary expenses	4000	0	0
Buying water right, Durleigh Brook	300	0	0
Pumping station at Creech	1000	0	0
,, ,, ,, Bridgwater	1000	0	0
Two lock keepers' cottages	500	0	0
One pumping station cottage	250	0	0
Sheet piling in canal	1438	0	0
Pitching slopes	5000	0	0
Bye waste, outlet works, and raising banks at outlet of Cannington Brook	200	0	0
Ditch each side of canal	565	0	0
Towing path ,, ,, ,, ...	1807	0	0
Mooring posts, lighting, &c.	80	0	0
Superintendence	2000	0	0
Highway Board, easements, compensation ..	1000	0	0
Sundry charges	500	0	0
Unforeseen expenses	2000	0	0
	91,255	0	0
Less value of clay	4600	0	0
Making total of	86,655	0	0

This estimate takes no account of compensation to the Great Western Railway Company for the use of their docks, or of their canal as a conduit. Neither does it reckon in any compensation to Lord de Mauley for interfering with his rights, if any, to the water of the Cannington Brook. All things considered, I do not believe a canal would be constructed under a cost of £100,000. Assuming this sum was borrowed at $3\frac{1}{2}$ per cent., and had to be repaid in fifty years, then the annual sum of money required to pay off this debt would amount to £4266, or approximately $4\frac{1}{4}$ per cent. on the borrowed sum.

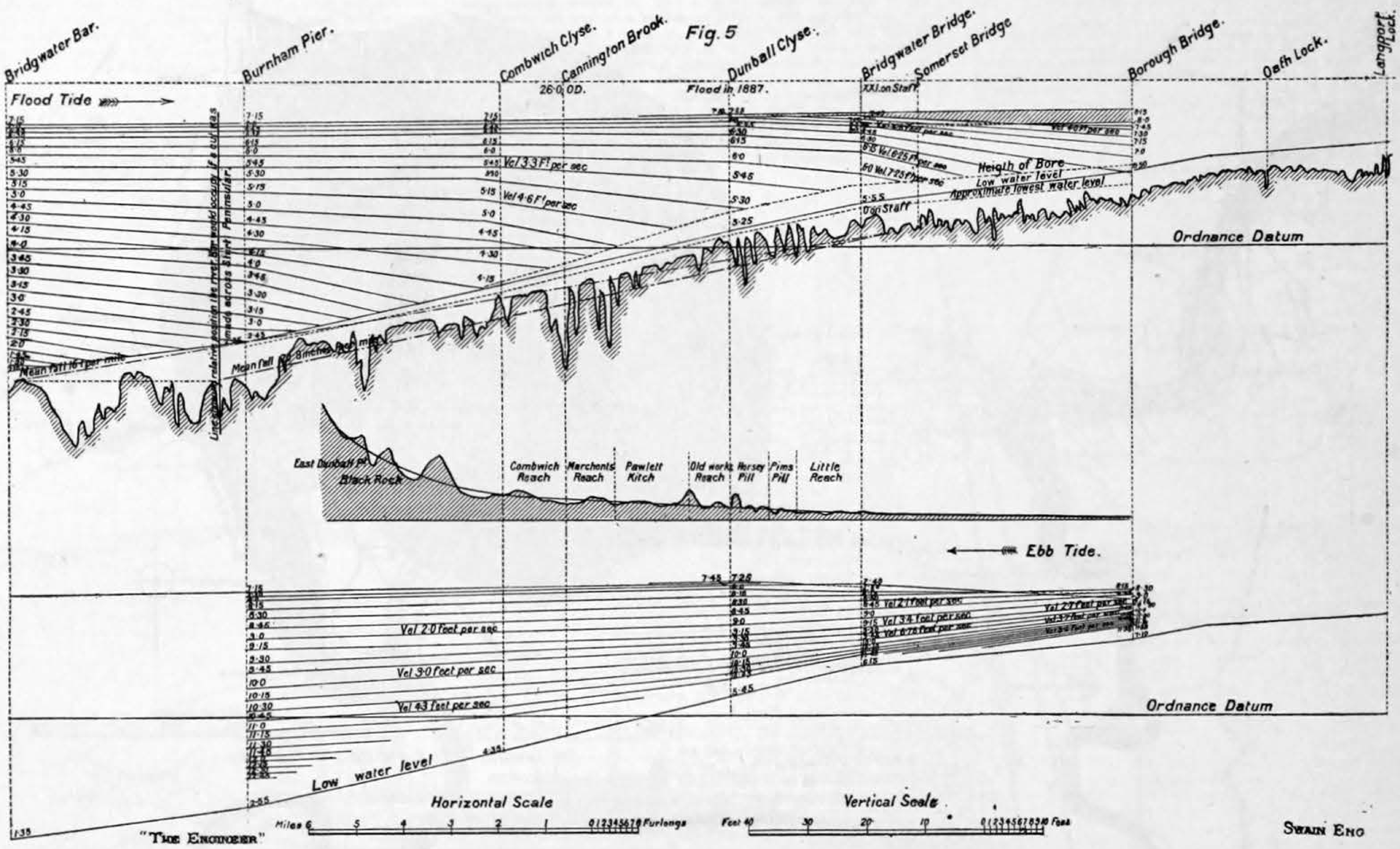
The rateable value of Bridgwater is £41,353, and a rate of 1d. in the pound produces £150 per annum. Thus if the borough alone had to pay for the canal there would have to be an extra rate of 2s. $4\frac{1}{2}$d. in the pound in order to pay off £4266 annually—an increase of more than one-third on the present rate. The annual cost of maintenance of the canal I should reckon at about £600 per annum.

Having now shown my reasons against the construction of a canal, I will proceed to set out what I consider to be the best scheme to adopt. I have made a most careful inspection of the river Parrett, from Burnham to Langport, and also of the rivers Tone and Brue. I have taken tide readings—Fig. 5—of the Parrett, without which it is impossible to thoroughly investigate a tidal river, and I have also taken samples of water, and velocity gaugings at different points along the channel. I attach special importance to the tidal diagrams, as they demonstrate the peculiarities of the river, which if not taken into account would tend to lead to wrong conclusions. The peculiarities of the Parrett are mainly due to the geological formation through which it flows; the great rise of tide, combined with a wide-mouthed entrance channel; and to the sand banks at the mouth of the river. The effect of these last is so to retard the tidal wave, that on a high spring tide such as that of September 30th, 1894, there was a difference of level on the rising tide between Burnham and Combwich, immediately before the tide reached the latter place, of 7ft. 6in. in a distance of five miles. Between Combwich and Dunball this amount was 9ft. in five miles, and between Dunball and Bridgwater 6ft. 3in. in two and three-quarter miles. This great difference in level gives rise to the "bore," which is largest where the contraction of the channel is greatest, *i.e.*, between Dunball and Bridgwater. The velocity of the tidal wave was as follows:—

Between	Bridgwater Bar	and	Burnham	5ft. per second.
,,	Burnham	,,	Combwich	4·5 ,, ,,
,,	Combwich	,,	Dunball	6·4 ,, ,,
,,	Dunball	,,	Bridgwater ..	8·0 ,, ,,
,,	Bridgwater	,,	Borough Bridge	9·1 ,, ,,

High water level at Combwich was 7in. higher than at Burnham.
,, ,, ,, ,, Dunball 1ft. 4in. ,, ,, ,, ,,
,, ,, ,, ,, Bridgwater 1ft. 1in. ,, ,, ,, ,,
,, ,, ,, ,, Borough Bridge 2in. ,, ,, ,, ,,

A study of a map of the district shows what a wandering course the tidal rivers have carved out, through the estuary deposits they have built up. These wanderings give rise to tidal oscillations, which when once set up are most difficult to stop, and their tendency seems ever to make the channel less and less straight, as may be



PLAN No. 1—DIAGRAM SHOWING FLOOD AND EBB TIDE 30th SEPTEMBER, AND DIAGRAM SHOWING BREADTH OF RIVER PARRETT seen by following the old flood banks along the river, which appear to trace out a much more direct course than the present ones do. The result is that the fall of the river per mile of its course gradually diminishes, and tends to the deterioration of the channel. The mouths of the Parrett, Brue, and Axe, each demonstrate the influence of the south-westerly gales, which beat up a bar across their outlets, causing them to take first a north-easterly and then a south-westerly course. Thus there is little doubt in my mind that Stert peninsula is the old bar of the Parrett, which long caused it to take a north-easterly direction. The time is even within the recollection of some of the pilots, when ships could pass in and out between Stert Island and this peninsula, and although this is now impossible, there is at the present day an exactly corresponding channel immediately north of this island, and called the "westerly course," through which there is still a sufficient depth of water for ships of moderate draught to pass. This only shows how the channel has tended further and further to the north-east, until at last the hillocks raised by the wind blowing across the Gore sand became a formidable enough barrier to effectually turn the channel, which is now well on its south-westerly tack, which it will probably continue until turned once more by the limestone cliffs west of Stolford. The Gore sands will accumulate, and in twenty or thirty years, perhaps less, there will be, I believe, an island a mile west of Berrow, where there are now very few feet of water even at the highest tides. These facts are impressed upon one by a study of Fig. 3, which is reproduced from the Admiralty sheet.

I have dealt rather fully with the conditions at the mouth of the Parrett, because they have considerable bearing upon a portion of my scheme. The part of the river between "Nine Streams" reach and "Little" reach is the portion which gives the chief difficulty to navigation owing to the sharp bends. The depth of water between Combwich reach and Bridgwater wants if possible increasing, so that ships of ordinary draught may reach the latter place at all tides. The present low-water channel may be described as a series of pools called "Bights," varying from 5ft. to 15ft. deep, which occur at the outer side of the bends, and which are connected by rapids of shallow water, often not more than 6in. deep. The irregularities of the river bed are shown on Fig. 5. Between two opposite curves, the flood and ebb channels take different sides of the river, leaving a shoal or sandbank between them, and in a rapid river this is well nigh impossible to prevent.

There is only one way of increasing the available depth of water in the channel, and that is by deepening the river bed, and thus lowering the low water line. This can be accomplished permanently by shortening the length of the present channel, so as to increase the fall per mile, or it can be done temporarily by scouring out a deeper channel, and giving a more uniform fall to the river bed. My scheme is to deepen the present channel of the river, and to make it follow better lines. I also suggest the making of a channel across Stert Peninsular.

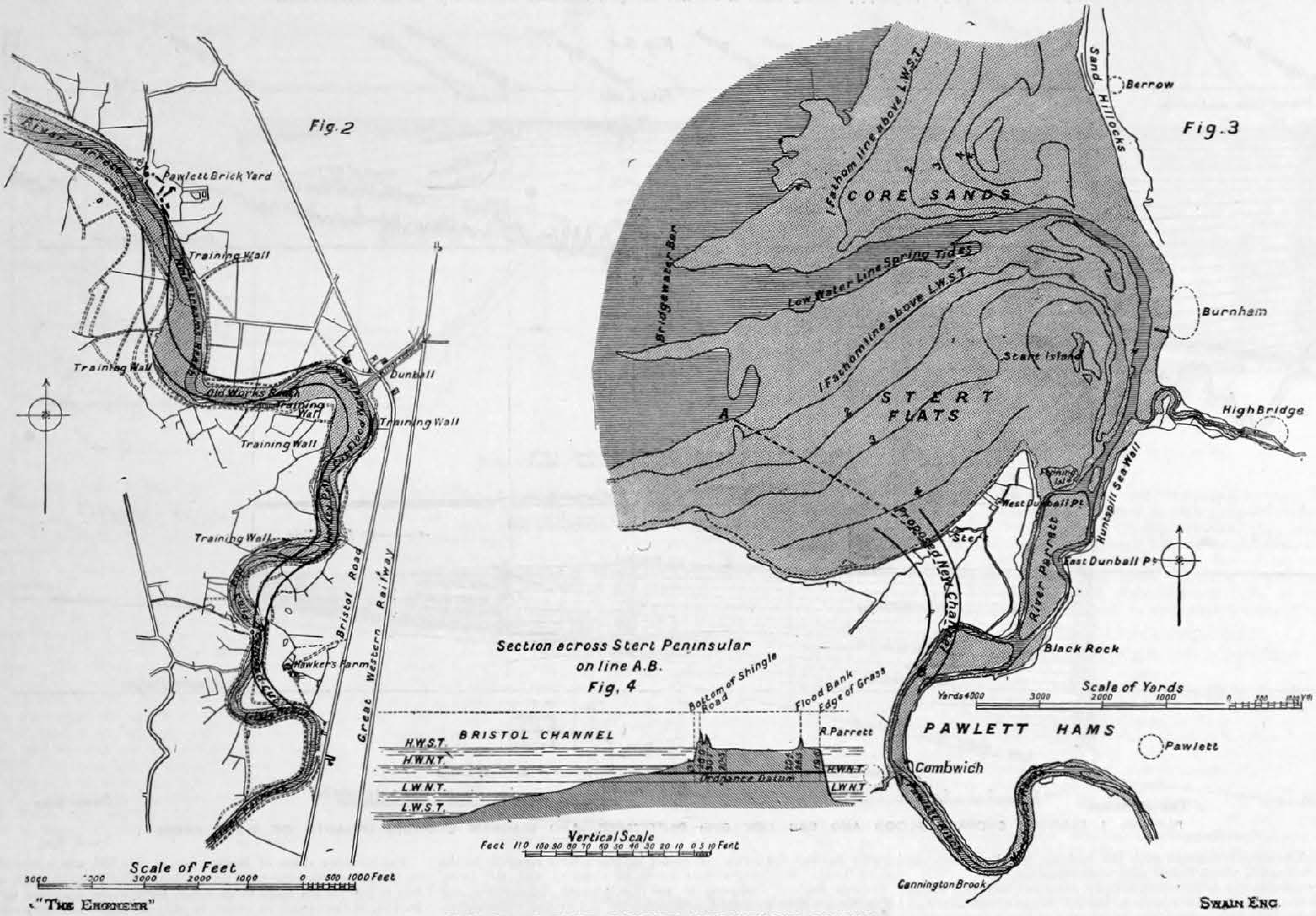
I recommend the purchase of a steel-hulled steam launch for the purpose of carrying out the improvements proposed in this scheme. The requirements of this launch may be stated as follows:—It must be capable of steaming up against the ebb tide, and while so doing of stirring up, scouring, or eroding such portions of the bed of the river as lie high, of clearing out ships' berths, washing away sandbanks lying above water level, and cutting if possible through bends of the river. Its manager would conduct such training works as shall hereafter be described, and would superintend the carrying out of such operations as from time to time would be required for the improvement of the navigation. Several systems might be adopted for scouring the bed of the river. I may mention those of forcing water or air, by means of jets, into the silt, of eroding the bed of the river by means of revolving cutters, mounted on a vertical shaft, or of raking up the bed of the river by drawing a harrow along the bottom. I shall recommend a combination of the first and last of these methods. Plan Fig. 1 shows a launch 60ft. long, 14ft. beam, and drawing 4ft. of water. She will be fitted with a compound surface condensing engine of sufficient power to drive the boats 8 knots, with a locomotive marine type boiler, capable of supplying steam to the above engine, and also to the following:—Two auxiliary donkey engines for purposes of working the air, circulating, bilge, and feed pumps: one pair of compound coupled surface condensing engines, for purposes of working, and connected directly with two 8in. centrifugal pumps, to work at 300 revolutions per minute, with an outlet pressure of 20 lb. per square inch, and capable of discharging together 2400 gallons per minute. These pumps will be able to deliver water either to the stern or to the bow of the launch as required, by means of 8in. diameter cast iron pipes passing along and under each side of the deck.

For scouring and deepening the bed of the river, I propose to pump water to the stern of the boat, and round a U shaped 8in. diameter wrought iron pipe, pivoted as shown near its top ends, and connected by means of hose pipes with the two pumps. The bottom of this U bend will be of square section, and to its lower side will be screwed eight 2in. diameter discharge nozzles, through which water will project against the bed of the river. I propose also to fix rakes along this pipe, in front and in line with the jets, to assist them in their work. The lower end of this U bend will be suspended by ropes with pulleys from davits as shown, so that the jets can be lowered to the required depth, or when not in use, lifted up into a horizontal position when the U bend will fit the stern of the boat. This method has the advantage that it automatically adjusts itself to any depth less than that to which it is set. It will also be desirable to direct jets of water from the bow of the launch, for the purpose of cutting into and through sandbanks, clearing out ships' berths, and generally for scouring into such places as are difficult to deal with from the stern. The drawing shows the arrangement of these jets. Two vertical 8in. diameter cast iron pipes, capable of being removed when not in use, are fixed on each side of the bow of the launch. Both are capable of being turned round on their vertical axis by means of handles at their tops. At the bottom of each pipe is a curved nozzle, with a 3in. diameter outlet, which will be bolted to the bottom of the vertical pipes, by flanges cast at an angle of 60 deg. to the vertical axis. By so doing it will be possible to set the nozzle at any angle to the vertical axis as shall in practice be found most effective. The connection with the 8in. pipes from the pumps will be made by short lengths of hose pipe. One person at the bow of the launch will thus be able to direct the jets in any required direction.

A considerable annual expense might, I think, be saved by adopting a more economical method of removing the silt from East Quay. At present this is done by men throwing it out into the middle of the channel. A method I propose is to lay a 15in. cast iron pipe along the quay wall. At every 40 yards of this pipe there would be a 12in. diameter branch pipe, with a sluice valve to control it, which pipe would lead downwards and be connected with a 12in. diameter pipe 40 yards long, running at the bottom of the quay wall on the graving bank. Each length of such pipe would have 120 small ⅜in. diameter holes placed along it. Water would be pumped from the river by the steam launch into the 15in. pipe at any convenient point, say near the bridge. All that would then have to be done would be to open and close each 12in. sluice valve in turn. I believe the whole graving bank could by this means be cleared of mud by two men in less than a day, and if this could be done, it would certainly save Bridgwater £120 per annum. I should recommend giving this system a trial for a short length to see how it answers. I have not estimated the cost of laying these pipes in my scheme, and, indeed, only offer the suggestion as a possible use to which the steam launch might be put.

None of the large bends above Combwich can be cut off without interfering with existing works, such, for instance, as those at Dunball, Pawlett, and Combwich. The one cut which would, I believe, be beneficial to all concerned, would be that across Stert Peninsula. The effect of making such a channel would be of enormous benefit to Bridgwater. Not only would it shorten the distance from the bar to the town by 4½ miles, or nearly a quarter, but what is even of greater importance, it would increase the time of flood tide at Bridgwater by a full hour, allowing ships to get up from twenty minutes to half an hour earlier than at present, and permitting them to leave later. High water at Bridgwater would be some fifteen minutes earlier, and from 3in. to 6in. higher than at present, and at Borough Bridge it would be as much as half an hour earlier, and about 2ft. higher. The mean fall in the bed of the river from a point half a mile above Bridgwater Bridge to the bar of the river would be increased from 16·1in. to 20·8in. per mile. I have no hesitation in saying that the result of increasing the fall by this amount would alone materially improve the depth of water at all times, and with the aid of mechanical scouring as already described, I believe sufficient depth of water could be obtained for ships to reach Bridgwater at all tides.

Another important result of making this channel would be that the tidal volume passing up and down the river would be much increased. This would result not only owing to the extra depth of water at the bottom of the river which the tide would fill, due to the deepening of the channel, but what is of far more importance, because the tide would reach and fill the upper part of the river, which at present it has not time to do. Unfortunately, I did not at first realise the importance of this point, so that my tidal readings did not extend above Borough Bridge, and I am, therefore, unable to calculate what quantity of water this would represent; but assuming a mean width at high water between Bridgwater and Borough Bridge of 35 yards, then the extra quantity of tidal water passing Bridgwater four times daily, on such a tide as that on September 30th, and when the quantity of fresh water coming down was small, would be nearly 40 million gallons for that length alone, and if the river above Borough Bridge were reckoned in, this quantity would probably be increased to something like 150 million gallons. I have shown hatched on the flood diagram Fig. 5 the area of water between Dunball and Borough Bridge which is not filled by the tide. The reason of this is not very difficult to explain. The tidal wave on September 30th took 5 hours 35 minutes to travel from Bridgwater bar to Borough Bridge. High water at the latter place was just an hour later than it was in the Bristol Channel, and at that time the water at Burnham had already sunk 3ft. 3in. It will be thus seen that the water at Borough Bridge never had time to rise to its proper level, consequently all the beneficial scour of this quantity of water, which would have passed nearly the whole tidal length of the river, was lost. No doubt the tide of which I took the readings was an exceptionally high one, but the same thing occurs every day, only on a smaller scale.



