HYDE PARK LOCOMOTIVE WORKS, SPRINGBURN, GLASGOW.

No. II.

MACHINE AND FINISHING SHOPS.

WE are now in a region of the Hyde Park Works which teems with machine tools of a great variety of make and for manifold purposes. As it would scarcely be possible, even if desirable, to notice these in the order in which they come before the visitor proceeding through the shops, we will not attempt to follow the itinerary method of dealing with the several bays and their hundreds of tools. The great bulk of those readers who are in any way conversant with locomotive works will be familiar with most of these, both through acquaintance with the tools at the scene of operations, and with the illustrations of them published from time to time in this and other engineering journals. We will therefore here simply draw attention to views taken at various parts of the shops—marked "machine shop," "finishing shop," and "light tool shop," on our general plan—at which tools of outstanding interest are located. It may here be stated that the photographs from which the views, given in last week's and in the present issue, were taken by John Stuart, Limited, of Buchanan-street, Glasgow, who are well known for their successful work in this branch of photography. Figs. 21, 22, 23, 24, 25, 26, and 27 are all views taken within the shops named, at points, mainly, where noteworthy tools are located Fig. 21 is a view down the bay in which turning is more particularly carried on, and it is seen to contain a wealth of machine tools adapted to the accurate and expeditious production of the special parts with which this department deals.

In the left foreground is a very fine Gisholt lathe, which deals with cylinder covers and pistons, but which, since this photograph was taken, has been transferred to the new cylinder shop, afterwards to be noticed. In this section, at various points, not seen on any of our views, are a number of boring and turning mills by Geo. Richards and Co., Manchester, the Niles Tool Company, and others. Two of the Richards mills are 6ft., and two others 3ft., all being fitted with two tool posts to the cross slide. These are highly perfected tools, and the larger mill admits 72in. in diameter, takes in 28½in. under tool holders, and 37in. under cross slide, the boring bars having a traverse of 24in. The table is 65in. in diameter, and the cone has four steps, and in addition to a 16 to 1 back gear, has an intermediate gear of 4 to 1. The countershaft has two speeds, 155 and 180 revolutions per minute respectively. The table is driven by a machine-cut spur gear, which is 60in. pitch diameter, 4in. face, and 2in. diametrical pitch—a form of drive which ensures freedom from any lifting tendency. The cone is placed at the side of the machine, much the handiest position, and there is a large range of speeds. The spindle is of great length, and has very large bearings, the top being 8in. diameter and the lower 5in. diameter. The table is provided with a supporting bearing, which extends nearly to the outer edge. For high speeds, and also for dealing with light pieces, the table can be lifted slightly to lessen friction. The boring bars are octagonal in section, and to facilitate the setting of the bar for boring with double-sided cutters, a dowel pin is fitted to one bar when in the central position. The feeds are operated by friction discs, and are independent, thus enabling a coarse feed to be taken with one bar, and a fine feed with the other, or *vice versâ*, as required. The caps of the tool posts are wide apart, being the full length of traverse, plus the diameter of balance pulley and necessary clearance, thus forming a long support to the tool posts.

Two of the lathes in the turning shop which specially arrested our representative's attention were double duplex-axle lathes by Hulse and Co., which simultaneously turn both journals of straight axles, the axle being gripped in and rotated by a powerful geared central-driving headstock, driven by a longitudinal shaft, with four-speed cone pulley placed at the end of the bed. The sliding carriages are provided with duplex rests, one back and one front, and operate simultaneously on the two journals of the axle. These lathes are very powerful, and take very heavy cuts.

Fig. 22 gives a view of the machine shop at a point where several very special motion grinding machine tools are stationed of the Hyde Park firm's own make for milling out and grinding motion links after they have been case-hardened, the links when coming out of the furnace being of unequal radius, and having to be ground up to a true surface. Here also are surface tables on which the link-and-motion gear is tried and adjusted for every engine. Another special tool in this neighbourhood, also of Hyde Park make, is one for polishing rods, by the use of which very much of the draw-filing by hand, formerly so much in vogue, is done away with.

Fig. 25 illustrates very clearly a section of the machine shop where the now highly-approved milling machines are employed on various classes of work for which they are so well adapted. Some idea of the variety of such work is suggested by the well-stocked racks of milling cutters seen in the background, all of which, it may be mentioned, are made within Hyde Park works.

The tools here are mostly by Alfred Herbert, Limited, Smith and Coventry, and Brown and Sharpe. There is a vertical milling machine by Herbert, in connection with which our representative noted some points of interest and comparative novelty. The table of most of the English-made vertical milling machines is circular, and it is in most cases difficult to chuck or hold effectively a long piece, and impossible to chuck a gang of pieces. The table in this instance is of great length, and is unusually well supported, thus enabling long pieces or gangs of pieces to be set. This machine, having evidently been designed largely for repetition work, possesses every facility for the rapid chucking or fixing of work. The circular table is an attachment and can be removed. The spindle head can be raised and lowered by rack and pinion and is balanced, the hand wheel for fine adjustment being provided with micrometer adjustment. The pull of the belt is not taken upon the spindle but on a fixed sleeve, and the drive of the spindle is through two keyways, by means of an equalising driver. All the gearing of the machine is completely enclosed, and the handles for operating the various motions are placed in front, within easy reach of the operator. The feeds are automatic in all directions, and reversible, and have automatic trips and dead stops.

For milling link motion, connecting and coupling rods, &c. &c., there is a very noteworthy special horizontal straight milling machine of Hulse's make. The tee-grooved table is surrounded by a trough for the lubricant, and is fitted with variable self-acting feed motion, and with self-acting feed motion at any part of the traverse, and also quick power traverse motion in either direction by hand or power, which may be readily suspended by clutch and lever placed in suitable position for the operator. The uprights are of box form, and firmly bolted to the bed, connected by a cross stay, and carrying within them the weights for counterbalancing the cross slide. The cross slide is adjustable vertically on the uprights, and carries a cutter headstock adjustable transversely thereon, and provided with a conical steel spindle running in hard gun-metal bearings, and fitted with a patent chuck on the spindle nose for readily gripping, and withdrawing the cutter arbors.

Smith and Coventry are the makers of a notable vertical milling and copying machine, which does straight and circular milling and the outlines of objects of irregular form, as well as surface work. The spindles are large in diameter and conical in the lower bearings, which are bushed with gun-metal. The bearings can be raised or lowered to suit the height of the work, rendering the spindles equally rigid in all positions. The tables have longitudinal transverse and circular movements, the two latter being fed automaticaly, and fitted with disengaging clutches, so that they can be controlled by hand.

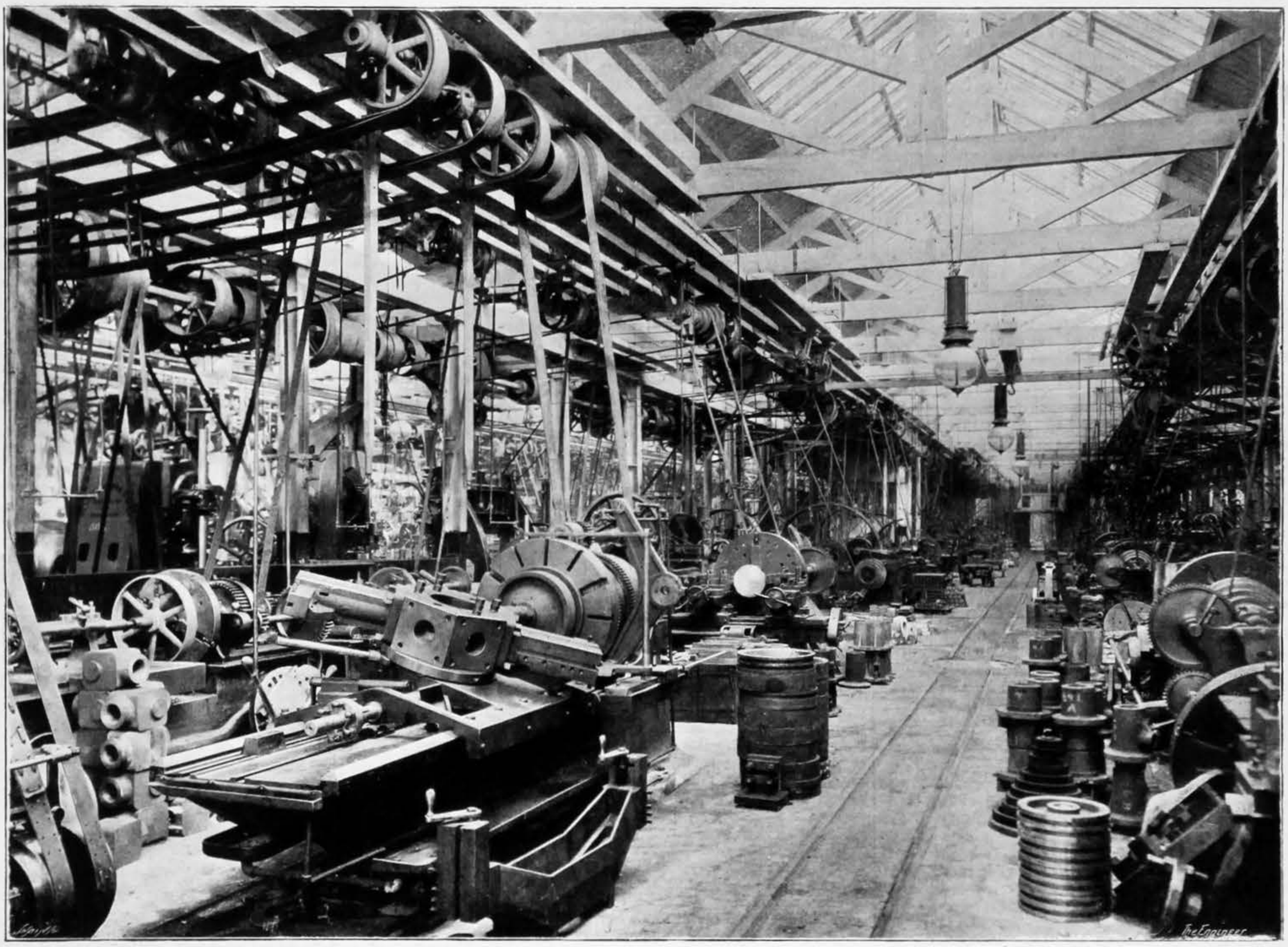


Fig. 21—TURNING SHOP

NEW CYLINDER SHOP.

To relieve the somewhat overtaxed machine and finishing shops of some of the work carried on there, and of a proportion of the tools so thickly installed, a special shop for dealing with cylinders exclusively and completely, was recently erected at that part of the works where extensions have been most convenient to carry out. It will be convenient at this point to give a few particulars as to the equipment of this department. This shop, as

will be seen on the plan, abutts on Flemington-street, and adjoins the large material store, and cab and tank fitting shop. As will also be seen, it is brought within the sweep of the service rails leading from the general machine and finishing shops. A view of this shop, from which some general idea of its equipment may be gathered, is given by Fig. 28. It is in two bays, each 120ft. long by 50ft. broad; one bay, named "cylinder machine shop," being served by a 5-ton three-motor crane of Broadbent's make; and the other, the cylinder finishing shop by a 3-ton, single-motor floor-walking jib crane. Amongst the machine tools transferred to this department from the machine shops, was a Gisholt lathe for dealing with cylinder covers and pistons, which is seen in the right foreground of the present view, and still more clearly in the left foreground of Fig. 28, taken before the transference. A fine example of this tool was illustrated in our issue for March 24th, 1899, page 293. Beyond the Gisholt lathe are two of Craven's milling machines for dealing principally with valve faces and ports, and rendered specially essential where cylinders, as is now becoming common, are cast in pairs. Beyond this is a series of cylinder-boring mills, two of which are notable modern productions by Craven Brothers, and W. Sellars and Co., the others being older machines by the Hyde Park firm themselves, also transferred from the machine shops.

In the cylinder-finishing bay are radial drills by Harvey, Kendal and Gent, Richards, &c., cylinder-rubbing and other machines, and here also are a number of drilling and tapping machines, one a horizontal boring, tapping, and stud-inserting machine of Harvey's make. On the left of our view is a series of planing machines, several of which are by Hulse and Co., and others by Loudon Brothers. The Hulse planers deal with castings 10ft. long by 5ft. wide, and 5ft. high, and are fitted with four tool boxes, viz., two on the cross slide and one on each upright. They are provided with powerful treble gearing suitable for planing cylinders, &c., the tool boxes being fitted with patent broad traverse feed mechanism.

TOOL-GRINDING SHOP.

Near the centre of the machine shop section our plan shows a small oblong space entitled "tool-grinding shop." This is a department set above the level of the shops in which all the grinding of tools is carried out by expert operators on tool-grinding machines of the most approved make. These comprise tool grinders by Sellars, Gisholt, Sterne, Kendal and Gent, and others. Access to this small but very important section of the works is obtained by a spiral staircase, and the tools to be operated upon, either singly or after collection in the shops, are taken up by hoist. The systematic collection of tools to be ground, their storage in the shops after being operated upon, and their distribution to the respective machine men, are matters which have been thoroughly well schemed out, and the working of the system is found to be most satisfactory, and an immense saving of the workmen's time as compared with the older-fashioned method of each man attending to the sharpening of his own tools. Formerly considerable delay was caused through workmen having to execute the sharpening themselves—even having to wait their turn of the use of the grinders available. Now a tool which has to be sharpened, or which has broken, merely requires to be taken to the stores attached to this department, left there, and a fresh and scientifically-ground tool borne off and expeditiously fitted to its work. The presence of a grindstone or other sharpening appliance on the floor of the shops will in course of time be exceptional, if not unknown.

ENGINE AND TENDER-ERECTING SHOP.

By a method and skill which, after all attempts at elucidation, may perhaps simply be accounted to the Hyde Park management as their trick of the trade, the multifarious component parts of locomotive engines and tenders, operated upon throughout this wide ramification of shops, are systematically and concurrently advanced and eventually marshalled in the erecting shop, to be built up with commensurate facility into the thing of beauty and power a modern high-class locomotive undoubtedly is. The immense shop in which this work, both as regards engines and their tenders, is conducted may in some measure be gathered from an inspection of the two views, Figs. 29 and 30. The combined length of the engine-erecting and tender-erecting shops, as has already been indicated, is 703ft., and the width 43ft. Serving the whole of the bay are four powerful overhead electric cranes, one 70-ton five-motor two-crab crane by Craven Brothers, one similar crane of 40 tons by same makers, one 15-ton three-motor single-crab crane also by Craven Brothers, and one similar crane by Vaughan and Sons. All the cranes enumerated are shown in our views, Figs. 29 and 30, and for further features of equipment throughout this department readers may be referred to these illustrations. In Fig. 20 it may be noted the engine in the foreground, and nearest completion, is the Koningin Wilhelmina, built for the Netherlands State Railways. This example of Hyde Park workmanship was shown at the recent Paris Exhibition, and earned for its designer and makers the Gold Medal and other awards.

STEAMING SHED.

To the right of the engine-erecting shop and open to it is the steaming shed, where the completed engines are finally steamed and tested before being sent out to assume their duties on the railways. It has a capacity which, large though it is, is oftentimes scarcely great enough. Series of pits run parallel across it, in which are sets of rollers on which the steaming properties of the engines are thoroughly tested, some stipulating for tests over a period of four hours. Provision is, of course, made for the removal of all smoke and steam during the test by means of movable chimneys, which are raised or lowered so as to cover the funnels of the engines and conduct the smoke and steam to the open air. Lines of rail extend from the shed out across the open yard and within the radius of the 5-ton electric jib crane there. These lines are made the storage place of large groups of wheels and axles, as our view depicts. After steaming tests the engines are backed into engine-erecting shop, and being placed under the powerful overhead crane of 70 tons there, are lifted and transferred to the line of rails which cross the shop and conduct to the paint shop at the western end of the establishment. Here, as well illustrated by Fig. 31, they assume by gradual and careful manipulation on the part of the experts, those durable coats of colour and varnish which, in all weathers and temperatures, seem never to lose their brilliancy. The engines destined for abroad are, of course, disposed of otherwise. These are stripped in the steaming shed, and the dismantled parts delivered into the packing shop which adjoins. Thence the packages are removed for loading into wagon or cart for transport to the harbour and the ship awaiting them, as explained more fully when dealing earlier in this article with general and railway facilities.

LIGHT TOOL SHOP.

The light tool shop, of which Figs. 24 and 25 are illustrations, occupies the outmost, from the administrative offices, of the bays which comprise the machine shops. Here, beginning at the east end, are grouped a very large number of automatic lathes for various purposes, two and three machines being under the charge of one youth. The machines are ranged in five parallel rows; the row nearest the centre of the bay, and the railway which traverses it, consisting mostly of automatic lathes of the hollow-spindle order, engaged executing formed work, and disposed obliquely in order to allow of the ready insertion of "stock." It is impossible to enumerate the notable machines observed at work here by our representative; but amongst those which specially arrested his attention were half a dozen automatic machines and attachments by the Cleveland Machine Screw Company, of Cleveland, Ohio, U.S.A., engaged "forming" and "threading" multiple parts from stock rods. Also noteworthy are several full automatic screw machines by Alfred Herbert, Limited, of Coventry, one of which at the time of our representative's visit was engaged in producing, by forming tool, pillars for locomotive handrails. These were each 7in. long, with screwed end, and were produced in a marvellously rapid manner. Hand-rail pillars of the varying lengths and diameters customary in such parts can be produced in from fifteen to twenty minutes each.

Amongst notable tools here also are a number of turret lathes by the Jones and Lamson Company, and the Pillater Tool Company, of Germany. A notable turret machine here is one by the Spencer Company, U.S.A., for stud-making. In this machine studs are formed complete, including the screwing of both ends, at one operation. Amongst bolt and nut-screwing machines there are two by the Acme Machine Company, and three of Barrows' patent screwing machines, of Smith, Beacock, and Tannett's make.

NUMBER OF WORKMEN, OUTPUT, &c.

The annual returns of workmen employed made by firms themselves to the Press supply a very fair criterion of the state of the trade as a whole, and in a measure also the relative importance of the work accomplished—as respects volume at least—by the several locomotive-building concerns. But the output really varies so much at present, owing to the amount and character of the inspection of British engineers, that any figures intended to convey an adequate impression of the work put upon engines would only probably be misleading. This, we are assured, is at least true of work at Hyde Park, where, judging from the examples on hand at the period of our visit, the management would apparently not grudge to spend twelve months, in place of twelve weeks, on single engines, provided it was paid for such protracted attention. This should certainly be borne in mind when comparisons are made as to the number of engines turned out by works in this country and that by works in the States or elsewhere.

At the end of September in each of the past five years the official returns as to men employed in Hyde Park and other private British firms were as follows:—

	1896.	1897.	1898.	1889.	1900.
Neilson, Reid, and Co., Glasgow	2,360	2,600	2,937	3,275	3,331
Dubs and Co., Glasgow	1,868	2,004	1,931	2,017	2,128
Beyer, Peacock, and Co., Limited, Manchester	1,727	1,756	1,792	1,863	2,063
Sharp, Stewart, and Co., Limited, Glasgow	1,333	1,432	1,435	1,561	1,616
Kitson and Co., Leeds	1,192	1,190	1,357	1,440	1,444
Vulcan Foundry, Limited, Newton-le-Willows	770	752	894	1,047	1,075
Robt. Stephenson and Co., Limited, Newcastle-upon-Tyne	586	885	713	820	622
Nasmyth, Wilson, and Co., Limited, Patricroft	459	443	335	509	472
Manning, Wardle, and Co., Leeds	370	483	517	526	509
Hunslet Engine Co., Leeds	245	271	270	300	314
	10,910	11,856	12,181	13,363	13,574

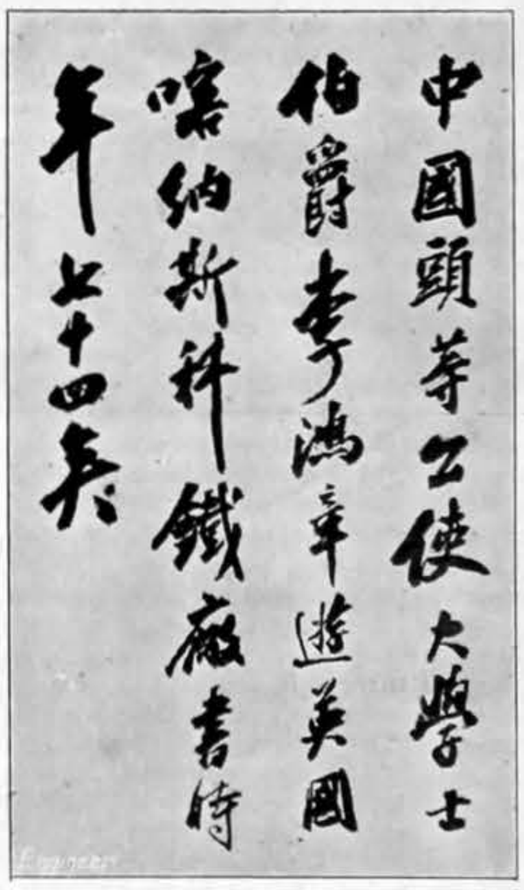
At the present time the number of workmen employed reaches 3500, and a few particulars as to the method of time-checking, &c., of this vast army of operatives may not be amiss. Each workman, on entering the service, is known by a number, and his entrances to the works are noted by the gate-keeper putting a chalk mark across the particular number which he calls through the window. The numbers are engraved on slates, each hundred occupying three lines, with the index number at the left-hand side. Until recently the men entered by two gates, one in Ayr-street and one in Flemington-street, with two recorders at each. The entrance in Flemington-street is now closed, and the numbers are taken by four men occupying movable offices, which are drawn across the gateway at meal times. From these offices the men also receive the tin boxes containing their pay on alternate Saturdays, and so effective is this method that ten minutes suffice to pay upwards of 3000 men.

The piecework system of wage earning is in force in many branches of the work in Hyde Park, in all departments; indeed, where it can conveniently and equitably be applied. This in itself is an assurance to the management of fairly expeditious and steady industry. As is only just and natural, nevertheless a watchful surveillence is exercised on the workmen as respects their regularity and steadiness. It is fortunately, however, of rare occurrence that the Hyde Park management have seriously to diminish their forces. An instance of the system observed in taking account of the workmen's time where the temptation to loiter is strong, and the detection of it difficult, as a rule, is found in the regulations for the use of latrines and similar conveniences. All such accommodation is provided at one place, and an attendant and time-checker is an important factor in the regulation of this department.

Here it may be stated that the foremen and under-foremen in all departments, not only receive their stated salary, but also benefit from a system of bonus-earning or profit-sharing based on the tonnage output and proportionate to their respective salaries; such bonus being handed to them at the half-yearly holiday periods—Christmastide and the Glasgow Fair.

While the Hyde Park Works are owned and administered by the sons of the late Mr. James Reid, the practical control of the huge concern in no small degree devolves on the managing staff so well organised prior to Mr. Reid's decease; the principal members of which indeed have been associated with the works from a time coincident with, if not prior to Mr. Reid's joining the concern. The chief of the designing and drawing department is Mr. Edward Snowball, who became associated with the Hyde Park concern a few years after its transference to Springburn in 1860, and though now ably assisted by younger lieutenants, still keeps firm hold of the manifold responsibilities of his position. The general working management is in the capable hands of Messrs. Thomas McGregor and Alexander Mitchell, both of whom very early in the history of the concern became hands in the shops, and have for many years occupied their present highly responsible positions, Mr. Mitchell having control more particularly of the producing as distinguished from the finishing and erecting branches. Under these principal heads there are—it almost goes without saying, considering the magnitude of the works—a number of assistant and department managers, all having well-defined duties to discharge.

With regard to expeditious output at Hyde Park, it may be noted that an order for twelve tank engines was received from the Nippon Railway in Japan, involving



LI HUNG CHANG'S SIGNATURE

entirely new drawings and patterns, to be delivered complete all within 139 days under the extraordinary penalty of £100 per engine per week, but the whole of the engines were passed in steam within 84 days from receipt of order. These engines weighed 31½ tons when empty, or nearly 40 tons in working order. An order was booked late in December for five heavy tank engines, weighing 45 tons empty, or close upon 60 tons in working order. The whole of these where shipped in 126 days, including the new year holidays. Last year orders from the War-office for South Africa were booked for thirty-one engines at various times from April 6th to May 24th, and the last was steamed on December 6th. Twenty-five of these were tender engines, each engine and tender weighing

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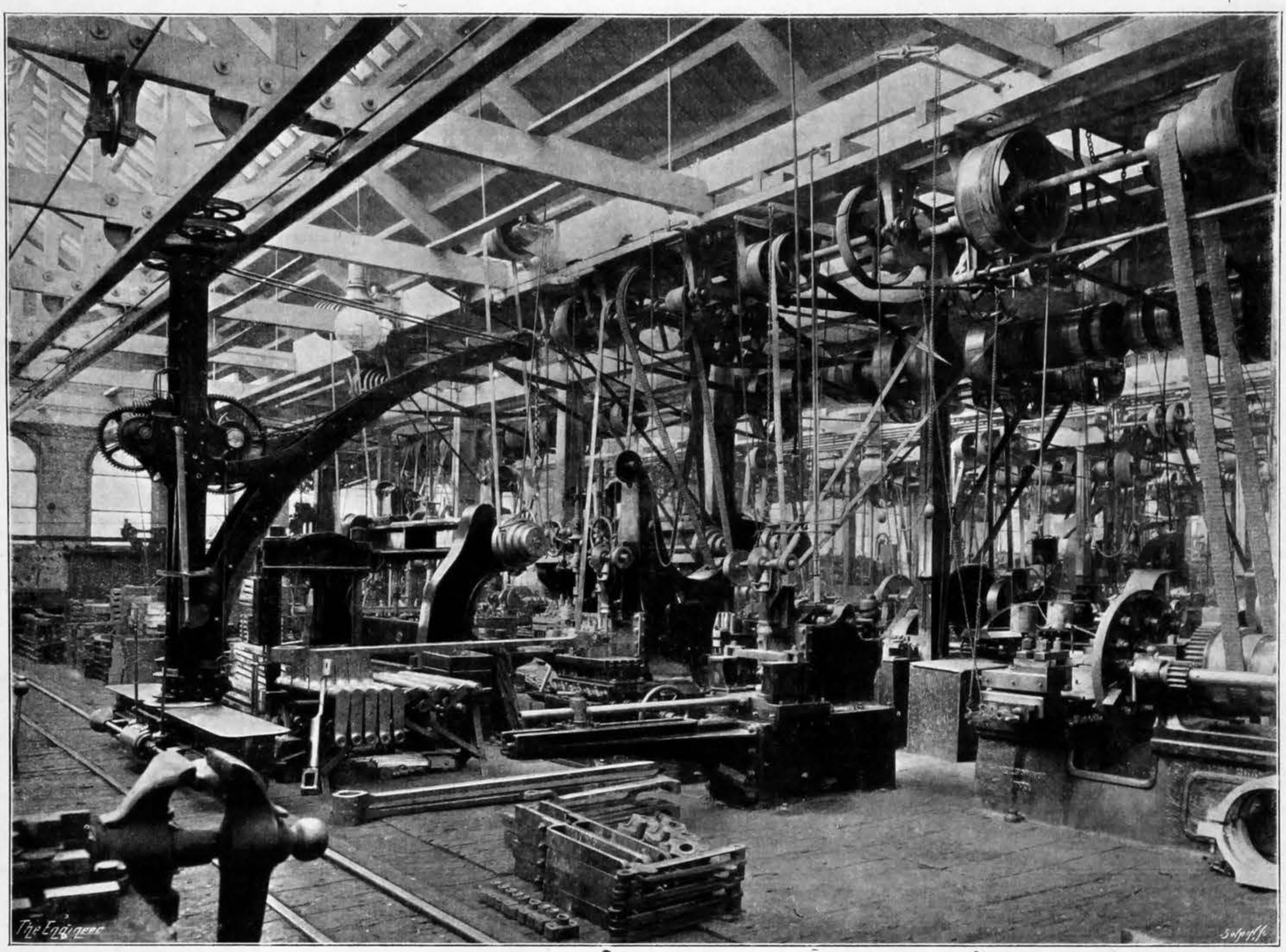

Fig. 22—MOTION GRINDING MACHINES

empty 59¾ tons, or 80¾ tons loaded, the rest tank engines weighing each 37¾ tons empty, or 52¼ tons loaded.

DINING AND ENTERTAINMENT HALL.

Attached to the works and intended primarily for the use of the employès in connection with their meals, but at the same time available and highly suitable for many other purposes, such as social entertainments of different sorts, is a large hall with spacious side and cloak rooms. With entrances from the works as well as from the outside street, the main hall, which has seating accommodation for about 1200 people, is 80ft. by 60ft., and is spanned by an arched iron roof. A gallery extends along three sides of the building, the fourth side being occupied by a spacious removable platform, 30ft. long by 14ft. deep, placed in an arched alcove, thus avoiding any necessity for encroaching on the floor space. The gallery is also carried on cantilever viaducts, and as columns are thus dispensed with the whole floor space is available for use. The value of these arrangements may better be appreciated when it is stated that one of the minor objects for which the hall was designed was its use as a drill hall. During the day excellent light is obtained through the glass roof —evidence of which is afforded by our view of the interior, Fig. 32, on page 540—and for evening use both gas and elecric light installations are provided. Adjoining the hall are spacious kitchens, fitted with all modern requirements for cooking for a large number of men; and there are in addition ample lavatory and cloak-room accommodation, besides three side rooms, the largest of which is 43ft. by 17ft. A caretaker's house completes the internal accommodation. The exterior of the building has a castellated façade of red brick with white sandstone. The buildings were designed by the works' staff, and reflect credit for their completeness. This feature in the amenities of Hyde Park Works, from the point of view of the social well-being of the workmen, is one which all sections appreciate.

THE WOODFORD AND ILFORD RAILWAY.

THIS useful local line, authorised by the Great Eastern Railway (General Powers) Act of 1897, is now making rapid progress towards completion. Intended to develop a new district which, in spite of total absence of railway accommodation, has steadily increased in population, it will open up the beautiful residential neighbourhood of Chigwell, and also afford a convenient route for the crowded inhabitants of Romford and Ilford to get to Epping Forest. Hitherto it has been necessary for dwellers on the Loughton and Epping line to go round by Stratford to reach stations on the Colchester main line, at considerable expense of time and money, but with the increased population along both routes this has been felt as a grievance. From the railway company's point of view the relief to traffic at Stratford will also be an advantage worth having.

The new connecting link in question begins between the Woodford and Buckhurst Hill stations of the Epping and Ongar branch, at a point about nine miles five furlongs from Liverpool-street. The junction will be in a cutting where no connection yet exists, but a few yards off the works commence, and a heavy embankment is being carried out to cross the valley of the Roding. A short break, yet to be filled up, brings the line to the river Roding, ordinarily a small enough stream, but liable to floods at times. A viaduct of three arches, faced with blue brick, of about 30ft. span, crosses this, only the middle arch being over the normal bed of the stream. The centres of these arches were still up at the date of our visit. A temporary bridge of wood, south of the viaduct, carries a rough single line of rails across the river. This, in fact, extends throughout the works from end to end. From a little further on, the embankment is all tipped as far as the site of the Chigwell Station, about 1½ miles from the junction near Woodford. Near Chigwell is a shed for some of the engines, water being provided there and at two points at the bottom of the long bank. At Chigwell the line goes under the main London and Ongar high road, the bridge floor is of six girders with jack arches, and is finished all but the parapets. Meanwhile the road is diverted. A large space succeeding is to be the site of the station, but so much earth has still to be got out that the buildings have not yet been begun. There will be a bridge over it at the further end also, carring Hainault-road. The foundations for this are being put in, a wooden bridge carrying the road traffic. On this piece of work, east of Hainault-road, two steam navvies are at work. The cutting, which is in the upper London clay, soon leads up to a short tunnel through the shoulder of a hill. Two shafts have been sunk, the pit heads at the top showing from a long way off and giving the impression that coal has been discovered, to those who are ignorant of their significance. The tunnel is being lined, of course, with brickwork.

At this point the direction of the line, which has been eastwards, begins to curve round to the south. The character of the country suddenly alters from an exceedingly pretty, wooded and hilly champaign, to the bare, almost treeless, level known as Hainault Forest. From the top of the hill by the tunnel shafts, beautiful views across the Roding Valley to Epping Forest on the one side, and over the great levels stretching away to Romford and the Thames on the other, may be had. Coming out of the tunnel, the line goes under Manor-road, a little below Mount Pleasant. Here the bridge is about finished, the flooring having just been asphalted; the usual temporary divergence of the main road is to the south. Another station site is being prepared at this place, in a shallow cutting. The point is convenient for the large village of Chigwell-row, the centre of which is distant about a mile. Another embankment now succeeds to the hilly Chigwell section, running out over Hainault Forest for a couple of miles in a straight line. Two stations are being built on this embankment, at about five and nine furlongs from Manor-road. They are at roads which cross the Forest from east to west, but have no population near them, and seem to be intended rather for prospective than present needs. In both cases the platforms rest upon blue-brick viaducts, the railway running on the bank between them. Except a short gap between the two stations, this section is practically finished. The girder bridges over the roads adjacent to them are by E. C. and J. Keay, Limited, of Darlaston.