PLAN No. 2—RIVER PARRETT IMPROVEMENT SCHEME

While on this subject I should like to point out how intimately the interests of the Port and Navigation and of the Somerset Drainage Boards are connected, and of the benefits that would accrue if they could work more in conjunction. I am indebted to Mr. F. Lowry, A.M.I.C.E., the engineer to the latter Board, for that part of my tidal diagram showing the river bed between Bridgwater and Langport. This section shows a large deposit above Borough Bridge, due no doubt to the fact that the energy of the flood tide is here exhausted in damming back the fresh water; the result is slack water, and a deposition of the coarser particles held in suspension. I here give the results of samples of water taken at different points along the river, showing the proportion of sediment by weight and by volume in a gallon of water. The volume was measured by allowing the sediment to settle in a gauged glass, and to obtain the weights I dried the deposit and had it accurately weighed. Samples were taken at half flood and half ebb at each of the places:—

River Parrett Water.—Proportion of Sediment, September 30th, 1894.

		Proportion by volume.	Quantity in 1 gal. of water. lb.
Burnham Pier	Half flood	1/123	·034
	Half ebb	1/172	·0242
Combwich Clyse	Half flood	1/34	·1213
	Half ebb	1/43	·0971
Dunball Clyse	Half flood	1/16	·2621
	Half ebb	1/78	·0534
Bridgwater Bridge	Half flood	1/57	·0728
	Half ebb	1/20	·2087
Borough Bridge	Half flood	1/172	·0242
	Half ebb	1/191	·0225

I do not think there is a great deal to be deduced from these samples, as the amount of sediment is much influenced by local circumstances. The muddiest sample, that taken at half flood at Dunball, is chiefly due to the rough water immediately below that place in "Old Works" Reach. The extremely muddy sample taken at half ebb Bridgwater Bridge, I can only account for by the river being contracted above the bridge, and hence the curre it more rapid at this point.

The brickyard rubbish above Bridgwater and Somerset Bridge wants removing, so as to permit the bed of the river being lowered at these points. This could easily be done by barge men, paid piece-work. There are a few other places below Bridgwater where the bed of the river will want lowering by other means than by scouring, notably, a ridge of limestone rock which crosses the river bed immediately opposite Combwich. Improvements in a tidal river are mainly to be looked for by a free access of the tide, assisted in the case of a sluggish river by dredging, or in a river such as the Parrett, by mechanical scouring or eroding.

Locks and sluice gates especially in a muddy river are an absolute mistake, and only lead to the silting up of the channel above and below them. There is not a single example in the neighbourhood where this is not the case. The flood gates on the Brue at Highbridge I consider the greatest mistake. The banks above them are constantly having to be raised to prevent the land being flooded, because the river is now so sluggish that it cannot carry the sediment it brings down to the sea. The Somerset and Dorset Railway Company spend hundreds of pounds annually in clearing out the tidal deposit from Highbridge Clyse. The river Brue has a drainage area of 207 square miles, and instead of being navigable, and a source of prosperity to the district, it does not even answer the purpose of a canal, nor of a really efficient drain. There are hopes that with the new sluice gates now nearly completed, the free run of the tide will once more be admitted. From a perusal of Mr. Grantham's report in 1872-73, I understand that the land between Crip's Corner and Yarsdale lies between 4ft. and 5ft. below the highest flood tide level. The river banks for these seven miles would have to be specially seen to, but I have no doubt that if the tide was admitted to-morrow, this river from that day with a little help would gradually improve and deepen its channel. I lay some stress upon this point, because should such a cut across Stert Peninsular as I have suggested be contemplated, it would be of considerable importance both to Burnham and Highbridge, that as large an amount of tidal water as possible should be admitted up the river Brue.

It may no doubt be said that the effect of shortening the course of the Parrett would be to materially alter the present conditions between Combwich Reach and Burnham. No doubt the low-water channel would suffer, and in time perhaps some of the present estuary would silt up, but this would not matter in the upper estuary, and as far as Burnham and Highbridge are concerned, I believe their conditions would be improved. There is 40ft. of water opposite Burnham Pier on a high tide, enough and to spare for the largest man-of-war, and although this depth might, and probably would not always be maintained, there would with such a tide, and with the water flowing up the river Brue, always be sufficient water. It must not be lost sight of that the sand and such a model in connection with the Mersey estuary, and know that very valuable results may be so obtained.

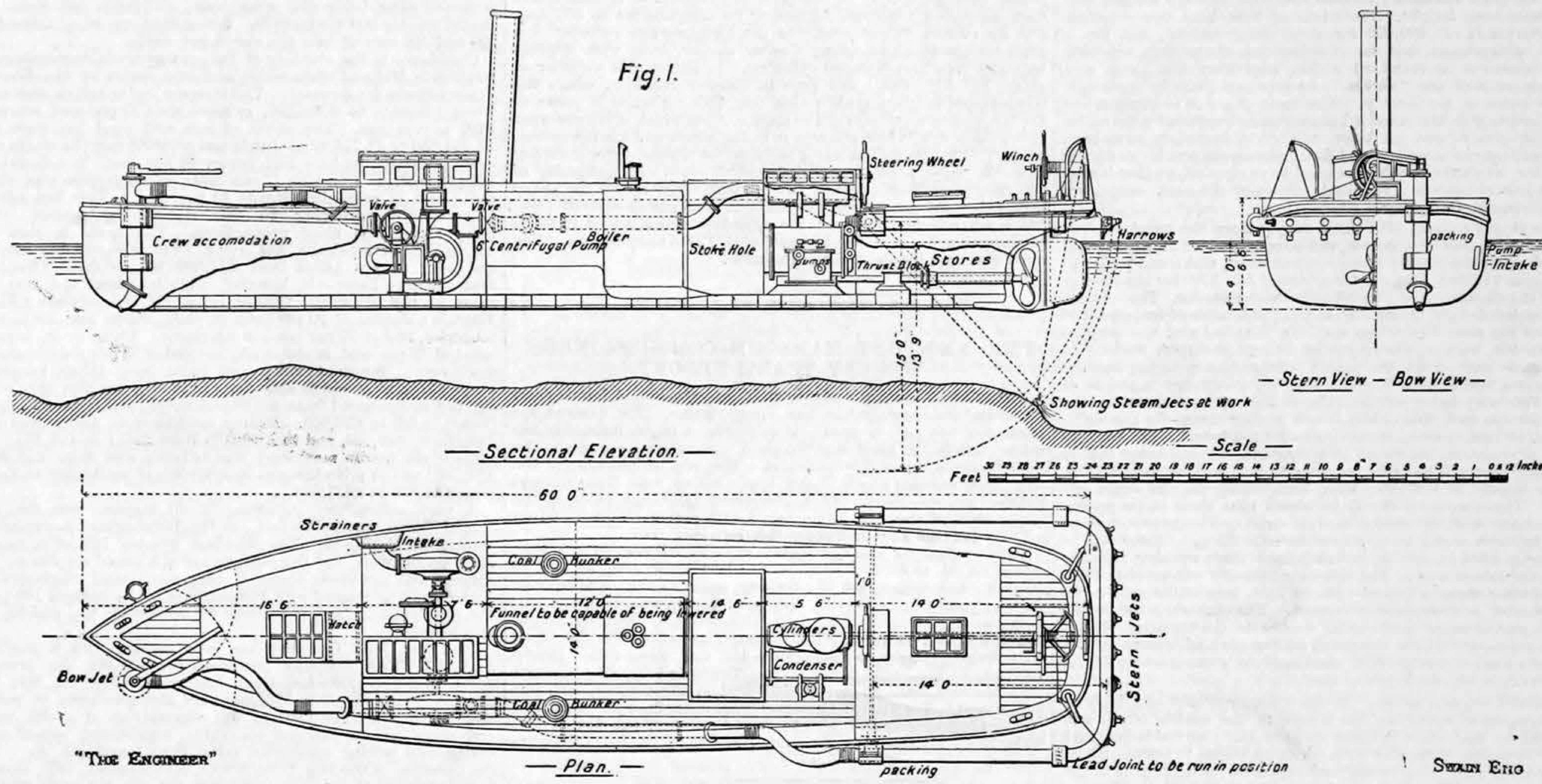
I shall now deal with that part of the river which wants most attention, and which it is part of my scheme to rectify. "Little" reach—see Fig. 2—has undoubtedly the worst bend in the river for ships to get round. This bend has a radius of only 300ft., which is far too small, in fact no curve in a navigable river of this size ought to have a less radius than 1000ft. The other bad curves appear to be those at "Nine Streams" reach, with a flood channel bend of 350ft. radius; "Horsey Pill," with a radius of 400ft.; and "Pims Pill," with a radius of 450ft. Nobody knowing the river Parrett would ever attempt to dredge any material in order to improve the waterway. Such a proceeding would be absolutely futile, as the channel changes with every tide. Sandbanks weighing thousands of tons are removed at a single "spring" or freshet, and deposited elsewhere. The only chance is to humour the river, to train it gradually to maintain, if possible, one low-water channel only, and to follow a course which, while gradually easing the sharp bends, shall at the same time be in accordance with the inclinations of the river. The oscillations of the water from one bend to the next are like the swing of a pendulum. If the water is checked suddenly, as occurs in a sharp corner, the result is that the energy of the tide is expended in eroding the bank. In this lies the secret of the cure. Training walls, either of timber, fascine work, brickyard rubbish, or better still, a combination of these to suit the particular conditions, should be placed at points above and below the curve to be dealt with, which shall so deflect the current as to make it impinge on the point to be removed, and in time wash it away. Hitherto all that has been done has been to strengthen the banks at such points as were being eroded. This, although it may answer for a time, will effect no cure. It is like attempting to stop a swing in the middle of its oscillation, it requires a lot of doing, whereas if it is taken in time at the extremes of its course there is no difficulty. In the same way I propose to deal with the worst places in the river, they must be taken above and below, not at the spot itself. The curve at "Little" reach is so sharp, and the channel so narrow, that I shall recommend cutting across it, and I have shown on Fig. 2 the new course set out at a radius of 1000ft., and striking the two adjoining curves at a tangent. The length of this cut will be about 350 yards. I should propose at first to make a cut 21ft. broad and 12ft. deep by manual labour. Into this the steam launch would float, and I should expect to be able to complete the rest of the work by its means alone. Assuming the excavation could be done at 10d. per cubic yard, the first cut would cost £392. As, however, I feel a little uncertainty whether the launch will be able to do this work, I have allowed in my estimate £2500 for cutting across the bend. Spring tides bring up more deposit than they the expenses incurred, apart from the maintenance of the launch, or the cutting through of "Little Reach," might amount to £200 annually during the first ten years, after which, and when the river had begun to flow in better lines, the expenses ought to be less, and certainly nothing like what is now expended annually by the Drainage Commissioners in maintaining the banks. The making of a channel across Stert Peninsular would not in my opinion be a very expensive undertaking. A small passage if once cut through would, I believe, be soon enlarged by the action of the tides. I show a section of the ground on Fig. 4, the thick line showing the depth I should propose to make the first cutting. It will be observed how remarkably flat the ground is, being in fact below the highest spring tide level, except at the north end, where it rises for a short distance to a maximum of 10ft. above the average ground level. The subsoil is no doubt mild blue clay with layers of sand intervening, and at the north end the high ground will probably be composed of sand and shore pebbles. The work might be let to a dredging contractor, and from inquiries I have made from such, I believe it could be excavated at 1s. per cubic yard. Assuming a channel 50ft. wide by 15ft. deep was made, then the cost at this price would amount to £9500. Such a channel once cut, could, I have little doubt, be enlarged by the steam launch, assisted by the tide.

It is impossible for me to estimate the total cost of this undertaking without knowing how the proposal would be viewed by such places as Burnham, Highbridge, and Stert itself, but as far as the engineering is concerned, the work seems very straightforward. I estimate the initial expenses of my scheme as follows:—

	£	s.	d.
Making cut across "Little Reach"	2500	0	0
Land at "Little Reach," ten acres at £80 per acre ..	800	0	0
Steam launch complete	2000	0	0
Unforeseen expenses, sundry charges, &c.	200	0	0
	£5500	0	0

Assuming this sum was borrowed at 3½ per cent., and had to be repaid in fifty years' time, then the annual amount to be paid would be £235. I estimate the annual expenses as follows:—

	£	s.	d.
Maintenance of launch — crew and fuel — at say £6 10s. per week	338	0	0
Training operations, say £200 for the first ten years	200	0	0
Repairs, wear and tear of launch	80	0	0
Superintendence	200	0	0
Interest on borrowed sum, and sinking fund to clear off debt	235	0	0
Sundry charges, say	37	0	0
Total	£1090	0	0



PLAN No. 3—PROPOSED STEAM DREDGER LAUNCH, RIVER PARRETT IMPROVEMENT SCHEME

mud banks of Bridgwater bay are due to the deposits brought down by the Parrett, and that Burnham is gradually losing its sea front. Its water now so muddy would be clearer, and in many respects would be placed more under conditions similar to those of Weston-super-Mare.

It may be said that the Bath brick trade would suffer through the shortening of the river. I have given this matter a good deal of consideration, and do not believe that such would be the result. The effect of the cut would no doubt diminish the size of the "bore," and by allowing the tide to penetrate up the river more easily and sooner, would at the same time render the water slightly less turbid. On the other hand, there would be more water passing up the river, so that the rise of tide though less quick, would be considerably longer; and moreover the duration of high water would be lengthened, which is the time when the greatest deposit takes place. As to the peculiar nature of the slime, I do not believe that this would be altered to an appreciable extent. Bath bricks can be made anywhere between Dunball and Borough Bridge, a distance of 8½ miles, and there is far from a dearth in the present quantity of slime, which settles on the slime "batches" as much as 12ft. thick in the year.

Fig. 3 shows the course I should suggest for this cut. It is set out approximately to a radius of one mile. It is found in practice that a river follows a slightly curved course better than a straight one, as the low-water channel follows the outer bank instead of wandering from side to side. Stert would thus be on an island, and it would be necessary to provide a ferry to the mainland. There would be no difficulty in doing this, and in every respect this place would be immensely benefited. I have put forward this part of my scheme with some hesitation, owing to the magnitude of the change and the interests at stake. There has not been time to investigate the subject as thoroughly as it deserves, and I have kept it separate in my estimate of the cost.

Should it be held worthy of consideration, I should suggest the making of a working model of the river Parrett from Bridgwater to the river bar, on a horizontal scale of 2ft. to the mile, and a vertical scale of 8ft. to an inch, in which the conditions are as nearly as possible those actually existing. Up this model the tide would be made to ebb and flow, at intervals of a few minutes, by means of a rocking shutter at the sea end. When the conditions had become similar to those now existing a cut would be made as proposed, and its effect on the lower part of the river thus experimentally determined. I had on a former occasion to deal with take down, and the balance is only maintained by the fresh water floods. Thus in the summer months when there is an absence of rain, the river becomes very much more choked than during the winter. The flood tide takes a more direct course than the ebb, and to it I chiefly look for training purposes, it rises very much more rapidly, and has to do the double work of damming back the fresh water, and working its way uphill. The ebb tide assists the low-water channel, and it acts longer and more uniformly than the flood tide. These differences will assist a little in determining how and where to place training barriers.

I have shown on Fig. 2, by means of black lines, the ultimate course to which I should aim at training the river. Of course many years would elapse before it would flow in anything like the course shown. In "Nine Streams Reach" the flood tide will be directed on to the left bank, by a barrier placed on the right bank, 300 yards south of Pawlett brick-yard, and again by another barrier on the left bank higher up the reach, so as to direct the force of the current on to the point at the corner. I have shown the positions at which I should propose to place these barriers. In "Cut flood way" reach, the flood water should, if possible, be made to hug the right bank, which is also the side of the river the ebb tide takes. This will best be accomplished by fixing and filling out the right bank immediately south of Dunball Clyse, as shown in Fig. 1, where serious erosion is now taking place. At the same time a barrier may be gradually projected from the left bank where shown. Other reaches will be dealt with in the same way. The most difficult, Pim's Pill, coming in the middle, must be taken last. I am quite confident as to the success of this training, and have no doubt that in time the river could be made to take any desired course.

A little experience will soon show the form of training wall or barrier best suited for the particular conditions. In a few cases it might be advisable to drive small piles 10ft. to 15ft. apart, between which a fencing of copse oak poles would be nailed, or a training wall could be made by laying layers of fascines side by side, broom end towards the channel, with intermediate layers of brickbats. In places where the bank has to be projected and strengthened, which as a rule would be all that would be done, I should recommend the present system being continued, *i.e.*, of driving in stakes, pinning bushwood, and tipping down the banks stones and brickbats, anything, in fact, heavy enough not to be carried away by the force of the current. This training would be done under supervision from the steam launch. I estimate that This sum on the rateable value of the borough amounts to 7½d. in the pound. The above estimate is, I believe, full. The present bend at "Little Reach" would, after the making of the new cut, in time fill up, and the land could be put into cultivation. In other places, where training operations were conducted, as much land would, I consider, be reclaimed as was taken. I have deducted nothing in my estimate for the value of the clay excavated in cutting through "Little Reach." This, although it would be of a "mild" nature, would no doubt be worth sixpence per cubic yard for the first 9ft., and its value at this price would amount to £184.

Before concluding I should like to acknowledge my indebtedness to Mr. F. Wills, whose experience in connection with scouring the bed of the Upper Parrett with his launch, the Pioneer, has been of considerable assistance to me. I would even suggest that before trying a new launch he should be asked to experiment in the lower portion of the Parrett. I do not, however, consider his boat is powerful enough to carry out my scheme, even if arrangements could be made with the Drainage Commissioners. I am also indebted to Captain Jobson, who has given me every assistance; and last but not least to Mr. Thomas Griffith, without whose experience as a pilot of the Parrett I should have been at a great loss.

I have the honour to remain, Gentlemen,
Your most obedient servant,
H. G. FOSTER-BARHAM, A.M.I.C.E.
Dated this 29th day of October, 1894.

REFERRING to the armament of the new cruisers of the Spencer programme, the *Army and Navy Gazette* says:—"It does seem a little risky to give them nothing heavier than a 6in. quick-firer. The Severn class were said to be overarmed with 8in. guns, the present First Sea Lord, among others, condemning them in this respect, although Lord Hood overruled the objection. The Aurora class also carries guns of 9·2in. calibre, while in the Talbot and other modern ships of equal tonnage with the Aurora there are only 6in. and 4·7in. guns. It may be, of course, that increased rapidity of fire is held to be a compensation, and it is also an advantage, doubtless, to lessen the number of different types of ordnance a ship carries." Which last sentiment we thoroughly endorse, and consider that such an advantage is well worth some sacrifice.

AMERICAN ENGINEERING NEWS.

(*From our own Correspondent.*)

The acetylene gas controversy. — There is at present much interested discussion in scientific circles as to the possibilities of the manufacture of calcium carbide and acetylene gas, certain parties having been publicly exploiting the industry by disposing of stock in companies owning the Wilson patents. Dr. Birchmore, in a recently published article, says that no carbide has been made commercially by the system shown in the Wilson patents, which is a modification of the Siemens furnace. In laboratory experiments he has made carbide by five different methods—(1) the Wilson patent method; (2) the Morehead practical unpatented method; (3) the Cowles method; (4) the Clarke patent method; (5) the Moissan unpatented method. Some alleged carbide which came into his hands would yield neither ethine, methane, nor hydrogen. He states that it is perfectly well known to all who have examined the question that the Wilson patents are valueless as far as protecting the monopoly of the manufacture and the use of carbide are concerned. He is of opinion that when a burner is produced which will burn ethine properly, numerous carbide industries will spring up without any professional promotion. As to the use of ethine for illuminating purposes, he did not think it commercially practicable to distribute the gas through street mains on account of the great percentage of leakage that would occur, and suggested the use of steel "bottles" or cylinders as now used for other gases, the gas being compressed under such pressure as to be liquefied. One such cylinder has already exploded, however, killing three persons, and there would be continual disastrous accidents from the handling of these cylinders by individual consumers, especially in connecting them up to the gas pipes.

The New York State canals.—In the annual report of the Superintendent of Public Works it is stated that silting up of the canals has been going on for twenty-five years, and in the absence of sufficient appropriations for thorough cleaning, the only cleaning done during this time has been the removal of bars formed by inflowing streams. The result has been the gradual accumulation of about 2,250,000 cubic yards in the Erie Canal alone, or sufficient to reduce the draught of boats from 6ft. to 5ft. 4in. if it were uniformly distributed over the bed. Proportionately large deposits exist in the other canals. The superintendent favours such means of improvement as will enable the speed of the boats to be materially increased, considering this as being more beneficial than any attempt to increase the size or carrying capacity of individual boats. The traffic on the New York State canals in 1895, amounted to 3,500,314 tons, of which 2,327,481 tons were moved eastward, or to tide-water, and 1,172,835 tons were moved westward. Of these amounts 1,762,663 tons were through freight, and the balance local freight. The State of New York has voted an appropriation of £1,800,000 for canal improvement, not for a general enlargement, but for cleaning out, deepening, widening narrow portions to standard width, improving the locks, and replacing some of the "flights" of successive locks by hydraulic balance locks of vertical lift. The main object is to increase the depth, and to give the standard dimensions of section for the entire length of the canals. A large number of engineers have been employed to make complete and detailed surveys and levels during the winter, when the canals are closed to navigation, so that it may be seen just what work is required. Some of the rock excavation will be begun in the spring.

Water supply tunnel.—The water supply from the great Nashua reservoir, fifty miles from Boston, will be conveyed to the distributing reservoirs near the city by a large aqueduct, of which one part will be a tunnel 11,319ft. long, with a grade of 1 in 5000 for the greater part of the distance, and 1 in 2500 for the remainder. The sections are of varied design, to suit the varying character of material met with, but the clear dimensions are 10ft. 10in. high at the middle, and 12ft. 2in. wide at the springing line of the roof, which is a semicircular arch of 6ft. 1in. radius. Below the springing line the sides have a radius of 14ft. 4in., and the invert has a radius of 14ft. The brick lining will be 12in. or 16in. thick—three or four rings—for the roof, 8in. to 16in.—two to four rings—for the walls, and 4in. to 12in.—one to three rings—for the invert. The backing will be of concrete, brickwork or dry rubble. At the lower end of the tunnel part will be built in open trench, and here the work will be largely of concrete, with brick lining for the walls and invert. The concrete arch will be about 14in. thick at the crown. Some of the working shafts used in driving the tunnel will be closed by brick arches and stone and earth filling. Others will be only partly filled in, leaving a brick-lined shaft opening into one side of the tunnel roof. The concrete masonry will consist of five parts of clean stone or gravel—½in. to 2½in. largest diameter—two parts of sand, and one part of cement. The concrete must be laid rapidly, and rammed until water flushes to the surface. Mortar for brick masonry will be composed of one part of cement to one, one and a-half, or two parts of sand, and for stone masonry it will be one part of cement to two of sand.

Automatic telephone system.—In the ordinary system of telephone exchanges, each subscriber has a wire to the central office, and must call up that office in order to have his wire connected with that of any other subscriber with whom he wishes to communicate. This involves very complicated and expensive switchboards at the central station, with an army of operators to attend to the connections. In most of the automatic telephone exchange systems which have been invented, each subscriber would have an individual switching mechanism at the central office or exchange, and his line would connect with the lines of every other subscriber, involving very complicated connections, and complicated special apparatus for each subscriber. In the Callender system, however, the apparatus is very simple, and the costly outfit of switchboards and operators is avoided. The subscriber's apparatus consists of the usual telephone transmitter, receiver and call bell, and also a special signalling transmitter consisting of two graduated indicator dials, and numbered from 0 to 9. For a larger exchange, having any number of telephones not exceeding 999, a third dial is used, while the addition of a fourth dial would increase the capacity to 9999 telephones. A subscriber desiring to put himself in communication with another subscriber, say No. 36, places the indicator arms or pointers over the proper numbers on the plates; that is to say, the left-hand pointers over 3 and the right-hand pointer over 6. He then pulls down the lever at the right-hand side of the box and releases it. This completes the operation, as the signalling transmitter automatically turns in the proper signal, and in less than twelve seconds the call bell rings. If the desired communication is effected, one long ring is given. Two rings indicate a "busy" call, if the telephone signalled for is already in use. The signal-receiving mechanism is made capable of storing a call, so that should a call arrive during a busy hour when the system is in full use, this call will be stored or held for a few seconds, long enough to allow some part of the system to become inoperative, and thus enable the stored call to be operative. When the telephone already in use is released, the stored call becomes effective, and a "connected" signal is sent over the lines of both parties to the new connection then made. The mechanism connects the "caller" and "called," if the latter's line is not in use. The call bells of both subscribers are then rung through the movement of the circuit closing agent along the signalling track. Finally both subscribers are left in undisturbed communication, all of the apparatus having passed out of their control, with the exception of the progressive switch seized and individualised for the "caller," and the connector element connecting the "called" with the "caller." The other parts of the apparatus revert to common use as soon as each has served its independent function.

Irrigation.—The State of Illinois has a fertile soil for agricultural purposes, but even here irrigation has been found advantageous in increasing crop products. In 1894 the crops on the farm of the Eastern Illinois State Hospital for the Insane, 1000 acres, were ruined by drought, and the management had to expend 15,000 dols. for vegetables, fruit, &c. In consequence of this an irrigation system was installed, and during the dry season of 1895 the farm produced all the fruit and vegetables required, including 2000 bushels of turnips fed to the cattle. In the spring of 1895 plans were adopted to supply water for the irrigation of 150 acres of garden and orchard. Pipes were laid from the Kaukakee River, and ditches dug across the land. Two pumps, of 2½ and 3 million gallons daily capacity, furnish the water for the entire institution and for the irrigating system of 100 acres of vegetable garden and 50 acres of orchard. A 10in. main leads from the pumps to the building, and from this there is a 6in. pipe 1200ft. long to the highest point of the farm, about 25ft. above the river. From this summit 2000ft. of 4in. and 800ft. of 3in. pipe extend to various parts of the land, and hydrants are placed at intervals, short lengths of hose leading from the hydrants to the furrows made by a ditching plough. The depth of water in the ditches does not exceed about 3in. or 4in. The onion bed, and certain other portions, were flooded instead of ditched. By means of portable dams of sheet iron the streams in the furrows are kept under control and the water is directed to any desired point. Seven crops of peas were raised. The cost of such a system, using oil, steam, or wind engines and pumps, for an ordinary farm is estimated at £3 to £4 per acre irrigated—this being for the first year only, the subsequent expense being merely for fuel and labour.

Air compressors driven by water-wheels.—A compressed air power plant has been installed by the North Star Mining Company, of California, in which the compressors are driven by the largest Pelton "impulse" water-wheels ever built. The wheel is 18ft. 6in. diameter, with rod spokes, mounted on a 10in. shaft, and has a series of buckets on the rim, which receive the impulse from a 1⅛in. jet nozzle in a pit below the wheel. An automatic device regulates the amount of water according to the power required, thus maintaining a uniform speed and a uniform pressure in the receiver. The water is conveyed to the plant through five miles of 20in. riveted steel pipe, with a head of 775ft., or a static pressure of 335 lb. per square inch. The wheel is guaranteed to give 85 per cent. efficiency, running at 110 revolutions per minute, and the great size of the wheel was adopted in order to give proper piston speed to the compressors under the high head available, the piston speed being 400ft. per minute. The wheel shaft is connected direct to two compound air compressors, with cylinders 10in. and 18in. diameter and 24in. stroke. The air is compressed to 30 lb. pressure in the initial cylinders at 160 deg. Fah., then passes through a cooler consisting of fifty copper pipes 1in. in diameter and 18ft. long, placed in the wheel pit, and thence to the second cylinders, in which it is compressed to 90 lb. It then passes through 1000ft. of 6in. pipe to a receiver at the shaft, and then through a reheater—increasing its temperature to 350 deg. and its volume 43 per cent.—to the high-pressure cylinder of a cross-compound direct-acting Corliss engine, built with slightly enlarged ports and jacketed cylinders. It leaves this cylinder at about 130 deg. Fah., and goes to another reheater, where the temperature is raised again to 350 deg. Fah. Thence it passes to the low-pressure cylinder of the engine, from which it is exhausted into a brick flue, which conveys it to the offices and change-house, where it is discharged to warm and dry the miners. For pumping from the mine, a compound differential pump with a capacity of 600 gals. per minute at 500ft. lift is used. The air for the pump is reheated and sent down the shaft in a magnesia-covered pipe, but is not reheated between the cylinders, which allows it to be discharged into the shaft at a comfortably cool temperature. The air is also used for the drills in the mine.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

THERE was a large attendance on 'Change to-day. A fair demand for steam coal prevailed at last week's prices. The demand for house coal was not so good. If anything, a slight reduction has taken place in the price of pitwood. A buoyant tone prevails in the manufactured iron and steel trades. The coal shipments for the week have reached nearly 70,000 tons. Stems with the principal shippers are well filled. An improvement has taken place in the importation of iron ore, as compared with previous weeks. Great activity prevails all round in the ship repairing trade.

Prices ruling on 'Change to-day were as follows:—Coal: Best steam, 8s. 3d. to 8s. 6d.; seconds, 8s.; best house coal, 10s. 3d. to 10s. 6d.; dock screenings, 5s.; colliery, small, 4s. 6d.; smiths' coal, 6s. 6d.; patent fuel, 10s. 3d. Pig iron: Scotch warrants, 47s. 3d.; hematite warrants, 48s. 8d., f.o.b. Cumberland; Middlesbrough, No. 3, 38s. 5d., prompt; Middlesbrough hematite, 46s. 6d. Iron ore: Rubio, 11s. 9d. to 12s.; Tafna, 11s. 3d. Steel rails: Heavy sections, £4 15s.; light ditto, £5 5s. Tin-plate bars, £4; Siemens tin-plate bars, best, £4 5s.; all delivered in the district, cash less 2½ per cent. Tin-plates: Bessemer steel coke, 9s. 0½d. to 9s. 3d.; Siemens (coke finish), 9s. 4½d. to 9s. 6d.; ternes, per double box, 28 by 20 C, 21s. to 22s. Pitwood, 15s. 6d. to 15. 9d. Freights steady.

LAUNCH.—On the 4th inst. a large petroleum tank steamer Cowrie was taken for trial off the Tyne. The weather was very hazy, but an excellent trial of the machinery was made, and it gave every satisfaction to those on board. The Cowrie is one of two vessels built by Sir W. G. Armstrong and Co., at their Walker shipyard, for Messrs. M. Samuel and Co.'s Shell Line of steamers. The vessel has been built of steel, under Lloyd's special survey for their highest requirements. Her chief dimensions are:—Length, 387ft. 6in.; breadth, 48ft.; depth, 31ft. 6in. She has a deadweight capacity of 7000 tons, which she carries on her statutory draught of water. Like the rest of the same fleet, she has been specially constructed under the supervision of Messrs. Flannery, Baggallay, and Johnson, of London and Liverpool, for the double duty of carrying oil in bulk to the East and returning to European ports with general cargoes of fine goods. She is fitted with ample engine and boiler power, her engines having cylinders 27½in., 43½in., and 73in. by 48in. stroke, and on her trial trip these developed about 2000-horse power. It is a source of great satisfaction to Messrs. Samuel that the vessels of their existing fleet carry out this exacting service in the most efficient manner. The space set apart for oil in the Cowrie is, as in her sister ship Nerite, divided longitudinally and transversely into sixteen separate oil-tight compartments, with special trunk-ways to allow for the expansion of the oil under variations of temperature. The pumping arrangements are most complete, so as to enable the oil cargoes to be discharged with the utmost rapidity. When this work is done the tanks are all properly and efficiently cleansed and ventilated by means of special appliances fitted on board for this purpose. For dealing with the general cargoes of the vessel a large installation of deck machinery has been fitted, so that the cargo may be worked from all the hatches simultaneously. The accommodation for the captain and officers is in the bridge, the engineers in a deck house aft in the poop, and the crew in the forecastle. The propelling machinery is of the triple expansion type, manufactured by the Wallsend Slipway and Engineering Company. Electric light, including search light for use in the Suez Canal, has been fitted. The speed attained on the trial trip was over 11½ knots, and everything about the engines and boilers worked without a hitch, and steam was easily kept. A feature of the trials was the thorough testing of all the auxiliary gear, which was found to work to the satisfaction of the company's superintendent, Captain Coundon, and the superintending engineers. Immediately after the trial the Cowrie proceeded on a voyage to Batoum, under the command of Captain Parsons.

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

(*From our own Correspondent.*)

ALTHOUGH wages for engineering work at home and on the Continent are not so widely different as are those paid in iron and steel manufacturing proper, yet ample evidence is forthcoming that even in the structural departments there is quite sufficient divergence to act deleteriously to British interests, and to deepen the conviction at present entertained by many British engineers that in their sphere of trade, no less than in the production of material, there is urgent need for practical steps of some sort to be taken to lessen the gulf in the matter of establishment charges which now separates the engineers and machinists of Great Britain from their competitors across the English Channel. Statistics just available give the following comparative statement of the rates of wages per day paid in the engineering shops of England and Belgium respectively, together with the amount of difference, which it will be seen is, in each case, against the English engineer: — Roll turners, England 4s. 8d., Belgium 3s. 1½d., difference 1s. 6½d.; smiths, 4s. 8d., 2s. 10d., 1s. 10d.; fitters, 4s. 8d., 3s., 1s. 8d.; labourers, 3s. 5d., 2s. 7d., 10d. These differences, although considerable, are not, as we have previously intimated, by any means so great as in the case of ironmakers, which is shown by the following comparison of the wages rates at the celebrated Seraing Works of the Cockerill Company and those at one of the largest establishments in England, employing, like the Cockerill Company, close on ten thousand workmen:—Rolls, first roller, England 9s. 6d., Belgium 5s. 5d., difference against England 4s. 1d.; second roller, 5s. 8d., 3s. 9d., 1s. 11d.; third, 5s., 2s. 11d., 2s. 1d.; first heater, 15s. 1d., 6s. 3d., 8s. 10d.; second heater, 5s. 6d., 3s. 6d., 2s.; third heater, 4s. 6d., 3s. 2d., 1s. 4d., men at open-hearth furnaces, smelters, 12s. 11d., 4s. 6d., 8s. 5d.; assistant smelters, 7s. 5d., 2s. 11d., 4s. 6d.; other labour—average —6s. 3d., 2s. 4d., 3s. 11d. The foregoing statistics appear to emphasise what is the prevailing opinion in the iron and steel and engineering trades, namely, that in the recent report upon foreign competition the British Iron Trade Association scarcely gave sufficient emphasis to the manner in which British manufacturers are handicapped in this respect.

On 'Change to-day, Thursday, in Birmingham a fair amount of business was transacted, and prices were well sustained at last week's level. The revival since its resumption is not going forward with the leaps and bounds that characterised the last few months of 1895, but there is a healthy tone generally about business, and if progress is rather slow, it is held to be sure. Prices are unchanged on the week. The Gospel Oak Ironworks, Tipton, are to be restarted after being idle some time. When in full work they should employ 200 workpeople. Some time ago they turned out 300 and 400 tons of bars and sheets per week.

Confidence in the stability of the current trade improvement is inspired in Midland engineering and iron circles by the Board of Trade returns for January. The increase under metals and metal-wares amounts to £525,236, or more than 25 per cent. compared with a year ago. The value of iron and steel has risen from £1,351,086 to £1,716,072. In pig and puddled iron the rise in value is 64 per cent., in bars and angles 30 per cent., in railroad iron 106 per cent., in iron wire 17 per cent., in telegraphic wire 62 per cent., and in galvanised sheets 49 per cent. This last advance is especially gratifying to this district, galvanised sheets being one of its chief productions. The trade in this class of iron with Australia has risen from £36,860 to £52,391; and with South Africa from £17,360 to £50,625. Our third best market—India—is, however, slightly under last year, the value of the shipments thither being £32,003, against £33,023. There is a decline of 20 per cent. in plain sheets and hoops to all countries, and of 22 per cent. in tin-plates. There is an improvement of 32 per cent. in steam engines and of 13 per cent. in general machinery. South America and India have taken locomotive engines, the value of the shipments to India upon this time a year ago having increased from £2749 to £29,695; and to South America from £16,685 to £23,005. Mining machinery to Africa rose from £30,007 to £49,693, and to Australia from £3811 to £21,245. The value of the textile machinery sent to India rose from £53,231 to £94,766; and of miscellaneous descriptions of machinery to Europe from £87,550 to £131,543.

A very satisfactory gathering in all respects was the sixth annual dinner, on the 9th inst., of the Birmingham Association of Mechanical Engineers. The members number 161, or an increase of 27 on the year, and the finances are in a sound condition. The Mayor, who presided, observed that mechanical engineers had been closely associated with Birmingham for upwards of 100 years. The city had long been celebrated for machinery, tool making, and engineering.

The Star Tube Company has been formed with a capital of £100,000. This company purchases for £38,000 the premises, plant, machinery, stock-in-trade, and goodwill of the Star Tube Company, established in 1891, who are manufacturers of weldless steel tubes, which are used in the construction of cycles, marine and other boilers, heating apparatus, condensers, superheaters, boring and mining apparatus, axles, guns, carriages, &c. After the purchase of the Star Tube Works, in November, 1891, from the former owners, the vendors reconstructed the tube mill, and laid down new plant. These alterations and extensions were not completed until 1894. The profits for the thirteen months ended July 31st, 1895, are certified at a sum sufficient to pay interest on the contemplated debentures, the dividend on the preference shares, and a dividend on the ordinary shares at the rate of 8 per cent. per annum.

The new coalfield about to be developed between Retford and Tuxford is creating much interest, and the first sod of the new colliery is to be turned this month. The shaft is to be sunk between Haughton and Walesby, and will not affect the famous dukeries. As the Duke of Newcastle has, however, sold the minerals underlying a very large area, it is possible that several other shafts will be sunk ere long, and, indeed, it is said that there will be five in all.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—A strong tone characterised the iron market at Manchester on Tuesday, and there was a full attendance, with a considerable weight of business offering, buyers being prepared to place orders for fairly large quantities whenever they could get some slight concession upon present quoted rates. Makers, however, who in most cases have been selling pretty heavily recently, are not only very firm at their full rates, but in some cases disposed to harden further upon these, and amongst merchants and dealers there are now very few low sellers, the strong position of makers naturally operating as a decided deterrent against underquoting, unless the iron is already held in second hands. For local brands of pig iron makers are still quoting about 46s., less 2½, for No. 3 foundry, delivered Manchester, but are very chary about selling beyond small quantities at these figures, For district brands higher prices are ruling, Lincolnshire being now generally quoted 42s. 6d. for forge to 44s. 6d. for foundry, net cash, with ready buyers at 6d. under these figures; and foundry Derbyshire averages 46s. 6d. to 47s. 6d., net cash delivered Manchester. Outside brands offering here have also shown an upward move, and could scarcely now be bought within 6d. of last week's prices, 46s. 10d., net cash, being the minimum for foundry Middlesbrough, delivered Manchester, whilst Eglinton is quoted from 47s. 6d. and 48s. net prompt cash, delivered Lancashire ports, to 49s. 9d. and 50s., delivered Dock Quays, Manchester.

In the finished iron trade, makers, who in bars have been selling freely at their recent full rates, have made an advance of 2s. 6d.

per ton, £5 12s. 6d. for Lancashire and £5 12s. 6d. to £5 15s. for North Staffordshire qualities, being now the minimum figures. Prices for other descriptions of finished iron are without alteration, sheets remaining at £7 10s. to £7 12s. 6d.; and hoops at £6 2s. 6d. for random, to £6 7s. 6d. for special cut lengths, delivered Manchester district, with 2s. 6d. less for shipment.

In the steel trade there is a decided upward move as regards hematites, in which some large transactions have been put through, one Sheffield firm, it is reported, having during the past week placed orders for no less than 50,000 tons, and makers have generally advanced their prices quite 1s. per ton upon those which were being taken a week ago, 56s. 6d. to 57s. 6d., less 2½, being now the minimum for No. 3 foundry, delivered equal to Manchester. Steel boiler plates, however, do not yet show any very appreciable improvement, and can still be brought from Scotland at £6 5s., with Lancashire makers asking £6 5s. to £6 7s. 6d. per ton, delivered in this district.