The bank ends near Barking Side, where an overbridge with long sloping approaches runs from the corner of Tanner's-row by the church. A station here is partly constructed, the platform walls and those of the offices to just above ground level being in. This station will be of as much utility as the last two will, apparently, be of little. The overbridge is not yet open to the public, the temporary line of rails used in tipping the slopes being still down. From Barking Side the line runs into a short gravelly cutting, much of which is still unexecuted, at the back of a hamlet called, from its principal hostelry, The Horns. A temporary overhead foot bridge and the wing walls for the permanent structure are completed, and the foundations of a road bridge are being proceeded with. A steam crane for getting up the spoil, and pumping plant for ridding them of water, are laid down here; another navvy or excavator lies a little further on. About half a mile further Hatch-lane is reached, on the north side of which a station yard of ample size is partly excavated. It will serve Ley-street, where a large number of working-class houses has sprung up of late years. The line goes under the road. Yet another steam navvy, advancing from Ilford way, is here, close up to where the road will require a bridge. An hotel is to be built, the plot of ground for it being already boarded off. A bit of rough common comes after Hatch-lane, the line running in a shallow cutting of gravelly soil, with brick earth below. Approaching the Colchester line of the Great Eastern, a double curve begins at Vicarage-lane, the left-hand branch leading to Seven Kings Station, and the right-hand one through Cauliflower brickfields to Ilford carriage sidings junction, where it joins the main line, five or six furlongs east of Ilford station. At Vicarage-lane an over-bridge for the road will be necessary, the spoil for which is already tipped, whilst a temporary wooden bridge, just made, will be brought into use, and the level crossing discontinued very shortly. In the triangle of lines between the two curves and the Great Eastern main line is another engine-shed and a quantity of plant for use in the construction of the new work. The length of the easternmost of these curves, which is termed "Railway No. 2" in the Act, is about 400 yards, that of the western one being included in the total length of the Woodford and Ilford Railway, which is 5 miles 7 furlongs and 7 chains. The contractor for the whole is Mr. C. J. Wills, of Manchester and London. Amongst other engines of the large plant employed we noticed the six-coupled saddle-tanks Stockport, Milford, Heatley, Ribble, and Gertrude, and the four-wheelers Kaffir and Lord Mayor, the last three named having outside cylinders. The temporary road laid throughout the works is as strong as many permanent lines were not so many years ago, consisting of old permanent-way materials, with bull-head steel rails fished at the joints, and chairs of large size. Very steep inclines exist on it here and there, but the gradients of the finished line will not be exceptionally severe.

THE HYDE PARK LOCOMOTIVE WORKS, GLASGOW

(*For description see page 525*)

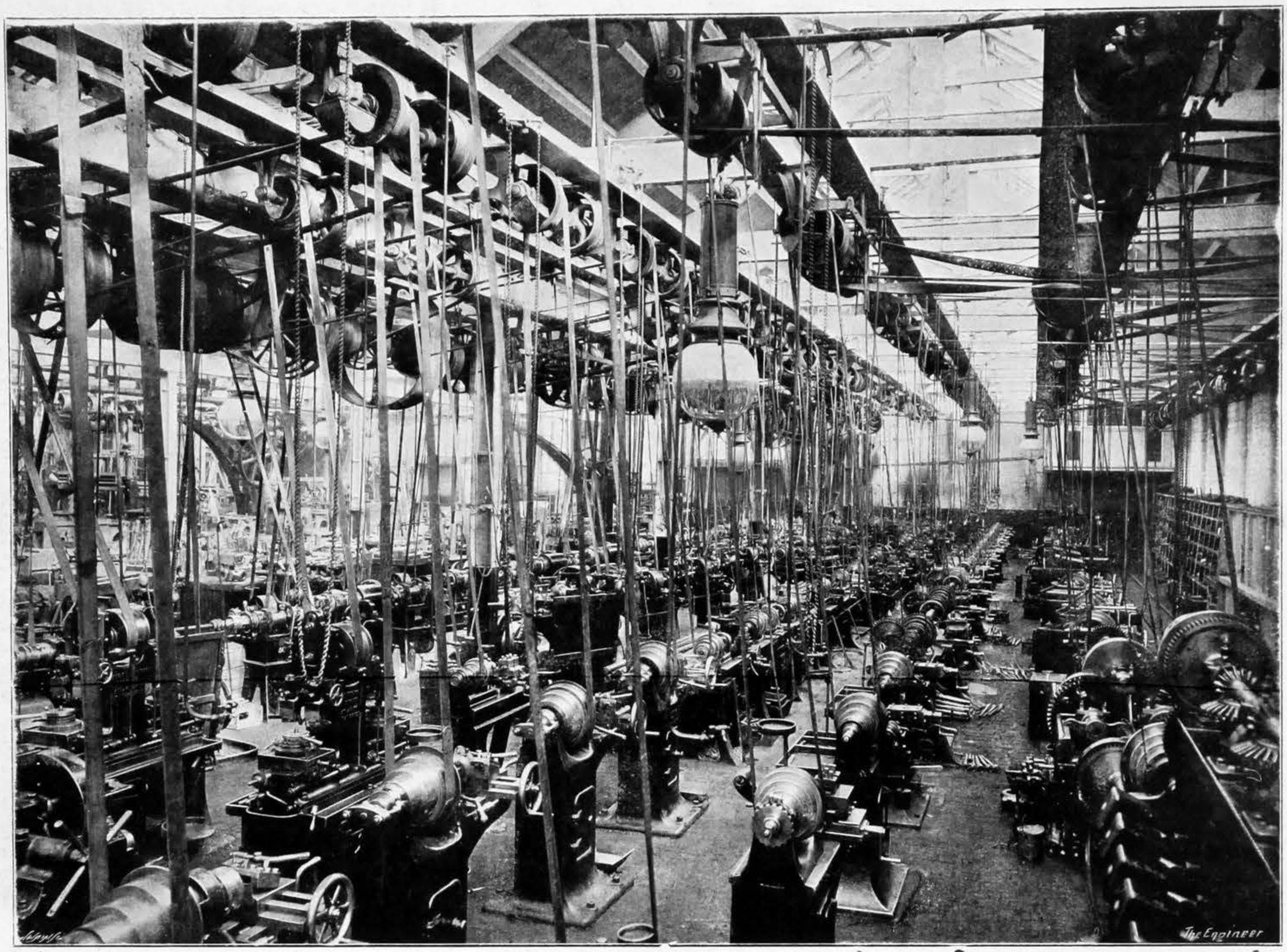

Fig. 23 LIGHT TURNING SHOP

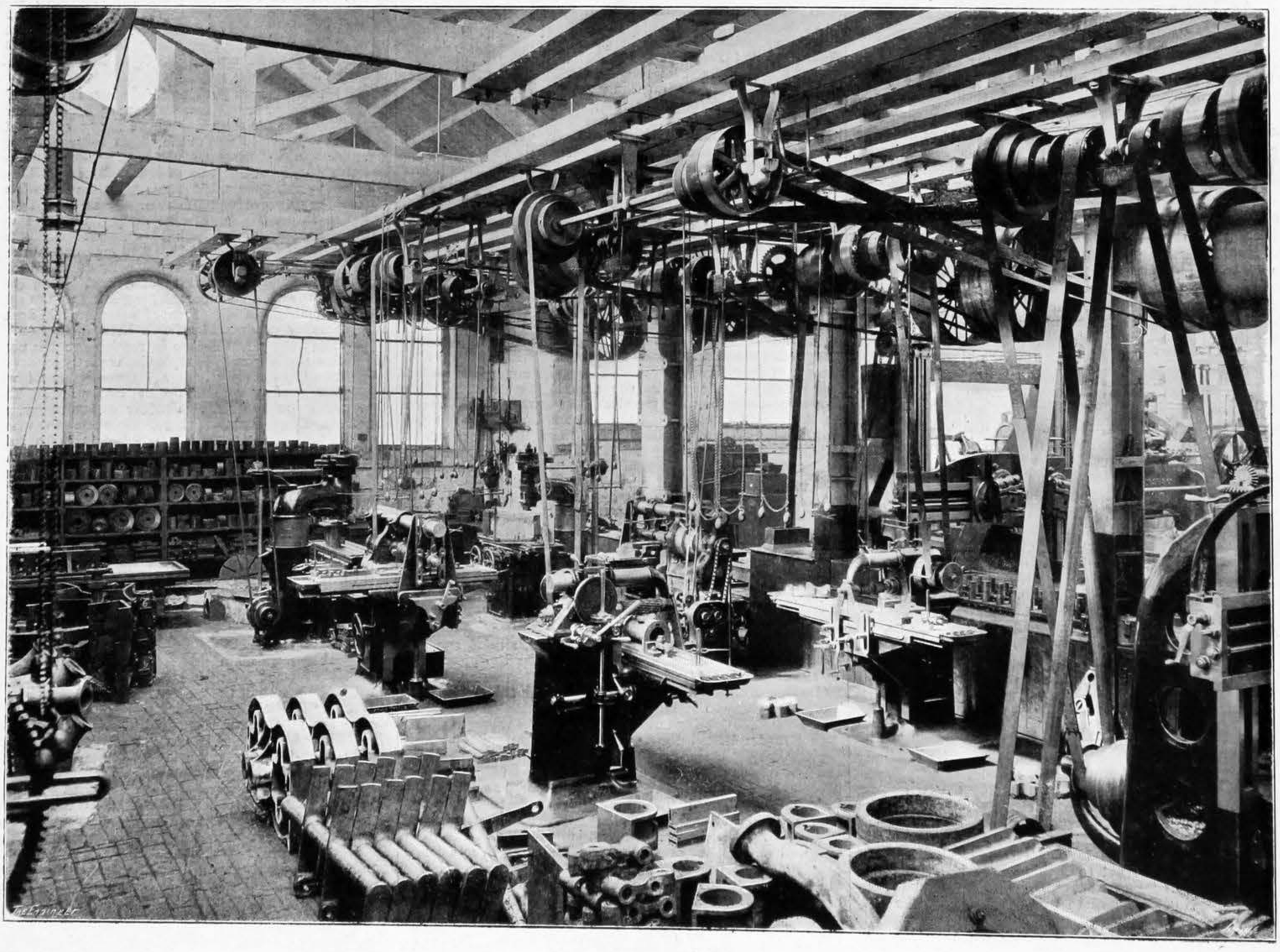

Fig 24—MILLING MACHINE SHOP

THE HYDE PARK LOCOMOTIVE WORKS, GLASGOW

(*For description see page 525*)

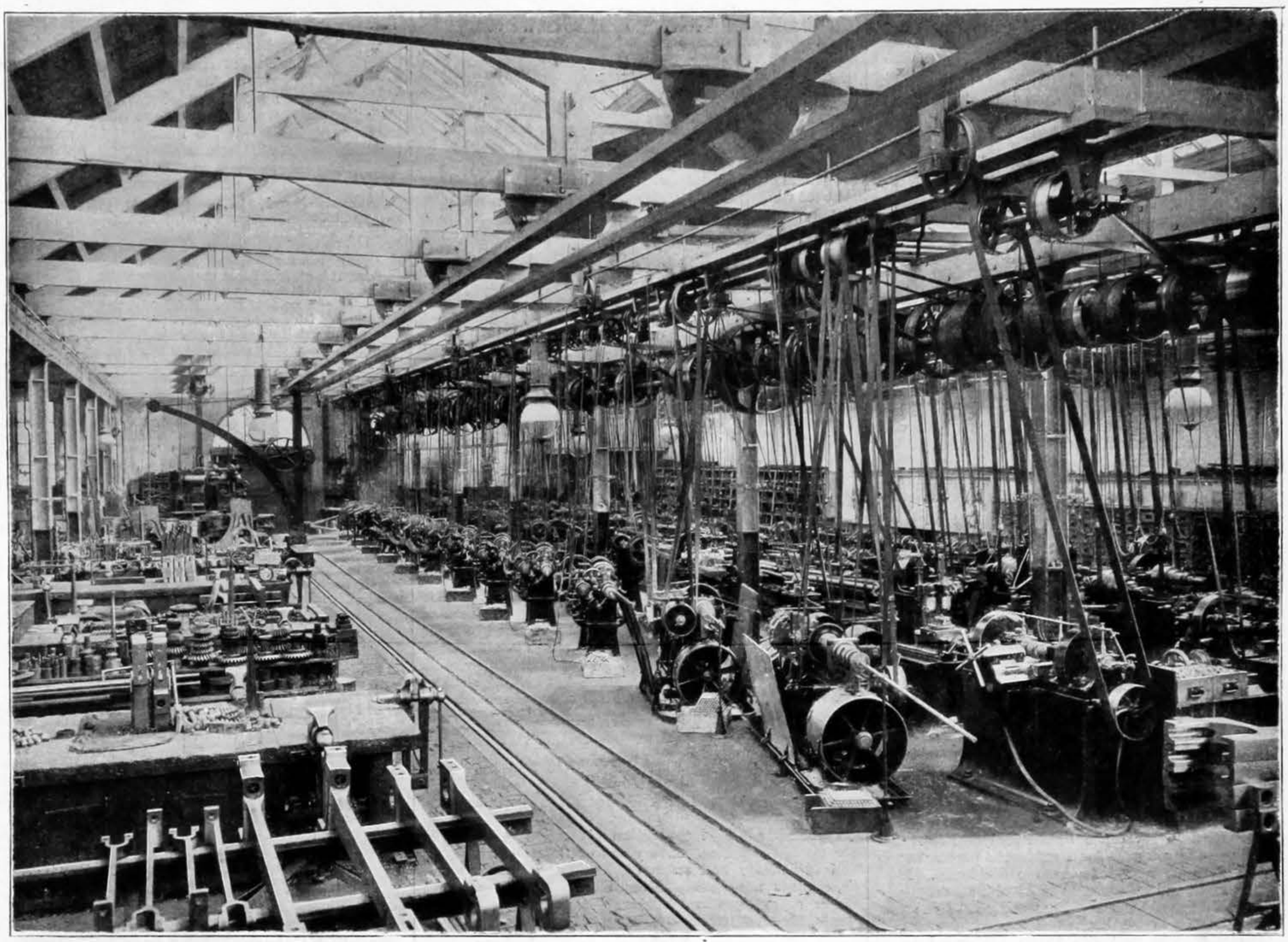

Fig. 25—AUTOMATIC MACHINES

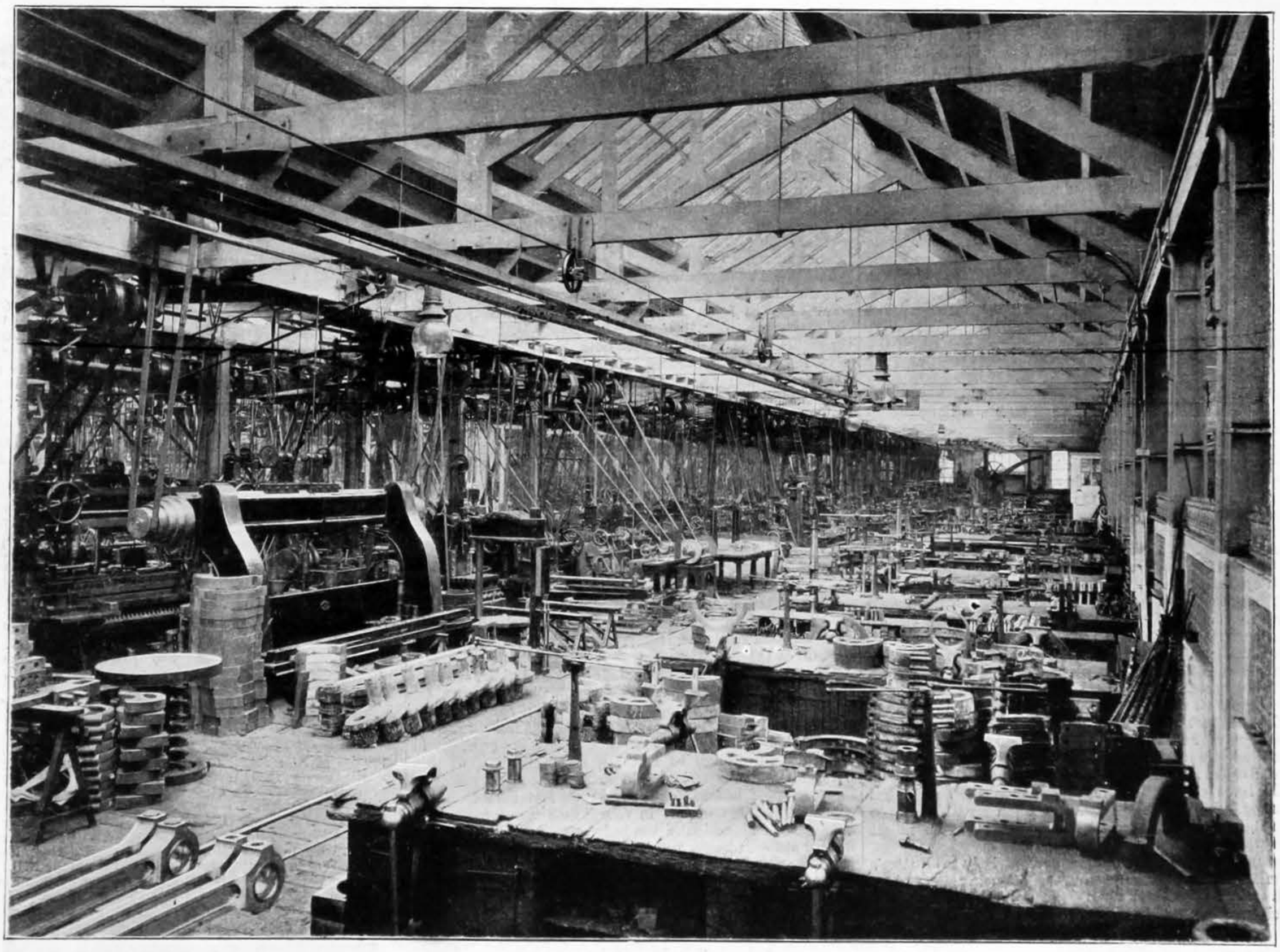

Fig. 26—FINISHING SHOP

LITERATURE.

New Tables for the Complete Solution of Ganguillet and Kutter's Formula for the Flow of Liquid in Open Channels, Pipes, Sewers, and Conduits. By Colonel E. C. S. MOORE, R.E., M.S.I. Published by B. T. Batsford. 1901. Thirty tables and one diagram. Price 15s.

THE devotion of the professional part of the human engineering race to formula and long rows of figures is a profoundly mysterious and pathetic psychological phenomenon. The longer one ponders it, the more deeply is one convinced that there are certain fundamental ingredients in human nature that remain unchanged throughout the æons. One of these is the imperative need of the human mind to worship what it does not understand, and what it has no use for. For many a long century stocks and stones satisfied this mental necessity in the elementary form which it took in the babyhood of mankind. The stocks and stones were hewn and chipped into very angular and ragged shapes, and were worshipped with more and more blind and abject reverence the uglier and bonier they grew. They grew very ugly and very bony indeed, and men who mingled piety with a far-sighted and calculating prudence found it profitable to imitate them in personal angularity by reducing their bodily frames to emaciated skeletons. These men justified and supported this bony existence by help of astrological and other runic complex calculations which pretended to wrest secrets from the heart of Nature, but which were based upon not a shadow of a trace of a relation with the true living nerve and muscle of Nature's physiology. When at last they were found out, men could not worship them any longer, and had to search for more modern stocks and stones. China led the way in giving up the emaciation business, for which it had gone in heavily in its earlier history, but to this day it maintains the runic astrology as a strong political and social force. European nations in the past century found it necessary to invent new forms of meaningless and therefore mysterious numbered diagrams. The latest and most improved, up-to-date, and go-ahead fetish is the most subtle and most powerful of all the generations of all the fetishes. He is the Algebraic Formula and the Seven-Place Decimal. Everybody has implicit faith in the Algebraic Formula, because nobody understands him. Not being able to trip him, or to cut him up, or to tear him in pieces, they stand in fear and awesome trembling before him, and let him have his way. He rules in all the designing offices without question or hindrance, and poor Nature, asking for only a little attention and consideration, slinks away unheeded. And when he blossoms out and matures in the fruit of Seven-Place Decimals, men bow down in reverence before him and subscribe share capital, and ask only for a moderate percentage of their capital to be repaid to them in dividends. Most men are modest, and take care to leave him alone.

It is touching to observe the pious attitude of the professional engineer in his behaviour towards the Seven-Place Decimal. The first rite to be performed is, of course, to pay his guinea for his fifteen millions of printed figures which are to help him to tell the Public Works Committee whether the new sewer is to be 3ft. or 3½ft. in diameter. The payment of the guinea produces a glow of holy satisfaction and content. Then, if there be no pressing call at the telephone, he turns over the pages of the tables in awe-stricken dreamy admiration of the endless maze of S.P.D.'s rising tier upon tier in giddy columns *de profundis ad astra*, and stretching left and right from $-\infty$ to $+\infty$. Somehow they always seem to average in O, but this is only the effect of the daze upon the eyesight. The third rite to be performed is quiet contemplation of the shelves and pious consideration of in which place they—it, he, the fetish, the S.P.D.—would look best. The place is chosen, and the Tables are laid up in it. They lie there. They are taken down once every two years, to see that the S.P.D.—*Spiritus Pontificus Divinus*—is still there all right in his pristine glory and magnificence, and has not shrivelled into any semblance of common sense; also in order to wipe the dust off. From his quiet resting place upon the shelves, the Spirit is breathed throughout the office, and pervades the minds of engineers, without noise or effort, with potent inactivity. It is enough that he is there; he penetrates without pushing; he dominates without energy or the possibility of a germ of energy arising within him.

Colonel Moore's newly-published tables for liquid flow in pipes, et cetera, are deduced from Kutter's well-known formula for the velocity of flow, which contains three constants besides a variable coefficient measuring the roughness of the surface of the channel. The constants are derived from experiment. On pages 214 to 215 Colonel Moore gives in three tables very useful figures, showing examples of the roughness coefficient obtained in different circumstances. This coefficient varies through considerable ranges, even when the conditions are apparently not much changed. A large collection of examples of this variation are to be found in Hamilton Smith's classical memoir. Slight alterations of condition that cannot be measured, and which cannot in their nature be maintained uniform from day to day, exercise material influence on the flow. Ganguillet and Kutter adopted three constants which made their formula fit in with such experiments as well as might be. Translated into terms of English feet and seconds, Colonel Moore gives these three figures as 41·6604676, 1·8113250, and 0·0028075. If he had left out the last six figures from the first of these, five from the second, and two from the third, he would have obtained the same degree of substantial accuracy. Indeed, the third has such small influence upon the practical issue of the calculation that he might quite well write ·003 for it.

Assuming that one should adhere strictly to Kutter's formula, Colonel Moore's method of using it is very good. In its original shape the formula makes the velocity equal a function in which there appear 13 symbolic factors. This is too many for practically useful rapidity of calculation. Hence the numerous tables published to facilitate the application of this formula. Besides, astrologically, 13 is an unlucky number, likely to lead to arithmetical break-downs such as sometimes result in a calculated diameter of $\frac{1}{16}$in. in place of 2¾ft. Colonel Moore, therefore, reduces it to the more seductive shape

$$v = \frac{N\,R}{\sqrt{R} + D}.$$

Here each of the two factors N and D involve both the gradient of the channel and its roughness coefficient. In all practical problems one can find out the gradient to be used with fair accuracy, and one may also guess the roughness coefficient to within, say, 50, or at least 80 per cent. of what will turn out to be, for a time at any rate, the truth. Hence, if you have tabulated a large number of values of N and D co-ordinated with measures of slope and of roughness, you can find suitable values of N and D to insert in the above formula, which then gives a comparatively easy calculation to find the velocity v for any given size of channel as measured by R, its mean hydraulic depth. The major part of Colonel Moore's book is filled with this tabulation of N and D for various slopes and various roughnesses. This tabulation occupies 165 out of the 230 pages of the book. The size of section being given, the hourly discharge can be directly and simply calculated from the velocity. Most engineers, however, grudge even this small amount of calculation, and most of the other published tables are founded on another shape of formula, such as permits, by dint of neglecting variations of roughness, the tabulation of both velocity and discharge for all likely sizes and inclinations.

Moreover, the above formula, although simple enough to use in the above way when the size is known, is of no direct use when the hourly cubic discharge is given along with slope and roughness, and when from these it is desired to find the suitable size. Converted into the form adapted to the solution of this more frequently recurring practical problem, it becomes an equation of the sixth degree, that is, one such as only a few hydraulic engineers are prepared to make use of. Thus with the help of Moore's tables, this problem of finding a suitable size can only be solved by the process of making trials of various guessed sizes, and finding by the above calculations whether they give more or less discharge than is needed.

The other tables referred to above which tabulate directly the discharge, can be used to find by simple inspection either the discharge with given slope and size or, conversely, the size needed for given slope and discharge.

The author in his introduction gives five examples of the use of the tables. Every one of these is a calculation of velocity and cubic discharge from given sizes. As regards minuteness of result these examples are rather more than satisfactory. Brought together, the results are as follows:—

	Velocity. Feet per second.	Discharge. Cub. ft. per second.
(1)	3·5583	42·699
(2)	5·02087	126·1884
(3)	1·3369	·060998
(4)	3·6216	33·1524
(5)	5·0177	126·194

It is most consoling, and makes one feel sure that the British Empire will not go to the dogs so long as we can do this sort of thing, to know that we can find out to the one-millionth part of a cubic foot per second how much liquid is flowing through our sewer. Examples (2) and (5) are from the same data obtained by different methods, the last reading the coefficients from a graphic diagram.

The discharge is calculated from the velocity by multiplying by the given section, and it is curious to note that the two discharges (2) and (5) differ only by one-tenth of the ratio in which the calculated velocities differ; and still more curious to observe that while velocity (2) is greater than (5), discharge (2) is less than (5). Into such incoherence does the S.P.D. lure the devotee.

In the tables the factor D is calculated to eight figures, and the factor N sometimes to six, generally to five, and sometimes to four. For the sake of regularity and simplicity, we think it would have been better to keep throughout to three figures for both N and D. N is the more influential of the two in the result of the calculation, and there is no reason why D should be more minutely tabulated than N.

A very strange defect in the tables is the irregular progression of the values of the roughness coefficient chosen for the succession of tables. This irregularity makes interpolation between the given figures extremely awkward and difficult.

The gradient is given by the reciprocal of the sine of the inclination. This also is made to progress in a strangely erratic fashion in the higher sections of the table. The steps in one part are by 5 and 10; in another part steps of 8, 4, 6, and 2 are mixed up in the same page in an incomprehensible manner. At the end of the table the largest of these steps means a difference of gradient of $\frac{1}{176}$in. per mile, or $\frac{1}{14080}$in. per chain, so that accurate and really careful levelling is needed to make full use of these tables.

The gradient starts with a slope of 1 to 1. This is certainly steep for hydraulic work, but small pipes are run at all manner of inclinations to the vertical, and if the tables are intended to help in such work, they should have started with a still steeper gradient than 1 to 1. The gradient is carried out to 21,120 to 1. Why the tables stop at this particular point is not explained. Perhaps the printer's fonte of type became exhausted; we feel sure that the finish at a slope of 1ft. in four miles was not due to collapse or exhaustion of the indefatigable calculator. If he had stopped half-way back at, say, 3000 to 1, we should have thought he would in that respect have satisfied all reasonable requirements. It is hardly necessary to mention that even the largest and slowest rivers have a fall much greater than ¼ft. per mile, and that such hydraulic slopes exist only in lakes and similar broad and quiet expanses of water.

Moreover, the gradients following page by page, commence and finish the pages in no systematic manner helping the easy finding of the place desired. We have such endings as 14,960, 7280, 4600, 2700, &c. This is certainly a disagreeable feature of the arrangement.

The tables, however, are beautifully printed in the clearest and most readable type, and on excellent paper. In this respect the publishers deserve the highest credit and the most ungrudging praise. Various other tables follow the main one above discussed. These for the most part facilitate the finding of the area and mean hydraulic depth of sections of various shapes and sizes.

SHORT NOTICES.

Commercial French. In two parts. By W. Mansfield Poole, M.A., and Michel Becker. Part I. London: John Murray. 1901. Price 2s. 6d.—A small hand-book intended for learners, say, from the age of fourteen to sixteen, who have been already grounded in the elements of the French language. At the normal rate of teaching it is proposed that the course contained in the book should spread over from two to two and a-half years. The present volume is the first of a series of two. It is hoped that the second part will be published later on in the year. The general idea is to take the student through a series of short abstracts in French, chosen for the usefulness of the words and phrases they contain. In addition there are intermingled with these phrases a number of sample business letters. By studying all these the student is gradually familiarised with a large number of words, and with the proper form of French business letters. Attached to each abstract and to each letter are a list of questions based on what immediately precedes it, and finally there is also attached a few grammatical exercises. The whole is written in French, and should prove of value to teachers and students alike, and will no doubt be of service to those intending to study French with a view to utilising it in commerce.

The "Royal" Road Book of England. A guide to the main routes throughout the country. With 300 contour plans. London: Gall and Inglis. Price 1s. net.—A most useful little book. The contour plans are small, but each one gives an excellent idea of the ground likely to be met with on over 200 separate routes. Those journeys which have no map are adequately described. Each map has, in addition to the contour, the names of the places passed through and the distance in miles. An index at the end contains all the names in the book. A lamp-lighting table is given which, in connection with a special map, tells at once the time for lighting up at any given place. The book also contains other useful information.

The Motor Engineers' and Electrical Workers' Hand-book. Published by William Lintern, West Park, Ohio. London: E. and F. N. Spon, Limited. 1901. Price 2s. net.—This book, which has evidently been designed for putting in the breast pocket, being 7in. by 3½in. by $\frac{5}{8}$in. thick, contains an immense amount of information likely to be of use to men in charge or having work in connection with electric trams or railways. There are in all twelve chapters. These deal with elementary principles, magnetism and electromagnetic induction, circuits, dynamos and their working, motors and tests, electric motor-cars and apparatus, controllers, &c., the whole being contained in some 150 pages. There is a number of illustrations.

Conduit Wiring and Erection, with special reference to the Simplex System of Steel Conduits. By L. M. Waterhouse. London: S. Rentell and Co. 1901. Price 2s.—This small book contains a complete description of this system of wiring, the whole installation being illustrated with, for the most part, excellent engravings. A series of tables are given, which show the maximum number and size of conductors which can be threaded through Simplex conduits; the capacity of stranded conductors, the comparison of wire gauges, and particulars of Simplex conduits. Those contemplating wiring premises on this system will find in this book all the information they may require.

Land Area Tables. By Wm. Codd. London: E. and F. N. Spon, Limited. 1901. Price 3s. 6d.—There are in all nine tables, mounted on a linen sheet some 14in. square. Three of them are conversion tables, and the others serve to find the acreage represented by areas on maps drawn to various scales. The form is convenient, and the tables are clearly printed. The tables fold up into a board cover.

BOOKS RECEIVED.

Sell's Dictionary of the World's Press and Advertisers' Reference Book, 1901. By Henry Sell. London: 167, Fleet-street. Price 7s. 6d.

Moteurs Synchrones a Courants Alternatifs. Par André Blondel. Paris: Gauthier-Villars; Masson et Cie. Price 2 francs 50 cents and 3 francs.

Society of Engineers. Transactions for 1900 *and General Index,* 1857 *to* 1900. Edited by Perry F. Nursey, secretary. London: E. and F. N. Spon, Limited. 1901.

Progress of British Newspapers in the Nineteenth Century. Illustrated. Supplement to Sell's "Dictionary of the World's Press," 1901. London: Simpkin, Marshall, Hamilton, Kent, and Co., Limited.

Electric Lighting: A Practical Exposition of the Art for the Use of Engineers, Students, &c. Volume II.: Distributing System and Lamps. By Francis B. Crocker. London: E. and F. N. Spon, Limited. 1901. Price 12s. 6d.

City and Guilds of London Institute. Programme of Technological Examinations, including regulations for the registration and inspection of classes in technology and manual training. Session 1901-1902. London: Whittaker and Co. Price 9d. net.

How to Avoid Payment of Debt. Intended to Show that it is Possible to Avoid Payment of One's Debts, and the Need for Legislation on the Subject. By a Solicitor. London: Simpkin, Marshall, Hamilton, Kent, and Co., Limited. 1901. Price 2s.

The Elements of Machine Design. Part I.: General Principles, Fastenings, and Transmissive Machinery. By W. Cawthorne Unwin, F.R.S. New edition, revised and enlarged. Eighteenth impression. London: Longmans, Green, and Co. 1901. Price 7s. 6d.

Public Water Supplies: Requirements, Resources, and the Construction of Works. By F. E. Turneaure and H. L. Russell. With a chapter on Pumping Machinery, by D. W. Mead. First edition. First thousand. New York: John Wiley and Sons. London: Chapman and Hall, Limited. 1901. Price 21s.

Excerpt Minutes of Proceedings of the Institution of Civil Engineers. Vol. cxliii. Session 1900-1. Part I. Edited by J. H. T. Tudsbery, D.Sc., secretary. Airy on geodesy. Body on the drainage of the Valley of Mexico. Bolton on the high office-buildings of New York. Cardew on the telautograph. Harriott on the Balram Dass Waterworks, Raipur, Central Provinces, India. Guttmann on machinery for the manufacture of smokeless powder. Hobson and Wragge on the metropolitan terminus of the Great Central Railway. Prentice on flow gauge for fire hydrants. Rawson and Broome on a stiffened suspension bridge on a steep incline at the Westport-Cardiff Coal Company's Mine, New Zealand. Shield on the height of waves at Peterhead, N.B. Wark on the use and durability of wrought iron pipes. Also abstracts of papers in scientific transactions and periodicals. London: Published by the Institution, Great George-street, Westminster. 1901.