Generally, a fairly good business is reported in the metal market, and except that there are perhaps not the large contracts that just before the rise were being placed, the recent advance has had no appreciable effect in checking the ordinary run of orders coming forward. Considerable quantities of brass and copper tubes and sheets are being taken for all branches of engineering; electrical engineers are also very busy, and their requirements are considerable for miscellaneous goods.

I understand that at last a method of making an aluminium joint without alloy, and which, without either being soldered, brazed, or keyed, is rendered homogeneous, and practically unbreakable, has been perfected. This joint has been tested by the leading cycle manufacturers for the manufacture of cycle frames entirely of aluminium, which, with equal strength, will be 50 per cent. lighter than steel. Mr. Wm. Pearson, of Birmingham, is the inventor of this new process, which is being taken up by the Cramp Manganese Bronze Company, of Nottingham, who will, I am informed, make the metal tubes and fittings, and supply them to three of the leading English firms of cycle manufacturers.

Steadily increasing activity continues to be reported throughout the engineering trades of this district. Boiler makers during the last few weeks have booked a large number of orders, no less than 150 boilers, I understand, having been placed with different Lancashire firms, about 70 of these having gone into the hands of one large maker. Stationary engine builders are also fully engaged, and in the above branch of industry a number of additional men have been put on during the last few weeks. Other branches of engineering are in much the same satisfactory position as I have reported recently.

The returns of the engineering trades unions are this month of a very encouraging character. With the return to employment of the men affected by the recent shipbuilding dispute, and the general improved condition of trade, the out-of-work list of the various societies shows a considerable reduction. In the Amalgamated Society of Engineers, there are now only about 5 per cent. of the total membership on donation benefit, whilst in this immediate district less than 4 per cent. of the local membership are on out-of-work support, the improvement in trade being such that the local secretary is unable to meet the demand for certain classes of workmen. The Steam Engine Makers' Society reports a decrease of 1 per cent. in the number of unemployed members, only about 2 per cent. of the membership being now in receipt of donation. The reports from the different districts as to the state of trade indicate a decided steady improvement, although in some of the marine centres trade does not seem to become any better.

The compilation of the comprehensive annual reports which are now issued by some of the principal trades union organisations must not only be a very laborious task to the officials, but involve a great deal of careful research into outside matters of special interest to the members. I have been furnished with a few details with regard to the compilation of the just-issued report of the Steam Engine Makers' Society, an abstract of which appears in another column, which are certainly interesting, and afford some idea of the work involved. The report, which is a bulky volume of 416 pages, is filled with branches' financial returns, abstract statements, detailed balance-sheets, statistics, and Government returns on various questions appertaining to the working classes. The Society has 101 branches in different parts, and the report gives the name of every member, a summary as to those who have removed to other towns, any members who have gone abroad, and of those who have left the engineering trade, and gone into some other business. Following this are records of the amounts paid to members for superannuation, sickness, or unemployed benefit, and as the names, amount, and number of weeks are given separately, each member practically becomes his own auditor of the report. A balance sheet is also given of the working expenses of each branch. Much space is devoted to the payments, past and present, in superannuation to aged members, from which it is evident that the Executive Council are making a strenuous effort to provide for future claims, and of late years a special fund for this purpose has been raised and invested with corporate bodies, so that it may be separate and distinct from the general funds of the Society. Amongst the tables in the report are a number of statistics extracted from the reports issued by the Labour Department of the Board of Trade. Other tables are given of an educational character, which no doubt will be studied by the more thoughtful members, and give them some idea of foreign trade. These tables include the exports of engines and machinery, the production of pig iron in the United States, the continent of Europe, and the United Kingdom, from 1854 to 1894, the production of steel rails, coal and tonnage of ships launched, whilst casualties amongst the working classes are given in tabular form, as compiled from H.M. Inspectors of Factories, Mines, Railways, and Board of Trade returns, each year since the passing of the Boiler Explosions Act. Taken on the whole, Mr. Swift, the general secretary, has compiled a report that not only shows his society's finances to be capable of bearing criticism, but also includes instructive information that will, no doubt, be fully appreciated by the members.

The paper read before the Manchester Geological Society on Tuesday by Messrs. J. Barnes and W. F. Holroyd, on the rocks and fossils of the Yoredale series of the Marsden and Saddleworth valleys, raised an interesting point as to the correctness of present accepted theories with regard to the strata in which such fossils as the authors exhibited are only to be found. The observations were chiefly made in the new section recently exposed by the making of the London and North-Western Railway tunnel from Diggle to Marsden, and very interesting finds of anthracosia and other allied forms were made in the same set of shales at Marsden, from the end of the tunnel, and from material brought out by sinking the new shaft at Flint pits. Side by side they had in the same beds gomatites of at least a dozen different shapes, some of which were not yet determined, and at least four species of nautili, with descites; three species of othoceras; two species of producta; one of gervillia, evidently marine forms, along with such fossils as anthracosia of several species, posidonia, and a number of small gasteropoda, and occasional fish remains—fish teeth, small fish scales of small ganoid forms, and large scales, mostly detached and preserved singly in small ferrous carbonate nodules, and evidently belonging to some large fish, such as the megalichthys, holoptichthys, saurichthys, &c. In the discussion which followed, the hope was expressed that the sections given might be entered in the Society's transactions, as they opened out some very important new questions; and Mr. Bolton expressed the opinion that the positions in which the fossils had been found by Messrs. Barnes and Holroyd tended to alter their ideas of the lower coal measure series, and went to prove that the Yoredale, millstone grit, and the lower coal measures were part and parcel of the same series. He added that at Owens College, Professor Dawkins had placed together the collections of Yoredale shells and fossils in the coal series, so that visitors could see the genesis of the Yoredale fossils, and contrast them with the adjacent coal measure fossils, this having been done chiefly to warn people from supposing that whenever they found these particular fossils they would also find coal.

In the coal trade no improvement can be reported, the position being weaker, if anything, and although collieries are working less time, four days per week being a very general average, supplies are plentiful. House-fire coals continue in but slow demand, with a want of firmness in prices, although there is no actually quotable giving away. Best Wigan Arley is now only in exceptional cases fetching more than 10s.; Pemberton 4ft. and seconds Arley, 8s. up to 9s.; and common house coals about 7s. per ton at the pit mouth. In the lower qualities of round coal suitable for iron making, steam, and general manufacturing purposes, supplies are in excess of requirements, with prices extremely low, 6s. being still about an average figure for ordinary steam and forge coals at the pit mouth, with 5s. 3d. to 5s. 6d. taken for common steam coal for shipment. At some collieries supplies of engine fuel are short to meet requirements, whilst at others slack is accumulating in stock, and there is consequently rather a wide margin in prices, common sorts ranging from 2s. 9d. to 3s. 6d., and better qualities from 4s. 3d. and 4s. 6d. up to 5s. at the pit mouth.

Business remains quiet in the shipping trade, with ordinary steam coal still not averaging more than 7s. and 7s. 6d., and better qualities about 8s. per ton, delivered at the Garston Docks, or the High Level, Liverpool.

Barrow.—There is a generally improved tone in the hematite pig iron market, and business is growing week by week as the season advances. The make of iron is increasing. At Barrow this week another furnace has been lighted, and other furnaces are being prepared for blast in the Cumberland district. Thirty-seven furnaces are now in blast in the district, compared with twenty-three in the corresponding week of last year. Prices are firmer at 48s. 9d. net cash sellers of warrant iron, and 48s. 8d. buyers. Makers' iron is quoted at 50s. 6d. net f.o.b. Stocks during the week, owing to bulling operations, have increased by 5700 tons to 303,705 tons, being 14,530 tons more than in the beginning of the year.

There is not a corresponding improvement in the iron ore trade, as Spanish iron ore is now seriously competing with the native product. Prices are firm at 10s. for ordinary sorts, and a fuller demand is looked for.

Steel makers are well off for rail orders, and for orders for plates for shipbuilding and boilermaking purposes. There is also a good business in hoops and billets, and the mills at Barrow, which were stopped owing to an accident, are now again in full swing. Heavy steel castings are in demand, and a good business is doing in steel sleepers at the West Cumberland works.

Shipbuilders and engineers are very busy, and expect to be more so in the immediate future.

The coal and coke trades are brisk, and fuller deliveries are coming to hand. The consumption is increasing, and prices are firmer, though not quotably higher.

The shipping trade is showing new life. The exports of pig iron from West Coast ports during last week, 8136 tons, and of steel 8224 tons, compared with 1900 tons and 5607 tons respectively in the corresponding week of last year, an increase of 6236 tons of pig iron and 2617 tons of steel. The aggregate shipments this year to date represent 30,727 tons of pig iron and 43,361 tons of steel, as compared with 26,728 tons of pig iron and 31,495 tons of steel in the corresponding period of last year, an increase of 3999 tons of pig iron and 11,866 tons of steel.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

BUSINESS in the South Yorkshire coal district still continues in the same unsatisfactory condition. Pits are working but four days a week, while a few are only employed three days. Even with these few working days stocks are reported to be accumulating, and production is far in excess of the current demand. Household fuel is only moderately asked for, and a further decrease in working hours will have to take place, unless a sharp spell of cold weather sets in immediately. There is only a slight quantity of household fuel taken over both the Midland and Great Northern Railways, while reports from London are very discouraging. The request from other markets is slight, although the Eastern Counties are taking a larger tonnage of gas coal. Quotations have not changed very much. Silkstone, which is eagerly sought after in London, is sold at 8s. to 9s. 3d. for best qualities, and 6s. 9d. to 7s. for secondary sorts. Barnsley "softs" in good demand at 7s. 3d. to 8s. per ton.

Flockton coal is obtainable at about the same prices. Thin seam coal, however, can be procured at 6s. to 6s. 3d. per ton at the pits in quantities. A fair trade is transacted in steam coal, considering the season of the year. Since the opening of 1896 business has been very good, and about on an average compared with the beginning of 1895. Grimsby has done a fairly average trade, although values are small and competition keen. The largest district coalowners in South Yorkshire have forwarded a good tonnage to Hull, and with one or two exceptions have improved their positions slightly since the year began. Railway companies are taking a large tonnage out of the district, mainly on contract account. Quotations in the open market range from 6s. 6d. to 7s. per ton for best steam coal, with secondary qualities at 6s. per ton at the pits. Gas coal continues in excellent demand, taking into consideration the small consumption of gas for heating and other purposes. Values are from 6s. to 7s. per ton in company's own wagons at the pits. Manufacturing fuel is in slightly better request. All descriptions are plentiful, and prices rule very low. Small nuts are in moderate request at 4s. 9d. to 5s. 6d. per ton. Good screened slack is obtainable at 3s. 6d. to 4s. 6d., and ordinary pit slack at 2s. 6d. to 2s. 9d. per ton. Smudge is plentiful at low rates. Coke is in a slightly better condition, and North Lincolnshire is taking an increased tonnage, while a similar remark applies to Derbyshire and Northamptonshire. Values range from 8s. to 9s. 6d. per ton at works.

The Yorkshire collieries sent to Hull last month 150,944 tons, as compared with 142,576 tons in January of 1895. The exports to foreign countries reached a total of 56,452 tons, as compared with 53,733 tons in the opening month of 1895. The principal foreign customers were Germany, 13,842 tons, against 10,466 tons; Sweden and Norway, 18,833 tons, against 11,342 tons; and Holland, 17,802 tons, against 3514 tons.; while Russia showed a considerable decrease. A significant fact is shown in the January returns; 133 collieries appear on the list sending coals to Hull, against 172 last year. This means that 39 collieries have dropped out of the competition, these being presumably those working the expensive seams or doing a small turnover, for it has been already and repeatedly stated in THE ENGINEER, this is the day of the great producer.

In the heavy industries business has improved of late. After the war material departments the most actively employed are those engaged in the production of railway tires, axles, springs, buffers, &c. Many of the home railway companies have placed some very extensive orders, and these will take some little time to execute. A similar state of things is reported from abroad, foreign companies having given out several most satisfactory orders to English makers. The Penistone Steel Works are busier this month than they have been for a year. The carriage and wagon builders report an excellent business doing.

It was anticipated that a settlement of the shipbuilding strikes on the Clyde and at Belfast would immediately result in a rush of orders being placed for marine work. This has not been the case, however, but a healthy continuous demand has sprung up, and is far more acceptable than a "boom." The carrying business is in rather a poor way, with freights at a very low ebb; and this is not calculated to encourage the marine industry. Siemens-Martin and Bessemer steel are in excellent request. Hematites have dropped 2s. to 3s. recently, and quotations are as follows:—Bessemer billets, £5 12s. 6d. to £6; hematites, 56s. to 57s. for West Coast; and 54s. to 55s. for East Coast; Lincolnshire forge iron, 39s. and 40s.; ditto foundry, 40s. to 41s.; with bar iron at £5 10s.

The Board of Trade returns for January show a value of hardware and cutlery exported amounting to £181,519, compared with £149,617 in January of 1895, the principal increasing markets having been the British Possessions in South Africa and the East Indies, as well as Australasia and British North America. Foreign West Indies and Brazil have shown a considerable falling-off. In steel, unwrought, the value exported was £191,763, as compared with £107,648 for January of 1895. The chief increasing markets were Russia, Sweden and Norway, Denmark, Germany—from £16,106 to £38,990; Holland—from £5546 to £12,112; the United States—from £18,296 to £26,399; British East Indies—from £3998 to £17,153; Australasia—from £6138 to £11,243; and British North America—from £2533 to £6308. Not a single market showed a decrease.

The lighter trades are not in so good a condition as they were just before Christmas. Orders have kept the men well employed up to the present time, but it is somewhat discouraging to note that orders are not coming in, and the future outlook not very promising. Contracts for both table and pocket cutlery have been placed by the Government for the army and navy. These orders, which will furnish a good amount of employment for many months to come, have been placed at very low rates, and several leading firms have not taken any part in the competition. Skate makers are almost without hope of clearing off their stocks, but they rarely anticipate two good years in succession.

The annual report of Messrs. Vickers, Sons, and Co., River Don Works, Sheffield, shows that the company has had a most prosperous year. After the payment in August of the interim dividend on the preferred stock, there remained for distribution the sum of £156,267 10s. 4d. After paying the balance of the 5 per cent. on the preferred stock, and 15 per cent. on the ordinary shares, requiring for both £118,625, there remains to carry forward £25,642 10s. 4d. The directors add that they have paid off during the year 2895 debentures to the amount of £28,000, and intend to pay off the remainder of the debentures as they fall due. The company has been, and is now, very busy on military, marine, and railway material.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THE state of trade becomes more favourable as the year progresses, and in almost all branches of the iron and allied industries a substantial improvement in demand has been recorded this month, with some increase in prices. It is very satisfactory to note some revival in the finished iron trade, for that has been very backward in experiencing any upward movement, and consumers in the iron trade generally were reluctant to believe in the genuine character of the revival, while finished iron continued depressed. Not only has there sprung up a brisker demand for iron plates, bars and angles, but some advances in prices have been secured, and so promising are the prospects that one of the leading iron plate manufactories in this district, which has been idle for over five years, is likely to be reopened shortly; indeed, negotiations with that end in view are now in progress. There is also a probability of another small iron manufactory being reopened. On the whole business in the iron and steel trades generally is more active than it was at any time last year, for though there may not be quite so much doing in the pig iron trade as there was in the autumn, yet both the finished iron and steel trades are decidedly brisker, as are also the allied industries, more particularly the engineering, shipbuilding, and pipe founding branches. Prices both of finished iron and steel have touched as high figures as were attained at any time last year, there having been advances in a good many departments. Thus Cleveland hematite pig iron has been raised 6d. per ton; hematite iron ore, 3d.; Cleveland, No. 3, and grey forge, 3d.; iron and steel plates, angles, and bars, 2s. 6d.; and producers are in no hurry about selling, as everything tends to strengthen their position, and to lead them to expect still better prices.

Makers of Cleveland pig iron have no reason to complain of the amount of business they have done either this or last week, and they could have done more if they had been prepared to commit themselves to deliveries over next quarter. This they are naturally loth to do, because that will be almost the busiest period of the year, when they may expect to sell to more advantage than they can at present. No. 3 this week has been sold chiefly at 38s. for early f.o.b. delivery, but 38s. 3d. is now the general rate, and it is difficult to meet with anyone, either maker or merchant, who will let his iron go at 38s. There have been a few sales of No. 3 for delivery over the second quarter at 38s. 6d., but 38s. 9d. is now the figure that is being asked. The Consett Iron Company has restarted a furnace which has been idle for a year, and it will produce hematite pig iron, as will a furnace which Messrs. William Whitwell and Co. are to blow in at the Thornaby Ironworks, but to counterbalance these two furnaces at other works producing Cleveland pig and a third producing hematite are likely to be blown out very shortly in order to be relined. Cleveland warrants have advanced to 38s. 7d. cash. The stock of Cleveland pig iron in Connal's warrant stores on Wednesday night was 181,181 tons, the increase for the month being only 388 tons. This is a much better record than has been known for some months, for the average daily increase has been only 32 tons, whereas last month it was 300 tons, and in December 500 tons. The exports of pig iron from the Cleveland district have shown considerable improvement this month; up to Wednesday night they reached 27,372 tons, against 23,237 tons in January, and 20,044 tons in February last year; but it must be remembered that trade in this month last year was greatly hampered by the very severe weather, which seriously curtailed the deliveries both to Scotland and the Continent. Inland consumers have also had larger quantities, so that there is no doubt the next statistics of the Ironmasters' Association will be more favourable than have been those of the last three months.

No. 4 Cleveland foundry pig iron is realising 37s., and grey forge has been advanced to 36s. 6d., with white at 35s. 6d. Mixed numbers of Cleveland hematite pig iron have been sold at 47s. per ton, and that is the regular quotation now—a rise of 6d. this week, and this is as high as was obtained at any time last year. Thus all that was lost through the collapse has been regained. The price of average quality Rubio ore has been advanced to 12s. 9d. per ton, delivered at wharves on the Tees.

Mr. Walter Hill, who was manager of the Claylane Ironworks, Southbank, for some years, has been appointed manager of Messrs. Walker, Maynard and Co.'s Redcar Ironworks. Mr. William Bulmer, who for forty-seven years has been connected with the North-Eastern Railway Company's dock at Middlesbrough, for many years as superintendent, has resigned. Mr. Bulmer received his early training with Messrs. Fossick and Hackworth, engineers. He is to be succeeded by Mr. A. E. Bullan, who was at one time at Hull Docks, but for the last five years has been manager of the Corporation Wharf at Stockton. Mr. Charles Steel, of the North-Eastern Railway, has been appointed general manager of the Highland Railway, in succession to Mr. Andrew Dougall.

A good trade is at last being done in finished iron, which has hitherto shown little recovery from the depression, and prospects may be considered encouraging. The steel industry is showing excellent features, works being well employed and orders numerous, with consumers willing to pay advanced prices. Thus steel plates have been raised to £5 2s. 6d.; steel boiler plates to £6 2s. 6d.; steel ship angles to £5; iron ship angles to £4 15s.; steel girder plates to £5 7s. 6d., all less 2½ per cent. and f.o.t. Common bars have been advanced to £5, less 2½ per cent. f.o.t.

The rail trade continues as active as ever. There is no slackening in the inquiry, and manufacturers are well situated, with very satisfactory prospects. Heavy steel rails are firm at £4 15s. net at works. The exports of rails from the Tees are heavy this month, especially to India, but there does not appear to be much doing in the steel sleeper or the cast iron chair trades, certainly nothing like so much as the activity in the steel rail trade would lead one to expect.

A considerable improvement can be reported in the engineering industry, all branches sharing in this, but particularly the locomotive branch. As yet, however, the improvement has been chiefly in demand, and very little upward movement in prices has been noticeable. At the shipyards work is actively carried on, and there is nothing like the interruption that there was in February last year caused by the severe weather. Outdoor operations have this winter not been interfered with by the weather; in fact, such a favourable winter season on this score has never been experienced within the memory of the present generation. This has allowed of the plate and angle mills being kept fully employed. Bolts, nuts, and rivets are in good request.