THE HYDE PARK LOCOMOTIVE WORKS, GLASGOW

(*For description see page 525*)

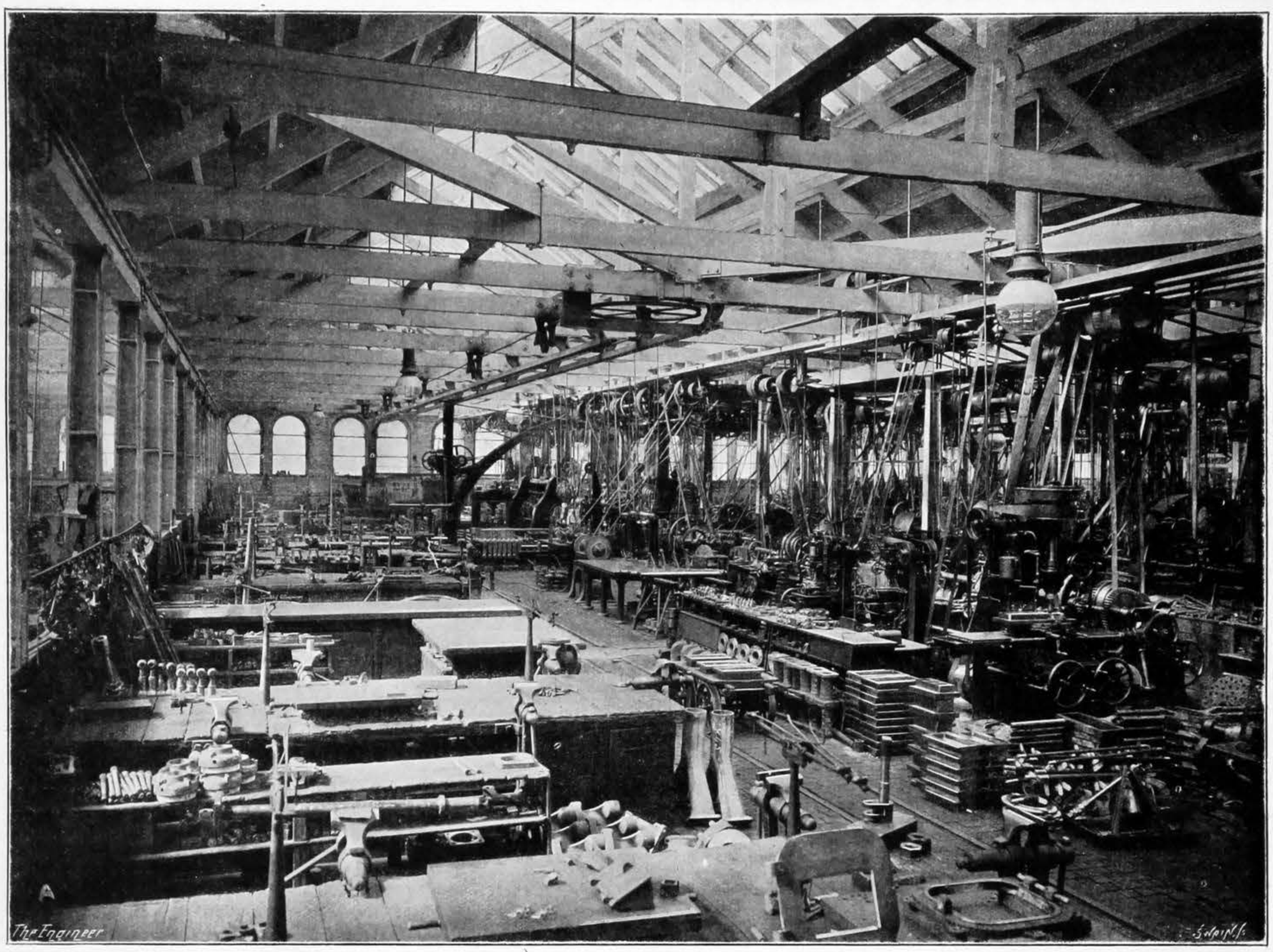

Fig. 27—PART OF FINISHING AND MACHINE SHOPS

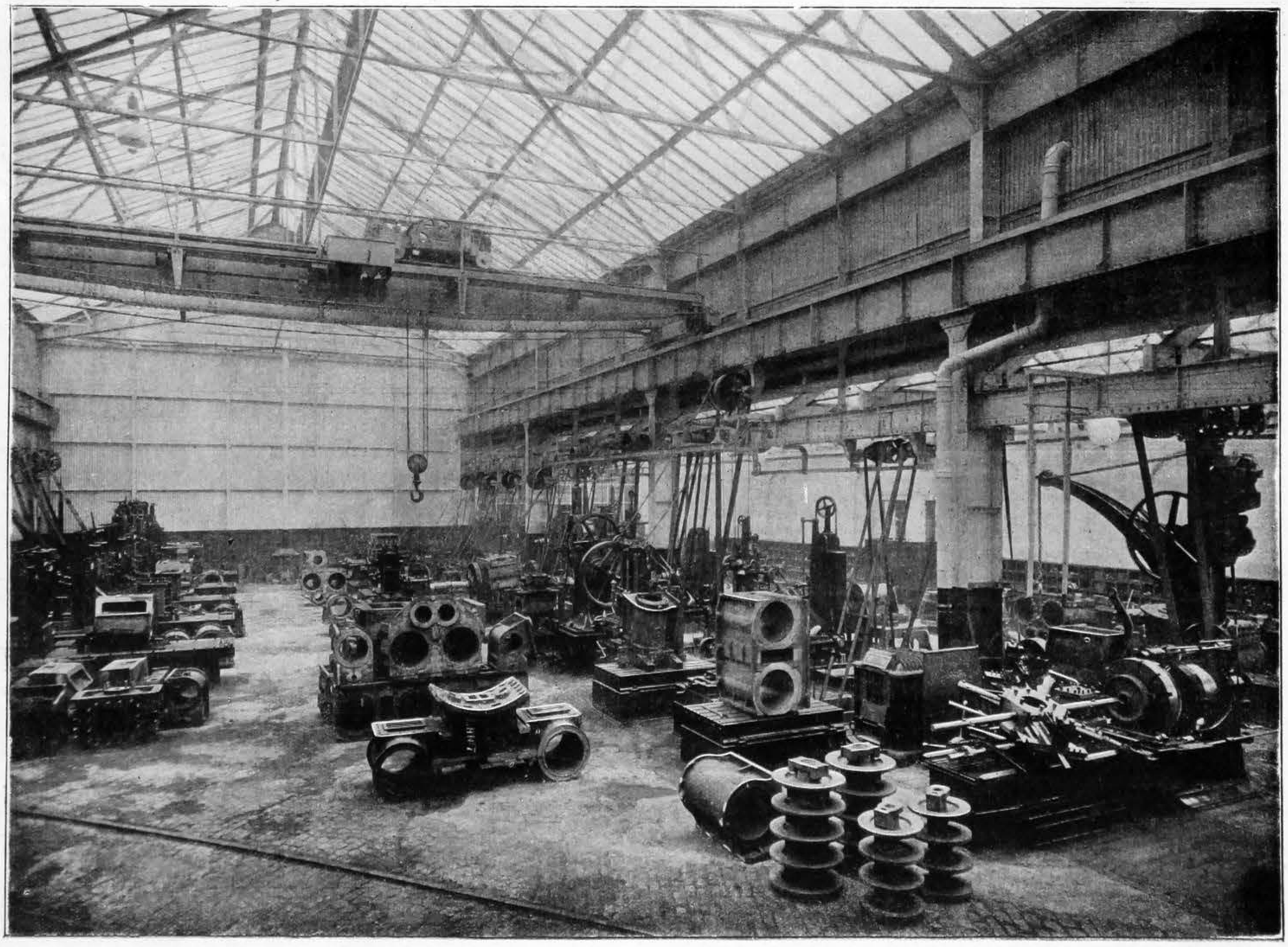

Fig. 28—NEW CYLINDER SHOP

THE HYDE PARK LOCOMOTIVE WORKS, GLASGOW

(For description see page 525)



Fig. 29—ENGINE ERECTING SHOP

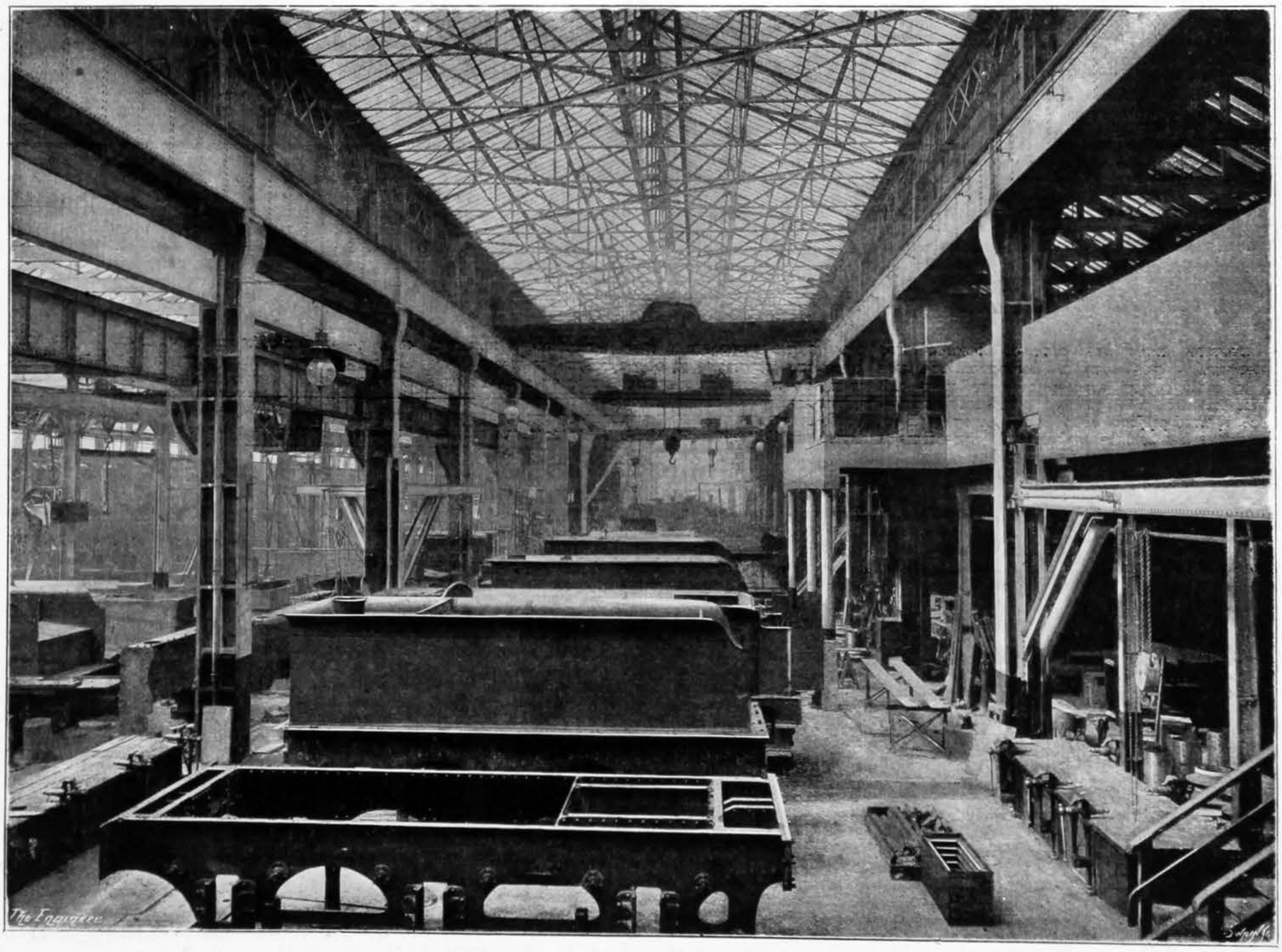

Fig. 30—TENDER ERECTING SHOP

CAST IRON PIPE IN THE UNITED STATES.

(*By our Special Commissioner.*)

No. VIII.

CONTINUING the description of the process of moulding the pipe we come now to the bead ring forming the bead on the spigot end of the pipe. It is formed from a semi-fluid "mud," made strong by an admixture of clay and wheat flour, while an iron ring is embedded in it to give it strength to prevent fracture when the molten metal is poured. This bead ring centres the upper end of the core in the mould. In its inner edge, facing the core, are formed six to twelve semi-circular notches, forming the gates through which the metal poured into the runner flows into the mould. Another similar notch, protected from the molten metal, forms the riser for the escape of air and gas as the iron fills the mould. The ring is baked in an oven, and is sometimes called the cake ring. The base ring, socket ring, and bead ring are made in separate parts of the foundry, independent of the manufacture of the core and mould, but the work is carried on systematically, so that the cores and rings will all be ready as soon as the moulds are dry. Each part is given a facing of lamp-black, and they are dried in separate ovens.

For forming the bead space in the moulds of pipe cast with the bell at the top of the flask, a special machine has been devised by Mr. James Thomson, and used for some five years by the Gartshore-Thomson Pipe and Foundry Company, of Canada. This is shown in Fig. 23, in which *a* is the pouring stool, and *b* the sand. The device is attached to the bottom of the pattern, and consists of two "slickers" or adjustable lugs *c*, hinged to a disc *d*, having a gear cut on the inside face. They are hinged so as to hang normally within the diameter of the pattern. Their outer edges are formed to the contour of the bead. When the pattern is lowered into the flask by means of the rod *e*, the two lugs catch on the top surface of the pouring stool *a*, and are forced outward as the pattern drops still further to its seat in the conical pocket of the stool, in which the base *y* of the pattern fits. Sand is then rammed into the mould in the usual way, as at *b*. The bottom piece of the pattern, or disc *d*, carrying the lugs, is then revolved by a pinion *h* on a rod *f*, which extends up through the pattern, being journalled in the top, and carrying a crank handle *g*. The revolution of the projecting lugs compresses the sand and forms the space of the bead. As the pattern is withdrawn the lugs fall inward by their own weight, so as to be clear of the mould.

One of the most important features of the design of a pipe foundry is the crane equipment, which will readily be understood when we take into consideration the amount of handling required for the flasks, moulds, patterns, cores, ladles, and pipes, &c. The use of travelling and jib cranes has already been referred to, and plans of both systems have been given. The Wellman-Seaver electric jib crane has also been illustrated in connection with the description of the Addyston plant in an earlier part of this article.

In a number of pipe foundries, however, hydraulic cranes are used, and drawings are here given of different types of such cranes built by the Morgan Engineering Company, of Alliance, U.S.A. Fig. 24 is a general cross section of the foundry of the Cincinnati and Newport Iron and Pipe Company—now absorbed by the "pipe trust." This shows a 10-ton travelling crane at the side, and two 30-ton hydraulic jib cranes serving the pit. These latter are of peculiar construction, having

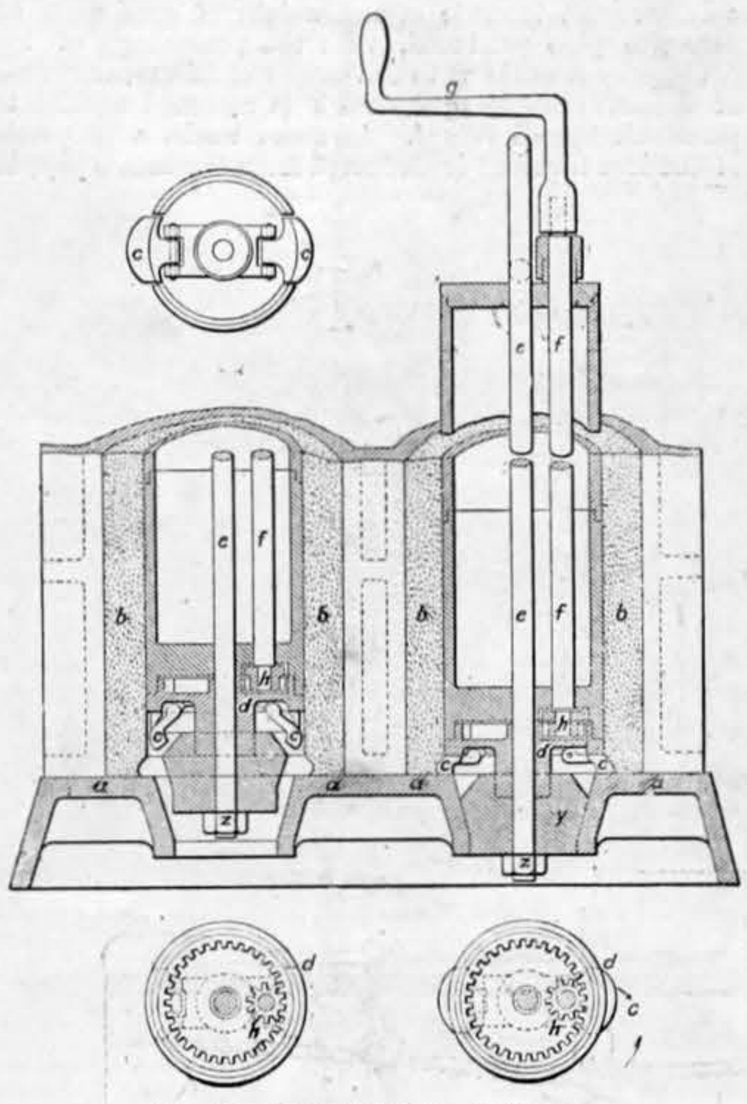

FIG. 23—PIPE BEADING MACHINE

horizontal plate girder frames or arms, with heavy struts and tie bars to the post. The carriage or trolley on the plate girder has a travel of 20ft., and is operated by the piston-rod of a hydraulic cylinder mounted horizontally upon the girder. All the operations are controlled by means of levers arranged at the base of the revolving crane post. The clear inside width of the building is 90ft., and the height from the floor to the horizontal boom of the roof truss is 32ft. The hydraulic cranes have jibs 30ft. 6in. long from centre of column, while the travelling crane has a longitudinal travel of 98ft., and a transverse travel of 7ft. 3in. for the hoisting trolley. In Fig. 25 are given other drawings of a somewhat similar crane built for the same foundry. This is of 30 tons capacity, with a lift of 16ft., and a travel of 20ft. for the hoisting carriage. It is fitted with hydraulic motors for revolving the crane post.

In Fig. 26, page 535, is shown a double-power hydraulic crane of 5 and 10 tons capacity, built for the Addyston Pipe and Steel Company—now also absorbed by the "trust." The column, arm, and strut are of built-up and riveted members. The carriage—instead of being operated directly by a hydraulic cylinder, as in the crane previously described—is operated by chains led to inverted hydraulic cylinders attached to the crane post. The hoisting chains are operated in the same way by a third hydraulic cylinder at the base of the column. The crane has a turntable base, with annular rack, and is revolved by hydraulic motors. The height of lift is 18ft., and the carriage has a travel or racking movement of 20½ft. Similar cranes of six tons capacity have been built for this same foundry.

When the moulds are ready in the casting pit, the cupola is tapped and the molten iron run into ladles holding from three to six tons of metal. If the iron is so hot as to be likely to injure the mould, the temperature may be lowered by the addition of a little scrap or broken pig iron. The dross or slag is skimmed off, and a handful of sand thrown on the metal near the spout of the ladle to keep back any fresh dross. The ladle is handled by a crane, and the man in charge of the pouring—who tilts the ladle by a hand wheel and worm gear—must keep the runner filled so as to prevent any impurities floating on the iron from passing down through the gates into the mould, and so perhaps spoiling the pipe. At the same time he must not let the iron overflow the runner and go to waste. The gases generated in the sand escape through holes and vents in flask and core bar, while the gas and air in the mould, which are displaced by the iron, escape through the risers at the top.

In certain cases the mould is "bottom poured" by a main gate about 1½in. diameter, leading down through the mould to an opening into the socket or bell. This lessens the chances of injury to the socket ring, and when this ring has been covered the main gate is closed, and the rest of the metal poured in the usual way. It is said that in the interval between the bottom pouring and the top pouring the metal in the bell may take a partial set or a skin may form on its surface; in either of which cases a "cold sheet" or seam may result. The specifications of the city of Cincinnati require this method to be adopted in casting pipes of 30in. diameter and over. Its use is quite exceptional, however, and the most general practice is to do all the pouring from the top.

When the iron has set, but is still red, and sometimes at a cherry red heat, the core is withdrawn from the mould by a crane, stripping the bar from the hay and sand, the hay blazing up in flames as soon as the air gets access to it. If large pipes are left too long, the contraction of the pipe may grip the core so tightly that it cannot be removed, and the pipe must then be broken up, or the hay must be slowly cut out with a long knife. With large pipes the core is usually withdrawn as soon as the hay rope is burned. The flask is allowed to remain in the pit until the pipe is black, sometimes standing in the pit all night. It is then lifted out and swung over a pair of skids. The clamps are knocked off, allowing the flask to open, the pipe dropping upon the skids, while the

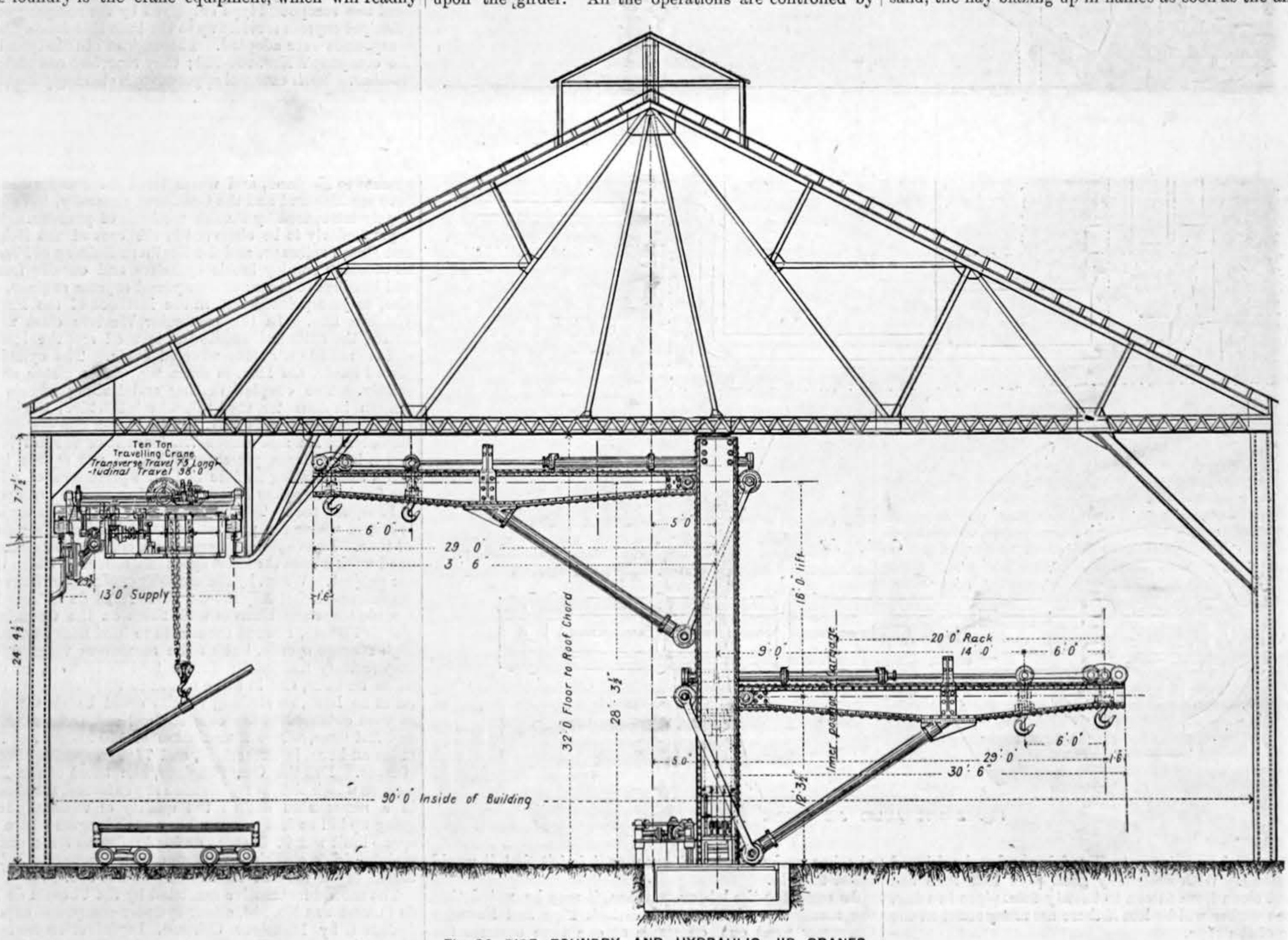

FIG. 24—PIPE FOUNDRY AND HYDRAULIC JIB CRANES

sand falls through into the pit below. The pipe is rolled outside of the foundry on a skidway or runway, and the flask, after being cleaned of sand, is ready for use again. In many cases the pipe is taken out while still at a dull-red heat, but this is probably the cause of many cracked and defective pipes, particularly in the smaller sizes, and especially with shells of unequal thickness, a condition which does occur occasionally, in spite of the most careful work. Pipe made in cold weather especially should be left in the pit until the red colour has disappeared, as internal strains may be set up by too rapid or unequal cooling due to exposure.

The pipe has now to be cleaned, the socket ring taken out, the adhering clay of the core removed with long rods

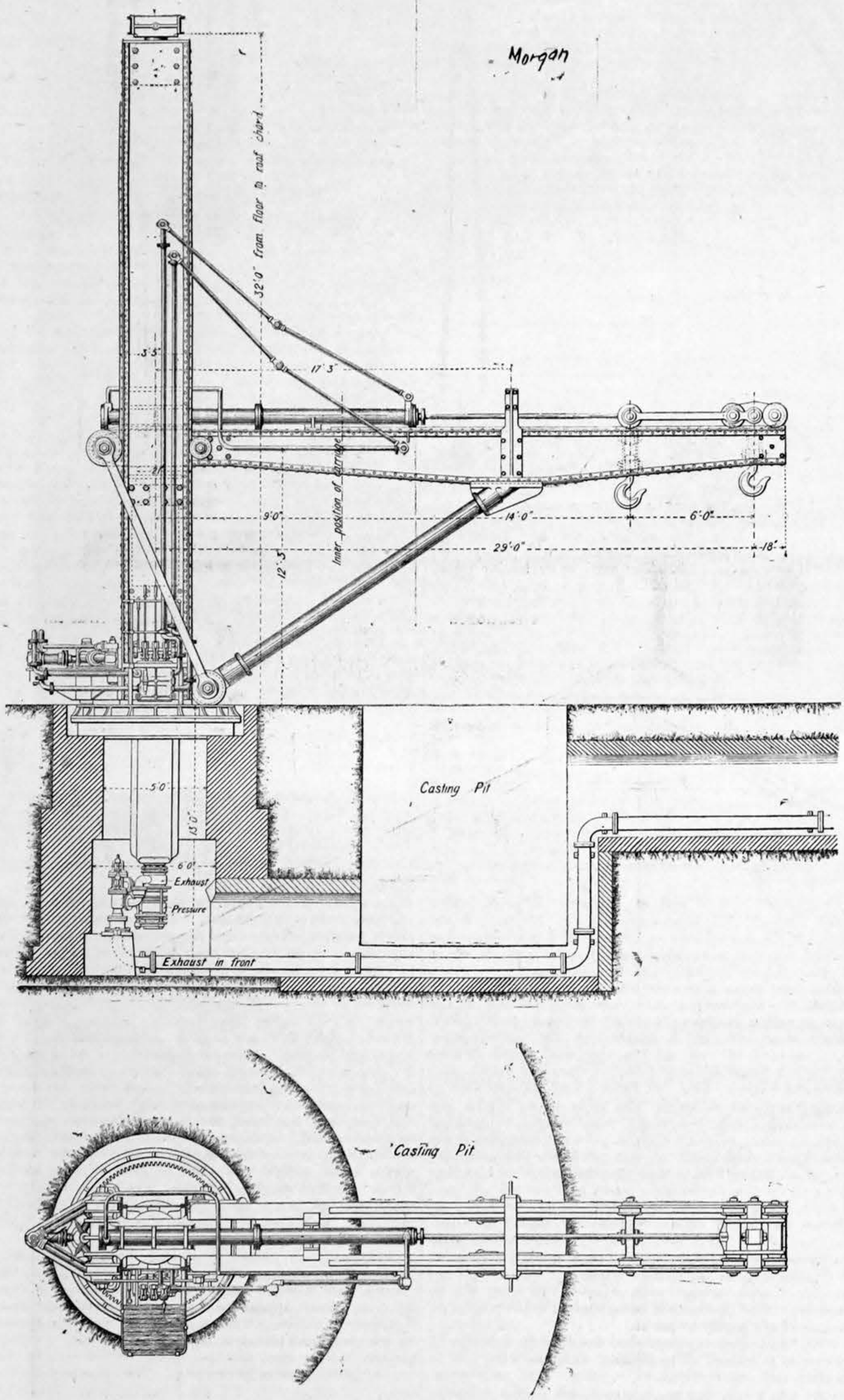

Fig. 25—HYDRAULIC JIB CRANE

and wire brushes, gates cut off, and fins and scabs chipped and cleaned. With ordinarily good pipe four men can chip and clean from fifteen to twenty 48in. pipes in a day, but the number will be less if there are many scabs on the surface of the pipe.

The first pipe of each size made each day is termed the weigh pipe. This pipe is taken to a special pair of skids and carefully measured to determine the inside and outside diameter, the lead-room or joint-room, depth of socket, and thickness of metal. If it conforms to the specifications, it is then weighed to see how near it comes to the standard weight specified, for a very slight variation in the diameter of the core or mould will make a material difference in the finished weight. If this pipe fully conforms to the specifications, the balance of the day's work is done to the same templates.

The finished pipes after being cleaned are examined for defects, and pipe to be used for water mains is dipped in a tar or composition bath. Pipe for gas mains is left uncoated. The pipes are then sent to the testing department, where each one is tested by hydraulic pressure of about 300 lb. per square inch, being struck a few sharp blows with a hammer weighing 1¼ lb. to 3 lb. while under test. Complete records are kept of each pipe, and a daily report is made of the weight of good pipe and defective pipe produced, with the percentage of loss. An inquiry is made as to the causes of failure, and in case of defective moulding the work is reported against the pit which turned it out. At some works a proportion of the loss involved is deducted from the men's pay, but at other works this is not done, as it is felt that it would cause trouble.

In regard to the labour question, it may be noted that the mechanics of the old American Pipe and Foundry Company went out on strike at one time because the company employed cheap unskilled labour for trimming and cleansing the pipes after they came from the mould. This work had formerly been done by the mechanics, and they demanded that it should be done only by men getting mechanics' wages.

Correction.—In article No. V. of this series in THE ENGINEER of April 19th, the works described beginning on page 390 are at Addyston, not Anniston. In the first part of the article, beginning on page 389, there is a brief description of the latter works—at Anniston—and the cranes employed there; while on page 391 is a view of the interior of the pipe foundry at that place. At the bottom of the second column on page 390, however, a description of the Addyston plant begins; the sentence, "A description of the 'Anniston' works will give a good idea of a pipe foundry," &c., should read "A description of the Addyston works will give," &c. This is particularly important, as the mistake tends to give the credit for making 7ft. pipe to the Anniston works, whereas it properly belongs to the Addyston works, which are under entirely different management and in a different part of the country.

LOCOMOTIVE EXHIBITS AT VINCENNES.

By CHARLES ROUS-MARTEN.

No. VIII.

THE third locomotive belonging to the Chemin de Fer l'Etat, or State Railway of France, shown at Vincennes—the second exhibited by the company itself—was a non-compound having no very special or exceptional characteristics. It was a four-wheeled coupled outside cylinder express engine, with a leading four-wheeled bogie. The cylinders were 17¾in. by 25½in.; coupled wheels, 6ft. 7½in.; steam pressure, 199 lb. per square inch; weight in working order, 50 tons. This engine, No. 2754, differed from the standard Etat type in use prior to the advent of the compounds and Americans mainly in having a leading bogie instead of a pair of leading wheels; and higher steam pressure, 199 lb. instead of 184 lb.; also in having a wind-cutter front of a pattern similar to that used with the latest Paris-Lyons-Mediterranean engines, and described in my article No. V. It was of a useful but not remarkable type.

Having now referred to the Vincennes exhibits of the Nord, Orleans, Midi, Paris-Lyons-Mediterranean, and Etat railway systems, while the Est Exhibition engine has been dealt with by another pen, I have next to notice the Chemin de Fer de l'Ouest, or Western Railway, the only one still remaining unmentioned among the main lines of France. To avoid misconception I may as well say, although perhaps this is unnecessary, that the order of sequence which I have adopted has been, as usual, that of "Bradshaw's Guide," so far as possible—my only exception being where convenience of grouping required—and that, therefore, the Western line comes last in my list merely because it does so in that of "Bradshaw," not by any means as a matter of relative merit, for the Ouest is entitled to a high place in respect of its locomotive practice and of its work under difficult conditions.

In the Vincennes Annexe, the Chemin de Fer de l'Ouest was represented by three locomotives. One was of the standard non-compound type employed by the company on its principal express services up to the time that four-cylinder compounds were adopted. The engines of that type bear the company's Nos. 939-998; they therefore are sixty in number. Their external appearance is strikingly English; they have inside cylinders, Gooch valve gear, Crewe-pattern dome-cover, Ramsbottom safety valves, Midland type of splashers. It may not be deemed disrespectful for me to point out in this connection that all the European continental railways which geographically approach nearest to England, and which form the communication between England and the Continent generally, have been largely influenced by British methods of practice. This is particularly to be observed in the case of the Belgian and Dutch railways, and the Northern Railway of France, all of which employ inside cylinders and outside frames and bearings in their non-compound express engines, and also, as just pointed out, in the instance of the French Western line. In the particular Western class under notice, the extended smoke-box is used and the leading end is carried on a four-wheeled bogie. The cylinders, placed inside, are 18in. in diameter, with a piston stroke of 26in. The coupled driving and trailing wheels are 6ft. 8in. in diameter, the bogie wheels 3ft. 2in.; the boiler, of telescope design, is 12ft. 1in. in length and 4ft. 3in. in diameter. Its axis stands 7ft. 5in. above the rail level, and it has a steam pressure of 156 lb. per square inch, and a total heating surface of 1309 square feet, of which the fire-box supplies 107·6 square feet. The grate area is 19 square feet. The engine weighs 46 tons in working order, of which the proportion available for adhesion is 28 tons. I have always found these engines do extremely good work within the strict speed limitations to which they are subject. When, by the courtesy of Monsieur Sauvage, Ingénieur-en-chef-Adjoint du Matériel et de la Traction, I made some experiments with them on the Chemin de Fer de l'Ouest, I found them able to haul heavy trains at high average speeds, but as the maximum velocity was imperatively limited by decree to 100 kiloms., or 62·1 miles an hour, and in some places to 90 kiloms., or 55·8 miles an hour, no striking results could be shown, such as were obtained in the case of the Nord, Orleans, Midi, and Est lines, where a maximum of 120 kiloms., or 74·4 miles an hour, is authorised, and 77·5 in special circumstances. But the Ouest engines, like those of the Etat line, on which similar restrictions are enforced, manifested in a remarkable degree the quality of uniform merit, going up hill as fast as down hill on the lengths where the speed limit was 90 kiloms., or 55·8 miles an hour, and so maintaining a singular evenness of rate throughout. The engine of the class at Vincennes was No. 951.