Business in the coal trade shows no sign of revival, and lower prices than even those of last year have to be accepted. Thus the contracts for the supply of Durham coal to the Swedish State Railways have just been renewed, but at a price 6d. below those of last year, which themselves were 1s. 4d. below those at which the 1894 contracts were placed. The latest prices vary between 11s. 10d. and 12s. 1d. delivered c.i.f. Stockholm. House coal is in small request, but the mildness of the season is not favourable to a good demand. Last month's coal shipments from North-Eastern ports amounted to 1,571,467 tons, or 309,142 tons more than in January, 1895. Coke is in excellent request, and the production is increasing, as more is called for, as well in this district as on the West Coast, which receives large supplies from Durham. The present price of coke is 13s. 9d. delivered Middlesbro' for the best qualities, and 13s. for average sorts. At Craghead on Saturday the officials and workmen presented to Mr. James Fairley an illuminated address and a gold watch on the completion of his twenty-fifth year of service as manager and agent of the Craghead and Holmside Collieries.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE Glasgow pig iron market has been rather unsettled, but a considerable business has been done in the principal classes of iron. Scotch warrants have sold from 47s. 3½d. to 47s. 5d. cash, and 47s. 6d. to 47s. 8d., one month. The general improvement in trade, the favourable Board of Trade returns, and the proposal to make further important additions to the Navy have all exercised an encouraging effect, and there has been a renewed disposition in the last few days to invest in iron. Cleveland warrants have sold from 38s. 3½d. to 38s. 5½d., cash, while Cumberland hematite has brought 48s. 8½d. to 49s. 0½d. cash, and up to 49s. 2½d. one month.

It is rumoured that a considerable increase may shortly be made in the number of furnaces in blast. Pig iron can, it is understood, be produced at present at very moderate cost, labour and fuel being cheap, and the idea seems to prevail that additions might well be made to stocks now in the expectation of making a future profit out of the adventure. Since last week an additional furnace has been put in blast, and there are now 78 in operation, compared with 74 at this time last year. The output of hematite pigs has been reduced about 600 tons per week, while that of ordinary pigs has been increased 800 to 900 tons. The consumption of Scotch-made pig iron at home is on the increase, and the imports of English pigs into Scotland are considerably larger than at this time last year.

The prices of Scotch makers' iron are as follow:—G.M.B., f.o.b. at Glasgow, No. 1, 48s.; No. 3, 46s. 6d.; Carnbroe, No. 1, 48s. 6d.; No. 3, 47s.; Clyde, No. 1, 50s.; No. 3, 47s.; Gartsherrie, Calder, and Summerlee, No. 1, 51s.; No. 3, 48s. 6d.; Coltness, No. 1, 53s. 6d.; No. 3, 49s. 6d.; Glengarnock, at Ardrossan, No. 1, 50s. 6d.; No. 3, 47s.; Eglinton, No. 1, 48s.; No. 3, 46s.; Dalmellington, at Ayr, No. 1, 48s.; No. 3, 46s.; Shotts, at Leith, No. 1, 53s. 6d.; No. 3, 49s. 6d.; Carron, at Grangemouth, No. 1, 52s. 6d.; No. 3, 49s.

Foreign shipments of Scotch pig iron are still small, the clearances of the past week showing no improvement. The total shipments, coastwise and foreign, were only 3414 tons, against 4678 tons in the corresponding week of last year. There was dispatched to the United States 80 tons, South America 120, Canada 30, India 132, Australia 160, France 40, Germany 65, Belgium 60, Spain and Portugal 185, China and Japan 200, other countries 230, the coastwise shipments being 2112 against 3336 tons in the same week of last year.

A fair business is being done in manufactured iron at comparatively firm prices, and the steel market is very active, the current inquiries being on an extensive scale, and the orders actually placed such as will keep the works well employed for a considerable period. The foundry trade is improving, and the different branches of the engineering trade are sharing in the general revival. Locomotive engineers are in a specially favourable position, most, if not the whole, of the makers of these engines in the West of Scotland being in possession of contracts that will keep them going throughout the year.

A considerable number of shipbuilding contracts have been intimated in the course of the last few days.

There is no improvement in the tone of the coal trade as a whole. For certain classes of coal used in manufactures the demand is steadily expanding, but the output more than keeps pace with the inquiry, the result being that an easy feeling characterises the market and prices remain low. Main coal is quoted, f.o.b. at Glasgow, 5s. 10d.; splint, 6s. 3d. to 6s. 6d; ell, 6s. 9d.; and steam, 7s. 6d. per ton. At Ayrshire ports prices are, for house coal, 6s. 6d. to 7s.; steam and main, 6s. to 6s. 3d.; triping, 5s. 3d.; dross, 3s. to 3s. 6d. The total coal shipments from Scottish ports in the past week were 116,246 tons, against 128,121 in the preceding week and 107,680 in the corresponding week of last year. The trade continues backward in Fifeshire.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

THE iron and steel trades have been much more active of late, and if the old average despatch of steel bar were only going on, there would be little cause for complaint. The demand for steel rails has improved, and prospects in that branch are becoming brighter. It is expected that substantial orders are coming from the colonies and foreign countries.

Last week Cardiff shipped 1000 tons to Trinidad, and Newport despatched 2200 tons to Savona. Rumours are about that rails to Japan and South Africa are likely to figure on some of our ironmasters' books. In addition, home demands are certain to increase. A local authority calls attention to the fact, that the estimate of the engineers of the Port Talbot Dock, and various lines of rail, amounts to £673,297, of which the Ogmore Valley extension lines are likely to cost £557,875, and the South Wales Mineral Railway £115,421. Then, in addition, there are the Great Western Railway promotions, to which I have called attention of late. These are expected to run over £100,000, and some say considerably more so. For a long time expansions and extensions have been rumoured, and now it would appear they are close at hand. Many are in the Cardiff district.

The first month in the year has figured well in respect of coal export. The total dispatch from the chief ports of Wales during January was 1,771,632 tons, as against 1,487,621 tons for January, 1895. Cardiff figured particularly well, dispatching 1,082,853 tons coal to foreign destination, and 192,849 tons coastwise; Newport, 237,341 foreign, and 99,640 coastwise; Swansea, 99,479 foreign, and 49,747 coastwise; Llanelly, 10,615 foreign, and 6108 coastwise. Cardiff shipment of iron and steel during January was larger than it has been for a long time—8949 tons, coke 9559 tons, and 26,573 tons patent fuel. Swansea sent 2460 tons coke, and 18,470 tons patent fuel.

I should add that Cardiff total coal exports for January is a record one. In round numbers it represents close upon a million and a-half, and, as discussed on 'Change, if maintained at that rate would represent 18 million tons a year, a figure which is expected some day in the near future to be reached. The previous record month was May, 1895, when 1493 tons were shipped.

Last week, with the partial stoppages of some of the Ferndale group and the Plymouth difficulty in front, showed a lessened despatch, but I note that up to mid-week heavy tonnages have figured—several between 4000 and 5000 tons for Port Said and Buenos Ayres, and over 3000 tons to Colombo, Marseilles, &c.

The award of the umpire in the Mardy dispute leaves the men slightly benefited.

I regret to state that a serious accident occurred at the Mardy Colliery—Locketts—on Tuesday. The cage was being lowered with twelve men, when it came in collision 150 yards down with a temporary platform, and the result was that the poor fellows were all more or less badly injured, though fortunately, not one was thrown out. Most of them have broken limbs, and the injuries of some are regarded as serious, though not fatal.

Coal shipments during last week at Swansea exceeded the corresponding week last year by 10,000 tons. Newport, Mon., also indicated a good brisk trade.

The Tylerstown pits are again at work. I am glad to record the settlement of the North's Navigation collieries dispute. Concessions have been made on both sides, and at a large meeting on Saturday night last the ratification was finally given that brought about a peaceful arrangement.

The Plymouth Hill collieries remain quiet. Meetings are constantly held, and end without leading to resumption. It has been intimated that the colliers of neighbouring districts are helping the "lock out," yet it can only be at starvation figures, compared with the 25s. and 30s. the men would earn on ordinary employment. The help of other colliers rarely exceeds 6d. or 1s. per man per week.

Coal prices mid-week at Cardiff were not quite so firm as one could wish. For best the market was slightly weaker, and inferior kinds were cleared at lower prices. Latest quotations are:—Best steam, 10s. 3d. to 10s. 6d.; seconds, 9s. 6d. to 9s. 9d.; drys, 9s. 3d. to 9s. 6d.; best Monmouthshire, 8s. 6d. to 8s. 9d.; and seconds, 8s. For best small steam prices are 5s. to 5s. 3d.; slightly inferior, 4s. 6d.; inferior, 3s. 6d. to 4s. 3d. The mildness of the season continues to tell upon house coal. Cardiff prices are 10s. 6d. to 11s. for best; No. 3 Rhondda, 9s. 7½d. to 9s. 9d.; No. 2, 7s. 9d. to 8s.; through, 6s. 3d.; small, 4s. 3d. to 4s. 6d. Swansea prices:—Steam, 9s. 6d. to 10s. 6d.; seconds, 8s. 9d. to 9s. 6d.; No. 3 Rhondda, 10s. to 10s. 6d.; No. 2 from 8s. 9d.; anthracite best, 11s. to 12s.; seconds, 10s. to 10s. 6d.; ordinary large, 8s. 9d. to 9s. 6d.; small, 3s. 9d. to 4s.

On 'Change, Swansea, this week pig iron was regarded as 6d. per ton better than last week, and the improving character of that trade was stated to be satisfactory. No improvement was recorded in Bessemer bars, for which the demand continues to decline. This in part was due to the preference shown for Siemens, with shorter carriage, and prices, as will be seen, are little different: block tin at £60 10s. to £61. The latest quotations, Swansea, are as follows:—Pig iron, Glasgow, 47s. 4d.; Middlesbrough, No. 3, 38s. 5d.; hematite, 46s. 3d.; Welsh bars, £5 5s. to £5 10s.; sheet iron and steel, £6 12s. 6d. to £6 17s. 6d.; steel rails, heavy, £4 10s. to £4 15s.; light, £4 17s. 6d. to £5 5s.; Bessemer steel, tin-plate bars, £3 17s. 6d.; Siemens, £3 18s.; tin-plates: Bessemer steel cokes, 9s. 1½d. to 9s. 3d.; Siemens, 9s. 4½d. to 9s. 6d.; ternes per double box, 28 by 20 C, 17s. 6d., 18s. 6d., to 22s. 6d.; best charcoal, 12s. 6d. to 13s. 6d.; wasters, 6d. to 1s. less; odd sizes, usual extras. Briton Ferry hematites 1, 2, 3, 49s. 6d. to 50s. There is no brightening up of the tin-plate industry, and, in fact, prospects are getting more gloomy than ever. It was announced this week that one of the most important tin-plate works of the district—the Beaufort Morriston—is to close temporarily, and others are likely to be laid by until times improve. One large failure was announced on 'Change this week, and it is stated that the movement to open up new markets is to be abandoned. These are rather alarmist views, and may suggest more serious times than will happen, as the tin-plate is often quick in rallying from grave depression. Probably it is necessary that the lowest deep should be reached, as often happens in the coal trade, before a rebound. Briton Ferry outlook is quite as bad as that of others. Closed works or partial employment are common features. All the mills at Earlswood were quiet last week for want of orders. At the Vernon four were kept on, and at the Villiers three mills. Raglan Bay and Gwalia, on the other hand, were full of work. Last week the total shipments from Swansea amounted only to 27,628 boxes, while the receipt from the works totalled 46,106 boxes. Total stock at present consists of 159,405 boxes.

Patent fuel is moderately brisk at Cardiff and Swansea, at last figures; coke is also in fair demand, without change of quotations. Pitwood, Cardiff, 15s. 3d. to 15s. 6d., downward tendency, principally on account of heavy arrivals. In iron ore prices are advancing, and a fair business is being done. This week heavy consignments have come in for Blaenavon, Cyfarthfa, Dowlais, and Ebbw Vale. Cardiff last prices were:—Rubio, 12s.; Tafna, 11s. 3d. to 11s. 6d.; Garucha, 10s. 9d. to 11s. c.i.f. Swansea imported 1653 tons pig iron last week, 639 tons scrap steel, and 60 tons tin bars.

I regret to announce the death of Major Bell, general manager of Nixon's Collieries in the Merthyr Vale and Mountain Ash districts. He succeeded Col. Gray in this post, and had the satisfaction of enjoying the entire confidence of the company and of the men. His immunity from accident was in a great measure due to the excellent provision of Mr. Nixon, who, in the laying out of his collieries, was particularly attentive to ventilation and general means for safety.

The great topic of the day is the Bute and Rhymney fusion, which in the light of the full agreement [of the shareholders is understood as almost certain to be a successful enterprise on the part of the promoter, Sir W. T. Lewis, Bart.

There is a rumoured hitch in the Swansea Corporation arrangement with their threefold scheme, and some discussion is going on as to whether the tramway part will be adopted. In local circles the wish is strongly expressed that it should not be allowed to drop.

The miners' eight hours per day argument is again to the front. The opinion conveyed to the deputation hinting at the suggestion that such matters are more for individual settlement and agreement than for enactment is held strongly in many parts of the coalfield. One doubter points out that the next subject for legislation will be the time of the dinner hour.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

A FAIR account can be given of last week's trade in iron and steel. Specifications come in pretty freely, and work has been secured for a considerable time ahead; prices continue firm, on the whole, but are favouring buyers rather than sellers.

Quite a satisfactory business is done on the Silesian iron market, both makers and manufacturers reporting their order books well filled; especially the pig iron trade may be considered in a favourable position. There is a good business done in bars and girders, and also for plates a regular demand is being experienced, and an advance in quotations is looked forward to.

There is no novel feature to be noticed on the Austro-Hungarian iron market, business transactions generally being limited. Here and there better prices have been obtainable, especially for plates of all descriptions, which is due, not only to the rising home demand, but also to the continually improving condition of the German iron industry, the pressing offers from that quarter having almost entirely ceased of late. The railway department is looking forward to being busily occupied; the rails required for the Vienna Railway amounting to 6322 t., of which, however, only a small lot—1652 t.—is to be delivered in 1896, the remaining 4670 t. falling on 1897. Hitherto the shipbuilding and engineering line has been but moderately employed, but spring is likely to bring more orders, the Austrian Lloyd having resolved the building of a large steamer. Austrian total import in iron and steel was for 1895, 229,883 t., worth 18,014,745 fl., against 178,566 t., worth 15,287,235 fl., in 1894. The greater part of import falls to Germany—114,463 t.—of which 70,206 t. were pig and scrap iron. Great Britain comes next with 993 t., of which 826 t. were foundry pig. A considerable decrease in import may be perceived for wire, axles, and tools, while almost all other articles show an increase. Total export in iron and steel was for 1895, 38,667 t., worth 15,004,892 fl., against 43,368 t., worth 12,528,671 fl., in the year 1894 There were exported to Italy 9676 t.; Russia, 6914 t.; Germany, 6717 t.; Servia, 3555 t.; Roumania, 2808 t.; France, 652 t.; England, 507 t.; Switzerland 502 t.; and to other countries, 7335 t.

As a result of the languid and irregular demand which has been coming forward on the French iron market during the past weeks, a dull tone prevails in almost all departments. The majority of the works are kept going pretty regularly, but there is not much gained at the present quotations, which are generally less firm than in late autumn.

In Belgium the iron and steel trades are, on the whole, favourably situated, and a fair account is given by makers, as well as manufacturers, of the current demand. A specially good inquiry is coming forward in the steel trade, and structural iron is also in very healthy request. Prices are the same as before, but they show much firmness, and are likely to improve soon.

There is little change to note in the condition of the Rhenish-Westphalian iron industry, which continues altogether satisfactory, though no large amount of business has been done, but makers are pretty hopeful with regard to the future, and if prices do not rise as rapidly as some wish, it certainly is a prudent measure on the part of producers to wait for a further increase in demand, ere quotations are universally advanced. Pig iron is in very lively request, and inclined to advance; in the Siegerland makers are said to have sold their total output for the second quarter. Production of the German blast-furnace works was for 1895 as under:—

	Forge pig. Tons.	Bessemer. Tons.	Basic. Tons.	Foundry pig. Tons.
January	153,950	38,166	226,649	75,810
February	131,330	26,141	206,999	70,234
March	138,160	37,388	230,464	75,132
April	120,763	51,236	227,891	70,530
May	123,042	42,870	250,673	73,044
June	115,577	41,704	242,245	70,366
July	120,290	36,131	236,555	79,027
August	116,866	36,608	259,952	77,559
September	116,913	36,591	242,662	82,789
October	113,967	38,494	267,247	91,556
November	131,801	36,708	243,851	77,462
December	141,675	27,458	263,288	77,984
	1,524,334	444,495	2,898,476	921,493

Total output in pig iron was for 1895 5,788,798 t., against 5,559,322 t. in 1894.

The malleable iron department has not met with any perceptible improvement, the mills being regularly but not satisfactorily occupied, as prices are too low to allow of a profit, especially when quotations for raw material are decidedly rising. A good activity is going on in the railway and engineering departments; besides large orders that have been given out by the Prussian State Railways, contracts have also been secured from the Wurtemberg Railways, one being for 800 load wagons.

The requirements of the Prussian State Railways are estimated to amount for 1896-97 to 113,811 t. rails—M. 12,495,000; 39,301 t. small articles—M. 5,750,000; and 53,875 t. sleepers—M. 5,437,000. Average prices, per ton, have been fixed on M. 109·8, M. 146·3, and M. 100·9. The requirements in pit coal have been estimated on 3,571,214 t., worth M. 29,791,500, or M. 8·34 p.t.; of these, 1,740,336 t. are to be supplied by the Westphalian district at M. 8·41 p.t.; 1,299,164 t. at M. 7·71 p.t., from Upper Silesia; 291,064 t. at M. 9·58 p.t., from Lower Silesia; and 136,920 t. at M. 10·51 p.t., from the Saar district. The consumption in artificial coal, which is to come from Westphalia, has been estimated at 305,005 t., for which M. 2,851,000 have been fixed. The coke required will be partly supplied by the Westphalian district—48,776 t.—and partly by the Lower Silesian district—26,287 t.—M. 12·63 and 12·65 p.t. having been fixed as average quotation. For brown coal and artificial coal—29,931 t.—M. 172,400 has been fixed, which is equal to about M. 5·76 per ton. The consumption of pit coal on the Prussian State Railways rose in 1894-95 from 2,946,000 t. on 2,984,533 t.; total expenses, on the other hand, having decreased from M. 37,169,788 on M. 37,157,701. The consumption of pit coal briquettes amounted to 246,309 t., worth M. 3,327,398, for 1894-95, against 241,170 t.—M. 3,455,441—in the preceding year; in coke 65,248 t. were consumed in 1894-95, for which M. 1,213,370 were paid, against 62,776 t. at M. 1,276,809 in the year before. Of the total quantity of fuel consumed in 1894-95, 90·55 per cent. were pit coal, against 90·7 per cent. in 1893-94; briquettes, 7·47 per cent., against 7·4 per cent.; and coke, 1·98 per cent., against 1·9 per cent. in the year before. From the Upper Silesian district 1,059,938 t. pit coal, 2621 t. artificial coal, and 1500 t. coke were ordered; from Lower Silesia, 230,660 t. pit coal, and 26,864 t. coke; from Westphalia, 1,520,219 t. pit coal, 241,688 t. briquettes, and 36,581 t. coke; from the Aachen district, 54,382 t. pit coal; from the Saar mines, 117,150 t. pit coal; from other districts, 2178 t. pit coal; and from different gasworks, 303 t. coke.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, February 5th.