The second locomotive exhibited by the Chemin de Fer de l'Ouest was No. 533, a four-cylinder compound express designed by Monsieur Clérault, Ingénieur-en-chef du Matériel et de la Traction to that railway, and compounded on the de Glehn system, as in the case of the four-cylinder compounds shown by the other French railways. Like them, it has two high-pressure cylinders placed outside driving the trailing wheels, and two inside driving the third pair of wheels. The steam is distributed by the Walschaert valve gear in the case of both pairs of cylinders. The cranks are set at an angle of 180 deg. Intercepting apparatus permits the engine to be worked as compound or non-compound at the option of the driver. The two high-pressure cylinders placed outside are 13⅜in. in

DOUBLE-POWER HYDRAULIC CRANE FOR PIPE FOUNDRY

(*For description see page* 534)

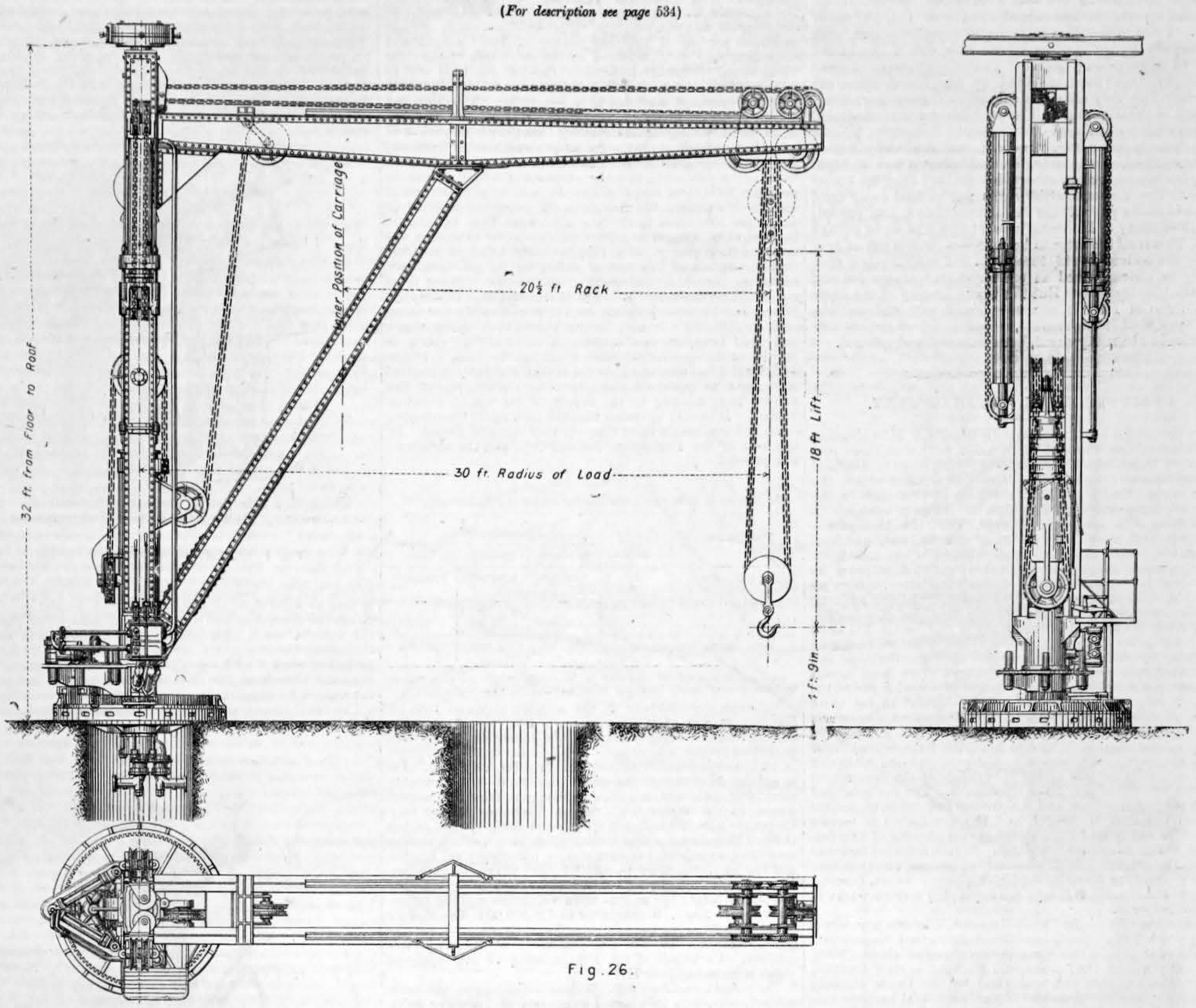

Fig. 26.

diameter; the two low-pressure, inside, 20⅞in.; the piston stroke is 25⅛in.; the four driving wheels are 6ft. 7in. in diameter. The boiler is 12ft. 5¼in. in length between tube plates, and 4ft. 6⅜in. in internal diameter. The axis is 8ft. 2in. above the rail level, the total heating surface 1439 square feet, and the steam pressure 199 lb. per square inch. The total weight in working order is 48¾ tons, adhesion weight 30½ tons. There are forty of these locomotives at work on the Chemin de Fer de l'Ouest, numbered 503—543.

They were preceded by two experimental engines, Nos. 501 and 502, built in 1893, which resembled them in most respects, but were slightly smaller in all dimensions excepting the diameter of the driving wheels and the length of the piston stroke, which were identical with those of the later locomotives. Monsieur Sauvage, the able Ingénieur-en-chef-Adjoint, writing as to several years' experience with the two pioneer engines of the type, remarks that if they cost a little more than ordinary two-cylinder locomotives, this excess finds compensation to a large extent in economy of fuel, while the expense of upkeep and repair does not appear to increase. Compared with eight of the non-compound Western engines, of the standard type already described, and employed alternatively on the same duty, these two four-cylinder compounds were found to show an economy in coal to the amount of 12 per cent., which M. Sauvage believes would have been still larger had not one of the engines, owing to some small hidden defect, exhibited a persistent excess of fuel-consumption over its sister engine. Special care was taken to employ the two compound locomotives on various classes of service, to use fuel of an exactly identical kind for all, and to change frequently the drivers and firemen. The cost of oil was no greater in the case of the compounds than in that of the non-compound engines, while the wear of the valves was less in the case of the compounds in spite of the higher steam pressure employed, and the wheel tires of the compounds ran 36,000 miles without re-turning, as compared with 32,000 miles in the case of the non-compounds. It is held by M. Sauvage that as with four cylinders each cylinder performs a smaller fraction of the total work than does each of the two cylinders of a non-compound, the working parts undergo less strain, and therefore remain longer in good order, consequently the cost of maintenance does not appear greater with four cylinders than with two, while the compounds have the great advantage of economising steam by obtaining larger power for the same expenditure. This is valuable testimony to another side of the compound question than that of actual work performance which I myself have treated very fully in previous articles. Added to the remarkable results in this latter connection which I was able to record, a strong case seems to me to be made out for the four-cylinder compound.

The third locomotive shown by the Western Railway of France is a tank engine—a "locomotive tender," as the type is rather confusingly styled in France. No. 3712, which was built by Schneider et Cie. at Creusot, is a ten-wheeled engine, having six-coupled wheels 4ft. 11½in. diameter, and a leading four-wheeled bogie; outside cylinders, 18in. by 23½in.; 1416 square feet of heating surface; 19 square feet grate area; 171 lb. per square inch steam pressure; total weight in working order, 58 tons; adhesion weight, 43¼ tons. A noteworthy point about these tank engines, of which the company possesses twenty-five, is that they can carry as much as 1540 gallons of water in their tanks, and 2½ tons of coals in their bunkers, and consequently can be employed on services for which tender-engines are usually needed. They have also shown themselves to possess remarkable swiftness, having attained during special trials a speed of 73·3 miles an hour—a most exceptional, if not unequalled feat for a tank engine with wheels less than 5ft. in diameter. The mechanism being almost entirely exterior is exceedingly handy to get at.

With this engine my review of the French exhibits at Vincennes is ended. The Belgian exhibits were few in number and not particularly striking. The most noteworthy was a very fine ten-wheeled tank engine recently designed by M. Bertrand, Ingénieur-en-chef du Matériel et de la Traction of the Chemin de Fer de l'Etat Belge. It closely resembles Mr. H. A. Ivatt's latest tank locomotives on the Great Northern Railway of England, and like them has inside cylinders, four coupled driving wheels, leading four-wheeled bogie and a single pair of trailing wheels. It has cylinders 17in. by 24in., 6ft. coupled wheels, 171 lb. steam pressure, and weighs 61 tons in working order. A six-coupled tank engine, built by a Belgian company for the Barry Railway of Wales, calls for no detailed notice; neither do two handsome six-coupled goods engines constructed for the Etat Belge line, both of the latter being almost exact reproductions of standard goods engines designed by Mr. J. F. M'Intosh for the Caledonian Railway.

The Swiss engines shown were mostly designed specially for mountain gradients; two-cylinder, three-cylinder, and four-cylinder compounds all were represented. The Austrian, Hungarian, German, and Russian engines were remarkable for their variety of type and vastness of size and weight. Most of the express and goods engines representing those nations weighed considerably over 60 English tons in working order. Thus an Austrian express locomotive of the Gorlsdorf two-cylinder compound type with six-coupled 6ft. wheels, weighed 69 tons; a Hungarian 7ft. coupled two-cylinder compound, 64 tons; the German express engine by Krauss, with auxiliary motor, already referred to, 68 tons; and another by the same makers of what may be styled a reversed Atlantic type, having a leading Bissel truck and a trailing four-wheeled bogie with the second and third pairs of wheels coupled, also weighing 68 tons; and last, but not least, the colossal Russian engine—twelve-wheeled, double-six-coupled articulated duplex Mallet compound, weighing 86 tons without the tender, which latter weighed 46 tons, so that the engine and tender together weighed 132 tons, and the chimney top stood 16ft. 9in. above the level of the rails. Compounds prevailed, the Mallet, von Borries, Gorlsdorf, and de Glehn systems all having exponents.

So far as I can gather from the various lists which I have had before me of the locomotive exhibits at Vincennes, and from my own various inspections of those exhibits, there appear to have been sixty-four steam locomotives shown. Of these, thirty-five were constructed on the compound principle, eighteen having four cylinders, sixteen having two, and one three cylinders—the last named being a Swiss locomotive. The other twenty-nine were non-compound. Of the whole number, fifty-eight were constructed for the standard gauge of 4ft. 8½in. English, or for the Russian gauge of 5ft.; the other eight were for various narrow gauges, chiefly for that of 1 metre. Only one engine had single driving wheels—Mr. S. W. Johnson's Midland Princess of Wales; thirty had four wheels coupled, seventeen six wheels coupled, four eight wheels coupled, the other four being articulated with two groups of coupled driving wheels. The Walschaert valve gear was used in forty-four engines, the Stephenson gear in ten, and the Gooch in two—both French engines. Two of the locomotives exhibited, both French, used pressures of 228 lb. per square inch; two, both German, 220 lb.; six, including four French, one American, and one Italian, 213 lb.; six, including three German, two Swiss, and one Austrian, 206 lb.; two, both English—Mr. F. W. Webb's La France, and Mr. Worsdell's No. 2006—200 lb.; all the other pressures employed being below 200 lb.

It has been no easy matter to review the locomotive department of the Paris Exhibition of 1900, not merely

owing to the isolation of the Vincennes Annexe and the consequent difficulty of access, but also through the absence of a proper official programme, which had not made its appearance even at a very late period of the Exhibition season, and which even now I have never seen. I had in the first instance to compile a catalogue for myself under almost insuperable difficulties in the way of ascertaining details and dimensions. Subsequently I have been indebted to my friend Monsieur Herdner, the very able and courteous Ingénieur-en-chef-adjoint of the Chemin de Fer du Midi, for an admirable manuscript "Catalogue Descriptif." But even this is not entirely complete, inasmuch as the two Belgian goods engines, at any rate, arrived after it was written, and possibly one or two others, but of this I have no knowledge. The Vincennes Show was not in final order until a considerable part of the Exhibition season had passed, and thus many of its visitors never saw it at all in perfection. This is all the more to be regretted, inasmuch as probably the collection of locomotives and rolling stock may justly be characterised as the finest ever assembled and the most instructive. But the whole history of the Paris Exhibition of 1900 is one of splendid scientific, artistic, and practical achievement, marred by inconceivable ineptitude of management, both financial and general.

PRIVATE BILLS IN PARLIAMENT.

In the analysis of the Harbour Bills, and Bills affecting tidal waters, the Board of Trade deals only with those portions of them which have a direct reference to artificial structures and natural physical features situated within the tidal range. There are fifty-four Bills of this class in the present, compared with fifty-nine in the past session. Of the former, two are *hors de combat*. One, the Alexandra—Newport and South Wales—Docks and Railway, has been withdrawn; and the other, the Thames Pier and River Service, after passing its second reading, failed to prove its preamble to the satisfaction of the Committee. In commenting upon a few of the more important of these projects, and arranging them for convenience in alphabetical order, the Bristol Corporation comes fairly to the front. The same local authority sought for powers last year to construct important works in connection with its main drainage and general extension of its sanitary system. Two large sewers were proposed to be carried by means of a tunnel under the bed of the river Avon; and it was decided to lay three syphons in the same position. By its present Docks and Railways Bill the Corporation seeks to make a new dock, with an entrance lock thereto from the river Severn, near Dunball Island, and two embankments and sea walls. A couple of railways will skirt the foreshore of the Severn, and a third will cross that of the river Avon. The dredging and deepening of the Avon and the Severn and estuaries thereof within the Port of Bristol, and the acquisition of certain foreshore and bed of both rivers in the vicinity of the proposed works, is also contemplated. Powers are likewise asked for the construction of all necessary entrances, cut, channels, wharves, graving dock, jetties, landing-places, buoys, beacons, and other accessories always accompanying marine works of this description.

Under the title of the Dover Harbour Bill some new works are projected in connection with this important seaport and defensive citadel:—The construction of a pier about 1200ft. in length within the Commercial Harbour, on the southern side of the embankment, authorised by the Dover Harbour Act, 1891; the conversion of the existing tidal harbour into a wet dock, joined to the new Commercial Harbour by a lock on the north-east side of the present entrance, and the construction of embankments and quay walls on the western and south-eastern sides of the dock. The construction of a railway on a viaduct between the proposed lock and the middle of the Prince of Wales Pier and the deepening and dredging of the foreshore and bed of the Commercial Harbour, and of the sea adjacent thereto, as well as the abandonment of the two piers authorised to be constructed on the south-east face of the seawall authorised by the Act of 1891. The Humber Commercial Railway and Dock undertaking comprises several extensive additions and improvements, including the building of a dock with lock entrance on the north-west side of Grimsby harbour, on a portion of the lands to be reclaimed and enclosed by the following works:—A seawall extending in a northerly direction for a distance of half a mile; another bearing in an easterly direction for a distance of 4900ft. from the termination of the former; and a third running south, with a length of 700ft. Two jetties, each about a 1000ft. in length, and the laying of a railway along the top of the sea walls, constitute some of the minor works. Some heavy dredging operations and removal of rock from the site of the intended new dock and the approaches to it will be required, as well as in dealing with the foreshore and bed of the river Humber.

It is not at first sight quite apparent how the widening of the footpaths of London Bridge can be said to affect harbours or tidal waters. When, however, the manner in which the work is to be executed is taken into account, the reason becomes plain. A temporary footbridge is to be erected upon each side of the present structure. It will be carried upon piles furnished with all necessary fenders, and provided with the protective outworks usual to temporary timber bridges. The Bill has been referred to Committee as an unopposed petition, and will no doubt be passed in the usual course, as we ventured to predict in our columns.* As a considerable amount of public interest has been excited and public attention directed towards the alleged insufficient accommodation existing at the London Docks, it will not be out of place to allude to the following application. The London and India Docks Company—new works—propose the construction of a dock, with a lock or entrance from the river Thames at Galleons Reach, on the southern side of the Albert Dock, and of a pier on either side of the dock entrance, together with a cut or channel from the new dock to the Royal Albert Dock. What is of equal, if not of more importance, is that the company intend to dredge and deepen our metropolitan river, so as to afford a better access to the new works when completed. A new tunnel under the Thames will carry a part of the West and South London Railway, and will be located on the north side of the site of the recently demolished old Vauxhall Bridge.

The Bills relating to the supply of gas show the only increase in point of numbers, standing at 43 against 27 for last year, with respective capitals, raised by shares and loans, of £7,877,260 and £4,585,686. Three of these ask for sums exceeding a million. Heading the list is the South Metropolitan Gas Company, which requires £2,000,000 to empower it to purchase by agreement so much of the southern portion of the undertaking of the Gaslight and Coke Company as is situated on the south side of the river Thames, and for other purposes. The Bill has been sent to a Committee, and should the purchase not be effected only half the proposed capital will be sought for. A million and a-third is needed for the incorporation of the South Staffordshire Mond Gas Power and Heating Company, who intend to manufacture and supply gas for motive and heating purposes, but not for illumination. The special rate of dividend is fixed at 10 per cent., and the proposed standard maximum price per 1000 cubic feet is put at 3d. and 4d. Where gas is used for illumination the maximum price ranges from 3s. 6d. to 6s. 2d. per 1000 cubic feet. Newcastle-upon-Tyne and Gateshead want £1,200,000 as additional capital for extending the limits of their supply. The British Gaslight Company—Hull Station—estimates the cost of enlarging its gasworks, and extending its whole undertaking, at £280,000. There is no opposition to this Bill. It is a little singular that Devonport, Dover, and Richmond should each require exactly the same sum of £133,333. It may be mentioned that the Gaslight and Coke Company has withdrawn its Bill, in which it petitioned for powers to raise a million by loan, to create additional debenture stock, to enable the company to acquire lands, and to construct new gasworks. A synopsis of the private Bills relating to the supply of gas will be found in Table I. It should be stated that the Devonport Corporation (Gas) Bill was read a third time on May 9th, and passed. In the case of the Devonport Gas and Coke Bill the parties do not proceed.

TABLE I.—*Gas.*

The number of Bills which relate to the supply of gas amounts to 43.

Distribution.	Number of Bills.	Proposed capital.		
		By shares.	By loan.	Total.
England and Wales ..	42	4,868,900	2,983,360	7,852,260
Scotland	—	—	—	—
Ireland	1	15,000	10,000	25 000
Total for gas ..	43	4,883,900	2,993,360 (a)	7,877,260

(a) Including £201,000 proposed to be authorised for gas expenditure by Bills classed among Tramway Bills, and £25,000 by a Water Bill.

Although the difference in the number of Water Bills for the present and previous sessions is not very large in the abstract, the discrepancy between the corresponding capitals is of considerable magnitude. Briefly, the figures are forty in 1901, as compared with forty-six in 1900, and £6,572,328 as against £23,979,347. In order to explain this somewhat surprising difference, it will be necessary to take a retrospect glance at the Water Bills before Parliament last year. Under the title of London Water (Welsh Supply) the London Council introduced a Bill to enable it to construct storage reservoirs, to impound certain waters for supplying London and the adjoining districts, and for other works and purposes. The estimate for carrying out this extensive scheme was upon the same liberal scale as that upon which the gigantic undertaking was framed. It amounted to £18,100,000. The absence of this Bill from the present list sufficiently accounts for the great difference in the total amounts of the respective capitals. A schedule of the Bills relating to the supply of water is given in Table II.

The remark made in our previous article upon the same subject, respecting the class of promoters of Tramway Bills, applies, though not to quite the same extent, to Water Bills. Out of the total forty, one-fourth are brought forward by Corporations, and, in addition, a few are introduced by local authorities, which, in fact, may be regarded as Corporations upon a smaller scale. They practically occupy similar positions, and discharge the same duties. With a couple of exceptions, the sums proposed to be raised by the Bills for the supply of water do not figure largely. The first exception, which is immeasurably in excess of all the others, except the second, is the Leeds Corporation Water Bill. This petition demands £2,750,000, or more than a third of the total capital of all this class of Bills, to construct additional waterworks and to acquire the land for their sites. The second—that of the Stockport Corporation—is more modest, and states its needs at £820,000; while the Derwent Valley Water Board, whose Bill was read a third time on the 7th instant, asks for £400,000. South Essex and Harrogate are content respectively with £25,000 and £50,000 less than the last-named sum; while the Corporation of Barrow-in-Furness, and the Water Board of Heywood and Middleton, each estimate their expenses at £175,000. The Wolverhampton Corporation Bill has been relegated to that indefinite period of "six months." The preamble of the Heckmondwike Gas and Water (Transfer) has not been proved; the parties in the Llandrindod Wells Water Bill do not proceed; the London Water Purchase undertaking has fallen through, and so has the Rickmansworth and Uxbridge enterprise. The Hartlepool Gas and Water Transfer Bill was rejected upon failure of proof of preamble. There are eight Bills which contain provisions for the amalgamation of certain railway companies, or for the sale, lease, or transfer of certain railways, but as they would not possess any interest for our readers, so we have omitted to allude to them.

TABLE II.—*Water.*

The number of Bills which relate to the supply of water amounts to 40.

Distribution.	Number of Bills.	Proposed capital.		
		By shares.	By loans.	Total.
England and Wales ..	40	623,000	5,949,328	6,572,328
Scotland	—	—	—	—
Ireland	—	—	—	—
Total for water ..	40	623,000	5,949,328†	6,572,328

† Including £50,962 proposed to be authorised for water expenditure by a Bill classed among Tramway Bills, and £20,000 by Gas Bills.

INSTITUTION OF NAVAL ARCHITECTS.—Mr. R. W. Dana, M.A., A.M.I.C.E., has been appointed secretary to the Institution of Naval Architects, to succeed Mr. George Holmes, who has accepted a position under Government.

SAWING MACHINES.

THERE are few tools which have gained a wider or more well-deserved popularity than the hack-saw machine. We have never yet heard anything but praise bestowed upon them, and that generally without distinction of make. Originally they were rather crude in design and construction, but now-a-days are undergoing transformation. We illustrate below two of the latest forms made by Mr. Edward G. Herbert, of Cornbrook Park Works, Manchester, which show the progress of development. Fig. 1 represents an excentric

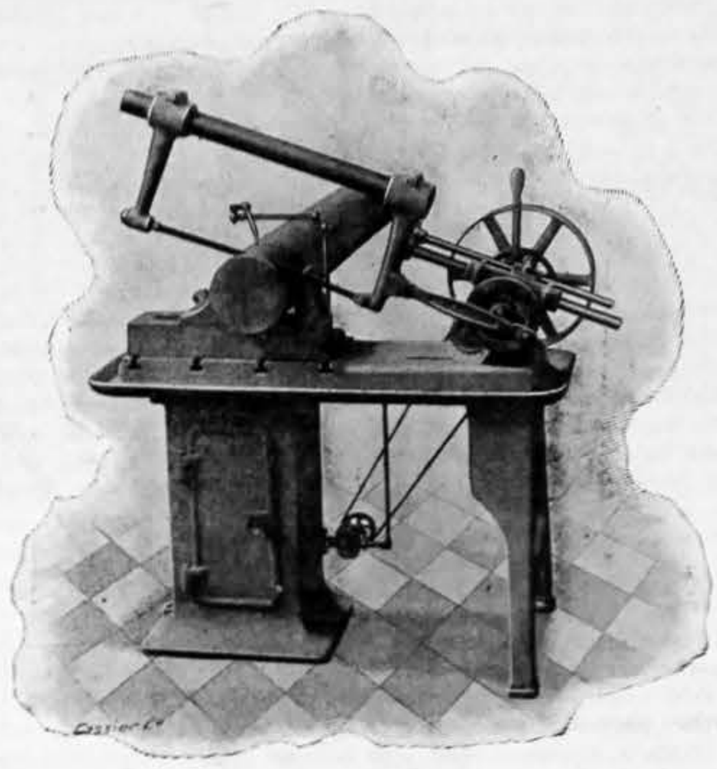

Fig. 1—EXCENTRIC SAWING MACHINE

sawing machine designed for heavy work. When such work is done by hand it is the custom to give a partial revolution to the bar every now and then, so as to reduce the length of the line of cut. This machine effects the same end by mounting the saw guide in an excentric, which makes a partial revolution after every twenty strokes of the saw. It runs at a high speed, 100 revolutions per minute, and a pump is provided for supplying a plentiful circulation of lubricant.

The other illustration—Fig. 2—shows a neat little vertical

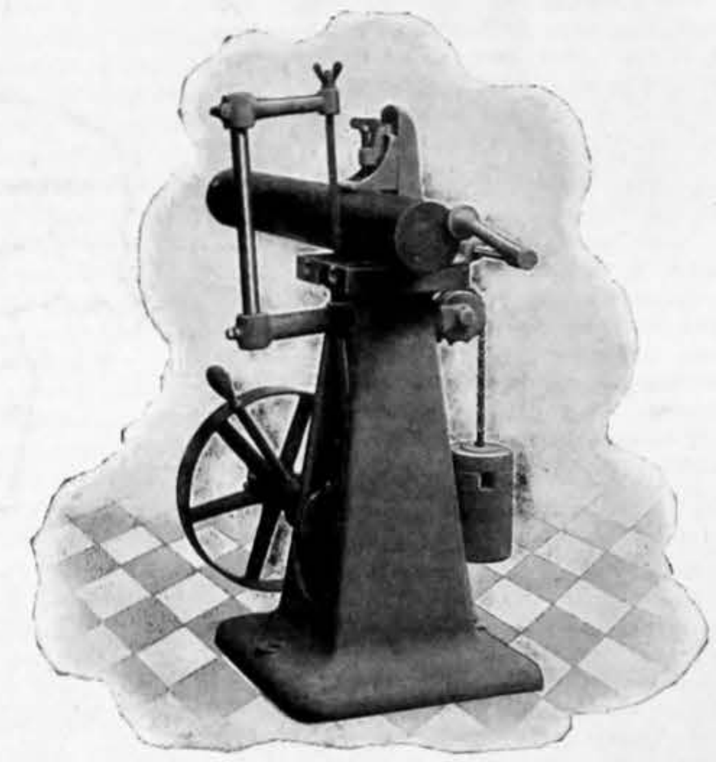

Fig. 2—VERTICAL SAWING MACHINE

saw of very simple construction. In it the saw frame is without the usual guides, being coupled direct to the crank pin. By this arrangement the saw cuts on the down-stroke, but is raised clear from the work whilst rising. The speed is from 100 to 120 strokes per minute. In both these machines the vice can be removed and the work bolted direct to the slotted table. A special saw with a tipping vice for cutting girders is also made by this firm.

HENRY BRUNTON.—A correspondent of the *Times* writes:—The death occurred in London, at the end of last month, of Mr. Henry Brunton, M. Inst. C.E., a man who holds a noteworthy place in the history of the international relations between Japan and this country. The treaty negotiated by Lord Elgin with Japan stipulated that the coast should be lighted and buoyed for the safety of general navigation. When Sir Harry Parkes drew the attention of the Japanese Government, in 1868, to this clause, which had not been fulfilled, he was informed that they were perfectly willing to carry out their obligations, but their ignorance and inexperience made them unable to fulfil them without further advice. Finally, Mr. Brunton was selected to aid them, on the advice of Messrs. Stevenson, of the Scotch Lighthouse Board. On his arrival in Japan he found that the work before him was not so simple as building lighthouses in his native country. Sir Harry Parkes persuaded the English admiral then in China to let him have the use of the despatch steamer Manila, and in that Mr. Brunton and his staff made a tour round the coasts of Japan, visiting some twenty sites, and making the necessary surveys and calculations. In ten years' time he had built fifty lighthouses, and had arranged a complete Government department for their maintenance. He further reported on, and made the plans for, the removal of the bars at the mouth of the rivers, on which the Government officials are even yet working. His design for the harbour in Yokohama Bay was thought too expensive by the Government at the time, but that subsequently adopted was on his lines. He also started the telegraph system in Japan, and introduced methods of constructing bridges, buildings, &c., to withstand earthquake shocks. On the completion of his lighthouse work he returned to this country. Before his departure he was presented to the Mikado, who gave him a special banquet in his summer palace, and a handsome present in recognition of his services. It is not too much to say that Mr. Brunton's complete and permanent success in all that he undertook for Japan had much to do with the gradual rise of the feelings of respect and admiration with which the Japanese have viewed this country and its institutions.

* "Widening of London Bridge," described and illustrated in THE ENGINEER, December 21st, 1900.

THE MOND GAS BILL.

No. I.

IN our issues of the 22nd and 29th of March and the 5th of April, we gave some account of the Bill about to be brought forward in Parliament for the supply of Mond gas throughout the Black Country, with a description of the gas itself, and of the origin of the scheme. The Bill came up for consideration before a Select Committee in the House of Commons, presided over by Colonel Welby, on the 25th of last month, and after a hearing extending over thirteen days, the Committee declared the preamble proved. A great many interesting facts and figures were given in evidence before the Committee, and we propose to give a short account of this evidence, omitting what are purely local considerations, and confining ourselves strictly to those points which will be of interest to our general readers.

The case was opened by Mr. Balfour Brown, K.C., counsel for the promoters, who quoted a statement by Mr. G. Bealby, president of the Society of Chemical Industry, to the effect that 5,000,000 of horse-power were generated in this country, consuming annually about 50,000,000 tons of coal, and that the whole of this power could be generated with an expenditure of only 10,000,000 tons if Mond gas were used in gas engines for the purpose. He gave the cost of a horse-power in Birmingham at 0·8 of a 1d. per hour, or £29 per annum if running continuously, and stated that the same work could be done by Mond gas at the price of 2d. per 1000 cubic feet, for £8 10s. per annum, if the engines were in both cases running continuously; or if the engine was run only during the usual working hours, the total cost for Mond gas per annum he estimated at £4 7s. 7d. Comparing this with electricity at even 1d. per unit (1¼d. being the price suggested by the South Wales scheme), he estimated the cost per annum for electricity at £27 4s. per annum. Counsel stated that the Mond scheme was essentially one for distributing in bulk to large consumers, and that it was neither proposed nor desired to supply small consumers, as the company considered that the leakage from numerous small connections, and the expense of carrying mains for the purpose, would be too heavy to recompense them for the gas sold; he was therefore willing to exclude altogether the use of Mond gas for all domestic purposes, and to limit its consumption to customers taking more than 1,000,000 cubic feet per annum, which was estimated to be about equal to supplying a 5 horse-power engine, when running continuously during ordinary working hours. Twenty-seven local authorities, three rural district councils, and sixteen gas undertakings were affected by the Bill. Six of the local authorities were opposing, and of the other twenty-one some reserved their right to oppose in the other House, while four did not appear at all; of the nine gas companies, of whom the Birmingham Corporation was one, six opposed, and the other three companies did not oppose. Of the seven local authorities owning gas plant, five were opposing, but he hoped the concession he had just made would remove the opposition of some of the remainder, whilst he contended that Mond gas was a totally different article from ordinary illuminating gas, and would be used for other purposes. It was proposed to put up five distributing stations, and the capital of the company would be one million sterling. Counsel stated that objection had been made to the proportion of carbonic oxide in Mond gas, but stated that in some of the American works as much as 90 per cent. of the gas supplied was water gas, which was very much higher in carbonic oxide than the Mond gas; however, to meet the objections of the Home-office the company were willing to have a clause inserted in the Bill limiting the amount of carbonic oxide to 14 per cent., whereas, as a matter of fact, Mond gas contained only 11 per cent. The map herewith will show the area over which the operations of the company will extend, and shows at the same time the position of the five distributing stations it is intended to erect.



MAP SHOWING AREA OF OPERATION OF THE MOND SCHEME

The first witness called was Sir Frederick Bramwell, who stated that the best result obtained with a steam engine was 1½ lb. of coal per indicated horse-power per hour, and this was only obtained with engines of 2000 or 3000 horse-power, and with the very best quality of steam coal. He further went on to say that steam engines only utilised 9 per cent. of all the heat supplied to them, whereas gas engines could utilise 29 per cent. If we have followed Sir Frederick Bramwell's evidence correctly, he would appear to have taken too low a figure, seeing that in our issue of October 13th, 1899, is given a list of steam engine tests collected by Mr. Bryan Donkin, showing efficiencies are as high as 20 per cent., and in one instance over 23 per cent. Having regard to the fact that the efficiency of a boiler and economiser may be over 80 per cent., this will give an efficiency from the fuel of 16 per cent. in the steam engine. If, on the other hand, the fuel is gasified in the producer and used in the gas engine, the efficiency of the producer is rarely over 60 per cent.; in Mond's producer, which is claimed to be the most efficient in existence, if the fuel required to raise the steam is included, the efficiency is only 66 per cent., which will make the combined efficiency of the engine and producer under 20 per cent. Perhaps the matter is put most clearly in a letter which will be found on page 632 of our issue of December 22nd, 1899, where Mr. Bryan Donkin gives the number of British thermal units consumed by the best steam engine as 196 per indicated horse-power, giving an efficiency of 21¾ per cent.; the best gas engines, 158 B.T.U., equal to 27 per cent.; and the best oil engine, 124 B.T.U., which is equal to 34 per cent., so that the difference in thermal efficiency between a gas engine and steam engine is nothing like three to one, as stated by Sir Frederick Bramwell. The best record we know is ¾ lb. of anthracite consumed in the gas producer of a gas engine, and 1 lb. of coal under the boiler of a steam engine using superheated steam. We call particular attention to this statement, because in his concluding address Mr. Balfour Brown made a great point of the fact that Sir Frederick Bramwell's statement as to the consumption of the steam engine being more than three times that of the gas engine had not been denied by the opponents. Sir Frederick Bramwell further stated that the ordinary puddling furnaces consumed 22 cwt. of coal per ton of iron produced, and gas furnaces only 5 cwt. We will return to this matter further on. The witness further stated that it was intended to use riveted steel mains, in 30ft. lengths, in those parts of the district where subsidence, due to mining, was to be feared, and to use the same type of joint employed by the Compressed Air Company in Paris. What this type of joint was was not given in evidence. Mains of this type, he stated, had been tested, and under a deflection of as much as 5ft. in the length were absolutely drop-tight. The other mains would be ordinary cast iron. This would seem to be an unfortunate introduction, as it was the riveted mains which proved so disastrous to the Compressed Air Company of Birmingham when adopted by them some years ago. He further stated that the estimates of the promoters were founded on their capabilities of supply, and that he expected one station would be put down first and the others added as required, and admitted that the object of the company in its present Bill was to "peg out claims," so as to avoid coming to Parliament for further powers later on. The diameter of the pipes would be 30in., and one would extend in each direction from the five stations; the five stations would be coupled together, so that in case of an accident at one station the supply would be continued from another. Under the pressure adopted, which was thirty-two times as great as that employed for existing illuminating gas, each pipe would deliver 60,000,000 cubic feet per day, through a pipe 2½ miles long, and the company expected to sell 600,000,000 per day for 310 days per annum. Questioned as to whether Mond gas might not be rendered luminous, he admitted that this could be done, but so could atmospheric air be equally rendered luminous by the addition of some volatile hydrocarbon. Each station would serve about 27 square miles of country, the total area which would be covered by the company being about 135 square miles. Pressure was intended to be supplied by an exhauster, similar to those used by gas companies for removing the gas from the retorts to the holder. Cross-examined, Sir Frederick maintained that 1000 indicated horse-power could be obtained with Mond gas cheaper than with coal, and maintained that it was utterly impossible to obtain a horse-power in an engine of 100 horse-power for 2 lb. of coal costing only 6s. per ton. Such a consumption could only be obtained in large engines with the best Welsh coal, and that 70 cubic feet of Mond gas would give 1 indicated horse-power at a cost of only one-eighth of a penny.