THE industrial situation is still disturbed by the effects of the movement of the Government to take one hundred and ten million dollars out of the pockets of the people to make up for what should have come through the Custom Houses. There is a general holding back and an unwillingness to enter into large contracts. A great deal of material is wanted for railroads, lake boats, agricultural and manufacturing requirements. The restriction of production during the past few weeks has been a matter of prudence only. The present producing capacity will probably be needed as soon as spring opens. Railroad companies will begin ordering rails about March 1st. Bridge builders have inquiries out for nine thousand tons of plates and shapes this week. Rods have sold freely, billets have advanced at tide water to 21 dols. asked. There is greater activity at all interior points, but it is measured by near requirements. A few large consumers have thought the conditions of the market to be such as to warrant placing orders for the delivery of pig, Bessemer, and billets up to June. The greater number of consumers do not feel willing to bind themselves, so far, yet they recognise the danger of an advance. If certain conditions came, there would be a rush of buyers. Lake ores are high. Coke promises to stay at 2·00 dols. Anthracite coal will sell 25 cents a ton higher than last year. Billets are up, and so are bars, sheets, and structural shapes, but only to a fractional extent. The conditions on this side are favourable to stronger quotations. Producing interests have demonstrated their ability to restrict production promptly and sufficiently to control prices. The manufacturing interests everywhere look for early and greatly increased activity, and the rush to anticipate an advance in prices will soon set in.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

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

29th January, 1896

2109. FASTENING DOORS, WINDOWS, &c., G. Inman, London.
2110. DOOR SPRINGS, J. Coffin, London.
2111. CANDLES, W. B. Fitch, London.
2112. BOATS, W. B. Fitch, London.
2113. ROTARY MOTION, G. Howard and E. T. Bousfield, London.
2114. MANUFACTURE of PORCELAIN BRICKS, P. Chapuy, London.
2115. JOINING UP TUBES, H. T. Turnor and J. Watkins, London.
2116. BOTTLE STOPPER, H. S. Jones.—(*C. Kemper, Belgium.*)
2117. DARK CHAMBERS, G. C. Dymond.—(*H. Hofmann, Germany.*)
2118. STAND, G. C. Dymond.—(*The Firm of W. Ullrich, and Co., Germany.*)
2119. APPARATUS for PLANKING FELT HATS, H. Sutton, Manchester.
2120. NEEDLE THREADERS, A. J. Mills, Liverpool.
2121. LABELS or TICKETS in ROLLS, A. Williamson, Manchester.
2122. COLLAPSIBLE PAPER BOXES, E. P. Lehmann, Liverpool.
2123. MACHINE for MAKING PAPER BAGS, F. Hesser, Liverpool.
2124. FILLING CARTRIDGE BELTS, H. Borchardt, London.
2125. OPENING SHEETS, J. Williams and G. H. White, London.
2126. STEAM UTILISING APPARATUS, C. Garver, London.
2127. GAS BURNERS, A. J. Boult.—(*The Continental Gas Glühlicht Aktiengesellschaft "Meteor" vormals Kroll, Berger and Co., Germany.*)
2128. MOTOR or TRACTION VEHICLES, C. T. Crowden, London.
2129. IMPRESSIONS of TYPE, F. R. and H. S. Spark, and J. B. Ellis, London.
2130. HANDLES, G. Walters, London.
2131. BOTTLE, W. Barnett, London.
2132. PORTABLE EXHIBITING NOTICES, W. Dixon, Bedford.

30th January, 1896.

2133. SECURING SAFETY of TRAFFIC, J. H. Hamilton, Belfast.
2134. SHAPE for GLAZED BRICKS, T. H. Brown, Liverpool.
2135. TOBACCO PIPES and CIGAR HOLDERS, C. Merington, Penge.
2136. STOVES, F. J. Reinisch and S. Osiecimski, London.
2137. PISTON-ROD LUBRICATOR for ENGINES, E. Reilly, Grimsby.
2138. INTERNAL COMBUSTION ENGINES, J. Roots, London.
2139. A NEW GAME, H. O. and J. O. Roberts, Gloucester.
2140. WATCHES, H. Heilmann, Manchester.
2141. SPEED GEAR for CYCLES, E. Deeley, Birmingham.
2142. CLIP for FIXING LOCKETS, E. Warrilow, Birmingham.
2143. OIL LAMPS, J. McNaughton, Glasgow.
2144. APPLYING PLASTIC MATERIALS, J. E. and C. S. Bedford, Leeds.
2145. CONSTRUCTION of SHIPS, J. Rowland, Sunderland.
2146. PUZZLES, J. Walker, Birmingham.
2147. HANDLES of UMBRELLAS, G. Huxley, Manchester.
2148. PENHOLDER, W. Fletcher, Scotland.
2149. RIVETING, A. and J. Stewart and Clydesdale, Ld., and J. Wotherspoon, Glasgow.
2150. DRYING BREWERS' REFUSE, R. Cunliffe, Manchester.
2151. PACKING for PUMPS, J. Weir, Cathcart, near Glasgow.
2152. CLOSING WATER-TIGHT DOORS, J. H. Boolds, Middlesbrough.
2153. ADAPTING HANDLES to BOXES, M. Holt, Staffordshire.
2154. DOUGH-KNEADING MACHINES, S. H. Hodges, Mass., U.S.A.
2155. LAVATORIES, J. Shanks, Glasgow.
2156. APPARATUS for GASIFYING PETROLEUM, F. H. Aschner, London.
2157. WINDOW SASHES, W. Thomson, Glasgow.
2158. TEA-POT J. Gullery, Belfast.
2159. DOMINOES, DRAUGHTSMEN, &c., H. B. Simpson, Westmoreland.
2160. BRIDLES, W. Farn and T. U. Clarke, Leamington.
2161. CONVEYING ELECTRIC CURRENT, P. Dawson, London.
2162. RULER and GUARD, J. Coker, Twickenham.
2163. CYCLE SADDLE, W. H. Hillsdon, London.
2164. CYCLE LAMP, R. F. R. Conder and W. H. Hillsdon, London.
2165. TRAY for PHOTOGRAPHIC PURPOSES, J. Airs, London.
2166. MUSICAL INSTRUMENTS, A. C. Pope, Tunbridge Wells.
2167. AGITATORS for CONDENSERS, T. N. Cretney, London.
2168. MANUFACTURE of AERATED WATERS, T. N. Cretney, London.
2169. CORSETS, J. S. Metcalfe, London.
2170. TRANSMISSION of HEAT, S. E. Morley, London.
2171. CYLINDERS, J. Lewis, Birmingham.
2172. BRAKE APPARATUS for TRAMWAYS, C. L. Schroder, Birmingham.
2173. PIPES, Ames, Crosta, and Co., and R. Ames, London.
2174. OPENING SLIDING WINDOWS, G. Jones, London.
2175. ADJUSTABLE DOORS for WARDROBES, J. Barber, London.
2176. PRESERVING MEAT, A. B. Pinto, London.
2177. STUD, F. W. Payne, London.
2178. CORKS, P. Boyd, London.
2179. MOUNTINGS, G. Wyatt and The Henry Rifled Barrel Engineering and Small Arms Company, London.
2180. TABLES, F. Weiss, London.
2181. FLOATING TABLET of SOAP, C. W. Lucas, London.
2182. ENVELOPE, C. W. Lucas, London.
2183. UTILISING the HEAT of GAS, A. G. Glasgow, London.
2184. MILLS, P. Hesse, London.
2185. CONSTRUCTION of LIFTS, S. G. Bennet, Staffordshire.
2186. CONSTRUCTION of LIFTS, S. G. Bennet, Staffordshire.
2187. CANDLE, R. F. R. Conder, London.
2188. DENTAL FORCEPS, G. C. Dymond.—(*F. Stepan, Austria.*)
2189. PENHOLDERS, I. Golwer, Liverpool.
2190. LIFTS, E. Kiebitz, Liverpool.
2191. ERASERS, CLEANERS, &c., J. H. L. Ewen, Liverpool.
2192. WATER HEATING APPARATUS, W. J. Woosey, Liverpool.
2193. ARTICLE in CONNECTION with CYCLES, M. G. Noble, Liverpool.
2194. ELECTRIC ARC LIGHTING, O. Bondy and A. Jordan, London.
2195. TOBACCO PIPES, E. W. Thurgar, London.
2196. COLOURING MATTERS, C. D. Abel.—(*The Actien Gesellschaft für Anilin Fabrikation, Germany.*)
2197. CHLORIDE SOLUTIONS, E. Hermite, E. J. Paterson, and C. F. Cooper, London.
2198. FEEDING of STEAM BOILERS, A. F. Yarrow, London.
2199. ELECTRICAL CURRENTS, J. Imray.—(*La Société Anonyme pour la transmission de la force par Electricité, France.*)
2200. HOT-WATER RECEPTACLE for FOODS, F. W. Taylor, London.
2201. MATERIALS for FABRICS, A. J. Boult.—(*L. P. Converse, United States.*)
2202. BRICK-MAKING, J. Berry, G. Beardsall, and The Ideal Brick Press Syndicate Ld., London.
2203. SPLICING for KNITTING MACHINES, W. James, London.
2204. CLIPS, A. J. Boult.—(*L. P. Converse, United States.*)
2205. A NEW ACID, J. W. Mackenzie.—(*C. Schmid, Belgium.*)
2206. ROTARY STEAM ENGINES, &c., W. J. H. Dalton, London.
2207. VALVES for TIRES, E. Marshall and T. Hands, London.
2208. TELESCOPIC JOINT for TUBES, E. J. Shaw, London.
2209. POINTING SKEWERS, J. Lemon and W. Jackson, London.
2210. MINERS' COAL BOX, A. Morris, London.
2211. RAILWAY WAGON, J. Angus, London.
2212. BOTTLES, &c., R. D. Bradford, London.
2213. PROCESS of TREATING WOOL, J. C. Anderson, London.
2214. CLIP, W. Purchase, London.
2215. NEW GAME and APPLIANCES therefor, W. Roden, London.
2216. VIOLIN SUPPORT, W. Purchase, London.
2217. JEWELLERY, F. W. White, London.
2218. DECORATIVE ARTICLE, A. E. and E. M. Saunders, London.
2219. PAINT, C. Sullivan, London.
2220. CLIP for CUFFS, J. T. M. and G. W. Farrier, London.
2221. NEW SAFETY DEVICE for CYCLES, J. P. Miller, London.
2222. RAISIN-SEEDING MACHINE, C. Bristow, London.
2223. CEMENT or ARTIFICIAL STONE, F. Turner, London.
2224. PREPAYMENT MECHANISM for METERS, C. O. Bastian and H. C. Hodges, London.
2225. EXTRACTING METAL from ORE, H. H. Bush and J. J. Shedlock, London.
2226. CORNICE POLE JOINTS, W. A. Hudson, London.
2227. STEAM MOTOR GOVERNOR, F. Clench and T. S. King, London.

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2228. AERIAL MILITARY APPARATUS, B. F. S. Baden-Powell, London.
2229. CORSET ATTACHMENT, A. Wardroper, London.
2230. SHIRT SLEEVE CLIP, G. H. McKay, Glasgow.
2231. PROPELLING SMALL BOATS, D. Champion, Shepperton-on-Thames.
2232. FOLDING TABLE, R. Schmidt and J. N. Rasp, London.
2233. WRITING TUBES and INCANDESCENT LAMP, C. Baker, London.
2234. COLLAPSIBLE BOAT, J. Fanstone, Brighton.
2235. GOLFING APPLIANCE, G. Lewis, Manchester.
2236. CYCLE CRANKS, D. Gray, Dundee.
2237. SPINNING YARNS, J. T. Ainsworth and J. Arkinstall, Keighley.
2238. PULLEY BLOCK, W. Dargue, Halifax.
2239. LAMP PENDANT, J. Harper and Co. and C. Retallack, Wolverhampton.
2240. GATE and DOOR STOP, H. R. J. Denton and J. R. Cartwright, Wolverhampton.
2241. ANCHORS, J. McCain, Newcastle-on-Tyne.
2242. TRAMCAR SEATS, E. J. Drysdale and J. S. Macgregor, Glasgow.
2243. MACHINE for RAKING HAY, F. S. Cocks, Peterborough.
2244. INDIA-RUBBER CAPSULE for BOTTLES, E. Cumming, Guildford.
2245. LOOMS, W. Sutcliffe, Burnley.
2246. RUBBER-TIRED WHEELS with WIRE SPOKES, G. W. Lomas, Manchester.
2247. RECOVERING OIL from FISH, &c., J. Jack, Glasgow.
2248. ELECTRICAL CUT-OUTS, H. Hirst, London.
2249. FUSES for ELECTRICAL CUT-OUTS, H. Hirst, London.
2250. MARKER for LEAVES of BOOKS, &c., G. W. Coe, London.
2251. FANLIGHT OPENER, C. F. Gray and H. Wilson, Birmingham.
2252. OIL LAMPS and STOVES, E. F. Hulse, Manchester.
2253. SUBMARINE VESSELS, S. Lake, Manchester.
2254. BORE HOLES, F. Walker and W. C. Sanderson, Barnsley.
2255. CYCLES, C. F. Winch, London.
2256. COOKING RANGE, P. J. Ekstrand and L. E. Waterman, London.
2257. CANS, A. J. Tolley.—(*F. T. Tolley, Australia.*)
2258. INDICATING VACANT SEATS in VEHICLES, D. H. Bruins, London.
2259. PIANOFORTES and PIANETTES, J. Strong, London.
2260. HYGIENIC MOVABLE BARREL HEAD, W. Norris, Middlesex.
2261. SPADES, J. Lee, Birmingham.
2262. SUNSHADE, A. S. Walker and T. H. Hooper, London.
2263. PLATE ATTACHMENTS to HORSES' HOOFS, A. S. Walker, London.
2264. HOT WATER CIRCULATING PIPES, C. P. Kinnell, London.
2265. BRACES, S. A. White, London.
2266. MORTAR MILLS, C. J. Williams and J. Hollick, London.
2267. ROLLER MILLS, C. J. Williams and J. Hollick, London.
2268. RIDING SADDLES, S. O'Connor, London.
2269. INCANDESCENT GAS LIGHTS, J. Moeller, London.
2270. MULTIPLE SHUTTLE POWER LOOMS, G. Schwabe, London.
2271. CHLORIDE of MAGNESIUM SOLUTIONS, F. T. B. Dupré, London.
2272. GLOVES, W. L. Pierce, London.
2273. PUZZLE APPARATUS, G. C. Dymond.—(*W. H. Bailey, United States.*)
2274. SYSTEM of AQUEOUS NAVIGATION, J. Fraser, Liverpool.
2275. BENCHES, W. T., G., J., and E. Evans, Manchester.
2276. SEPARATING HUSK from COTYLEDONS, P. C. D. Castle, Liverpool.
2277. BOAT, R. W. Ray, London.
2278. CHAIN GEARING for VELOCIPEDES, C. F. G. Low, London.
2279. WATER SPACE DEFLECTOR, J. P. O'Donnell.—(*J. King, C. Downs, and J. Waddington, South Africa.*)
2280. BICYCLE CRANKS, C. W. Wilson, London.
2281. LAMPS for BURNING HYDROCARBON OIL, A. Kiesow, London.
2282. ATTACHMENT for PIANOFORTE ACTIONS, A. Lexow, London.
2283. SURGICAL TRUSSES, J. H. Haywood, London.
2284. STANDS, H. C. Phillips, J. Palmer, jun., and P. R. Plass, London.
2285. BITUMEN for ASPHALTE, C. W. Bradshaw and H. A. H. Moore, London.
2286. FORCEPS, C. Barber, London.
2287. BRAKES for VELOCIPEDES, &c., J. D. Derry, London.
2288. ADVERTISING, H. J. Haddan.—(*M. Salinas, Spain.*)
2289. MECHANICALLY PROPELLED VEHICLES, H. Lane, London.
2290. GAS or PETROLEUM ENGINES, &c., H. Lane, London.
2291. APPARATUS for SEASONING CASKS, J. Metcalfe, London.
2292. CARVINGS, S. Willner and W. P. Thompson.—(*Wesse and Co., Germany.*)
2293. VELOCIPEDES and other VEHICLES, L. Boulay and E. Staes, London.
2294. FUSES for EXPLOSIVE PROJECTILES, J. C. Thompson, London.
2295. CONSUMING SMOKE, A. M. Kitchen and T. Pfister, London.
2296. MACHINE for PAINTING SHIPS' BOTTOMS, A. Simey, London.
2297. MACHINERY for DRYING TEA LEAF, W. Jackson, London.
2298. INCANDESCENT GAS LAMPS, J. W. Lea and J. H. Perrins, London.
2299. ICE-MAKING MACHINES, W. T. Whiteman.—(*A. McVicar and W. K. White, New Zealand.*)
2300. DESK RULERS, J. Walton, London.
2301. WHEEL TIRES, E. G. Wood and E. Armitage, London.
2302. TIMEKEEPERS, F. L. Hancock, London.
2303. "RISING" SAFETY VESTA BOX, W. T. Rising, London.
2304. LOCOMOTIVES, P. Purcell and J. J. Dunne, Liverpool.

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2305. LAMP BURNERS, D. C. Defries, London.
2306. DRAWING PINS, A. W. Bevis, Birmingham.
2307. MANUFACTURE of CUPS and SAUCERS, C. F. Bilson, London.
2308. SUPERHEATING of STEAM, C. D. Holmes, London.
2309. GOLF PUTTER, W. McIldowie, Belfast.
2310. CONNECTING TAPS, J. Phillips and F. J. Howard, Coventry.
2311. OIL LAMPS, J. M. L. Whitfield, near Huddersfield.
2312. SLIDES for BRACES, BELTS, &c., A. C. Twigg, Birmingham.
2313. RIDING SADDLES, J. A. Barnsby, Birmingham.
2314. MEANS for FINISHING METALS, &c., T. Weir, Dublin.
2315. TOBACCO PIPES, T. A. Naughton, Newcastle-on-Tyne.
2316. CLOSING WATER-TIGHT DOORS, A. Heine, Newcastle-on-Tyne.
2317. PURSES, E. Erlanger, London.
2318. LATHES, S. H. Wright and G. Webb, Herefordshire.
2319. BLAST FURNACES, G. L. Scott and J. G. Sanderson, Salford.
2320. KNIFE CLEANING MACHINES, E. K. Dutton, Harrogate.
2321. DRIVING BRICKMAKING MACHINES, W. Johnson, Leeds.
2322. VENETIAN or LOUVRE VENTILATORS, B. Waldron, Birmingham.
2323. HAND-ACTUATED CRANES, A. Menzies, Glasgow.
2324. IMPROVED ELECTRIC COUPLING, J. H. Tucker, Birmingham.
2325. TEA KETTLES, J. W. Hancock, Leicester.
2326. DELIVERY MACHINES, F. Lamplough and F. H. E. Shipton, London.
2327. METAL PLATING, T. M. Ash and H. N. Weldon, Birmingham.
2328. HANGING GAS and OIL LAMPS, J. B. Bruce, Birmingham.
2329. LETTER BOX THIEF PREVENTER, J. Carpenter, Southampton.
2330. CYCLE PADLOCKS, W. Arnold and G. J. Minors, Wolverhampton.
2331. PARAFFIN LAMPS, W. Macadam, London.
2332. MAKING ACETYLENE GAS, G. Holdsworth and G. S. Wilkinson, Huddersfield.
2333. JOINTS of DRIVING BELTS, E. Clarke, Birmingham.
2334. METAL POLISHERS' BRUSHES, J. E. and H. E. Hartley, Birmingham.
2335. ELECTRIC METERS, W. McWhirter, Glasgow.
2336. LOOMS, J. Clayton and J. Payne, Burnley.
2337. ELECTRIC APPARATUS, G. E. Sautter and H. Harlé, London.
2338. STRETCHING FABRICS, R. Gemmell and F. Buxton, Manchester.
2339. HEATING AIR, J. Langfield and G. H. Kenworthy, Manchester.
2340. SPINNING and DOUBLING FRAMES, W. Bodden, Manchester.
2341. LOOSE REEDS for LOOMS, J. J. Dearden, Manchester.
2342. FIRE-LIGHTERS, M. Firth, Manchester.
2343. EXTINGUISHING LAMPS, M. McCleary, Sawbridgeworth.
2344. DRESS PROTECTOR, &c., E. H. Smith, Northallerton.
2345. CAP for CYCLE and VEHICLE PEDALS, E. W. Settle, Coventry.
2346. TIRES for CYCLES, J. Lindsay, Dublin.
2347. MUZZLE for DOGS, T. Marples, Reddish.
2348. ELECTRIC SWITCH, J. M. Huisman and H. C. Gover, Glasgow.
2349. HEATING SMOOTHING IRONS, &c., G. R. Hislop, Glasgow.
2350. TOOL for SHAPING BOSSES, &c., E. Wilson, London.
2351. SHIRT IRONING MACHINE, C. and F. Townend, London.
2352. RAISING BLINDS, J. H. Nitzsche, London.
2353. MACHINE BELTING, C. H. Gray, London.
2354. SAFETY DEVICE for POCKETS, J. Wood, London.
2355. RAILWAY BRAKE APPARATUS, W. and H. Bormann, London.
2356. CHRISTMAS, &c., CARDS, H. C. Hall, Brownswood Park.
2357. CANDLE SHADE, C. E. Green, London.
2358. SINGLE-ACTING, &c., ENGINES, J. W. Restler, London.
2359. PHOTO-MECHANICAL REPRODUCTIONS, C. F. E. Fenske, London.
2360. MACHINERY and PROPELLERS for VESSELS, J. Huber, London.
2361. DEVICE for HOLDING, &c., SMALL-ARMS, M. and P. Reilly, London.
2362. INFLATING TIRES and FOOTBALLS, E. A. Bellow, Liverpool.
2363. FASTENING for CORSETS, W. M. Perry, Manchester.
2364. BAGS, J. W. Duxbury, Liverpool.
2365. RESPIRATOR, J. W. Towers, Liverpool.
2366. STREET GULLY, G. M. Reed and W. H. Knight, London.
2367. CLEANSING PRINTING BLANKETS, J. Platt and J. Holgate, London.
2368. LESSENING CONDUCTION of HEAT, H. P. Ibbotson and G. W. Giles, London.
2369. ASHPAN, R. W. Green, London.
2370. HOT-AIR ENGINE, H. Clifford and A. J. L. Glidden, London.
2371. SHIELD for RUBBER WHEEL TIRES, F. J. Money, London.
2372. FLOATING METALLIC PACKING, E. T. Ferrier, Cardiff.
2373. LETTER-CARD, G. Dowie and J. M. Morton, Glasgow.
2374. GLASS CLOTHS, F. J. Robinson and A. A. Attree, London.
2375. LAMP GLASS CLEANER, F. J. Robinson and A. A. Attree, London.
2376. TRACHEOTOMY TUBES, J. Fenigstein, London.
2377. TREEING MACHINE, B. Ladds and G. H. Gardner, London.
2378. TRACES or DRIVING REINS, J. Schmitz, Aix-la-Chapelle, Germany.
2379. ENGINE GOVERNORS, A. S. F. Robinson, London.
2380. FIRE INDICATING APPARATUS, W. H. Trimble, London.
2381. CUTTING and SHAPING MACHINES, P. P. Huré, London.
2382. DYNAMOMETERS, H. H. Lake.—(*G. W. Lewin, United States.*)
2383. DRIVING GEAR for CYCLES, &c., T. Shepherd, London.
2384. BOOK PROTECTORS, W. A. Stanfield, Belfast.