Mr. H. Humphrey stated that natural gas is being distributed in America at pressures as high as 260 lb. per square inch, and carburetted water gas at 20 lb. per square inch, a pressure considerably higher than they proposed to use for Mond gas. It was intended to use branch mains of 18in. and 15in. diameter, and a regulator at each branch to reduce the pressure to that required by the consumer, for whom a 3in. supply pipe would generally suffice. He also stated that mixtures of illuminating and water gas were now being distributed in London which contained a larger proportion of carbonic oxide than was present in Mond gas. Taking the thermal value of Mond gas at 100, he considered that of illuminating gas to be 400, and that of Dowson, Wilson, and other producing gases 80 to 90. Owing to the higher proportion of hydrogen found in Mond gas, he considered there would be a saving of from 40 to 70 per cent. effected by the use of gaseous fuel, and expected a great saving in labour, and in wear and tear in puddling furnaces worked by gas as much as 9s. 8d. per ton of iron made, and an improvement in the product, because Mond gas contained only about 20 per cent. of the sulphur contained in the coal, the remainder being removed by washing. He mentioned that the average cost for fuel of thirty-three electric light companies is three times as great as it would be if they used Mond gas, and further said that they anticipated reducing the price of Mond gas for large consumers to 1½d., and to small consumers 2½d., and considered that few engines in the Black Country were working with less than 9 lb. of coal per indicated horse-power per hour. Each of the stations would be about the same size as the one at Winnington, where they had twelve producers, and gasified 200 tons of coal per day. Questioned as to the number of companies using Mond gas, he admitted that Mr. Balfour Brown was mistaken when he said in his opening statement that seven firms had adopted it; it should have been that seven firms were preparing to adopt it; as a matter of fact four firms in this country had so far tried it, but all these companies—namely, Messrs. Crossley, of Manchester; the Premier Gas Engine Company, of Sandiacre; the Farnley Iron Company, in Yorkshire; and Armstrong, Whitworth, and Co., of Newcastle-on-Tyne—so far as we could understand, had not yet put up recovery plants, the plants used by them being only small ones of an experimental nature. So far as the evidence given showed, only one firm at Detroit, in America, has so far put up the complete plant as working at Messrs. Brunner Mond's own works, and such as the promoters propose to employ. Cross-examined as to the patents, he stated that the company did not rely upon patents, but upon Dr. Mond's twenty years' experience. He admitted that it was practically necessary for steel works to make their own gas on the premises, but maintained that they could afford to pay 1½d. for Mond gas, and did not believe that producer gas could be made at from ½d. to ¾d. per 1000ft., and that even with poor plant in bad condition, that the cost did not exceed 1d. per 1000. He had allowed in his estimate 0·248d. for distribution, and was aware that the lowest cost anywhere was at Oldham, where distribution cost 1d. per 1000, and that the average cost was 2½d. per 1000. His estimated cost of distribution included the compression of the gas, and all materials and labour required for maintenance and renewals of mains and valves, and repairs to meters, but did not include rates, salaries, or the cost of inspecting the meters. They had tried 50 tons of Staffordshire slack, which, it came out afterwards, had been obtained from Earl Dudley at the cost of 5s. 3d. per ton, and had taken it to Winnington, where it had been tried in the producers and pronounced satisfactory.

The estimate put in by the promoters was marked "Appendix A," and is given below:—

	Annual. £	Cost per 1000. d.
Cost slack, 225,000 tons at 6s. ..	67,500	·6428
Management, wages, stores, &c.	39,377	·3750
General expenses, salaries, rates, and taxes	15,300	·1457
	122,177	1·1635
Less residuals	66,660	·6348
	55,517	·5287
Compression and distribution, including renewals, repairs to mains, meters, &c., salaries, and inspection	29,375	·2800
	84.892	·8087
Say	85,000	..
Ten per cent. on capital		·9524
		1·7611

Other figures included in previous items, but asked for separately, were:—

	£	d.
Repairs to mains and meters, including inspection	5,334	·0508
Renewals of mains and meters, &c.	12,666	·1206
	18,000	·1714
Rates and taxes	7,500	·0714

He admitted that Messrs. Mond had over sixty boilers in their works, every one of which was fired by solid fuel, and he considered that it was cheaper to fire the boilers direct with mechanical stokers than to use gas for the purpose. They had at Messrs. Mond's works 1310 indicated horse-power derived from gas engines, and probably twenty times as much derived from steam engines, but they used the exhaust steam from their steam engines for evaporating pans or for heating purposes. Questioned as to the Duff gas producer, he stated that Armstrong, Whitworth and Co. might be putting one down at their Manchester works for all he knew, but they were certainly putting down a Mond plant at their Newcastle works. The promoters had not decided which station would be commenced first, but they should canvass and put down the first station where they would get most customers. He admitted that although the Mond gas had been known for twenty years he could only mention four places where it had been adopted partially up to the present time. He admitted that the Delwick-Fleicher water gas contained 300 B.T.U. per cubic foot, as against 150 in Mond gas, but did not know that the Delwick gas could be produced for 3d. per 1000 cubic feet, and maintained that to cut out part of the districts and keep the rest would upset their estimates, which were founded upon the whole district, and upon that basis they had reckoned upon 1000 customers and a capital expenditure of £1000 per customer. He was questioned as to whether the charges for the American natural gas, the cost of manufacturing which was nil, did not vary between 11d. per 1000 and 30d. per 1000, according to the distance it had to be conveyed to the consumer, and replied he was not aware what the charges were.

THE Russian armoured cruisers on the Far Eastern station are about to receive a sort of pinnace for coast and river work, and more especially for the purpose of pursuing Chinese pirate junks. The new boat is fitted with sails, and it can be propelled by a small engine which is driven by naphtha. Its length is 11 m., but it is only 2½ m. in beam, and it will be fitted with quick-firing guns of the smallest calibre. A protected air chamber prevents the boat from sinking, even if it should be making a great deal of water. The firm of Escher, Wyss, and Co., of Zurich, have undertaken to supply these boats to the Russian Government, and five boats have already been sent out.

GLASGOW INTERNATIONAL EXHIBITION.

No. VI.

FAVOURED by a spell of fine weather, which has lasted almost without a break since the 2nd inst., the Glasgow International Exhibition has already been attended by one and a-quarter million people, or an average of about 70,000 per day over the period of eighteen days. For a similar period the attendance at the last International Exhibition in 1888 did not reach more than one-half this number. The promoters and management of the undertaking have thus cause for gratification, and on the whole the general public find their visits well rewarded.

In the Machinery Section there are still a number of stands requiring a good deal of arranging before they can be considered complete, and this specially applies to those where exhibits are shown in motion, and it is, therefore, as yet too soon to speak of any of these in detail. To the stands at which no objects in motion are shown—that is, stands of the "trophy" order—we have already in Article IV. referred in general terms, particularly to a number of metallurgical collections, a branch in which the Exhibition is distinctly rich. To these we will again return in detail later, when photographs are available. Meantime, in the present series of general articles, we may notice others, and from them pass on to a general survey of the shipbuilding exhibits, which, as is only natural, form a prominent feature in the display.

The exhibit of Walter MacFarlane and Co., Saracen Foundry, Glasgow, is a striking example of artistic iron-founding. While its minarets and central dome at once command the attention of every one entering the Machinery Hall, a closer inspection reveals the fact that every detail in design and workmanship has been carried out with consummate care and thought. Taking the form of a rectangular pavilion, it is supported by twenty ornamental pillars of varied design. These carry a variety of spandrils and arches, some of which demonstrate most effectively the skill alike of designer, pattern-maker, and moulder. The treatment between the coupled columns at corners and centres, as well as the frieze, is in close harmony, merging in richly-developed foliage a happy reference to the thistle, rose, and shamrock. The upper portion of the exhibit rises from a moulded cornice, and consists of pediments, minarets, and large central dome. The treatment of the pediments varies in each case. Crowning that at the north end is a fine example of ornate casting, specially adapted to embrace a monogram and crest, while to complete the two sides there are handsome signboards in wrought and cast iron. To relieve these, and secure an effective terminal finish in the centres, a well-developed casting of the Royal arms in full heraldic colours surmounts the one side, while a statuette of her late Majesty, supported right and left by the British Lion, dominates the other. The effect of the upper portion is very graceful. With a fine touch of the "Oriental," at the corners rise four ornamental minarets, formed of delicate scroll work and enriched by fringed ornament, while the spire of each gives oportunity for displaying various types of the firm's finials. Standing beneath the central dome, the chaste design and colouring of the painted and stained glass present a fine picture. The internal effect of this central feature is enhanced by a combination of cast and wrought iron railing, panels, terminals, &c., and from this a series of electric light fitments are suspended. The exhibit further embraces a variety of individual castings for various uses, such as railings and gates for villa and mansion, verandah and conservatory castings, lamp pillars and brackets; one sample in this class being the base portion of the London County Council's new electric light pillar, which has been specially designed for the Victoria Embankment. But while there is such interesting variety in the ornamental, the ordinary requirements of the day are strongly in evidence, for we find sectional examples of iron drain pipes, bends, traps, and gullies, which in this age of sanitary science certainly appeal to many. These items are shown treated by the glass enamel process now so largely adopted for all high-class house drainage.

Another prominent exhibit, to which we made some reference in a previous article, is that of David Colvill and Sons, Limited, of Dalzell Steel Works, Motherwell. The arrangement of this imposing exhibit has already been described, but the following are more accurate details as to the principal items which make up the grouping. There are two steel plates forming mammoth loops, constituting a double arch, one being no less than 72½ft. long by 74in. wide, and $\frac{7}{8}$in. thick, and the other 65ft. long, 74in. wide, and $\frac{15}{16}$in. thick, both being to Lloyd's tests. Forming a floor for the exhibit there is a "Dalzell" steel boiler shell plate, 25ft. long, 11ft. 6in. wide, by 1½in. thick; it also conforms to Lloyd's and Board of Trade tests. Other items are a steel boiler end plate, 11ft. 7in. diameter, by $\frac{13}{16}$in. thick; a flanged end plate for boiler, 15ft. diameter; two steel cross connection pieces for Babcock and Wilcox water-tube boilers; a cogged slab of steel, 7ft. long, 54in. wide, by 13in. thick, weight 7 tons 11 cwt.; and a steel cogged bloom, 21in. square. As exemplifying the calibre of the machinery by which such mammoth items are produced, the company also show a cast steel roll for plate mill, 34in. diameter, by 12ft. long, weighing 18 tons. A cast steel roughing roll, for 32in. bar mill; and two cast steel mill pinions, one for 36in., and one for 18in. mill. The grouping also embraces a large proportion of the 380 sections rolled by the company; test pieces, and photographs of the works.

The British Hydraulic Foundry Company, Limited, Whiteinch, Glasgow, exhibit at No. 511 stand in the Machinery Section, a number of rings showing various diameters of cast iron lining for subways. Each ring is made up of six or more segments, which are bolted together in position. This lining is specially suitable for subways or tunnels made by means of a shield and compressed air, as was done in the case of the Glasgow District Subway, the Blackwall Tunnel, Central London Railway, and the Great Northern and City Railway, for which undertakings alone the British Hydraulic Foundry Company, Limited, supplied over 60,000 tons of segments. There is also shown an ingot mould used in steel manufacture, of about 22 cwt. capacity, made from pure hematite pig iron, these being made up to 12 tons capacity. The stand also contains a number of cast iron railway chairs, amongst which are samples and models of a patent "keyless" chair, claimed to be an improvement on the keyed chair in general use in this country. There are also cast iron bases and straining posts, as used by the Indian railway companies; a 20in. diameter manhole cover, such as are used for covering the manholes in sewers, &c.; also a good selection of general castings, including castings for motors, flanges for pipes, signal castings, &c.

The Darlington Forge Company, Limited, of Darlington, are worthily represented in the Machinery Hall by small-scale models of many of their larger forgings and castings for marine purposes, and in the outside grounds they have one of the most imposing and attractive stands the Exhibition can boast of, consisting mostly of full-sized models of the "items" represented by small-scale models in the building. The full-sized models outside represent:—(1) The cast steel stern frame and shaft brackets, weighing 97 tons, of the twin-screw transatlantic liner Oceanic, built by Harland and Wolff, Belfast, for the White Star Line; (2) cast steel stern frame and shaft brackets of the twin-screw transatlantic liner La Savoie, built by Le Société Anonyme des Ateliers et Chantiers de Penhoet, St. Nazaire, weighing 79¾ tons; (3) forged steel solid crank shaft, as made for H.M.'s first class battleships Cornwallis and Albemarle, weighing 17¼ tons; (4) forged steel built-up crank shaft 20in. diameter, made for D. Rowan and Co., Glasgow, weighing 37¾ tons; (5) cast steel rudder frame, as made for H.M.'s battleship Albemarle, weighing 12 tons; (6) cast steel single-plate rudder with forged-steel stock, as made for Harland and Wolff, Belfast, weighing 15 tons; (7) forged-iron anchor davits, as made for H.M.'s first-class battleships Duncan and Cornwallis, weighing 7 tons each; (8) cast steel propeller blade.

A further interesting item at the Darlington stand is a cast steel stern frame taken from the s.s. Heighington, which went aground and fractured, and which has been welded with a view to prove that cast steel frames can be repaired by welding, and to ascertain the effect of welding upon frames. After being subjected to a number of bending tests—cold—at the weld, in the presence of Lloyd's surveyor, it was found that there was no disturbance at the weld, nor sign of flaw in the frame. There are also shown here a few steel castings, taken promiscuously from ordinary make, such as cylinder and steam chest covers, pistons, locomotive wheel centres, &c.; one of the latter having been subjected to a severe test, viz., dropped twelve times from a height of 50ft. on to a solid steel bed weighing about ten tons.

The Machinery Hall exhibit of the Darlington Company consists of a huge glass case containing electro-plated models of about seventy specimens of iron and steel forgings and steel castings for marine locomotive and stationary engines, hulls of ships, hydraulic machinery, rolling mills, colliery work, and general engineering. Notable amongst these are miniature representations of the cast steel stern frame and shaft brackets of the Oceanic and La Savoie, of which full-sized models are shown outside, as well as several other special stern frames and brackets, rudders, rams, &c., for home and foreign Governments and leading shipbuilders. There are also models of forged steel hollow crank and stern shafting for the latest first-class battleships of the Duncan and Cornwallis class.

On the eastern boundary wall of the Machinery Hall, Wm. Beardmore and Co. (late R. Napier and Sons), engineers and shipbuilders, Govan, show a very extensive collection of ship models and engine photographs. These are arranged in historical order, with warships to the right and merchant steamers to the left of the centre, and illustrates at a glance, by the different types of vessels built at this establishment alone, the progress of steam navigation during the past half-century.

Robert Napier, the founder of the firm, it is scarcely necessary to reiterate, was one of the most distinguished men in the annals of shipbuilding, and constructed his first marine engines in 1823. During the next twenty years he produced upwards of eighty sets, amongst them the machinery for the first Liverpool and the first Cunard steamers—which were built of wood—also the engines for the warships Vesuvius and Stromboli for the British Admiralty, and machinery for the principal shipping companies.

In 1842 he added iron shipbuilding to his engineering business, and the first vessel built in the Govan yard was the paddle steamer Vanguard, of 700 tons and 1000 horse-power, for the Dublin and Glasgow Steam Packet Company, the model of which shown is rather a quaint-looking production, and affords a curious comparison with the modern production Ophir, shown directly underneath it. A celebrated vessel was the Cunard steamer Scotia, the last of the ocean-going paddle-wheel steamers, and also the last fitted with side lever engines. She was referred to at the time as "the champion and model of a mercantile marine steamer," and was the first to cross the Atlantic in less than nine days, but after carrying the mails for fifteen years was superseded by the superior economy of the screw steamers, and converted into a twin-screw telegraph cable steamer, and is still extant under her original name after forty years' service.

The Government having sanctioned the use of the screw in mail steamers, Messrs. Napier launched the China in 1862, the Cunard Company's first screw mail steamer, and she was so successful in doing the same speed on about half the fuel that the supremacy of the screw propeller was established, and the ocean paddle-wheel steamers adandoned; after twenty years' service she was converted into a four-masted sailing ship, and is still doing duty for Hamburg owners under the name of Theodor.

The advent of the epoch-making steamship Aberdeen is illustrated by a photograph of her triple-expansion engines designed by the late Dr. A. C. Kirk, which constituted the forerunner of the principle of multi-expansion in marine engines now universally followed. The Aberdeen was followed by the Australasian for the same owners—George Thompson and Co., Aberdeen and London—whose triple-expansion engines were fitted with Kirk's patent valve gear. The triple-expansion paddle engines for the steamer Sylvester were also the first of that type, and were fitted on board in the river Volga. The Royal yacht Ophir is represented by her model, and a photograph of the beautiful saloon dome.

In addition to the foregoing there are many models of type steamers that the firm have built for the principal steamship companies, including the Allan liner Parisian, which, with the exception of the Buenos Ayrean, by Denny and Brothers, of Dumbarton, was the first mail steamer to be built of mild steel; four very handsome vessels of the Atrato class, for the Royal Mail Steam Packet Company; the Windsor Castle, amongst the first steamers for Donald Currie and Co.'s South African service; and the twin-screws Alnwick and Berwick Castle, now under construction for the Union-Castle Line; the Periere and Ville de Paris, for the Compagnie Transatlantique; Garonne and Pizzaro, for the Pacific Steam Navigation Company; Tamaulipas type, for the Compania Mexicana; Tewfik Rabbani class, for the Khedivial Line, from Alexandria to Constantinople; Kasuga Maru, for the Nippon Yusen Kaisha, Japan; Moravian, for the Aberdeen Line to Australia; Eastern and Australian, for that company's China service; Tagus and Trent, the latest mail steamers for the Royal Mail Company; and Highland Brigade, just completed, for the Nelson Line, Liverpool.

The first of the warship models shown on this stand is the paddle-wheel gunboat Jackal, built in 1844, which was the first war vessel built on the Clyde, and the forerunner of a long list constructed by Messrs. Napier for the British Admiralty. The contrast between the Jackal and the armoured cruiser Berwick, now under construction, a beautiful model of which is placed immediately under that of the Jackal, is an object lesson of the advance made in fifty years. The Jackal was followed by H.M.S. Simoon, one of the first iron steam frigates in the British Navy, and considered a "mighty fabric" when launched. She was subsequently transformed into a transport, and, after forty years' service, sold to foreign owners. During the Crimean War H.M.S. Erebus, the first armour-clad floating battery, was built by the Napier firm, and the machinery constructed for her sister ship the Terror. H.M.S. Black Prince was a notable ship, and amongst the first iron-clad frigates for the British Navy. Her armour was of 4½in. soft iron, in marked contrast with the present hardened steel. She is still a very handsome vessel, and is stationed at Queenstown as guard-ship. Models are also shown of H.M.S. Malabar, one of the famous Indian troopships launched in 1866, and until recently on service as a trooper; the Leander, Arethusa, and Phæton, the first steel ships built by contract for the British Navy, and also the first of the protector class; the Australia and Galatea, armour-belted cruisers, the first ship in the British Navy fitted with triple-expansion engines; the Gibraltar, first-class protected cruiser, of 7700 tons, completed in 1892, and at present flagship at the Cape. Of H.M.S. Berwick, now under construction in the Govan yard, a fine model is shown. She is the most modern type of first-class armoured cruiser, 9800 tons, and 22,000 horse-power; in marked contrast to the 370 tons, and 600 horse-power of the Jackal, whose model is shown in juxtaposition.

In addition to the types of warships for the British Navy, there are on the Beardmore stand models of vessels the firm have constructed for the Danish, Dutch, and Turkish Governments. The twin-screw triple-expansion engines of 12,000 horse-power for the Imperial Russian ironclad Sinope, built at Sevastopol, of which a fine photograph is shown, were the first designed for a warship.

The Napier-Beardmore firm, it may be added, have also made a speciality of steamers for laying and repairing submarine telegraph cables of the "Recorder" type, the most recent being the twin-screw John Pender for the Eastern Telegraph Company, built last year, of which a model is shown.

AN ELECTRICAL EXHIBITION will be held at the Royal Aquarium, Westminster, from Monday, December 16th, 1901, to January 26th, 1902. It is proposed to make the showing of the different kinds of machinery and apparatus in actual work the leading feature of the show.

RAPID TRAIN SERVICE.—The prospects of a rapid train service, with a speed of two hundred kilometres an hour, may, says the Berlin correspondent of the *Standard*, be regarded as improving; and it now appears that experiments are to be made with steam as the motive power. A German railway journal has just published an account of a project for constructing steam locomotives capable of dragging short trains at the above-mentioned speed over the existing permanent ways. This would undoubtedly be an improvement on the proposed electric express, which would necessitate new rails. The purchase of the road and the actual construction of electric railways would take time, which would be saved in the case of a steam railway. Various devices would be adopted to secure safety at such a high speed, and to provide an adequate pressure.

BOILERS IN THE HOUSES OF PARLIAMENT.—A battery of four new Lancashire boilers has been installed at the Houses of Parliament for supplying steam for warming and ventilating, and culinary work. They were built by the Oldham Boiler Works Company, Limited, and take the places of four boilers of similar type, and 7ft. diameter, which had been in service since 1869. They are 28ft. long by 7ft. 6in. diameter, and are constructed for a working pressure of 100 lb., according to the specification of the Manchester Steam Users' Association. The setting of the boilers has been carried out to the designs of the resident engineer, Mr. Palfreman. To maintain the original centre lines, while increasing the diameters of the boilers, special slab walls have been introduced. These are thinner than brick walls, and are built in cast iron channels. The feed pipes, valves, pumps, and injectors, are all in duplicate.

RAILWAY MATTERS.

THE number of locomotives on the railways of the United Kingdom at the beginning of last year was 20,461, an increase of 4224 since 1890.

GERMANY sent to Japan a large quantity of rails in 1900, and her imports of iron, bar, and rod, and other iron and steel, showed a considerable development.

A SYNDICATE at Durban is proposing a scheme for an alternative railway to Johannesburg, by which the time of the journey would be reduced to twelve hours.

WE are informed that, after an exhaustive investigation, the Prussian State Railway administration has definitely ordered nineteen locomotives—four being for express work, and fifteen for goods—to work with highly superheated steam on the Schmidt system.

AT the beginning of last year the railway companies of the United Kingdom owned 45,948 passenger carriages, an increase of 8880 on the 1890 figures. The number of goods wagons had increased by 145,437 in the same period, the total being 671,852.

THE introduction of electric tramcars in Glasgow has been attended to with a large crop of accidents. No fewer than eleven street accidents—one of them the cause of a death—happened at the end of last week. There were collisions between tramcars and between tramcars and other vehicles, while several people were knocked down by the cars.

LAST week the work of connecting the local line to Looe with the Great Western Railway having been completed, a new direct service was inaugurated. The local railway, which thus becomes a feeder to the Great Western, runs from Looe to almost the summit of the Caradon Hills, and is divided into two sections, constructed and owned by separate companies.

EXTENSION of the Japanese railway system progresses uninterruptedly. The most recent returns give the length of the railway lines as 3635 miles, 833 miles of Government, and 2802 miles of private railway on March 31st, 1900. This makes an increase of 65 miles of Government and 150 miles of private railway since April 1st, 1899, a length of 215 miles in all.

THE Select Committee of the House of Lords which has been considering the scheme for constructing a mono-line electric express railway between Liverpool and Manchester, has decided to allow the Bill to proceed, subject to the insertion of a clause providing that the centre of gravity of the cars when fully loaded shall be at least 12in. below the top of the rail.

IT now seems certain that the Exeter and Chagford Railway will, in the near future, be an accomplished fact, says the *Western Morning News*. It is only a few miles long, but has been rather expensive in the cutting, and the scheme has lagged through lack of capital. The announcement is made, however, that the whole of the capital required has now been subscribed, and this will enable the short length still unmade to be started.

LAST Friday a serious railway accident occurred at St. Pancras Station, when a train from Luton ran into the buffer stops at the end of the down platform. The stops were carried away, part of the stonework was demolished, the permanent way torn up for several feet, and a pantechnicon van standing on the platform was wrecked. There were about eighty or ninety passengers in the train, and, according to the official report, at least six complained of injuries.

A NEWSAGENCY is informed by Messrs. Shelford and Son, engineers of the West African Railways, that they have received a telegram from the chief engineer resident of the Gold Coast Railway line from Sekondi to Coomassie, *viâ* Tarkwa, reporting that the rails have now been laid as far as Tarkwa, that works are progressing for some twenty miles beyond Tarkwa, and that the labour troubles have been so far surmounted that 6300 men are now employed on the works. The railway to Tarkwa will be opened for public traffic at an early date.

THE Tramways Committee of the Lancaster Corporation last Friday had before them a proposal from a Birmingham syndicate for the acquisition of the whole of the powers to construct and maintain electrical tramways in the borough obtained in the Lancaster Corporation Act, 1900. The scheme of the Corporation involves a cost of £70,000, and provides for a network of tramways on the overhead wire principle, bringing the growing suburbs of Scotforth and Skerton into touch with the centre of the borough. It is considered improbable that the Corporation will accede to the proposal.

IN the annual report of the Amalgamated Society of Railway Servants, Mr. R. Bell, the general secretary, states that the Society commenced the year with 620 branches and finished with 628, a net gain on the twelve months' working of eight branches. The membership stood at the end of 1899 at 59,819, whereas at the end of 1900 the membership stood at 62,023, an increase of 2204 members. The Society's income from all sources during the year amounted to £74,218 6s. 2d., whereas the income for the previous year amounted only to £69,364 11s. 10d., an increase in favour of this year's transactions of £4853 14s. 4d.

WE understand that Mr. E. Manville, M. Inst. E.E., of the firm of Kincaid, Waller, and Manville, has presented his report upon the several questions submitted to him regarding the Leicester tramways scheme—in consequence of objections to the scheme which were raised at the meeting of the Council—which entirely supports the recommendations of the Tramways Subcommittee embodying the scheme which Mr. Mawbey prepared for them. The full Tramways Committee has therefore unanimously recommended the original scheme to the Council, and also that the surveys, detailed plans, &c., for the lines, power station, depôts, &c., be prepared. The system to be adopted is the overhead trolley.

THE work of constructing the Kreuzburg-Moscow section of the important Moscow, Windau, and Rybinsk Railway is rapidly approaching completion. From a Russian standpoint this line may be said to mark a new departure, for it has been built almost entirely in the interests of the manufacturing districts which lie between Moscow and the Russian ports in the Baltic provinces, and remarkable energy has been displayed since its inception. The line in question is destined to play an important part in the development of Russia's trade; first, it is within easy distance of the centre of European Russia; and, secondly, in view of its projected union with the Great Siberian Railway at Moscow, it will in course of time bring Riga, Windau, and the other Baltic ports into direct communication with the railroad traffic of the Far East and Siberia.

THE South-Eastern and Chatham Railway Company announces that on and from June 1st, the express afternoon continental service *vid* Folkestone and Boulogne, conveying first, second, and third-class passengers, will be re-established for the summer months, and will leave Victoria and Holborn Viaduct stations instead of Charing-cross and Cannon-street. Passengers will reach Paris and Brussels the same night, and Cologne early the next morning, in time to catch the day expresses to the Rhenish watering places, Munich, Berlin, Hamburg, and Europe generally. A special new feature of this service will be the addition of a dining car to the train between Boulogne and Paris. On the return journey passengers will be able to leave Cologne in the morning, Paris and Brussels in the afternoon, and reach Victoria, Holborn, St. Paul's or Herne-hill stations shortly after 11 p.m. the same night.

NOTES AND MEMORANDA.

THE Trinity yacht Irene has been for some time carrying out experiments with regard to the transmission of sound in fog.

THE total number of coal gasworks in the United States is 965. Of this list only fourteen are under municipal control.

VERY little hematite iron ore exists in the Corunna and Lugo mining districts, and all the ore is suitable for the basic process.

ACCORDING to the census taken in February, the population of Italy is now 32,449,000—an increase of 4,000,000 as compared with the 1881 census.

SEVENTY-EIGHT fires in the city of Chicago during 1901 are known to have been caused by electric wires. It is supposed that many others had the same origin.

THE best of the diamonds found in New South Wales are harder and much whiter than those mined in South Africa, and are said to be equal to those from Brazil.

THE total membership of the American Society of Mechanical Engineers now numbers about 2260. The American Society of Civil Engineers has a membership of 2350.

THE total output of coal in Spain last year was 2,747,193 tons, of which quantity more than half was mined in Asturias. In 1898 the amount of coal mined was 2,466,800 tons.

A NEW submarine boat, the Farfadet, was launched on Saturday at Rochefort. She is the first of a class of submarine vessels of a new type, of which three more are under construction.

IT is generally found that india-rubber washers, when screwed up tight and left undisturbed for long periods, adhere to the surface of the metal. To remedy this the washer should be coated with plumbago before being used.

THE correspondent of the *Standard* at Odessa states that it is semi-officially announced that a concession for the construction of a ship canal from the Black Sea to the Caspian will be given to a British syndicate, with a capital of 12 million sterling.

ACCORDING to a parliamentary return, the total output of coal in 1900 was over 225 million tons—an increase of more than five million tons. There was a decrease in three only out of the twelve districts, namely, Durham, South Wales, and the South-Western.

A NEW Bolometer, invented by Professor S. P. Langley for the measurement of heat wave lengths, is said to indicate heat to the one-thousand-millionth of a degree Cent. By the use of this instrument the Newtonian spectrum has been increased twenty times in length.

THE Corunna mines appear to be well worth attention, not only for the gold but also for the arsenic contained. An influential group of Cornish capitalists, largely interested in the arsenic trade, has lately sent out an engineer and mining expert to report on these mines.

HYDRAULIC pressure is being successfully employed at St. Etienne in the manufacture of steel in moulds, tapering towards the top by pressing from the bottom instead of from the top of the casting, as by the Whitworth process. This is said to produce a more homogeneous steel and to give better results generally.

THE torpedo boat destroyer Sprightly, built by Laird Brothers, Limited, Birkenhead, carried out on Wednesday on the Clyde her official full-power coal consumption trial at 30 knots with successful results, obtaining 30·2 knots as the mean of six miles, the speed for the three hours' continuous steaming being 30·03 knots.

OWING to the pressure of work in the department of the chief engineer of Portsmouth Dockyard, the entry of 250 additional mechanics has been authorised, the majority of whom are to be fitters and boilermakers. It has also been decided to increase temporarily by over 200 per cent. the outlay on new working plant in this department.

A GERMAN contemporary gives the results of investigations which have been carried out by Dr. A. Schweitzer to determine the influence of aluminium on the magnetic qualities of cast iron. The results of the observations may be summed up briefly as follows:—Admixtures of aluminium with cast iron effect a decrease of the induction for equal field strengths and an increase of the hysteresis losses for equal inductions. The magnetic qualities of the iron, in fact, are lessened in value.

A CONSULAR report on the trade of Japan, just issued, forms satisfactory reading for the British trader. The imports from the United Kingdom last year amounted to £7,313,000, an increase of £2,735,000 while there was a slight decrease in the exports to this country. The United Kingdom records the largest increase in value of imports, though the increase of Germany—70 per cent.—is the greatest in proportion. The percentage gained by the United States is 63 per cent., and by France, 40 per cent.

A NEW light steam motor carriage of English build has made its appearance. It is the outcome of the ingenuity of Mr. H. A. House, of Lifu fame. The weight is 14 cwt. The car is driven by a horizontal 10 horse-power two-cylinder compound engine. Steam is obtained from a multitubular boiler so designed that easy access for cleaning both inside and out is obtainable by means of suitable and easily removable manholes. The boiler is fired by means of a specially-designed burner, using common paraffin. All the gearing runs in oil baths.

IN a paper read recently before the Société Internationale des Electriciens, M. Picou, who was the engineer-in-chief for the electricity supply service at the Paris Exhibition, gave some figures as to the output and power consumption. The total duration of the electricity service was 2756 hours, during which public lighting was supplied for 909 hours, and the average number of hours of running of the generators was 713·5. The total connections to the mains represented 11,265 kilowatts—practically 20,000 horse-power. The mean daily output of the generators was 25,336 kilowatt hours.

As is generally known, the Anglo-American syndicate, the Edison Iron Ore Milling Company, Limited, has acquired enormous deposits at Dunderland, in the north of Norway, where a large industry is to be established, and last autumn a patent for the process was applied for in Norway. This application was referred to a specially-appointed Royal Commission, which has just decided that the patent be refused on the ground that the process is not a new one. The application was for "a process for the concentration and briquetting of magnetic ores," it being intended to export the briquettes for treatment by the English and Scotch ironworks.

THE new testing station of the British Fire Prevention Committee was opened on Wednesday afternoon. The following tests were undertaken in the course of the afternoon: One with a suspended ceiling protecting an ordinary floor and another with a thin partition, both by the Banks Fireproof Construction Syndicate, Limited, which were subjected to high temperatures for a period of one and a-half hours. Further, a test was undertaken with a heavy warehouse floor spanning 22ft. which was subjected to a very severe test for a period of three hours, whilst loaded to the extent of 2 cwt. per square foot; this floor was put forward by the same syndicate for investigation.

MISCELLANEA.

THE death is announced of Mr. Richard P. Rothwell, editor of the *Engineering and Mining Journal* for twenty-eight years, at his residence in New York.

THREE syndicates have been formed in Norway for working the coal discovered in Spitzbergen. The coal is found fairly near the surface and in the vicinity of the coast.

A STEAM engine and mining machinery combination is being formed in Milwaukee among prominent manufacturers in these lines, though two separate organisations may be made.

IT is to-day semi-officially announced that a concession for the construction of a ship canal from the Black Sea to the Caspian will be given to a British syndicate, with a capital of twelve millions sterling.

WE are requested to state that the forty-first annual dinner of King's College, London, will be held at the Trocadero Restaurant, on Monday, June 24th, with the Hon. Mr. Justice Byrne in the chair.

THE Canadian Government has determined to hold the Pacific Cable Bill until it has been decided whether the arrangement of New South Wales with the Eastern Extension Telegraph Company is detrimental to the British Pacific Cable interest.

LAST week there was launched from W. Denny and Brother's shipyard at Dumbarton the passenger steamer King Edward, which is the first commercial steamer to be fitted with steam turbines. A speed of 20 knots only is aimed at. The steamer is intended for Clyde coast traffic.

OF the iron and steel imported by Japan last year that produced in the United Kingdom showed a much greater increase in value than that from any other country. Iron nails, in particular, showed a remarkable growth, though the quantity obtained from America and Japan was less than in the previous year.

IT would appear that the objectionable trust to control the field of industry is getting a foothold in Japan. Last November the Japanese colliery owners signed a provisional agreement binding them to fixed rates for the sale of coal. Sales of coal below the prices specified are punishable by the penalty of a fine.

IT is difficult to understand the neglect of British shipowners in not having started a regular service of boats between the northern ports of Spain and the United Kingdom. The British Consul at Gijon says that if their competitors can make the carrying trade pay, there is no reason why they should not take part in it.

IT is announced that the firm of Sir W. G. Armstrong, Whitworth, and Co. has practically concluded an arrangement which will enable them for the future to make armour plate by the Krupp process up to any thickness—a privilege which had been confined hitherto to the three Sheffield firms and to Beardmore and Co., of Glasgow.

KEROSENE oil is one of the most important of the products, coming from abroad, which are in constant use in Japan; 67,842,324 gallons were imported in 1900, a considerable increase over the immediately preceding year. More than 70 per cent. of the oil comes from the United States, which sends increasing quantities to Japan.

THE British Consul in Nicaragua reports that rubber is becoming more scarce every year, and the planting of rubber trees has not been taken up to any extent, possibly through the long time necessary before any result is seen, and the difficulty of preventing stealing. The Government allows a bonus of 1 dol. on every rubber tree planted in certain districts.

THE Admiralty has informed the Devonport dockyard authorities that battleships and cruisers in commission for the home stations, and all vessels being prepared for the Reserve, Training, and Channel Squadrons, shall be fitted with wireless telegraphy apparatus. All future battleships and cruisers sent to the Mediterranean are also to be so equipped. Apps-Newton coils are being used.

IT is reported that the firm of C. S. Swan and Hunter, of Wallsend, has been commissioned to build a floating pontoon dock for Japan. The dock will be built in sections, with a view to being taken to pieces for shipment and final reconstruction at the Japanese port of destination. The Bermuda floating dock, which is being built by this firm for the Admiralty, and which is of exceptionally large dimensions, is now well advanced.

A NOVEL type of motor war machine is being built by Vickers, Sons, and Maxim, Limited. It has been designed by Mr. F. R. Simms, of 55a, Southwark Park-road, Bermondsey, and is an armoured car intended for the protection and inspection of railways. It runs on the rails and is propelled by a petrol motor, the armament consisting of a one-pounder Maxim gun. Each machine is constructed to be manned by one officer and two or three men.

ACCORDING to the reports of the well-known Spanish mining engineers and experts, the abundance of iron ore of every description is immense in the Lugo district of Galicia. In the neighbourhood of Rivadeo, in the valley of Buron, about nine miles from the Rivadeo-Villaodrid Railway, some 125 claims of very pure iron exist, which, according to the analysis of the School of Mines at Madrid, shows 68 per cent. of iron, and scarcely a trace of phosphorus, sulphur, and silicate.

A MEETING has recently taken place at the offices of the Swedish Iron Board in Stockholm by leading manufacturers of Lancashire pig iron to consider the depressed state of the iron market here prevailing, with the result that a resolution was unanimously agreed to not to sell this kind of rolled iron under 155 kr. per ton net, delivered at port of export. Not so very long since the price rose to 220 kr. per ton, but it has since declined as low as 150 kr., which is the cause of this combination.

THE French Government is believed to have under consideration a Bill intending to prohibit the use of white lead, in accordance with the recommendation of the Public Health Committee. The Chamber of Commerce at Lille, which is the centre of the manufacture of white lead in France, has taken up the defence of the white-lead interest, and has published a long memorandum in defence of the use of this material, which has been sent to the Ministers of the Interior and of Commerce.

THERE appears to be ample room for the supply of agricultural machinery in the Warsaw district of Poland. There are fourteen newly-formed agricultural societies in this district, one in each Government. It is said that agricultural machinery to the value of £29,000 passed through the hands of the Warsaw society last year. The societies will only deal with makers at wholesale prices. The address of each body is "Towarzystwo Rolniczne," at the chief town of the Government in which it is situated.

THE Roumanian State shipbuilding yard at Turn-Severin, in addition to carrying out a large amount of repairs in Roumanian, Austrian, and Russian vessels, have turned out a large amount of new work, including two lifting pontoons for the State river authorities, two 650-ton cargo steamers, two 380 horse-power twin-screw tugs, two 380 horse-power twin-screw passenger steamers, and 190 horse-power passenger steamer for the Roumanian Government steamship service. All the boilers on these vessels are adapted to be fired by petroleum residues.

THE HYDE PARK LOCOMOTIVE WORKS, GLASGOW

(*For description see page 525*)

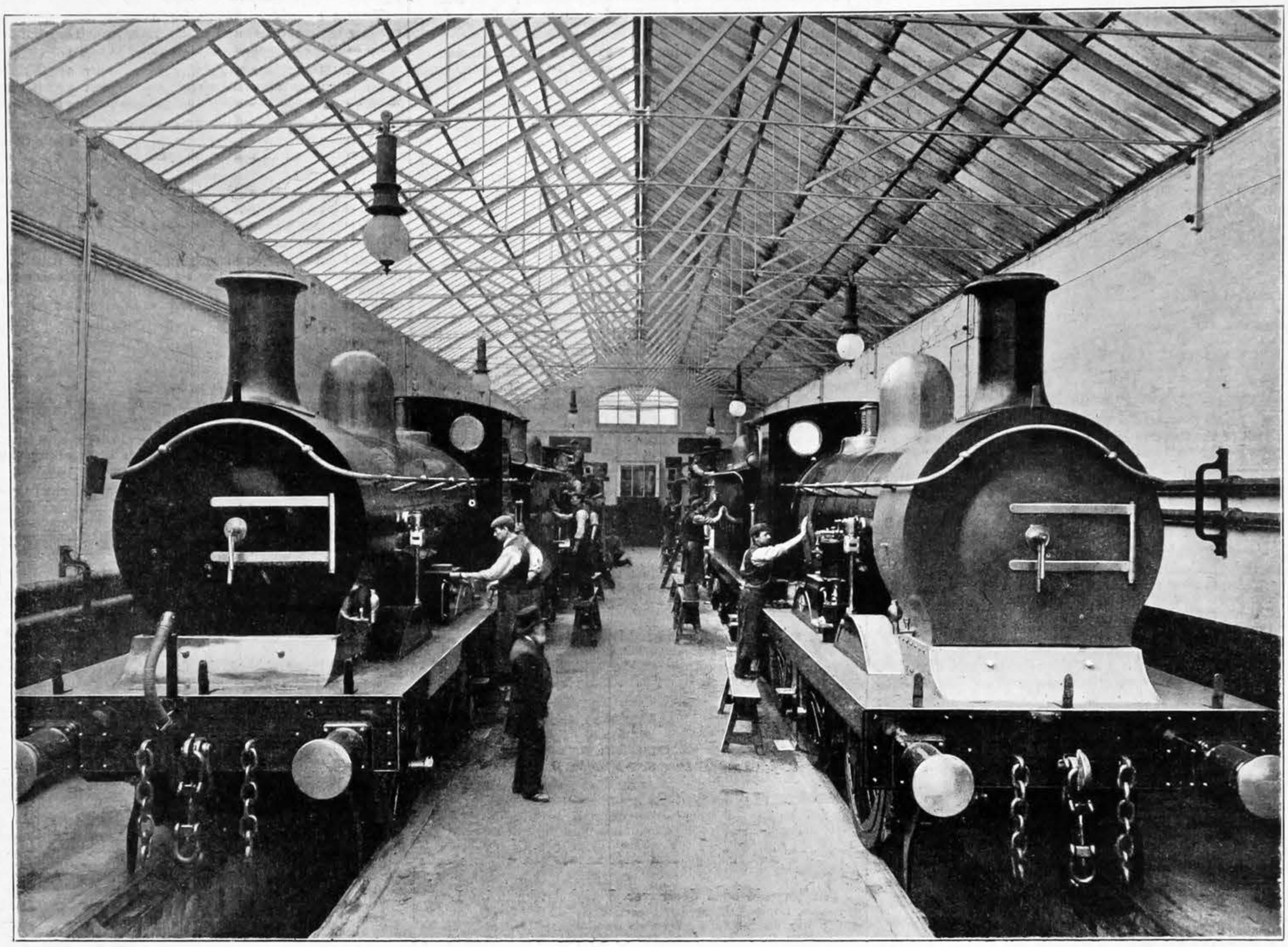

Fig. 31—PAINT SHOP

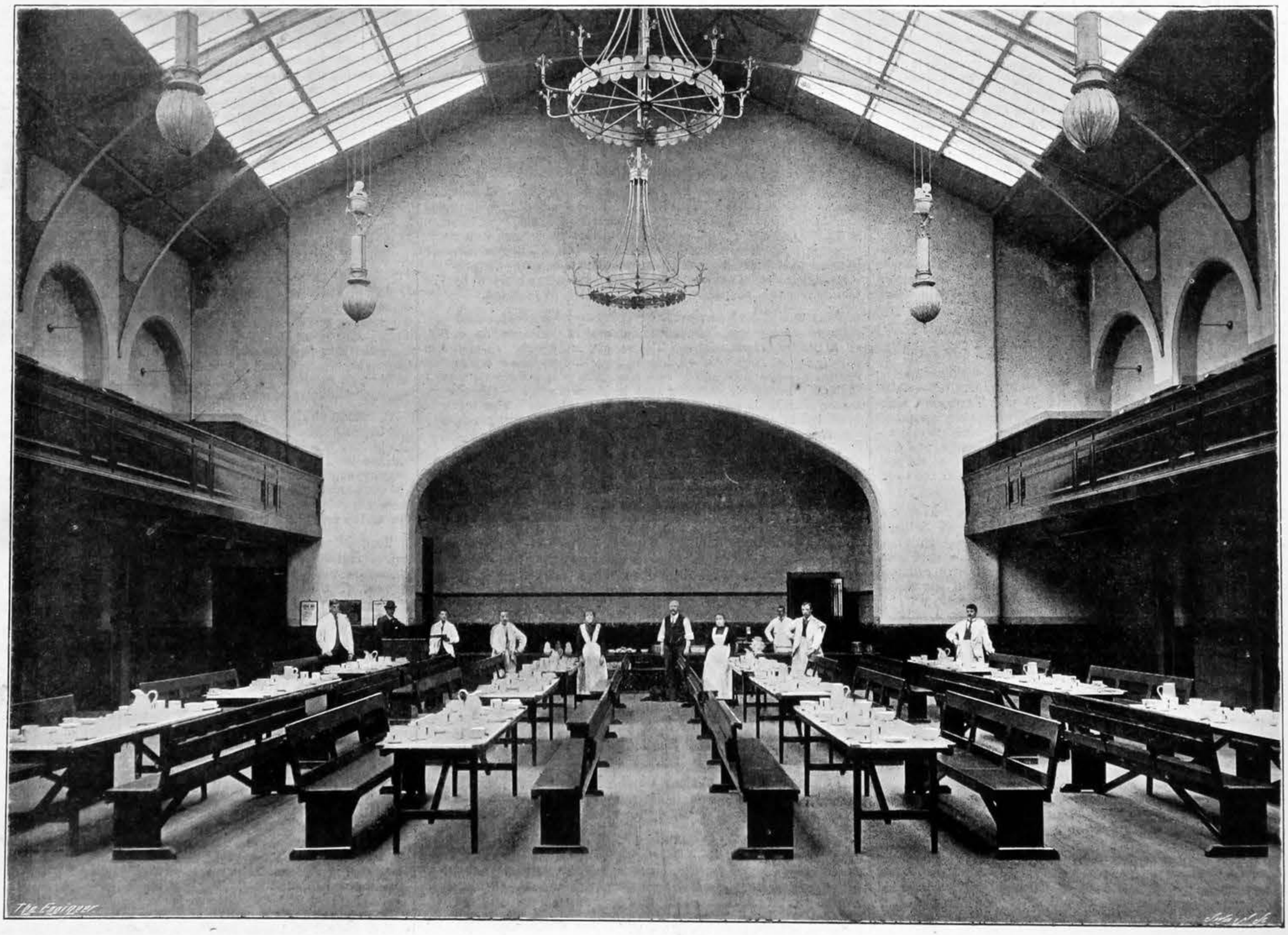

Fig. 32—DINING HALL

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Advertisements cannot be inserted unless delivered before Six o'clock on Thursday evening; and, in consequence of the necessity for going to press early with a portion of the edition, ALTERATIONS to standing advertisements should arrive not later than Three o'clock on Wednesday afternoon in each week.

Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

Telegraphic Address, "ENGINEER NEWSPAPER, LONDON."

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TO CORRESPONDENTS.

*** *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 stamped, 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.*

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

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

REPLIES.

G. F. W. (Donnington).—As far as we know, no successful machine working on these lines exists.

W. K. B. (Gorton).—You can obtain full information either from the Board of Trade, Whitehall, or from the Civil Service Commissioners, Whitehall.

F. S. C. (King William-street).—We know nothing of the American blocks of which you write, but we believe you can obtain them from Doulton's, of Lambeth.

DIFFICULTY.—We have failed to decipher your letter with certainty. We believe you speak of a Grasshopper beam pump. If you will state what your difficulty is, we shall try to help you.

A. R. (Hillsboro).—We advise you to procure an elementary treatise on mensuration, which can be had for a trifle at the shop of any dealer in second-hand books. You will then learn how to treat all such questions as those you have sent us, the replies to which would occupy much space in this column, and would be quite devoid of general interest.

MEETINGS NEXT WEEK.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, May 30th, at 8 p.m., at the Society of Arts, John-street, Adelphi, W.C. Annual General Meeting.

CITY OF LONDON COLLEGE SCIENCE SOCIETY.—Wednesday, May 29th, at 7.30 p.m. Paper, "Some Scientific and Engineering Artifices I have Known," by Mr. T. E. Gatehouse, F.R.S.E., A.M.I.C.E., &c.

ROYAL INSTITUTION OF GREAT BRITAIN.—Friday, May 31st, at 9 p.m. Discourse on "With the Allies in China," by Mr. A. Henry Savage Landor, M.R.I.—Afternoon Lectures at 3 p.m.:—Tuesday, May 28th (the Tyndall Lectures): "The Philosophical Undertones of Modern Poetry," by Prof. William Knight, LL.D.; Thursday, May 30th: "The Chemistry of Carbon," by Prof. Dewar, M.A., LL.D., F.R.S., M.R.I.; Saturday, June 1st: "The Biological Characters of Epiphytic Plants," by Prof. J. B. Farmer, M.A., F.R.S.

THE ENGINEER.

MAY 24, 1901.

THE MANCHESTER AND LIVERPOOL EXPRESS RAILWAY.

WE are glad to be able to announce that Lord Falkland's Committee have found the preamble of Mr. Behr's Bill proved. The clauses have been gone through, and the Bill ordered to be reported to the House of Lords for third reading. So far there is a prospect that a very important experiment will be made. The Bill, our readers will remember, is for the construction of a line on the mono-rail system between Liverpool and Manchester. The length of the line to be about thirty-five miles; the time of transit twenty minutes. The cars will carry forty or fifty passengers. About two miles and two minutes will be required to get up speed to 110 miles an hour, and the same time and space intervals for stopping. Although the Bill has got through the House of Lords Committee, it does not follow that it will get through both Houses of Parliament. We can only say that we hope it may. Our reasons are simply that we are always glad to see a considerable scientific experiment carried out; and the proposed railway is nothing if not experimental. The projectors have, indeed, little but assumption, analogy, and a very limited personal experience to rely on; but it may safely be said that the more novel and daring an experiment is, the more likely is it to prove interesting and to claim attention.

We believe that we do Mr. Behr no injustice when we say that the details of the experiment remain inchoate. It would have been scarcely worth while, indeed, to incur much expense in preparing detailed plans and specifications before it was known that the House of Lords Committee would sanction the proposal to construct such a line at all. This is, perhaps, the reason why one set of witnesses held that the proposals for constructing and working the line, as prepared by Mr. Behr, were satisfactory, while equally competent experts characterised them as quite impracticable. It has been staed, we cannot say with how much truth, that Mr. Behr himself in committee knew least about the details of the scheme. But this does not signify so long as a man of Dr. Hopkinson's ability is able to guarantee the success of the railway in so far as that depends on electricity. Much of the opposition urged by the Lancashire and Yorkshire Railway Company and the Cheshire Lines Committee, was based on the theory that it could not carry passengers enough to be a commercial success; but with that matter we have nothing to do. We can only charitably hope that this trial of a novel method of locomotion will be carried out by men with enough to bear with equanimity the loss which they will incur if the scheme is not a success. The prospective shareholders will no doubt keep the French proverb in mind, which tells the world that one cannot make omelettes without breaking eggs. There are, however, certain salient points, broad features of the scheme so to speak, on which it is possible to comment; and even, like Dr. Hopkinson himself, to arrive at certain definite conclusions. We have quite recently explained what working trains at 120 miles an hour involves. It appears that the highest velocity contemplated by Mr. Behr is only 110 miles an hour—a fact which may perhaps restore confidence to some timorous people, and no doubt diminish the chance of accident. It does not appear that Lord Falkland's Committee quite understood, any more than we do, the reason why a mono-rail was selected for the experiment; or that they recognised the eminent suitability of such a road for 110 miles an hour. They did stipulate, however, that Mr. Behr should satisfy the Board of Trade that the centre of gravity of the carriages will be 12in. below the rail when the cars are full of passengers. But this is only one of the problems which beset those who try to master the reasoning which has resulted in the scheme. The mono-railway is a very old invention. The advantages claimed for railways of the kind are that they cost very little, because there are no earthworks and little or no land taken up. In its elementary form we have a series of posts driven into the ground—short posts where the ground is high, long posts in the valleys. On the tops of the posts a level rail is secured, and on this runs a species of trolley, from which depend, on each side, baskets or boxes, in which are placed whatever has to be carried. The more elaborate Behr railway consists of numbers of trussed A frames, on the top of which is the bearing rail, and on each side guide rails. The vehicles straddle across, and the passengers sit back to back, as on an Irish jaunting car. We gather from Mr. Behr's proposals, however, that the cost of the line, although it will be nearly level, is estimated at £13,500 per mile this year. Last year the estimate was £18,000 per mile, but materials are now cheaper. If the final cost of this line is kept down to the estimated cost, it will, apart from all other peculiarities, be one of the most remarkable undertakings in England. We are not sanguine enough to believe that the cost will be less than £20,000 a mile. Under the circumstances we do not see where a saving is effected. A very good double line indeed, of the 4ft. 8½in. gauge, can be made for that price in level country.

However, we may take the road as we find it. Dr. Hopkinson has calculated that during the time of acceleration about 1500 indicated horse-power would be required. The work to be done represents, in round numbers, 421 foot-tons per ton of train. The car or "train" is to weigh 50 tons. Dr. Hopkinson does not doubt that it is quite possible to transmit that power from a generating station. Neither do we. Still there are difficulties. Is there to be one generating station in Liverpool and another in Manchester, or are we to suppose that 1500 horse-power will have to be transmitted thirty-four miles or so from a single station at one end of the line? To do that with reasonable economy seems to suggest a very high-tension current. No one appears, however, to have formed any definite notion of how the power is to be applied. Dr. Hopkinson does not think that Mr. Behr's arrangement would answer. The mono-rail, in truth, does not lend itself kindly to being worked by electricity. We gather that the car is to be supported on four wheels, each of which is to be driven by a motor weighing 2½ tons. On a double-rail system the motor can be put on the axle between the wheels; on the single-rail system it is obvious that a motor must be put at each side of the single wheel. This does not seem very commendable; consequently recourse is to be had to gearing. But, once more, no one knows how gearing or chains would work at 110 miles an hour. Assuming a wheel 20ft. in circumference, the revolutions per minute would be 484, which sounds high for gearing. However, Dr. Hopkinson knows of as much as 100 horse-power being transmitted by means of gearing on tramways. To get 375 horse-power out of a 2½-ton motor seems to be optimistic; but this we understand would only be required for a very short time. We do not know how Dr. Hopkinson has calculated the horse-power. If the motors exert a steady or fairly steady 1500 horse-power, then at low speeds the torque would be very high, and at the high speed towards the end of the acceleration period comparatively small. Assuming, however, as is most likely, that he has calculated it on the basis of the average velocity attained during the acceleration period, namely, 55 miles per hour, then the torque would be about 10,250 lb. The weight of the loaded car would be 112,000 lb., or much more than sufficient to satisfy the necessary conditions of adhesion.

Some capital was made by the opponents of the Bill on the assumption that the wind draught when two cars passed each other, a distance of only 18in. intervening, at 110 miles an hour, would be so enormous that the carriage windows would be forced out. Contentions of this kind carry us back to the days of George Stephenson and the cow. History, indeed, at the hands of learned counsel and expert witnesses has repeated itself. Just the same arguments have been urged against 110 miles an hour that were brought to bear in 1830 against thirty miles an hour. Such arguments are of no importance. To us the radical objection to the whole scheme is the mono-rail. Mr. Behr handicaps the proposal. In Germany, it will be remembered that a scheme for running at 120 miles an hour is making headway. It is, however, a significant circumstance that, according to the most recent information available, the cost and difficulty of working by electricity over a considerable mileage are found to be so great that it is now contemplated to use steam locomotives instead of electrical. A special type of locomotive is to be employed, hauling a single coach. The permanent way is to be re-laid and made so far perfect that a velocity of 120 miles an hour may be maintained with safety.

AS AN ENGLISHMAN SEES IT.

IN the current number of *Cassier's Magazine* an article entitled "The Copying of American Machinery; as an Englishman Sees it" appears under the name of Mr. Joseph Horner. We did not know before that Mr. Joseph Horner was an Englishman. We cannot say that we are pleased to know it now. We would rather that such articles as that to which we have referred were written by Americans. There would be as little fault to find with it then as there would have been with Mr. Horner if he had found all his plums in a British pie instead of in an American one. One who boasts of the prowess of his own people is often condemned. What shall be said of he who boasts of the prowess of others at the expense

of his own? We know the proverbial value of self-recommendation; yet surely the man who is guilty of praising himself is less ridiculous than he who stands on a stool to cry "I have a long cap on my head. I know not what I do. Buy from my neighbour. Buy, buy, buy! They be all weaklings and imitators in my shops. Cross the bridge to my friend, there, and buy, buy, buy!" It is no exaggeration to say that it is into this position that Mr. Horner, making himself a spokesman on their behalf, would raise all British machine tool makers. Virtually, he tells us that, as an Englishman sees it, no good thing comes out of England. We are a race of imitators who of necessity lag a pace behind those we follow. He insists on this point with a reiteration which has all the appearance of pique.

Time was when the "easy-chair of custom" had too many charms for British engineers; when it was the duty of all who had the welfare of their country at heart, and had the means of doing so, to make no half-hearted attempt to warn their friends of an increasing danger. That time has passed, and an article cast in the strain of this of Mr. Horner's is, at the least, an anachronism. British machine tool makers are fully alive to the position of their trade; they even know more about it than this Englishman, and, though it may be a revelation to him, there is actually a sale, and a very large sale, for their tools. It may surprise him even more to learn that they go to France, Germany, and even to America. Furthermore, Mr. Horner has jumped to a rash conclusion. He appears to take it for granted that American methods imported into this country would be as successful as in the United States. It seems not to occur to him that the types of tools made in Great Britain are adapted to the wants of Great Britain. It is surprising that a gentleman who has written so much on the subject should close his eyes to the condition of trade and labour in these islands, and should overlook the peculiar circumstances which have afforded America opportunities which she has not been slow to take. We might remind Mr. Horner that the iron trade with America flows through a check valve. The current runs easily in one direction; it is practically stopped in the other. We should have imagined that an Englishman, seeing things from an English point of view, would have been glad enough to lay stress upon such points, and to show the best side of the trade of his country.

It would be interesting to go through Mr. Horner's article paragraph by paragraph, and so to attempt in some measure to diminish the damage which such a contribution may do our reputation and trade. But that is evidently impossible. We select, however, one or two passages for comment. "It is well, in the interests of a nation's industries, and of the highest national and industrial life, that the burden of the human drudge shall be lessened to the last limits." The author is advocating automatic machinery. Let us ask him which is the greater drudgery, to watch five or ten machines which are quite competent to look after themselves, or to use one which demands the use of attention and intellect? We would furthermore ask Mr. Horner if the American system, which superannuates a man at forty, is better for the "human drudge" than a system which can find occupation for an old servant till his hair is white and his eye dim? The author is determined to make a plagiarist of the British tool maker, consequently we have a list of "the more notable examples of British imitation of American inventions." The list opens unfortunately. The case is quoted of the ordinary change gear for screwing. To effect a change, we are told, "seldom occupies less than fifteen minutes, and may take half an hour. It is repeated many times a day in a large shop. A few years ago an American devised a permanent arrangement of wheels by which the changes for different screws could be effected within a minute by the simple movement of a handle." We are not prepared to contest the statement that this gear was invented in America, but we are under the impression that the idea was borrowed from a foreign machine. Be that as it may, we have been assured by an authority on machine tools that it took no less than fifteen years for Americans to discover its value, and it is, as far as we are aware, only made for comparatively small lathes at the present day. In another passage we are told that the American screw machine "still holds its place by very long odds." To that we have not the slightest hesitation in replying that there is no machine on the market superior to some of British manufacture. The prevalence of the American machine is due to wholly other causes than its undeniable excellence. The author goes on to tell us that the turret originated in America—a statement which we imagine he would find it difficult to prove; and he continues, "American firms still went on improving until they made the movement of the machine wholly automatic." Mr. Horner does not mention that this was an improvement in one sense only; it reduced labour, but at the expense of time, for a hand-worked turret lathe is more rapid in its action than a full automatic. In the matter of gear wheels Mr. Horner again gives the truth in a biassed form. He says, "The common British practice has been to cast them roughly and inaccurately from patterns; the American to cut the teeth cleanly and truly from solid iron, steel, or brass." The author is evidently quite unacquainted with the excellent cast wheels that were formerly used in this country, and is as blind to certain advantages which a good cast tooth possesses as he is ignorant of the fact that it was the failure to cast good teeth in America that led to the adoption of cut teeth there. Even now firms who employ only cut teeth hold that their use is more a matter of fashion than of necessity. The advantage of the cut wheel lies principally in the ease with which it is made. As for gear-cutting machines, we do not for an instant deny the excellence of a well-known American make, but we know of at least one English machine which is equally good, and we have not seen any bevel gear cutter yet that can beat a certain English-made machine.

We do not desire to follow Mr. Horner's condemnation of British makers further. It would be easy to show that America owes at least as much to this country as we owe to her—we say this without the least desire to depreciate the excellent work and the inventive genius of the Americans. And it is impossible to avoid the natural thought that an Englishman would be better employed in finding and extolling the virtues of this country than in proclaiming her apparent weaknesses and holding her up to contempt and ridicule. Nothing is to be more regretted and more strenuously combated than the increasing tendency to run down our own country. It was not in that spirit that we gained our eminence, and in that spirit we shall not hold it. Boastfulness is preferable to servility. A little vanity is a great buttress to self-respect. In conclusion, we cannot refrain from quoting an admirable passage, bearing on this point, which appears in a story by Commander H. N. Shore, in the *Naval and Military Record*. A handy-man speaks:—"Now, to my mind, when chaps fall to and abuse their own countrymen, and blow about foreigners, it's time to jack up. If Englishmen are to creep about the world like a pack of whipped hounds, afraid to speak a word of what Englishmen have done, I say it's time to knock under. Do you think that was the spirit that made England what she is? Do you think Nelson would have carried the San Josef or Cochrane, the '——' with a passul of mean-spirited hounds at their back? Would our ships have beat the French at the Nile or won Trafalgar if they'd been manned by a lot of sneaking curs who were afraid to say a word for their country for fear of offending the foreigners? No! The way British seamen whipped their enemies was by making up their minds that each Britisher was equal to three foreigners! And, what's more, if you want old England to keep her place in the world, and your seamen to keep the foreigners from fooling us, you must put heart into them. You can't make men what's going to fight have too high an opinion of themselves and of their country. It was that what pulled the old country through her troubles in the past; aye, when all Europe was in arms against her, and she hadn't a friend dare strike a blow for her. And it's that as 'll pull her through again when she has to face odds in battle."

THE WORK DONE IN A BOILER.

In giving evidence, recently, before the Parliamentary Committee on the Mond gas power scheme, Sir Frederick Bramwell is reported to have said that the maximum efficiency of the steam engine was represented by the conversion of about 9 per cent. of the heat generated in the furnace into useful work. No doubt this is true of very large numbers of steam engines; but Mr. Bryan Donkin has shown in this journal that large engines now realise over 16 per cent.; and that in the best class of triple-expansion engines of moderate power 12 and 14 per cent. are obtained with comparative ease. Sir Frederick had no doubt overlooked the more recent, and in a way, exceptional developments of steam machinery. It is a noteworthy circumstance that, although the cost of fuel for power in large factories and mills bears but a small proportion to the complete working expenses, any invention which beyond question saves fuel by augmenting the efficiency of heat engines seems to meet with favour and adoption. We may cite as an example the Schmidt superheated steam engine, which is, we understand, being manufactured now on a very considerable scale. The phenomena attending the conversion of heat into water seem to possess a perennial interest. No matter how much is written about them, more seems left to be said; and a paper on steam-engine economy read before any scientific society in the world, at home or abroad, is certain to evoke animated discussion. Our readers well know how fully and frequently thermodynamical questions have been dealt with in our pages. We make no apology, however, for returning to the subject. Indeed, we are in a manner impelled thereto by certain recent utterances concerning energy, and reasonings about the meaning of the word which seem to be of importance.

It has always been held until quite recently that Clark-Maxwell's views concerning the energy of gases, specific heat, thermal efficiency, and, in one word, heat in general, were all but final. It is true that Maxwell himself has hinted, or more than hinted, at the existence of certain gaps in his theories. It may be said, however, that it has remained for Lord Kelvin to accentuate these discrepancies, and to say enough to lead to the belief that we are very far indeed from having heard the last word concerning energy and the molecular physics of gases. Thus, for example, whereas it was not so long since taught that the bombardment of the walls of an enclosing space by gas molecules produced what we call pressure, such difficulties have been at last recognised in the presentment of this theory that the more advanced physicists maintain that contact does not take place at all between the walls of a gas cylinder, and the flying molecules. A layer of ether is interposed between the two, which the molecules cannot penetrate. Again, the property of inertia, which we have constantly defined as "capacity for receiving motion," is now being stated, in all possibility, as an electrical phenomenon. We mention these things not because they have any special connection with the subject of this article, but because they serve to show that there is nothing extravagant, or out of the way, or alarming in the proposition that the so-called law of the conservation of energy may be found capable of modification. To apply this to the matter in hand. A British thermal unit is said by different authorities to represent 772, 774, and 776 foot-pounds by Joule's system. We need not concern ourselves about these small differences, nor have we the least reason or intention of disputing the accuracy of the deductions drawn from the various experiments which have been carried out; but we do say that there appears to be reason for doubting that, because a given quantity of heat energy applied in one way will raise the temperature of a pound of water one degree Fahrenheit, or lift a weight of 1 lb. 772ft. high, the same amount of energy applied in another way must produce a precisely equivalent result. Indeed, it is a matter of common knowledge that facts in chemistry do not harmonise with deductions from Joule's investigations, to say nothing of animal chemistry and mechanics. There are puzzles about explosives, endothermic and exothermic, which have yet to be solved.

When, therefore, it is stated that a given steam engine converts into useful work only 5 per cent., or any other quoted percentage of the calorific value of the fuel, it is just as well to bear in mind that this statement is true only within limitations. In other words, so far as we know, a given quantity of heat can only produce a given quantity of work. But it is not right to assume that this statement covers the whole ground. If we could see further into the secrets of the universe, we might perhaps be made to understand that the result in question was much better or much worse than we now suppose it to be. We know absolutely nothing of the nature of heat. To say that it is simply a long wave vibration of the ether as light is a short wave vibration, advances our useful knowledge not at all. The assertion that because a given quantity of vibrations—for that is what the statement comes to—producing a given rise in temperature in a pound of water can also lift one pound 772ft. high against the action of gravity, and that in this way we have a measure of the pressure-equivalent of the energy exerted by the ether waves, under all circumstances and conditions, no less and no more, is a generalisation which the advanced minds of the present day begin to see requires qualification.