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2385. WINDOW BLIND CORD PULLEYS, E. J. Field, Norwich.
2386. HOOK, J. Mullin, Dublin.
2387. HAND IRONS, C. Kirby, Leeds.
2388. STRAINING PAPER PULP and the like, F. W. Hall, Derby.
2389. STAND or SUPPORT for WASH-TUBS, J. Driver, Keighley.
2390. LAMP IGNITERS, W. H. Coops, G. A. Crighton, and R. Tatham, Liverpool.
2391. ROLLER SKATES, R. Thomson, Buckden.
2392. GAME, J. Gazard and H. O. and J. O. Roberts, Gloucester.
2393. MOTOR-DRIVEN VEHICLES or AUTOCARS, J. J. H. Sturmey, Coventry.
2394. VELOCIPEDES and MOTORS, J. J. H. Sturmey, Coventry.
2395. BOXES, W. Strain, Belfast.
2396. OIL DUCT, A. Snow, Bristol.
2397. MEMORANDUM, B. A. Tarbès, Bognor.
2398. CYCLE CLEANING STAND, C. P. Watson, Leeds.
2399. SEATS or SADDLES for VELOCIPEDES, J. C. Walker, London.
2400. WASHING and WRINGING MACHINES, H. C. Longsdon, Keighley.
2401. PROTECTING SHIPS' HULLS, C. and G. K. Craig, Newcastle-on-Tyne.
2402. WATERPROOFING VELWOOD, R. Rose and E. Bayspoole, London.
2403. HUMIDIFYING AIR, D. Hall and J. H. Kay, Manchester.
2404. SHANKING FLAT BUTTONS, J. Brown, Manchester.
2405. RAIL CHAIR, H. von Gersdorff, Liverpool.
2406. CANDLE BURNER, J. C. Brown, Higham Ferrers.
2407. WIRE DRAWING APPARATUS, W. Frese, Barmen, Germany.
2408. CORRUGATED METAL SHEETING, J. A. Main, Glasgow.
2409. TANKS, W. Orr, Glasgow.
2410. ROUNDABOUT carrying BALLOONS, W. Jackson, Nottingham.
2411. STOP COCK, W. McCaig, Glasgow.
2412. SELF-ACTING SPRING APRON, W. J. B. Woodrow, London.
2413. MUZZLES, T. Marples, Stockport.
2414. VENTILATING WATERPROOF GARMENTS, H. Markus, Manchester.
2415. PHOTOGRAPHIC FILMS, T. A. Garrett and W. Lucas, London.
2416. FLANGED BUILDING BLOCKS, M. M. Gueldenstein, London.
2417. UMBRELLA CLOSER, S. Fader, London.
2418. POCKET TABLETS for ALMANACKS, A. Gauld, London.
2419. ELECTRIC PENDULUM INDICATORS, F. Jones, London.
2420. HEATING APPARATUS, R. S. Calef, London.
2421. PERAMBULATORS, F. Cohn, London.
2422. ONE-TRIGGER DOUBLE-BARREL GUN, T. Southgate, London.
2423. DYEING BROWNS, J. Sanders and T. H. Sanders, London.
2424. USING DISINFECTANTS, T. Grimstone, London.
2425. ORNAMENTING WATERPROOF FABRICS, T. Birnbaum, London.
2426. PNEUMATIC SEATS for CHAIRS, H. Fairfax, London.
2427. MEASURING ELECTRICAL RESISTANCES, E. H. Griffiths, London.
2428. WATER-TUBE BOILERS, F. E. Rainey and the Mirrlees, Watson, and Yaryan Company, Limited, London.
2429. BICYCLE PROPELLING APPARATUS, R. Westall, London.
2430. PORTABLE SEATS, E. Jordan, London.
2431. TOBACCO POUCHES, H. W. Elworthy, Birmingham.
2432. CYCLES, T. W. Burley, A. C. McG. Hogg, and J. C. T. Murray, London.
2433. CARRIERS for EXPOSING TEA, S. C. Davidson, London.
2434. REMOVING PARAFFIN from ARTICLES, J. S. Beeman, London.
2435. DECOMPOSING SALTS, C. Buderus and J. Metz, London.
2436. PRODUCING, &c., MOTIVE POWER, H. Maxim, London.
2437. ELECTRIC HEAT for WELDING, &c., A. Hirsch, London.
2438. FILLING BOXES with MATCHES, V. Carassale, London.
2439. DOOR BOLT, Evered and Co. and G. Clarke, London.
2440. VELOCIPEDE WHEEL, J. Y. Johnson.—(*E. Joubert, France.*)
2441. ICE SKATING RINK, A. H. Tyler and J. S. E. de Vesian, London.
2442. STRAW HATS and BONNETS, G. Larousse and E. Mermilliod, London.
2443. CASH RECORDER for TILLS, T. O'Brien, Manchester.
2444. RECORDING MECHANISM for MUSICAL INSTRUMENTS, W. Neale, London.
2445. TREATMENT of WASTE PRODUCTS, W. H. Deaville, Manchester.
2446. AZO DYES, S. Pitt.—(*L. Cassella and Co., Germany.*)
2447. TELEPHONES, Muirhead and Co. and F. L. Muirhead, London.
2448. PLOUGH, S. D. Poole, London.
2449. SAFETY APPARATUS for LIFTS, J. Botterill, London.
2450. TOBACCO PIPE, R. Hornby, London.
2451. TREATMENT of MARBLE, &c., D. J. J. Froment, London.
2452. BURNERS for GAS LIGHTING, J. Lehmann, London.
2453. LEAF-TURNER for BOOKS, H. H. Lake.—(*E. Drisaldi, Italy.*)
2454. KNIFE-CLEANING MACHINE, C. Macdonald and A. Baker, London.
2455. BICYCLE TANDEM ATTACHMENT, M. Jakobson, London.
2456. KNITTED GOODS, J. H. Cooper and J. A. and A. Corah, London.
2457. CASTING PRINTING PLATES, E. Oldroyd and Co., E. Oldroyd, and H. H. Jennins, London.
2458. SHIRTS, &c., A. Weil, London.
2459. ELECTRIC WELDING APPARATUS, A. Hirsch, London.
2460. NON-FILLABLE BOTTLE, J. S. L'Hommedieu, London.
2461. SKATES, S. L. Schwartz, London.
2462. PEN EXTRACTOR, G. C. Baker, London.
2463. RAILWAY BRAKE, W. S. Whitney, London.
2464. MUSIC LEAF-TURNER, L. Carter and E. Kemble, London.
2465. CAR COUPLER, H. G. Wesemann, London.
2466. AUTOMATIC RAILROAD TRACK, H. G. Wesemann, London.
2467. DECORTICATOR, R. Little.—(*E. Mathieu, East Indies.*)
2468. CANS, &c., F. W. Durham, jun., New Barnet.
2469. BICYCLES, J. Etcheber, London.
2470. DOOR SPRING, J. Coffin, London.
2471. SIGHTING TELESCOPES, F. R. von Voigtländer, London.
2472. LENSES for TERRESTIAL TELESCOPES, F. R. von Voigtländer, London.
2473. NUT and WASHER for SCREW-BOLTS, J. B. Gunning, Sydney, N.S.W.

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2474. HYDRAULIC CARTRIDGE, W. G. Gass, J. Tonge, J Nicholson, and T. Eastham, Bolton.
2475. CHIMNEY COWL, J. McLaren, Dersingham.
2476. INVOICE and LETTER FILE, &c., G. Osborn, Croydon.
2477. MATCH-BOX, J. R. Robinson, Leeds.
2478. PREVENTING FOXES ENTERING FOWLHOUSES, H. Procter, Ripley.
2479. ROARER for SOLDERING PURPOSES, A. Ford-Slayd Southampton.

2480. Stand and Cigar Ash Tray, &c., S. P. Ming, Liverpool.
2481. Foot Warmer, C. Phillips, Leeds.
2482. Washing Minerals, W. C. Blackett and H. Palmer, Newcastle-on-Tyne.
2483. Vehicle Skid, T. Crooke, London.
2484. Inserting Wire in Boots, A. G. Brookes.—(*S. W. Robinson, United States.*)
2485. Builders' Scaffolding, A. G. Brookes.—(*F. B. Gilbreth, United States.*)
2486. Driving Rotary Sifters, &c., W. W. Willis, Ipswich.
2487. Door Guard, R. Parkinson, A. Hartfield, and T. Helme, Preston.
2488. Pencils, T. Turner, Longport.
2489. Sodium Silicate and Nitric Acid, W. Garroway, Glasgow.
2490. Puzzle, G. Barrett, London.
2491. Screw Propellers, H. Sidebottom, Manchester.
2492. Velocipede, W. Bown and G. E. Aston, Birmingham.
2493. Shirts, J. H. Gibbs, Bristol.
2494. Developing Negatives, J. Lewis, Birmingham.
2495. Preventing Boiler Corrosion, W. J. Tranter and O. Howl, Birmingham.
2496. Steam Condenser, L. F. Gjers and J. H. Harrison, Middlesbrough.
2497. Vegetable Kettle, J. Quarton, Birmingham.
2498. Inspection Junction for Drains, E. Codling, Manchester.
2499. Ventilator, G. W. Knowles, Bristol.
2500. Knitting Machine Mechanism, R. Wallis, Middlesbrough.
2501. Conveying Electricity to Cars, A. S. Krotz, W. P. Allen, and O. S. Kelly, Manchester.
2502. Screw Propellers, A. W. Case, London.
2503. Preventing Fibre Accumulating, B. and J. Booth, Halifax.
2504. Calico Printing Machine, F. D Haddon and A. A. Kuenemann, Manchester.
2505. Buckles, A. Caulkin, Birmingham.
2506. Cycle Tires, The Double-Arch Tire Company and D. Crowther, Huddersfield.
2507. Making Riding Saddle Trees, A. C. Russell, Walsall.
2508. Fireworks, &c., J. Nisbet and J. B. Nisbet, Glasgow.
2509. Adjustable Baby Chairs, J. P. McPhun, Glasgow.
2510. Governing Engines, D. Johnston and W. McAdam, Glasgow.
2511. Extracting Oil from Fish, J. Jack and M. Blake, Glasgow.
2512. Drip Collecting Attachment, L. K. A. Ehlers, Glasgow.
2513. Cycle Driving Mechanism, G. Beekman, Glasgow.
2514. Bicycle and other Vehicle Tires, A. Graff, Glasgow.
2515. Nursing Bottles, W. Fairweather.—(*The Dorothy Nursing Bottle Company, United States.*)
2516. Chaff Cutting Machines, W. S. Richmond, Suffolk.
2517. The "B." Tandem, H. Benson, Belfast.
2518. Waterproof Table and Wall Covers, M. Lavy, Berlin.
2519. Treating Coat Fronts, W. H. Sladdin, Brighouse.
2520. Domestic Fireplaces, J. Dawber, London.
2521. Game, E. W. Hopkins, London.
2522. Saucepans, H. B. Doughty and C. T. Barlow, London.
2523. Electric Railway System, A. Casazza, London.
2524. Cutting Metal Pipes, D. G. Brighton and E. M. Venning, London.
2525. Disjointing Iron Pipes, D. G. Brighton and E. M. Venning, London.
2526. Keys of Typewriting Machines, A. Hodgson, London.
2527. Chucks, E. Schmidtmann, Cologne.
2528. Heat Preserving Covering for Pipes, A. Zingen and O. Beckmann, Cologne.
2529. Stop Valves, J. Robinson, London.
2530. Buttons Made in Two Parts, C. Bordes, London.
2531. Apparatus for Making Suppositories, D. Genese, London.
2532. Collapsible Boxes, E. M. Fuller, London.
2533. Tap Holes of Stoneware Bottles, H. J. Ansell, London.
2534. Finger Stalls, E. Nash, London.
2535. Railway Chair, J. Jackson, H. T. Porter, and A. W. Lusby, Oxfordshire.
2536. Device for Use with Penholders, A. O. Joynson, London.
2537. Sole Laying Machines, J. G. Lorrain.—(*E. E. Winkley and B. Phillips, United States.*)
2538. Varnish and Oil Cans, &c., J. G. Heywood, London.
2539. Levelling Metal Plates, &c., J. F. Golding, London.
2540. Cycle Brake and Alarm, C. E. Johnson and L. A. Kinsey, London.
2541. Extension Feet, Lilley and Skinner, Ld., and W. G. Dell and P. J. M. Gunthorp.—(*E. L. O'Connor, United States.*)
2542. Nitrogenous Substances, J. S. Wallace and J. Castell-Evans, London.
2543. Dry Kilns, H. H. Lake.—(*A. S. Nichols, United States.*)
2544. Sole Levelling Machines, E. C. Judd and H. E. Cilley, London.
2545. Current Regulators, H. H. Lake.—(*S. C. C. Currie, United States.*)
2546. Clasps for Chains, H. H. Lake.—(*J. V. Washburne, United States.*)
2547. Travelling Trunks, E. King, London.
2548. Buffer Attachment for Brooms, &c., E. King, London.
2549. Typewriter Counting Attachment, A. H. Kinder, London.
2550. Watering Appliances, A. A. Champion and F. S. Perkins, London.
2551. Bottles, J. J. Walsh, London.
2552. Ash Sifters, A. Belot, London.
2553. Pneumatic Tires, F. L. Woodhouse, London.
2554. Focussing Scales for Cameras, T. M. Clark, London.
2555. Stair Carpet Holders, L. Humphreys, London.
2556. Cycles, The Trengrove Improved Cycle Frame Company and W. H. Trengrove, London.
2557. Type Cutting Machines, T. T. Heath, London.
2558. Type Writers, T. T. Heath, London.
2559. Typographic Machines, T. T. Heath and A. N. Verdin, London.
2560. Means for the Manufacture of Bottles, W. Dunham, London.
2561. Apparatus for Cleaning Knives, E. A. Attwood, London.
2562. Incandescent Gas Lights, T. W. Kellet, Liverpool.
2563. Producing Fuel from Turf, &c., W. Schöning, London.
2564. Manufacture of Iron Sheets, W. Roberts, London.
2565. Metallic Cots, S. J. Hoadly, London.
2566. Removing Foil, H. J. Haddan.—(*G. Wiedeman, jun., United States.*)
2567. Artificial Straw Hats, &c., J. L. Pollock, London.
2568. Air and Waterproofing Varnishes, J. L. Pollock, London.
2569. Motor Carriages, E. J. Clubbe and A. W. Southey, London.
2570. Telephone Systems, W. A. Houts, London.
2571. Feeding Cups for Invalids, A. J. Lely, London.
2572. Rapid Tanning of Hides, &c., H. L. J. Roy, London.
2573. Cigarette Boxes or Cases, J. Plenderleith, London.
2574. Breech-loading Ordnance, R. Matthews and J. Horne, London.
2575. Explosives, H. H. Lake.—(*The firm of Fried. Krupp, Grusonwerk, Germany.*)
2576. Incandescent Oil or Spirit Lamp, H. Hempel, London.
2577. Removing Dust, J. E. Howard and J. C. Taite, London.
2578. Manufacture of Casks, C. Wittkowsky, London.
2579. Nut Lock, S. Stevens, London.
2580. Feeding Fuel to Furnaces, A. O. Müller, London.
2581. Telephonic Apparatus, E. W. Smith and The New Phonopore Telephone Co., London.
2582. Rests for Two-wheeled Machines, T. P. Wood, London.
2583. Flues and Manhole Covers, W. Jordan.—(*The Hogan Boiler Co., United States.*)
2584. Feeding Water, W. Jordan.—(*The Hogan Boiler Co., United States.*)
2585. Coin-freed Delivery Machines, R. J. Moser and H. W. Phipps, London.
2586. Grease Separator, E. F. W. Wilkinson and A. A. Smith, London.
2587. Processes of Fermented Liquors, A. Myers, London.
2588. Adjustable Handle for Bicycles, G. A. Wheeler, London.
2589. Steam Generators, A. J. Boult.—(*J. B. Granjon, France.*)
2590. Marine Velocipedes, G. F. Cremer, London.
2591. Stoves, A. J. Boult.—(*C. M. Hess, ———.*)
2592. Sheet-metal Bends or Elbows, C. Carduck, London.
2593. Lamps, E. L. Williams, London.
2594. Extraction of Caustic Alkali, A. J. Boult.—(*G. Villani, Italy.*)
2595. Embroideries, The "Lehner" Artificial Silk Co., London.
2596. Stoppers, W. A. Landau, London.
2597. Boot Spikes, W. A. Landau, London.
2598. Spout for Discharging Liquids, W. A. Landau, London.
2599. Neckties, A. B. Davey, London.
2600. Bearing Reins for Horses, J. Parks, London.
2601. Slides for Photographic Cameras, E. Pocknell, London.
2602. Finger Shield, A. Thorpe, London.
2603. Tobacco Pipe, J. Fitchie, London.
2604. Bottles, J. Fitchie, London.
2605. Construction of Moulds, &c., J. Lewthwaite, London.
2606. Damp Proof Tobacco Wrapper, E. M. Harley, Surrey.