Leaving generalities, however, let us speak of the steam engine, and turn our attention for a moment to certain matters which are not quite so simple or readily understood as shallow thinkers would have the world believe. What is the work actually done by heat in a boiler? Leaving the steam engine to take care of itself for the moment, let us consider how far the boiler is or is not an efficient converter of heat into work. We shall only speak of the heat actually transmitted through the plates to the water, and to simplify matters we shall assume that the feed-water is raised to the temperature of the steam in the boiler before it is injected. The total pressure is 115 lb.; that is to say, the working gauge pressure is 100 lb. The volume of 1 lb. of the steam is 3·80 cubic feet, and the relative volume is 237 to 1; that is to say, one cubic foot of water makes 237 cubic feet of steam. Now the actual work done by the heat on any single pound of water consists in producing 3·80 cubic feet of steam against a pressure of 115 lb. on the square inch. Before it can do this the molecular attraction—as it is called, for want of a better phrase—of the water must be overcome. This absorbs—omitting small fractions, which are very useless and confusing now—876 thermal units. In this quantity, however, is included the work to which we have just referred, namely, the putting into the steam space of the boiler of a pound of steam which was not there before. This represents $144 \times 115 \times 3{\cdot}8 = 62{,}928$ foot-pounds, or 81·4 thermal units. All the rest of the heat is expended—in doing what? The text-book answer is, as we have stated, in overcoming the molecular attraction of the water; but what this really means no man living knows. Let us put the molecular attraction on one side, however, and proceed to consider our pound of steam. It is clear that on our hypothesis it has been produced by the expenditure of 81·5 B.T.U. As each pound of steam is made in the boiler it pushes another pound out of it, which acts on the piston of the engine during the full-pressure part of the stroke; and we have no difficulty in postulating theoretical conditions under which the whole of the 81·5 B.T.U. would re-appear as useful work done on the piston of an engine. But let us advance a step, and consider the use of this pound of steam expansively. By using the steam with only an eightfold expansion we can get, in round numbers, 160,000 foot-pounds out of it; that is to say, 97,000 foot-pounds from expansion alone. But, as we have said, the work done in the production of the steam, that is to say, the mechanical work properly so-called, only represented in round numbers 63,000 foot-pounds. Whence comes the 97,000 foot-pounds extra? The "latent" heat is greatly in excess of what is needed to supply this; and it is understood that this is expended or converted in overcoming some force holding the molecules of water in the condition of a non-elastic liquid, and compelling them to assume the condition of an elastic fluid. But no physicist now, or, indeed, for many years past, assumes that there is any heat latent in steam. The lost heat has been expended in doing work—part of it, as we have seen, in producing 3·8 cubic feet of steam against a pressure of 115 lb.; the remainder in doing some act, the precise nature of which is shrouded in mystery. It seems to be obvious that, seeing that one pound of steam can only represent the mechanical work done on it, without some change of conditions the moment we attempt to expand it we must draw on the so-called "latent" heat. In other words, liquefaction will take place. This is borne out, as we all know, in practice. But let us see what the liquefaction means. Heat was expended in overcoming molecular attraction. By causing the steam to expand, the molecular attraction re-asserts itself, and liberates heat, which heat is at once converted into work on the engine piston. Putting this in a somewhat different shape, we find that in the boiler, pressure is obtained by a process which is entirely different from that by which it is obtained in a compressing pump or in an internal-combustion engine. In the former, especially, the pressure rises from zero to the maximum; and a curve, very nearly a hyperbola, will delineate the progress of the rise in pressure. But inside a steam boiler nothing analogous to this takes place. Steam is invariably produced at once of the full boiler pressure; and there is apparently no equivalent of any kind for the

expansion portion of the diagram. That never comes direct from the boiler as it would from the receiver of an air engine. It is derived entirely indirectly from the complex process the nature of which we have indicated. No one knows on what the "latent" heat is actually expended. If for lack of a better name we call it "attraction," then it seems to be clear that this attraction is in some way competent to undergo conversion into mechanical work in a way different from that by which it was overcome; and, to sum up, we are led to the conclusion that the working of a steam engine does not represent, as it is said to represent—in a different sense, however—a closed cycle; work of one kind being done in the boiler which is never done backwards, so to speak, in the cylinder. Putting the whole thing into another form, we may say that the energy in a permanent gas is almost altogether and at all times dynamical. It is due to the motion of the gas molecules. In steam a very large portion of its energy is potential, and expansion cannot take place adiabatically against a resistance without the preliminary conversion of this potential energy into dynamic energy. The conditions are analogous to the work done in lifting a weight, then letting the weight fall, and using up the heat generated by its collision with the ground; the force, whatever it is, urging the water molecules together, being strictly analogous to gravity urging a stone to fall. The dynamic energy of steam is represented by its sensible temperature, and this, in the case considered, it did not obtain inside the boiler at all; it was obtained in the feed-water heater. Its potential energy is represented by its so-called latent heat.

Finally, no more work can be got out of steam than has been put into it. How much of it can be recovered depends on circumstances in part well known. It is the custom to say that the latent heat represents dead loss. It ought to be well known that this is not true. We have shown that this is not the case. It is convertible in some way that no one understands into useful work. The full-pressure part of the stroke is fairly well understood. We know how much mechanical energy is directly expended in producing a given weight of steam under pressure. So far we know what is the amount of work done in a boiler. The expansion part of the stroke has nothing, save by coincidence, in common with the expansion of a perfect gas. No expansion at all, save that due to its sensible temperature, could take place in a steam engine unless molecular attraction re-asserted itself, the molecules falling together and parting with their heat. In other words, our steam engines depend after all in some considerable degree for their efficiency, paradoxical as it may appear, on liquefaction during the expansion stroke. If that did not take place there would be little heat available to carry on expansion and do work. Nothing could make the difference between steam and a permanent gas more convincingly clear than this fact. When we bear it in mind we can appreciate the radical difference in the whole principle of action introduced by superheating the steam. In that case we are no longer dependent on molecular attraction for expansion, but on free heat bringing steam to the dynamic condition of a permanent gas.

THE MOUTHS OF THE DANUBE.

SOON after the portions of Bessarabia lying along the Pruth and Danube had once more been transferred to Russia in 1878 by the Treaty of Berlin, the Russian Government set to work to consider two projects for developing the region in question. One of these projects was the requisite canalisation of the Kilia branch of the Danube estuary, and the other was the construction of a system of strategical railways in the territory thus ceded by Roumania. While both these projects were under consideration, highways were made along most of the routes to be followed by the projected strategical railroads, and thus the question was more or less settled before a decision had been arrived at. Now the question of making the Kilia waterway navigable has come up again, and the Government and local authorities have presented a petition in favour of the project. All the necessary estimates of the cost, the surveys, and technical plans were drawn up some years ago and approved of, and the only matter now awaiting decision on the part of Russia is whether the Kilia branch of the Danube belonging to Russia shall be made navigable. At present ships enter the Danube by the middle, or Sulina mouth, although two-thirds of the volume of water discharged by the Danube flow through the Kilia arm. The compulsory use of the Roumanian mouth at Sulina entails the payment of river dues to the existing International Danubian Commission, and these dues would be avoided if the Kilia arm is made navigable. The Bessarabian landowners propose to levy taxes upon themselves with a view to effecting the improvement of the Kilia estuary, which engineering experts are of opinion can be done successfully, and it is believed that if the project is carried out the shipping now compelled to pass through the Sulina mouth would be attracted to the Kilia arm. In that case the shipping dues would in course of time repay the Russian Government the outlay of money which it is now called upon to make. But there are many other equally important claims being made just now on the Russian Exchequer, and this project will probably be once more deferred.

JOHN H. WIDDOWSON.—In our obituary notice of Mr. Widdowson last week there was a slight error. It was stated that he was appointed "under-manager of Mr. Hulse's works, and after the retirement of the proprietor he was raised to the manager's post." This is incorrect. We understand that Mr. Widdowson was appointed under-manager to Mr. Hulse at Whitworth's works. When Mr. Hulse retired, the management was given to Mr. Widdowson.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Chief engineer: W. H. James, to the Vivid, additional for the Halcyon on paying off. Engineers: W. S. Frowd, to the Mildura; L. J. Stephens, to the Duke of Wellington, additional for service in the Reserve; A. Cockburn, to the Pembroke, R. McCaig, M. W. Byrne, and J. Cameron, sen., to the Duke of Wellington, all for course of instruction. Assistant engineers: W. E. Swaine, A. E. Pierson, E. W. Collings, and J. D. Harris, to the Pembroke; A. Robertson, H. F. L. Hemmings, and S. Gordon, to the Duke of Wellington, all for course of instruction. Artificer engineers: E. J. Ottaway, to the Sans Pareil; W. E. Marshall, to the Pembroke, additional for the Mutine.

DOCKYARD NOTES.

CRAMP'S cruiser Variag, for the Russian Government, which did remarkably well on trials, is now at Cherbourg, and the Boiler Committee have been to have a look at her. According to *Le Yacht*, they are presided over by "Sir Domwile." Those French newspapers which are so upset at the condemnation of the Belleville may draw some satisfaction from the President's name.

IT is reported that the Medea and Medusa are to be reboilered; the Medusa with Dürr and the Medea with Yarrow boilers. At present these old ships have the cylindrical boilers.

NICLAUSSE boilers have been decided upon for the United States armoured cruisers Colorado and Pennsylvania.

THE Narcissus and Immortalité—the "Nasty Sister" and the "Immortalight," as the sailor insists on calling them—were commissioned as sea-going gunnery tenders on Tuesday, 21st, at Portsmouth and at Chatham respectively.

THE report that the Japanese are fortifying Matsumai, opposite Vladivostok, is a pure fabrication. The place, for one thing, is quite unsuitable. For another, they have just completed the fortification of a far better base fifty miles distant—Ominato, in Aomori Bay.

THE turbine destroyer Cobra has four funnels. The Viper has but three.

THERE is a good leading article in *Le Yacht* this week on the new French battleships Republique and Patrie. It does not add to the sum of our knowledge as to what they will be like; but that is still a closely-guarded secret. So, for that matter, was the Gambetta, which made her very first appearance in print in last week's ENGINEER. *Le Yacht's* article states that the twin turret—a feature of both the Gambetta and Republique designs—has not not been adopted without exhaustive experiments. The conclusions come to are that the Brennus idea, "which never ought to have been abandoned," has been taken up again, but we are disposed to question whether it is the "Brennus idea" exactly. The writer draws attention to the fact that in the Republique it will be impossible for medium projectiles "to introduce themselves freely" underneath the guns. We never read an article in French on naval topics without being re-struck with the fact of how limited English technical phraseology is in comparison.

THE big gun mountings of the new French battleship Iéna have been found unsatisfactory, and several changes have been ordered.

THE Aboukir, on trials, has reached 21·6 knots, with 21,352 indicated horse-power and 123 revolutions. This is half a knot in excess of the contract. Quite a number of French newspapers are recording this fact with admiration of the superlative order.

THE Cressy is to be commissioned shortly for the China station. She will not, however, leave at once, but do some further trials, and probably take part in the naval manœuvres, if there are going to be any. Of this there seems to be some doubt, the devising of a plan of campaign that could possibly give both sides a chance being a problem that, so far, has completely baffled the Intelligence Department, who hitherto have not soared above anything of the "discover what two and two make" order.

LABOUR TROUBLES.

THE Northumberland Miners' Association delegates have issued a report of their proceedings in London on the occasion of the coal tax, which is of general interest. They state that at the Conference, Northumberland, Durham, South Wales, and Scotland favoured a stoppage; Lancashire was divided; Yorkshire, Derbyshire, Notts, Cumberland, Somerset, and the Midland Federation were against stopping. Everybody felt that a sectional strike would be of no avail. The result of the vote was a large majority against the stoppage. After a defence of their procedure as one of honesty, and not bluff, the report ends as follows:—"All are strongly opposed to the export tax on coal, and we believe that a vigorous and general agitation will be, and ought to be, carried on throughout the mining districts of the country, until this iniquitous impost is withdrawn."

The Cambrian Collieries strike was on Thursday officially declared at an end, having lasted eighteen weeks. The workings have been proved free from gas, and an early resumption of work is certain.

The collier and haulier dispute, which has caused a great deal of trouble at Welsh collieries from time to time, was the subject of a County-court case last week at Pontypridd between Rees Davies, haulier, and the Tylerstown Company, when the Judge ruled that colliers could legally be called upon to do hauliers' work.

At Swansea a demonstration took place on Friday in support of the builders now on strike. The other employés in the trade threaten to come out. The local authorities are considered to sympathise with the strikers by ruling that the tender for work at the workhouse shall only be accepted by giving labourers 6d. per hour—the amount of the strikers' demand.

The Mining Association—owners—who suggested to the Chancellor of the Exchequer that the coal tax be levied upon the whole year's output, are not to receive the support of Wales. At a meeting of the South Wales Coalowners' Association on Friday, at Cardiff, the subject was debated at length, and a resolution was passed that it be not entertained. It was further decided to protest against the action of the colliers in deciding to take three days' holiday at Whitsun as a breach of the Sliding Scale agreement.

At Merthyr Tydfil, on Saturday, the builders' strike was ended, the employers conceding one halfpenny an hour—8½d. instead of 8d.—and the men waiving the hour on Saturday.

The employés of the London and North-Western Railway, ten in number, who were recently transferred or dismissed as a result, alleged, of their giving evidence against a superintendent, were examined by the directors at Euston on Friday. Each man was seen singly, and declared that his evidence, to the best of his belief, was true. At the conclusion the dismissal of several men was confirmed. The men leave their case in the hands of their society, and a large meeting was held at Stockport on Sunday, to deliberate.

The Darran colliers are out, having refused to concede the 15 per cent. required by owners. Tools brought out Saturday.

The Taff Vale Railway dispute cost the Railwaymen's Society, according to Mr. Bell's report, £3540 16s. 4d. Movement in connection with South Wales railways, a further sum of £3225 10s. Total branches, 628; total income, £74,218 6s. 2d.

The Court-y-Bettws Colliery dispute, arising out of breach of contract, has been settled, workmen paying costs and promising to give notices in future.

Celynen and Aberbeeg disputes settled; Arael Griffin still continuing.

It was officially stated at the South Wales Federation meeting, Cardiff, Tuesday, that there were nearly 3000 miners out of employment in Wales, through no fault of their own; about twenty collieries had ceased working in the Western district, Swansea, while the whole of the Blaenavon colliers were idle.

The Glanwern and Tyrisaf dispute is at an end. The Llansamlet district was much relieved on Tuesday by the return of the men, who had accepted a reduction of 15 per cent. The employers wanted 30 per cent. About 140 men were affected.

Garw Fychan Colliery notices have expired, but the men are working on "day by day." Masters want a 15 per cent. reduction. Nearly 300 men are employed.

Penrhyn Quarries are to be opened on June 11th "to all men who have applied to be allowed to return." The strikers as a body treat the notices just issued with indifference.

SIR COURTENAY BOYLE.

MANY of our readers will join us in regretting the death of Sir Courtenay Boyle, which occurred suddenly from heart failure on Sunday. He was born in America in 1845, the elder son of Captain Cavendish Spencer Boyle. After a somewhat brilliant school and college career, he became Lord Spencer's private secretary when that nobleman was appointed Lord-Lieutenant of Ireland. With his parliamentary life, however, we have little to do. In 1886 he became Assistant Secretary to the Railway Department of the Board of Trade, and in that capacity he came a good deal into contact with railway men. If his policy was not always popular, he himself was always respected. The passage of the various Railway Acts of 1889, 1893, 1894, and 1900, all threw additional work on his shoulders. He was made permanent head of the Railway Department of the Board of Trade. It must not be supposed that his duties were limited strictly to looking after railways. Tramways, canals, shipping, lighthouses, gas and water, patents, and latterly electricity, had each and all to be dealt with. He was an indefatigable worker. He always maintained that no one was too old to learn, and he was learning all his life. There is very little doubt that he undermined his health by incessant application to business. He never took the official holidays to which he was entitled. He possessed no small literary ability, and by none will his loss be more sincerely mourned than by those with whom he worked.

THE INSTITUTION OF MECHANICAL ENGINEERS.

THE annual conversazione of the Institution took place at the house of the Institution, Storey's Gate, Westminster, on Friday, the 17th inst. The guests were received by Mr. and Miss Maw. About 700 members and their friends were present. Admirable music was provided. The feature of the evening was a brief lecture by Sir Benjamin Baker on "The Assuan Dam," illustrated by a multitude of excellent photographs projected on a screen. Another feature, less entertaining, but from an electrical point of view not less interesting, was a curious failure of the electric light, which resulted in a fitful illumination, more or less weird in its effect. This performance lasted for about half an hour, and added to the amusement of the evening. Apart from this, all the arrangements were completely satisfactory.

INSTITUTION OF NAVAL ARCHITECTS.

THE summer meetings of the Institution of Naval Architects will be held at Glasgow on Tuesday, June 25th, and three following days. The Right Hon. the Earl of Glasgow, G.C.M.G., president, will occupy the chair. A strong local reception committee, with the Hon. Lord Provost Chisholm as president, is being formed to represent the city and county of Glasgow and the various corporate bodies and institutions in the district. Active steps are being taken to draw up a programme which will provide for the instruction and entertainment of the Institution. Papers have been already promised by Lord Brassey, K.C.B., D.C.L., on "Conversions and Repairs, and also on Mercantile Auxiliaries;" by Francis Elgar, Esq., LL.D., F.R.S., on "Education of Naval Architects and Marine Engineers;" by Prof. J. H. Biles on "Standardising Ship's Calculations;" by A. Denny, Esq., on "Freeboard;" by Dr. Waldo on "The Corrosion of Condenser Tubes."

Among the features of the programme which have been already arranged, it may be mentioned that the Lord Provost and Corporation have invited the Institution to a conversazione on the evening of Tuesday, June 25th. The members of the Institution will dine together on the evening of Wednesday, June 26th, at the Grosvenor Rooms, Exhibition Ground. Tickets for members, associate members, and associates will be 25s. each, including wine. Lord Glasgow will entertain the Institution at a garden party at Kelburne, Fairlie, Ayrshire, on the afternoon of June 27th. The Principal of the University of Glasgow will give a reception at the University on the evening of June 27th. An excursion on the Clyde and along the coast by steamer is also being arranged.

ROSIN-CORED SOLDER.—This is a new commodity which is being introduced. It consists of pure metals mixed in the correct ratio and having incorporated the requisite amount of rosin, so that no additional flux is necessary. This is attained by making the solder in the form of a tube with narrow bore, the central cavity being occupied by the flux. The material is being introduced by the Patent Solder Company, Limited.

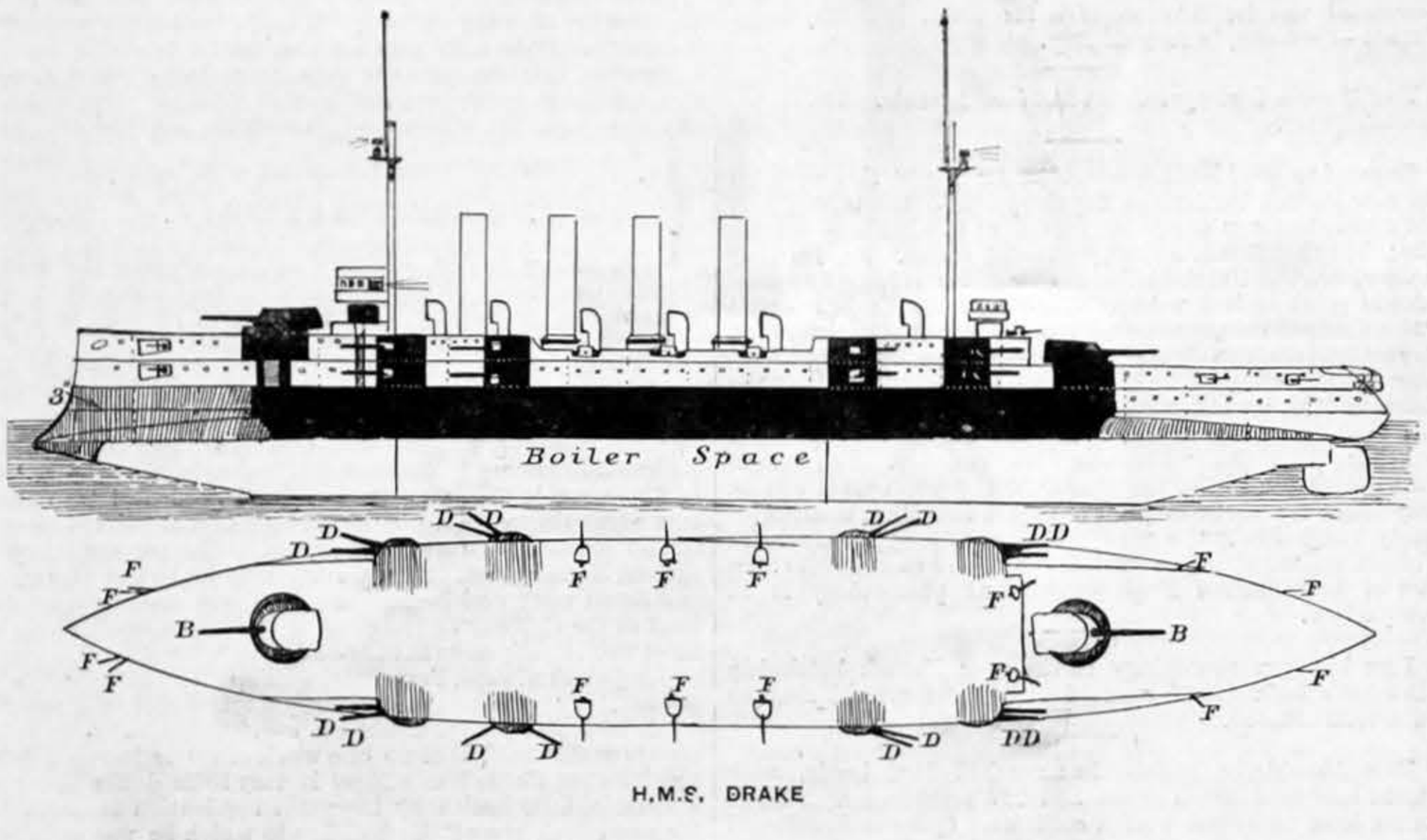
TRIALS OF MOTOR VEHICLES AT LIVERPOOL.—In connection with the heavy motor vehicle trials which are to be held in Liverpool next month, a number of light carriages will be provided for persons who wish to follow the runs. The dinner, at which the Earl of Derby will preside, will be held at the Adelphi Hotel, Liverpool, on Monday, June 3rd. It is requested that applications for seats in the carriages be made as early as possible to the secretary, Mr. E. Shrapnell Smith, the Royal Institution, Liverpool.

NEW FRENCH ARMOURED CRUISERS LEON GAMBETTA, JULES FERRY, AND VICTOR HUGO.

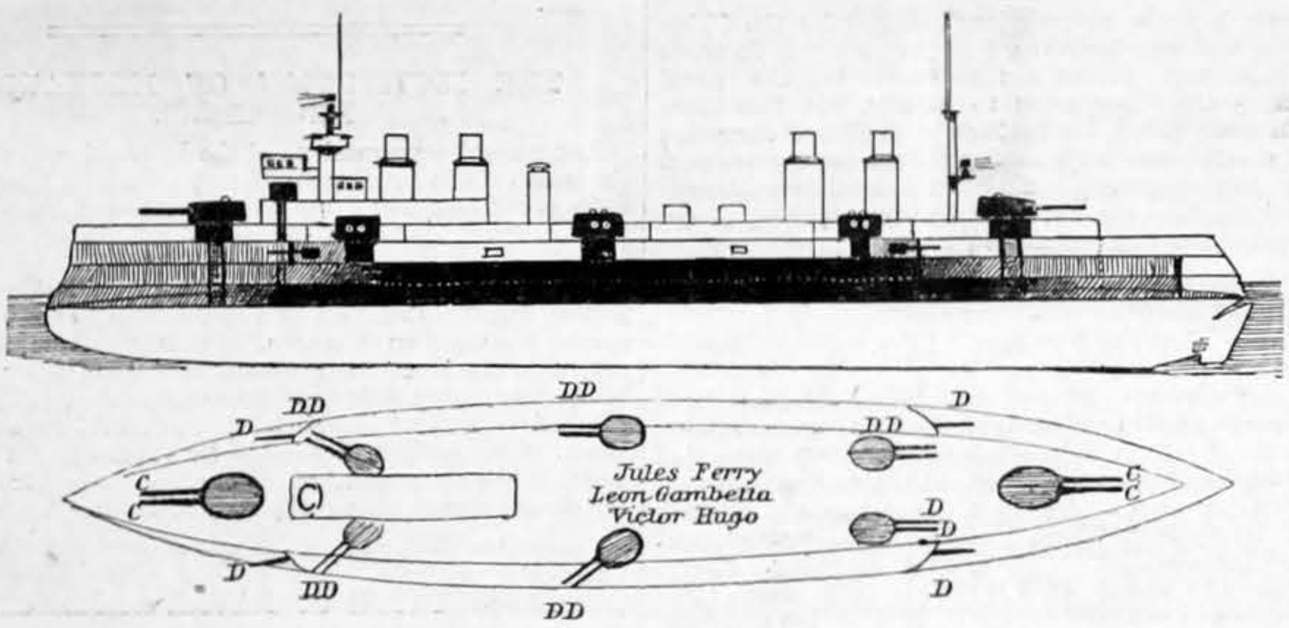
No. II.

THE plans and tabular particulars given below do away with any necessity of a lengthy description of the Gambetta's armour and armament. It will suffice to summarise it as follows:—

Two turrets, balanced, fore and aft, each carrying a pair of 194 mm. (7·6in.) guns, protected by 6in. of hardened steel, and supported by armoured pillars, inside of which are the hoist and machinery. Upon the sides, as widely apart as possible, are six similar turrets on the upper deck level, carrying each a pair of 164 mm. (6·4in.) guns. On the main deck, just forward and just aft of the end 6·4in. turrets, are casemates 4in. thick, each mounting a single 6·4in. gun. The upper belt protects the bases of these, and save for a small unprotected piece right aft this belt is continuous. The 3-pounders are distributed about the main deck and upper works. Following the now universal rule in the French navy, these will all be without the absurd little shields that still cover portions of British Hotchkiss guns, and serve no purpose beyond ensuring the burst of any shell that chances to touch them.



H.M.S. DRAKE



PROPOSED FRENCH CRUISER GAMBETTA

The characteristic French armoured cruiser is, or was, small. A complete list, with dates and displacements, is as follows:—

		Tons.
1882	Vauban	(circa) 6000
1890	Dupuy de Lome	6300
1892-94	Charnier class	4750
1895	Pothuau	5360
1899	Jeanne d'Arc	11,270
1900	Dupetit Thouars class	9517
1901	Desaix class	7700
Building	Condé class	10,000
Building	Aube class	10,014
Building	Gambetta class	12,416

Big cruisers, therefore, were initiated with the Jeanne d'Arc, and the Gambetta class continues the idea of this ship. With the medium and small cruisers we may deal in a later issue. Our present concern is with the monster cruisers intended for use with, or as, battleships, should occasion require. It is just this possibility that has led many capable experts to attack the big armoured cruiser. This school advocates the small cruiser, which must perforce do cruiser work; the big one, they say, will, in practice, prove to be only a weak battleship. However, France is a land of many "schools," and one of the most powerful of these argues that cruisers are all that France needs. Attacking battleships, they can use the torpedo—which makes all ships equal—attacking cruisers, the gun. It is all very pretty, but it is usually based on an imperfect conception of what a well-handled modern big gun can do. Fate has been unkind to big guns. At Yalu, the excellent 12·5 Canet pieces in the Matsushima class were out of order and fired slowly; the old 12in. Krupps in the Chinese ships lacked shell to demonstrate their powers on unarmoured ships. At Santiago the Americans had no modern big pieces, and the Spaniards seemingly had no ammunition for those 11in. guns that the American officers admired so much after the battle. A gun like the 12in. Mark IX. can certainly fire once every two minutes in battle, and as each battleship carries four, that means a rate of two a minute. If a battleship, even six knots inferior to a cruiser in speed, steams away it will take the cruiser twenty minutes to close 4000 yards, which means twenty shots from the after barbette under the most favourable shooting conditions. We cannot help thinking that we should feel a good deal safer behind the big gun than in the cruiser, even if the latter were able to assure herself with the delightful little theory propounded by the gunnery expert in the new *Naval Annual*, as to how long it will take a 6in. quick-firer to smash a big gun muzzle if it aims at it from 3000 yards. In point of fact, we do not see how the cruiser can avoid finishing her trip at the bottom of the sea. For practical purposes all big guns now a-days are quick-firers. Wherever and however a 12in. projectile hits, no ship is likely to be the same after it as she was before, unless, as happened at Santiago de Cuba, an unarmoured part is hit. But the modern cruiser, with any amount of thin armour over her, is an ideal bursting target for 12in. shell.

A NEW FEED-WATER REGULATOR.

THE accompanying illustrations show a system of feed-water regulating apparatus which has been introduced by the "Reliance" Patent Feed-water Regulator Company, of Glasgow. It has been specially devised for application to those types of boilers which contain a comparatively small quantity of water. Of course the danger in all automatic devices of this description is that they should fail to work. On this point we can say, in connection with this apparatus, that a number have been fitted and are at work, we are informed, satisfactorily; that one of our representatives has visited the works where the appliance is made, and has examined all the parts when opened up, and has also, on more than one occasion, seen it in operation on the boilers in the Court House at Glasgow. On the occasions of his visits he reports that the apparatus was working satisfactorily. We raised several points in connection with different parts of the mechanism where we thought trouble might arise, but the makers' replies to these were reassuring, and we shall refer to them at length when we have described the mechanism.

The regulating arrangement consists, in the first place, of a pin valve, inside the boiler drum, which is worked by a lever operated by a float and weight. The float and balance weight are so arranged that if the water does not raise the float the valve is open, but that on the water rising and lifting the float the valve is closed. The second part of the apparatus consists, as will be seen in Fig. 1, of a special form of check valve, which is provided with a steam regulating cylinder. The cylinder is fitted with a deep piston, having but a small length of travel, and a long gun-metal rod passing through two stuffing boxes to the check valve. The piston is capable of movement in the cylinder and also on the piston-rod. There are two coiled springs inside the piston. One of these, which rests on the bottom of the cylinder by pressing against the under side of the piston keeps it at the top of the cylinder when no steam is admitted through the needle valve. The underside of the piston has a valve face attached to it, and a corresponding face is screwed to the lower cover of the cylinder, so that when the piston is pressed downwards it comes into contact with the lower face and prevents any escape of steam. The piston has a small amount of vertical travel on the piston-rod, and ordinarily when no steam pressure is on it is kept pressed against the nut screwed on the end of the piston-rod by means of a second coiled spring, which is carried between the underside of the piston top and a collar on the piston-rod, as can be readily seen in the illustration. A drain outlet is provided at the bottom of the cylinder to carry off any condensed steam when the piston is up. The upper portion of the cylinder is connected to the pin valve on the boiler by means of a steam tube.

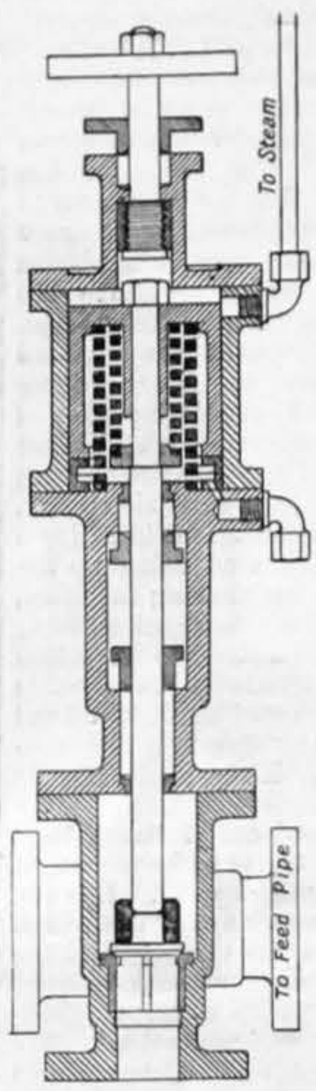


Fig. 1

With so much explanation we can proceed to discuss the method of working. When the water in the boiler rises above a given point the float, Fig. 2, is lifted, and the pin valve is opened. Steam passes through it, and is admitted to the upper part of the cylinder controlling the check valve. The piston descends till the end of the spindle rests on the check valve, compressing the outer spring only as it does so. The travel of the spindle being thus arrested, the piston itself continues to be forced down, thus compressing the outer and inner springs till the valve faces, formed on the piston and the lower cover, meet. When the water again falls in the boiler the float falls with it, and the pin valve is closed. The steam in the pipe and cylinder then condenses and the piston is forced upwards by the springs, which no longer have to contend with the steam pressure. The result is that the check valve is free to pass feed-water into the boiler. We are informed that in practice it has been found possible to keep the water-level from fluctuating more than ½in., that is ¼in. above or below a given level. If it is desired to fill up the boiler above the working level, the steam is shut off by the small cock on the supply pipe, and if at any time the water is required at a lower level than usual, the piston and spindle can be screwed down by means of the hand wheel on the top of the regulator, just in the same manner as an ordinary stop valve.