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2607. Photographic Cameras, &c., S. P. Hyatt, London.
2608. Looms to Weave Without Healds, J. Taylor, Waterfoot, near Manchester.
2609. Stopper, G. MacDuff, London.
2610. Dynamo-electric Machines, E. S. G. Rees, Wolverhampton.
2611. Curtain Hooks and Eyes, A. F. East, Winchester.
2612. Cooking Jams and Confectionery, G. Sara, Truro.
2613. Artificial Marble, W. Beer.—(*H. Lüschen, Germany.*)
2614. Artificial Stone, F. W. Maxwell and W. Beer, Manchester.
2615. Hopper Feeders, W. Lord and F. Woodhead, Manchester.
2616. Water-tube Boilers, W. R. Cummins, Fifeshire.
2617. Patent Slide for Scarf, J. G. Rolason, Birmingham.
2618. Handles for Cycles, &c., H. Stone, Birmingham.
2619. Tires for Cabs, Buses, &c., J. Watt, Glasgow.
2620. Detaching Devices, &c., H. L. Offerman, London.
2621. Safety Pins, G. Browning, Manchester.
2622. Controlling Curves on Tramways, J. McBean and J. Eaton, Sheffield.
2623. Electric Targets, &c., W. W. McLauchlan, Manchester.
2624. Safety of Ships, G. Russell, London.
2625. Boilers for Heating Water, J. Waugh.—(*H. Bolze, Germany.*)
2626. Bobbins, C. A. Rickards, Bradford.
2627. Machines for Dressing Stone, J. Spencer, Keighley.
2628. Engine Governors, J. Mallinson and W. P. Gibbs, Cardiff.
2629. Furnaces, J. Harper and Co., Ld., and H. Devonport, Wolverhampton.
2630. Disconnecting Ventilating Trap, A. Harkess, Leith.
2631. Aluminium Splice, S. H. Levi, Shepperton.
2632. Flanges, G. Ashton, Manchester.
2633. Stone Sawing Machinery, G. Anderson, Dundee.
2634. Ruler, T. T. Greenwood, Darwen.
2635. Hose Pipe Couplings, W. Cornish and A. Smart, Bristol.
2636. Devices for Doors, P. R. J. Willis.—(*L. Depp, United States.*)
2637. Connecting Tires to Wheel Rims, J. McConechy, Glasgow.
2638. Footballs, F. Sugg, H. Collins, and J. J. Warry, Liverpool.
2639. Ornamental Letters and the like, B. Bradford, Liverpool.
2640. Chessboard, A. Scott, London.
2641. Card Games and Markers, A. D. Musson, Grantham.
2642. Absorbing Vibration in Spindles, P. Fyfe, Glasgow.
2643. Tilting Barrels or Casks, T. Williams, Stockton-on-Tees.
2644. Gas Governors, A. Hallett, Huntingdon.
2645. Oil Lamps, J. Davidson and the Tourtel Gas and General Engineering Company, Ld., London.
2646. Baths, J. A. Hollem, London.
2647. Index File, C. W. Northrop, London.
2648. Folding Box, A. R. Buckton, R. W. Brumby, and S. Clarke, Sheffield.
2649. Cycle Bell Alarm, A. de Courcey, Birmingham.
2650. Envelope and Book-post Wrapper, H. B. Tucker, Bath.
2651. Velocipede Driving Gear Case, H. Bate, London.
2652. Swivel Rasp for Horses' Teeth, F. Swales, London.
2653. Treatment of Paper Pulp, A. H. Harrison, London.
2654. Umbrella Frame, J. Murphy, London.
2655. Tobacco Pipe, W. H. Humphreys, London.
2656. Cycles, &c., R. Bright, London.
2657. Driving Gear of Bicycles, &c., H. Comyns, London.
2658. Simplex Apparatus, R. J. Eke, London.
2659. Rolling Machine, R. J. Eke, London.
2660. Fumigator, W. E. Darlington, London.
2661. Producing Incandescent Lighting, T. Landi, London.
2662. Cutting Hair or Wool, A. Gray.—(*J. W. Newall, Australia.*)
2663. Milling Cutter for Iron, &c., W. D. Marshall, London.
2664. Automatic Scales, H. Clifford and A. J. L. Gliddon, London.
2665. Adjustable Carbon Resistance, S. P. Blackmore, London.
2666. Fluid for Galvanic Batteries, J. E. Preston, London.
2667. Apparatus for Receiving Messages, J. E. Preston, London.
2668. Spinning Top, I. Shulman and S. Mechlowitz, London.
2669. Detachable Hoof Pads, T. Cloke, London.
2670. Wheeled Vehicles, J. A. Mays, London.
2671. Magic-lantern Slides, W. C. Pexton, London.
2672. Boot and Shoe Stretchers, E. E. H. Wade, London.
2673. Drawing-off Frothy Liquids, A. E. Occleston, London.
2674. Armatures, P. R. Jackson and Co. and J. S. Lewis, London.
2675. Carrying Shafts of Lorries, J. Rawlinson, Liverpool.
2676. Machinery for Making Cigars, J. Lacoste, London.
2677. Vulcanite, H. Birkbeck.—(*P. W. Wierdsma and J. Kuipers, Holland.*)
2678. Treatment of Apatite, &c., J. G. Wiborgh, London.
2679. Machinery for Washing Grain, G. Daverio, London.
2680. Turbines, L. Benze and E. Bachmayr, London.
2681. Manufacture of Pigments, H. and S. H. Hawkins, London.
2682. Valves for the Supply of Liquids, W. B. H. Drayson, London.
2683. Electricity Meters, G. Hookham, London.
2684. Producing Crushed Malt, B. Rothenbucher, London.
2685. Fibrous Substances, I. A. F. Wallberg and J. D. Ullgren, London.
2686. Locking Shutters, A. J. Boult.—(*A. Lagarigue, France.*)
2687. Cutters, G. Brunton and W. A. Thornton, London.
2688. Shaft Tugs, W. Tyree.—(*F. N. Jones, New Zealand.*)
2689. Apparatus for Mixing Concrete, W. H. Baxter, London.
2690. Alarm Apparatus, A. J. Boult.—(*J. P. Dutilch, France.*)
2691. Filling Bottles, C. W. Clayton and R. J. White, London.
2692. A New Stud and Tie Clip, W. Heeley, London.

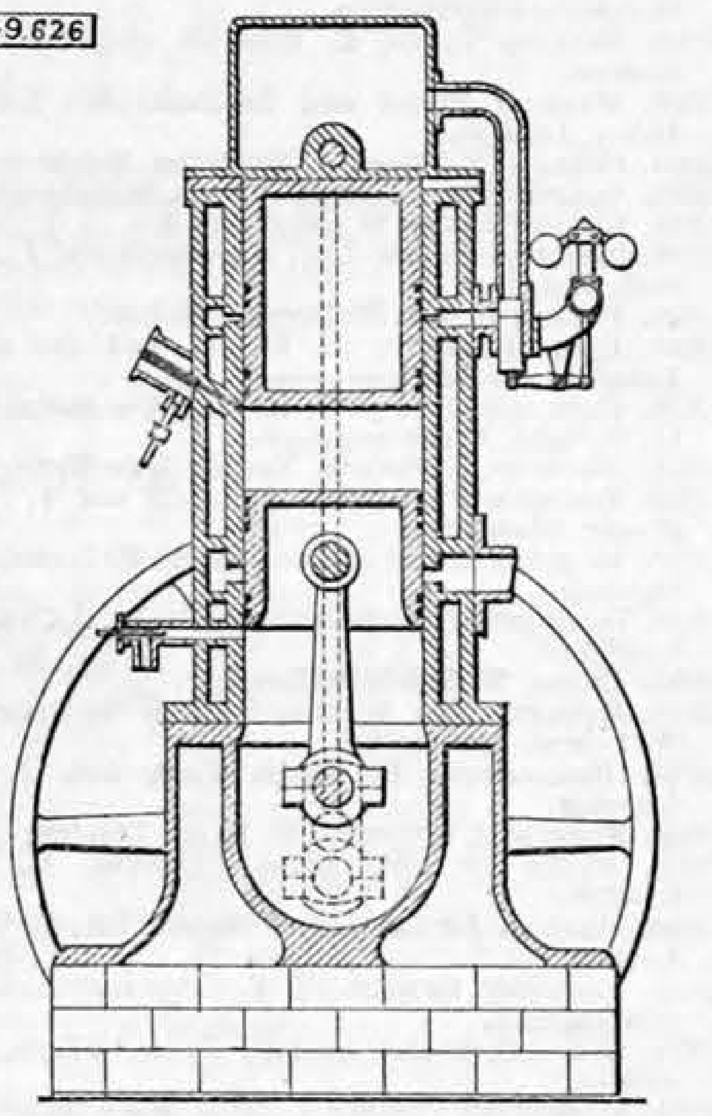
SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

549,626. Balanced Gas Engine, *F. Burger, Fort Wayne, Ind.—Filed August 1st, 1894.*

Claim.—(1) In a gas engine, a cylinder, two working pistons, a crank shaft having cranks connected with said pistons, a closed crank shaft chamber, a cross-head chamber, and passages connecting the two chambers, substantially as described. (2) In a gas engine, the combination with the enclosing case forming a chamber, of a cylinder mounted therein, two working pistons mounted in the cylinder, a shaft in the chamber, connections between the working pistons and shaft enclosed within the case, inlet and outlet ports controlled by the pistons, an inlet port to

549,626



the chamber controlled by one of the pistons, an igniter connected to the combustion chamber, and a governor controlling the passage of the gases from the chamber to the cylinder, substantially as described. (3) In a gas engine, the combination with the cylinder having a water jacket and provided with inlet and outlet ports, of two pistons mounted in said cylinder, a crank shaft connected to said pistons, a crank shaft chamber and a crosshead chamber having communicating passages, and connections between said chambers and the inlet ports, substantially as described.

549,668. Separator and Amalgamator, *F. L. Fisher, Granger, Oreg.—Filed November 6th, 1894.*

Claim.—(1) In a separator and amalgamator, the combination of a screw-threaded standard and a series of wheels having threaded hubs fitting said standard and having troughs of progressively increasing diameters adapted to deliver into one another from the top to the bottom of the series, and means for supplying the upper trough, substantially as set forth. (2) A

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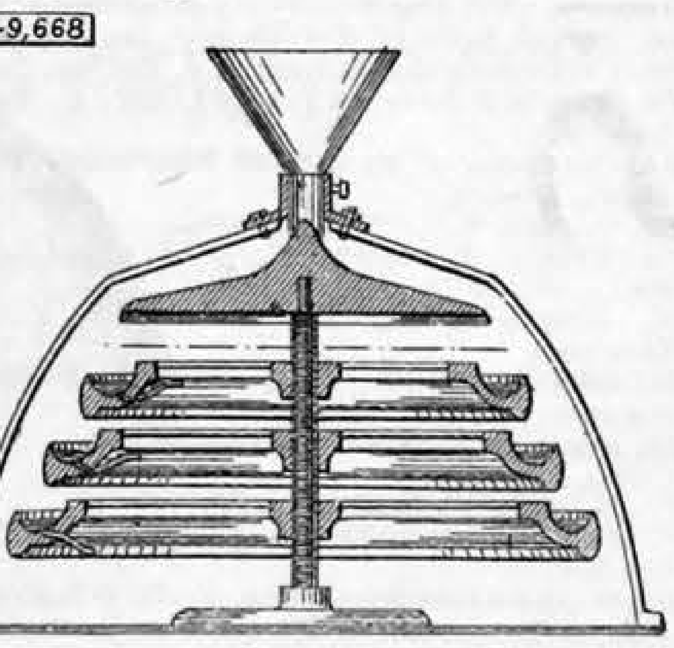
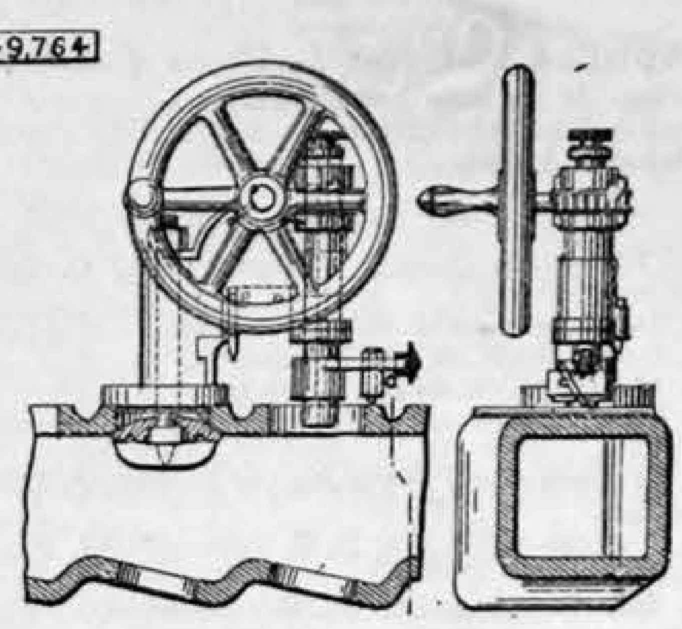


separator and amalgamator, comprising a screw standard mounted on a suitable base, a series of wheels having their hubs threaded to fit the standards and at their outer peripheries troughs arranged to deliver from one into the other, a spreader plate mounted on the top of the standard to deliver into the upper trough, the plate having a conical top, and a feed hopper delivering on the top of the cone, substantially as described.

549,764. Machine for Re-facing Surfaces of Handholes, *J. J. Cain, Bayonne, N.J.—Filed February 11th, 1895.*

Claim.—(1) A re-facing machine consisting of a body adapted to be secured in a fixed position, and having a shaft mounted to rotate therein, which is provided with a tool-carrying arm; means for rotating said shaft; means for adjusting said arm longitudinally on said shaft; a tool block mounted to slide on said arm to and from the shaft, and means for moving the tool block step by step across the work at each revolution of the shaft, substantially as and for the purposes specified. (2) The combination with the machine body of a tool shaft furnished with gear; a worm for turning said gear, and means for rotating said worm; a tool arm mounted to slide on said shaft; a screw for adjusting the position of the arm on the shaft; a tool block mounted to slide on said arm; a screw provided with

549,764



a wheel for adjusting the tool block on the arm; and a pin located in the path of revolution of said wheel for engaging the same, substantially as and for the purposes specified.

549,795. Traction Engine, *E. Ingleton, Pottstown Pa.—Filed March 13th, 1895.*

Claim.—(1) In a traction engine, an endless tread for the traction wheels, and means, substantially as described, for raising and lowering a section of the tread from the steering gear of the engine, as and for the purpose specified. (2) In a traction engine, the combination, with the traction wheel, upwardly swinging arms fulcrumed upon the axle of the wheel and extending beyond said wheel, and guards extend-

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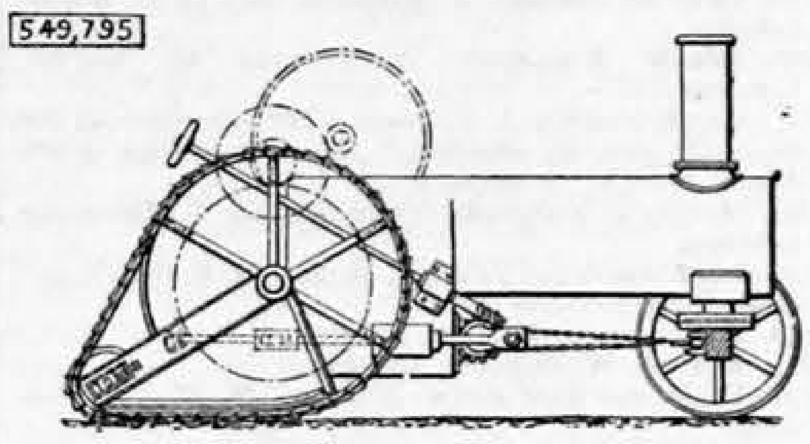

ing downward from the said arms, of an endless tread partially encircling the traction wheel and substantially engaging with the lower portion of the said guards, a tension wheel journalled in the said arms and engaging with the endless tread, and means for raising the arms, as and for the purpose specified.

549,815. Governor for Steam Turbine Valves, *C. A. Parsons, Ryton, England.—Filed September 26th, 1891.*

Claim.—(1) The combination with a cut-off valve for a steam turbine, of a spring pressed piston or diaphragm connected to said valve, a fluid compressing pump communicating with said piston or diaphragm, a valve admitting fluid to said pump, and means for controlling or governing said admission valve, substantially as described. (2) The combination with a

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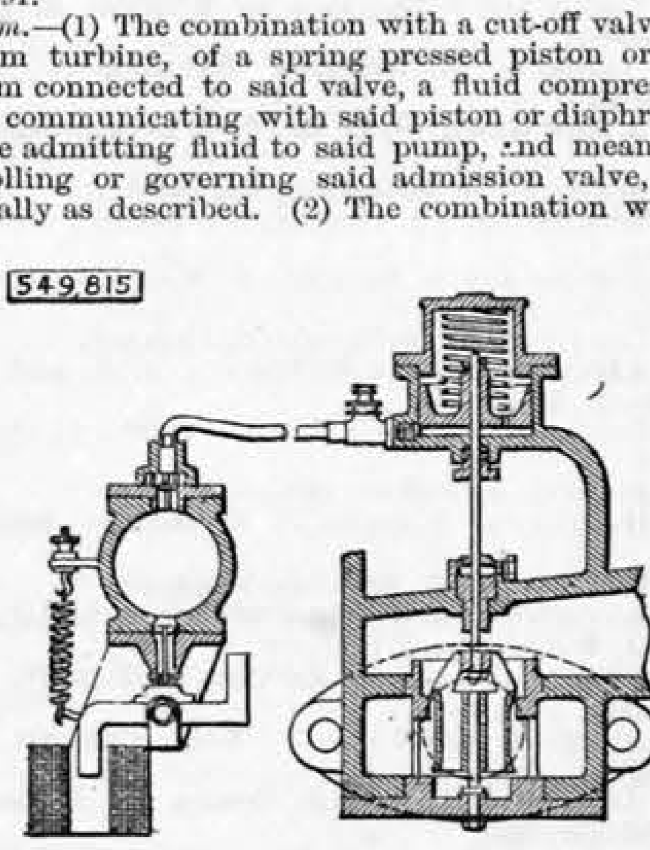

cut-off valve for a steam turbine, of a spring pressed piston or diaphragm connected to said valve, a fluid compressing pump communicating with said piston or diaphragm, a valve admitting fluid to said pump, a solenoid, a core and a cam carried by said core and adapted to engage said admission valve, substantially as described.

549,899. Plate for Storage Batteries and Process of Making It, *F. J. Clamer, Philadelphia, Pa.—Filed December 20th, 1895.*

Claim.—(1) A plate for electric storage batteries consisting of a central core of oxide of lead enveloped in a porous metallic jacket of lead and aluminium, as set forth. (2) The herein-described process of manufacturing porous plates for storage batteries, consisting of mixing a quantity of oxide of lead with a suitable binding material and forming a core of the same; drying said core, then suspending it in a suit-

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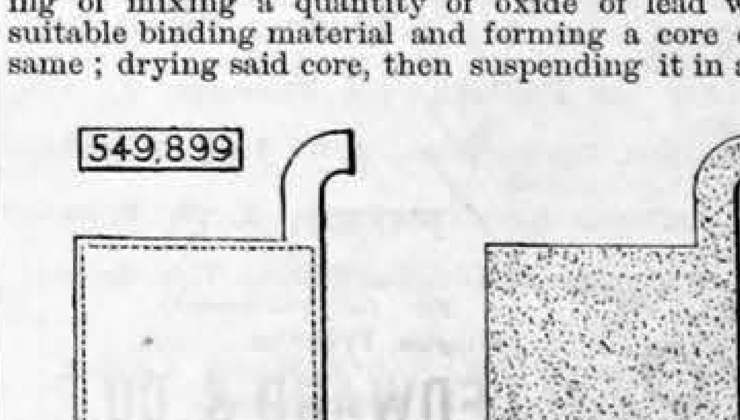
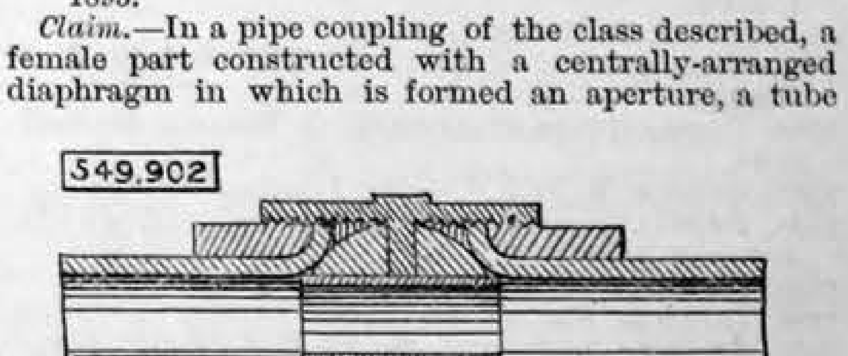


able mould and pouring therein a melted alloy of lead and zinc to form a metallic jacket or envelope around the core; afterward immersing the plate thus formed in a suitable acid, allowing it to remain therein until the zinc in the jacket has been eaten out, leaving a porous lead jacket enveloping the central core, substantially as described. (3) The herein-described metallic blank for making plates for electric storage batteries, consisting of a central core of oxide of lead enveloped in a metallic jacket composed of an alloy of lead, zinc, and aluminium, as set forth.

549,902. Combination Soft-metal Pipe Coupling, *J. B. Dockery, St. Louis, Mo.—Filed August 12th, 1895.*

Claim.—In a pipe coupling of the class described, a female part constructed with a centrally-arranged diaphragm in which is formed an aperture, a tube

549,902



arranged longitudinally within said aperture, hemispherically formed packings arranged upon the protruding end of the tube, and male parts located upon the flared ends of the pipe, said male parts being arranged within the ends of the female part so that the flared ends of the pipe engage against the packings.