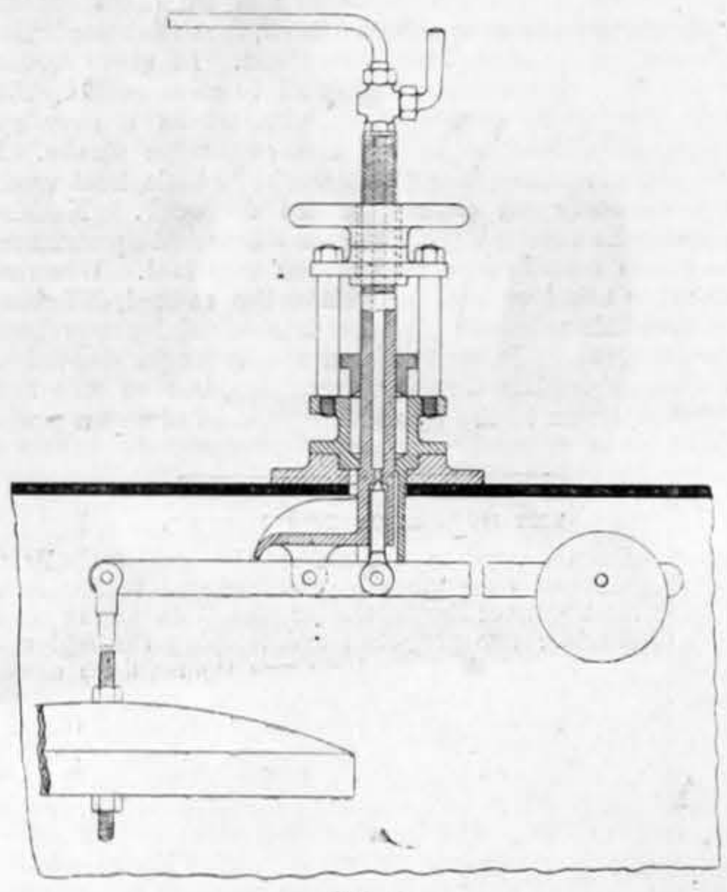


Fig. 2

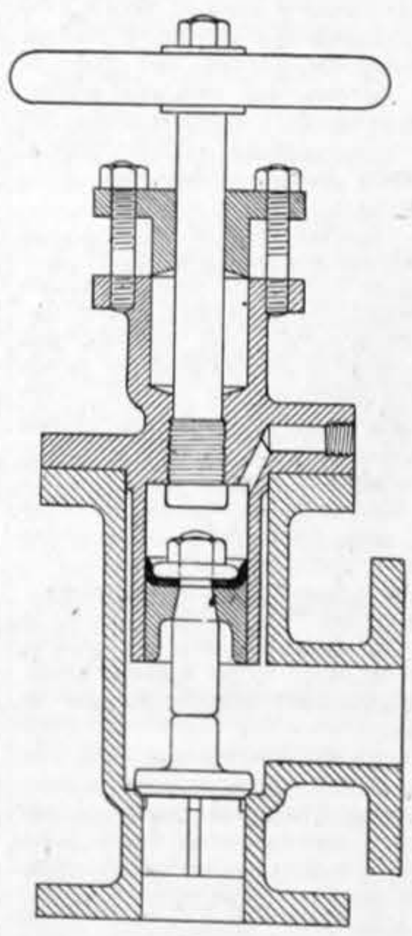


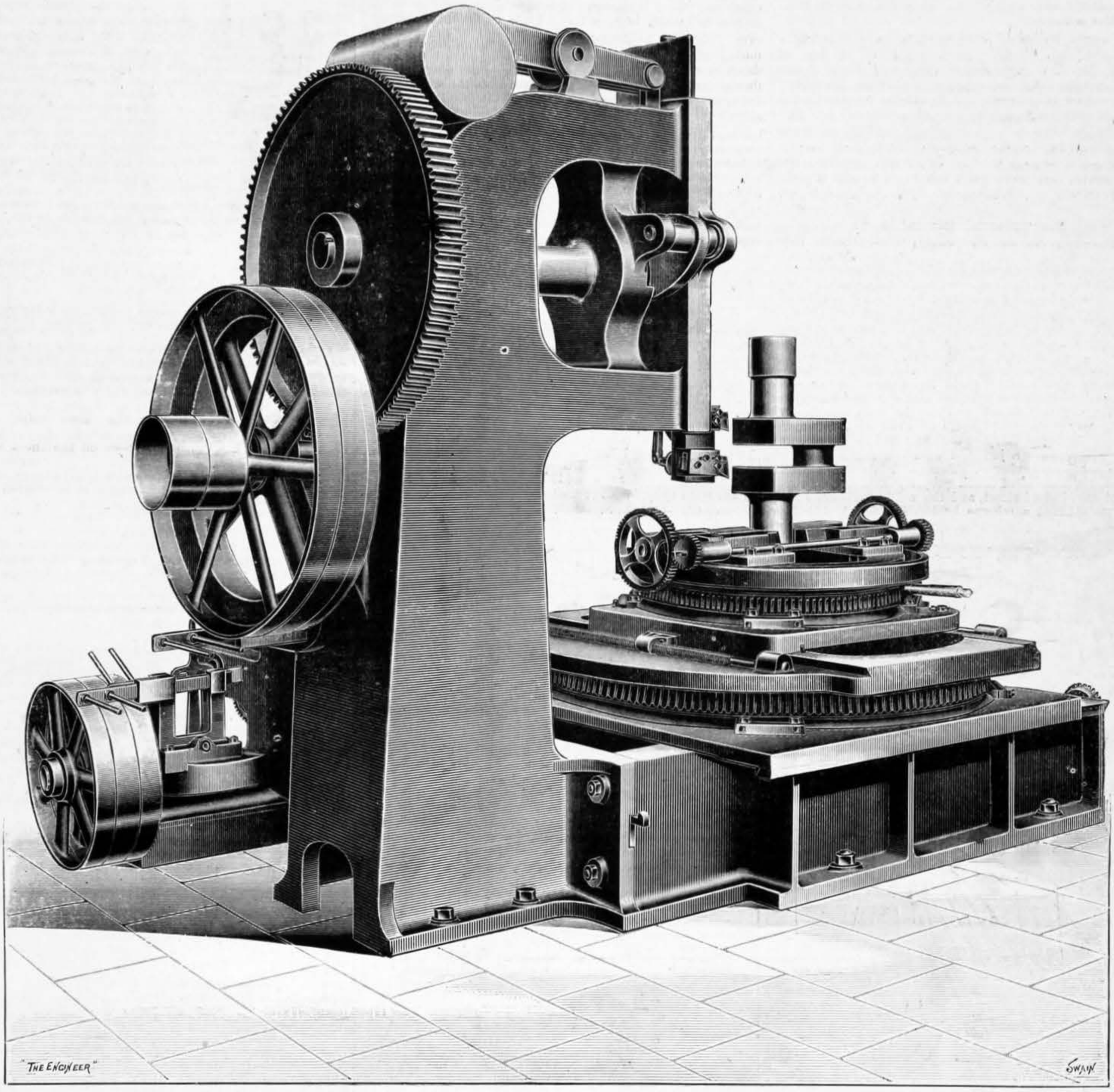
Fig. 3

In some cases where it is desirable to be able to alter the working level of the water while the boiler is under steam, an arrangement is supplied whereby the whole float gear with its valve can be raised or lowered from the outside. Fig. 2 shows how this is brought about. The bracket carrying the front gear has a tubular extension projecting upwards through a packing gland on the boiler. This extension is screwed, and can be moved up and down by means of a nut and hand wheel. The whole float gear can therefore be put in any desired position.

In applying this feed-regulating apparatus to a row of

CRANK WEB SLOTTING MACHINE

JOSHUA BUCKTON AND CO., LIMITED, LEEDS, ENGINEERS



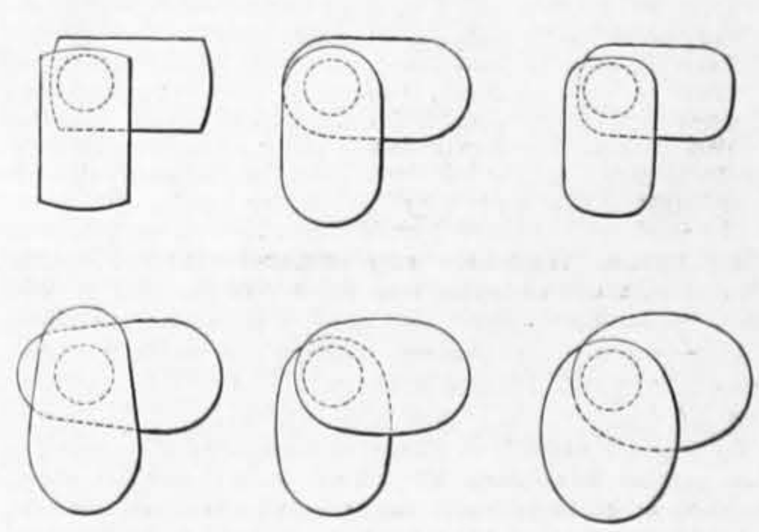
boilers, the feed pump is kept constantly at work, and it may sometimes happen that all the regulators are shut down at one time. Without some means of relieving the pressure this would put a heavy strain on the feed pipes and joints. A relief valve is, therefore, connected to the pipes, and is set to work at about 10 lb. above boiler pressure. The overflow from the relief valve is generally taken to the tank from which the pump draws its supply.

When, in the nature of the circumstances of working the boiler pressure fluctuates greatly, it is sometimes found that an ordinary spring relief valve set to work at the maximum steam pressure cannot be opened by the pump when the steam pressure is low. If nothing were done naturally the pump would stop. It is, of course, desirable that the pump should always be in motion, and another form of relief valve has been designed which adjusts itself to variations in the steam pressure. This valve is shown in Fig. 3, and is similar in its action to the regulator already described. A small cylinder takes the place of the ordinary spring, its area being slightly in excess of the area of the valve. The boiler pressure is conveyed to the outer end of this cylinder. The idea is that, however much the pressure in the boiler may vary, the relief valve is always held down by a pressure slightly in excess of that on its underside, as long as the feed-water has access to the boilers. The makers claim that the whole apparatus is particularly adapted for use in electric light and power stations.

One of the points we raised with the makers was as to the effect of dirty water. In reply to this they assured us that as the working parts of the regulator are completely cut off from the water in the boiler, no water, save that due to condensed steam, can get into contact with them. Further than this they say that there is no tendency for the piston to stick since it is kept moving up and down every few minutes. The springs which lift the valve exert an upward pressure of about 500 lb. The only time, they inform us, that the piston is likely to get fast is after a holiday stoppage, if the attendant has neglected to oil it. Even in this case it is easily freed by pouring in a little thin oil and moving down the piston by means of the screw and hand wheel on the top. Another place where we feared that trouble might arise was in the needle valve. We are assured, however, that no trouble has been experienced save in one instance when the water used was so foul with coal tar and other matter that all the boiler fittings were choked up, and there was so much sediment lodged in the boilers that about five barrow loads were removed from each boiler every six weeks. With this exception they have no record of these valves getting out of order, and they inform us that they have a number of valves of this type which were fitted ten years ago and are still in use. The whole apparatus as now made has now been at work for more than a year in different places with pressures varying from 60 lb. to 120 lb.

LOCOMOTIVE CRANK AXLE SLOTTING MACHINE.

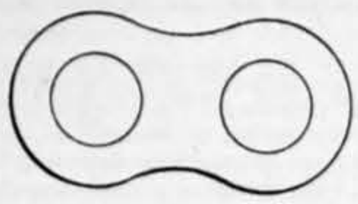
AT a meeting of the Institution of Mechanical Engineers early this year, Mr. Wicksteed described a machine for slotting crank webs which was far more rapid in its action than a milling machine for the same purpose. Through the courtesy of Joshua Buckton and Co., Limited, the makers, we are to-day enabled to illustrate this remarkable tool. The engraving above almost entirely explains itself. The machine is for finishing the profiles of the webs of loco. crank axles. Two cuts are taking place simultaneously, one upon each web, and by means of patent double-cutting tool-boxes a cut is taken both on the down stroke and on the up stroke of the ram. On some crank forgings a large amount of material has to be removed by the slotting tool, especially in rounding the corners, and the machine is of such power that the downward cutting tools will remove material up to 2in. deep, so as to cut off thick and thin before it within $\frac{1}{8}$in. of the finished size. On the upward stroke of the ram the alternative tools come into operation and remove the last $\frac{1}{8}$in., leaving good corners on the work and a bright smooth finish, so that once going round the crank finishes the profile of the web ready for erecting in the locomotive. The table of this machine is specially constructed for facility in fixing the crank axle in position. Half the axle drops down into a stirrup forming part of the top table, and it is there supported by a dead centre, while the upper part is held to the table by a pair of concentric vices. Thus the axle is mechanically fixed in a true vertical line. The profiles of cranks are of very various design, as shown on the accompanying diagram. These designs require on the feed of the table both parallel straight line motions, and motions for curves up to 28in. radius, also straight line motions for two converging sides, as in the egg-shaped design, No. 3. All these outlines are accurately slotted on the machine without the use of templates or formers; in fact, they can be slotted without being marked off upon the axle itself. If a workman is provided with a drawing giving him the distance from the centre of the axle to the radii of the different curves, he can adjust his table with scales marked in plain figures, so as to get the exact position of the radius of each curve required to coincide with the axis of the large revolving table of the machine.



TYPES OF CRANK WEBS

A usual outline for the web of a built up marine crank shaft

is shown in the diagram below, and the machine illustrated, besides being specially designed for loco. crank axles, is equally well adapted for finishing the profiles of such webs. For this purpose the parallel vices are removed from the table; the web, which may be 4ft. long, is fixed to the table, and without

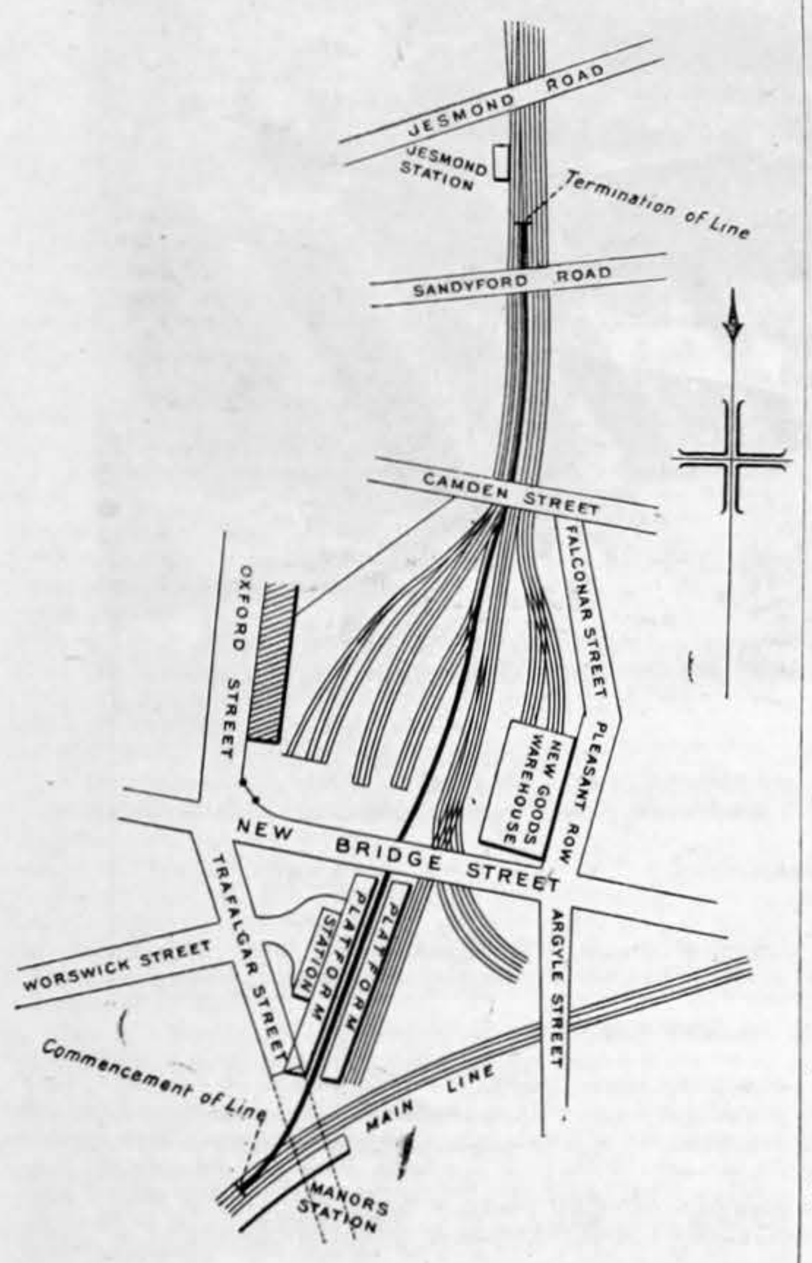


MARINE CRANK WEB

refixing, it may be slotted all round both the internal and external curves without leaving any mark to show where the curves run into each other, and the finish of the profile is bright enough to go into the ship without any hand labour.

NORTH-EASTERN RAILWAY WORKS AT NEWCASTLE.

THE letting of the contract for works in connection with the scheme for bringing the Blyth and Tyne section to a junction with the main line of the North-Eastern Railway at Newcastle is the first step towards the completion of a long-desired scheme. At present the terminus of the Blyth and Tyne section is in New Bridge-street, Newcastle, which is not a long way from the main line; but there is a block of property of some extent; there is also one of the goods stations; and with different levels a task of some difficulty and cost must be faced before there can be a union. In 1898 parliamentary powers were gained for a railway to commence at or near the bridge carrying the main line over Croft-street and terminating by a junction with the Blyth and Tyne Railway near Jesmond-road. These and later powers have led to the purchase of much property in Falconar-street, Pleasant-row, Oxford-street, and the neighbourhood, and in the presentation of a scheme by Mr. Charles A. Harrison, engineer to the North-Eastern Railway, which is now being begun. It not only aims at the junction of the Blyth and Tyne with the main line, but it re-models the station accom-



modation. The goods station, now at Trafalgar, is to be removed to the other side of New Bridge-street, whilst the passenger station is to be placed to the south of New Bridge-street, with modern platforms; the coal depôts are removed from the last-named street, the level of which is to be altered. The new line is carried beyond the point of actual junction at New Bridge-street, in order to allow of better gradients, the total distance to be laid from near the Manors Station to near Jesmond Station being a little under a mile.

The works will remove Picton-place, Ellison-terrace, with a large part of the west side of Falconar-street and Pleasant-row, and in the demolition of these streets there will be razed the birthplace of the late Lord Armstrong in Pleasant-row. It is difficult to give an idea of the cost, but as in one half year £87,000 were expended in the purchase of land and property needed for the works, it is probable that the total will—for site, lines, and works—considerably exceed a quarter of a million. The plan herewith of the works and lines as they are intended to be will show the changes that are to be made in this portion of central Newcastle by the union of the Blyth and Tyne and the main line of the North-Eastern.

THE naval estimates which are being prepared by the French Minister of Finance for presentation to the Chamber of Deputies, provide for a total expenditure in 1902 of 312,087,951f. This is apparently a reduction of 15,500,000f. as compared with the total for the current year, but in reality it is an augmentation of 11,597,200f., because it does not take into account the colonial troops which have been drafted over to the Minister of War. The chief increases are 6,458,780f. for new naval constructions, and 3,172,753f. for gunnery instruction, and for carrying out the new plan of armament.

LETTERS TO THE EDITOR.

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

THE PHENOMENA OF BOILER EXPLOSIONS.

SIR,—Referring to my previous letters on the above subject, I have been further considering the reason why the newly-generated steam, on the fall of pressure within the boiler, should lag or remain behind the escaping steam contained in the boiler at the instant of initial rupture. Let (w) be the weight of water in pounds evaporated at a pressure p lb. per square inch, the corresponding temperature of which is t deg. Fah., L the latent heat of the steam in B.T.U. at this pressure, V_s the specific volume, and W_2 the weight in pounds per cubic foot of such steam; W the weight of water in pounds having a volume equal to that of the steam weighing (w) lb.; W_1 the weight in pounds of contained water in the boiler at the instant of initial rupture, viz., 9125 lb. Assume the pressure within the boiler at this instant to be the same as that previously taken, viz., 170 lb. per square inch, the corresponding temperature of which is 368·2 deg. Fah.

Then, the buoyancy or upward force F in pounds causing the steam to rise to the surface will be

$$\begin{aligned} F &= (W - w) \\ &= \left(\frac{62{\cdot}5}{W_2} w - w\right) \\ &= (V_s w - w) \\ &= (V_s - 1)w \end{aligned}$$

supposing the steam was wholly generated at the lower pressure of p lb. per square inch.

But, $w = \frac{368{\cdot}2 - t}{L} W_1$ on the pressure suddenly dropping from 170 lb. to p lb. per square inch; while at a pressure of 170 lb., before a drop has taken place, the weight of water converted into steam will be $\frac{368{\cdot}2 - 368{\cdot}2}{857{\cdot}26} W_1 = 0$. And the buoyancy or upward force under such circumstances would be $(172 - 1)\,0 = 0$; 857·26 B.T.U. being the latent heat, and 172 the specific volume for steam of 170 lb. per square inch pressure.

The mean upward force or tendency of the steam would therefore be $\frac{(V_s - 1)\,w}{2}$ which, on substituting the above value of (w), would become

$$= \left\{\frac{(V_s - 1)}{2} \times \frac{368{\cdot}2 - t}{L} W_1\right\} \text{ lb.}$$

Assuming this to be constant, and as starting from the centre of gravity of the contained water at the instant of initial rupture, or h feet below surface of water, which works out to about 2·12ft., the initial value of (h), for a locomotive boiler I have taken, but which, of course, would slightly vary, decreasing in value as evaporation went on. Then the work done by the steam in order to reach the surface, assuming (h) as constant, will be about

$$= \left\{\frac{(V_s - 1)}{2} \times \frac{368{\cdot}2 - t}{L} W_1 h\right\} \text{ foot pounds.}$$

A proportion of this would be expended in overcoming the friction between the water and the steam, which we may assume as uniform and approximately equal to 50 per cent. of the total work thus performed by the steam. We have therefore the effective work done by the steam

$$\begin{aligned} &= \tfrac{1}{2}\left\{\frac{(V_s - 1)}{2} \times \frac{368{\cdot}2 - t}{L} W_1 h\right\} \\ &= \left\{\frac{(V_s - 1)}{4} \times \frac{368{\cdot}2 - t}{L} W_1 h\right\} \text{ foot pounds.} \end{aligned}$$

Let (v) be the average velocity of the steam during its passage through the water until it reaches the surface, then the kinetic energy of the steam will be

$$\frac{w\,v^2}{2g} = \frac{v^2}{2g}\left(\frac{368{\cdot}2 - t}{L} W_1\right)$$

We have therefore the following relation

$$\frac{v^2}{2g}\left(\frac{368{\cdot}2 - t}{L} W_1\right) = \left\{\frac{V_s - 1)}{4} \times \frac{368{\cdot}2 - t}{L} W_1 h\right\}$$

or,

$$\begin{aligned} v^2 &= \left[\left\{\frac{(V_s - 1)}{4} \times \frac{368{\cdot}2 - t}{L} W_1 h\right\} \times \frac{2g\,L}{(368{\cdot}2 - t)\,W_1}\right] \\ &= \frac{(V_s - 1)\,g\,h}{2} = 16{\cdot}1\,(V_s - 1)h \\ \therefore v &= \sqrt{16{\cdot}1\,(V_s - 1)\,h} \\ &= 4{\cdot}01\,\sqrt{(V_s - 1)h} \text{ feet per second.} \end{aligned}$$

On substituting the approximate value of (h), viz., 2·12ft., we get

$$\begin{aligned} v &= 4{\cdot}01\,\sqrt{(V_s - 1)\,2{\cdot}12} \\ &= 5{\cdot}81\,\sqrt{(V_s - 1)} \text{ feet per second,} \end{aligned}$$

And the mean time (t_1) required by the steam to reach the surface will be

$$\begin{aligned} t_1 &= \frac{h}{5{\cdot}81\,\sqrt{(V_s - 1)}} \text{ seconds} \\ &= \frac{2{\cdot}12}{5{\cdot}81\,\sqrt{(V_s - 1)}} \\ &= \frac{1}{2{\cdot}74\,\sqrt{(V_s - 1)}} \text{ seconds.} \end{aligned}$$

The following table shows the values of (v) and (t_1) worked out according to the preceding assumptions, and that the pressure has suddenly dropped from 170 lb. to p lb. per square inch. It will be observed that the lower the value of (p) the higher will be the value of (v), and consequently the smaller the time (t_1) required by the steam to reach the surface.

Table (α).

Value of lower pressure (p) in lbs. per sq. in.	The average velocity (v) of the steam during its passage through water until it reaches the surface, in feet per second.	The mean time (t_1) required by the steam to reach surface, in nearest fractions of a second.	The mean time (t_1) required by the steam to reach surface, in nearest decimals of a second.
120	89·06	1/11	0·0238
110	92·73	1/11	0·0228
100	97·03	1/10	0·0218
95	99·23	1/9	0·0213
90	101·79	1/9	0·0208
80	107·60	1/9	0·0197
70	114·28	1/8	0·0185
65	118·35	1/8	0·0179
60	122·70	1/8	0·0172
50	133·63	1/7	0·0158
40	148·09	1/7	0·0143
30	169·18	1/6	0·0125
20	203·93	1/5	0·0104
15	233·56	1/5	0·0090

Let us now consider the steam escaping through the vent caused by the initial rupture. According to Prof. Rankine, the velocity (v_1), in feet per second, of efflux or discharge of the steam, will be $v_1 = \sqrt{2g\,U}$, where

$$\begin{aligned} U &= A\,p\,a \int_a^l \frac{dx}{x} \\ &= A\,p\,a\,\log\frac{l}{a} \end{aligned}$$

Putting A = 144 square inches, or 1 square foot; and since the steam discharges into the atmosphere, the volume of 1 lb. of steam at atmospheric pressure, or 14·7 lb., being 26·38 cubic feet, the volume per lb. of steam at (p) lb. being (V_p) cubic feet. Then (l) and (a) become 26·38ft., and V_p ft. respectively, hence

$$U = \left(144\,p\,V_p \text{ hyp. log. } \frac{26{\cdot}38}{V_p}\right)$$

and

$$\begin{aligned} \therefore v_1 &= \sqrt{2 \times 32{\cdot}2 \times 144 \times p \times V_p \times \text{hyp. log. } \frac{26{\cdot}38}{V_p}} \\ &= 96{\cdot}3\,\sqrt{p\,V_p \text{ hyp. log. } \frac{26{\cdot}38}{V_p}} \end{aligned}$$

Now, the value of (v_1) for steam at 170 lb. per square inch, the initial pressure, was shown in my last letter to be 3130·1ft. per second. Therefore the mean velocity V_m of efflux or discharge will be

$$V_m = \frac{\left(3130{\cdot}1 + 96{\cdot}3\,\sqrt{p\,V_p \text{ hyp. log. } \frac{26{\cdot}38}{V_p}}\right)}{2}$$

which would be somewhat increased owing to the water evaporated between these pressures sustaining the pressure and thereby raising the mean value of it.

Again, the boiler selected was assumed to have an initial steam space of 56 cubic feet, which contained steam at 170 lb. per square inch pressure. This steam, on expanding down to atmospheric pressure, or 14·7 lb. per square inch, has a volume of

$$\frac{26{\cdot}38}{2{\cdot}75} \times 56 = \frac{1649}{172} \times 56 = 537 \text{ cubic feet,}$$

which would also be increased, owing to the volume of steam evaporated between the pressures of 170 lb. and p lb. per square inch.

Now, when the pressure in the steam space has dropped from 170 lb. to p lb. per square inch, the amount of the original volume at 170 lb. remaining in the boiler will be $\frac{p}{170} \times 56$, and consequently the amount discharged will be

$$\left(56 - \frac{p}{170} \times 56\right) = 56\left(1 - \frac{p}{170}\right) \text{ cubic feet at 170 lb. pressure.}$$

or,

$$537\left(1 - \frac{p}{170}\right) \text{ cubic feet at atmospheric pressure, or 14·7 lb. per square inch.}$$

Therefore the mean time (T_1) in seconds required for this discharge through a vent of (A) square feet, neglecting the steam evaporated subsequently to the intial rupture taking place, will be

$$\begin{aligned} T_1 &= \frac{\left\{537\left(1 - \frac{p}{170}\right)\right\}}{V_m\,A} \\ &= \frac{2\left\{537\left(1 - \frac{p}{170}\right)\right\}}{\left(3130{\cdot}1 + 96{\cdot}3\,\sqrt{p\,V_p \text{ hyp. log. } \frac{26{\cdot}38}{V_p}}\right)A} \end{aligned}$$

Assuming the area (A) of the initial vent or opening to be 10 square feet we have

$$T_1 = \frac{\left\{1074\left(1 - \frac{p}{170}\right)\right\}}{\left(31301 + 963\,\sqrt{p\,V_p \text{ hyp. log. } \frac{26{\cdot}38}{V_p}}\right)}$$

The following table shows the values of V_m and T_1 worked out according to the preceding assumptions, and that the pressure has suddenly fallen from 170 lb. to p lb. per square inch, the same as given in the preceding table.

Table (β).

Value of lower pressure (p) in lb. per sq. in.	The mean velocity of efflux or discharge V_m of the contained steam at the instant of initial rupture through an opening of 10 sq. ft. in feet per second.	The mean time T_1 taken by the escaping steam, in the nearest fractions of a second.	The mean time T_1 taken by the escaping steam, in the nearest decimals of a second.
120	2993·1	1/192	0·0052
110	2959·5	1/177	0·0063
100	2920·5	1/133	0·0075
95	2899·3	1/123	0·0081
90	2878·1	1/114	0·0087
80	2826·6	1/99	0·0100
70	2769·3	1/87	0·0114
65	2736·5	1/82	0·0121
60	2699·5	1/77	0·0129
50	2618·5	1/69	0·0144
40	2512·6	1/61	0·0164
30	2355·2	1/53	0·0187
20	2071·1	1/44	0·0228
15	1659·9	1/34	0·0294

On comparing Table (α) with Table (β) it will be observed that the mean rate of evaporation increases as the lower pressure (p) decreases, whereas the mean rate of efflux, or discharge of the steam through the vent caused by the initial rupture, decreases as the lower pressure (p) decreases, until at the pressure of about 50 lb. the mean rate of evaporation would appear to be equal to the mean rate of efflux or discharge of the escaping steam. Now, if we assume that the evaporating steam has got such a *momentum* that evaporation will go on until the pressure of the atmosphere is reached, the rate of evaporation will now be increasing, whilst that of the discharging steam will decrease, consequently an accumulation of pressure will take place after the lower pressure (p) is about 50 lb. per square inch.

Now, steam of 50 lb. per square inch pressure has a temperature of 282·3 deg. Fah.; we have, therefore, assuming the evaporation to go on through the *momentum* thus obtained, and putting the weight of contained water in the boiler as (W_p) lb. at a pressure (p) = 50 lb. per square inch, the weight of water evaporated between the pressures of 50 lb. and 14·7 lb. per square inch will be—

$$\begin{aligned} &= \frac{282{\cdot}3 - 212}{966{\cdot}6} \times W_p. \\ &= \frac{70{\cdot}3}{966{\cdot}6} \times W_p = 0{\cdot}0727\,W_p. \end{aligned}$$

Between the pressures of 170 lb. and 50 lb. per square inch the weight of water evaporated will be—

$$\begin{aligned} &= \frac{368{\cdot}2 - 282{\cdot}3}{917{\cdot}4} \times 9125 \\ &= \frac{86}{917{\cdot}4} \times 9125 \\ &= \frac{774{,}750}{917{\cdot}4} = 844{\cdot}5 \text{ lb.} \end{aligned}$$

Where 917·4 B.T.U. is the latent heat of steam at 50 lb. per square inch pressure. Consequently, the weight of water remaining in

the boiler when the lower pressure of 50 lb. per square inch is reached will be—

$$W_p = (9125 - 844{\cdot}5)$$
$$= 8280{\cdot}5 \text{ lb.}$$

Therefore the weight of water evaporated between the pressure of 50 lb. per square inch and that of the atmosphere, or 14·7 lb. per square inch, will be—

$$= (0{\cdot}0727 \times 8280{\cdot}5)$$
$$= 602 \text{ lb. of steam at } 14{\cdot}7 \text{ lb. per square inch.}$$

The original steam space, assumed at 56 cubic feet, would now be increased $\frac{368{\cdot}2 - 212}{966{\cdot}6} \times 146 = \frac{156{\cdot}2}{965{\cdot}6} \times 146 = 23{\cdot}6$ cubic feet, the original volume of the contained water being assumed at 146 cubic feet.

The volume of the steam space when the atmospheric pressure was reached, or when all the possible evaporation had taken place, would thus be $(56 + 23{\cdot}6) = 79{\cdot}6$ cubic feet. Again, assuming the pressure to go on accumulating owing to the momentum before mentioned, and following the hyperbolic or Boyle's law, the increased pressure (x) would be—

$$\frac{x}{14{\cdot}7} = \frac{602 \text{ lb.} \times 26{\cdot}38 \text{ cubic feet of steam per lb.}}{79{\cdot}6}$$
$$\therefore x = \frac{14{\cdot}7 \times 15{,}880{\cdot}76}{79{\cdot}6}$$
$$= \frac{233{,}447{\cdot}172}{79{\cdot}6}$$
$$= 2932{\cdot}75 \text{ lb. per square inch, neglecting the steam which would escape between the pressures of 50 lb. and the atmosphere.}$$

But, when the pressure has fallen to (p) or 50 lb. per square inch, the pressure in the steam space was shown to be about equal to this; we must therefore add this to the preceding, and we have the total accumulated pressure in the boiler equal to—

$(2932{\cdot}75 + 50) = 2982{\cdot}75$ lb., or 1·33 tons per square inch.

Again, on referring to Table (α), the values of the mean time (t_1) for 50 lb. and 15 lb. per square inch are respectively equal to $\frac{1}{63} = 0{\cdot}0158$ sec., and $\frac{1}{110} = 0{\cdot}009$ sec. Therefore the above calculated pressure would be accumulated, viz., from 50 lb. per square inch to 2982·75 lb., or 1·33 tons per square inch, during a period which is about equal to the difference between these corresponding values of (t_1), or

$$\frac{1}{63} - \frac{1}{110} = \frac{110 - 63}{6930} = \frac{47}{6930} = \frac{1}{147} \text{ sec.,}$$

or $$(0{\cdot}0158 - 0{\cdot}009) = 0{\cdot}0068 \text{ sec.}$$

Taking the escaping steam into account during the brief interval of about $\frac{1}{150}$th second, it will be found that the velocities of discharge for steam of 50 lb. and 2983 lb. per square inch into that of the atmosphere, or 14·7 lb. per square inch, will be 2107·04ft. and 5941·02ft. per second respectively. The mean velocity (V_m) of discharge between these pressures will be

$$V_m = \frac{2107{\cdot}04 + 5941{\cdot}02}{2}$$
$$= 3799{\cdot}03 \text{ft. per second.}$$

Assuming 10 square feet as the area of the initial opening or vent, the quantity of steam discharged in the brief interval will be

$$= \frac{3799{\cdot}03 \times 10}{147}$$
$$= 258{\cdot}43 \text{ cubic feet discharged in about } \tfrac{1}{150}\text{th second.}$$

Deducting this from the total quantity of steam evaporated from 50 lb. down to 14·7 lb. per square inch, the amount of steam left will be

$$(15880{\cdot}76 - 258{\cdot}43)$$
$$= 15622{\cdot}33 \text{ cubic feet at } 14{\cdot}7 \text{ lb. per square inch, or atmospheric pressure.}$$

Therefore, the increased pressure (x) due to the confined space of 79·6 cubic feet, following the hyperbolic or Boyle's law, will be

$$\frac{x}{14{\cdot}7} = \frac{15622{\cdot}33}{79{\cdot}6}$$
$$\text{and } \therefore x = \frac{14{\cdot}7 \times 15622{\cdot}33}{79{\cdot}6}$$
$$= 2885{\cdot}02 \text{ lb. per square inch.}$$

Adding the 50 lb. for the lower pressure (p), we have the resultant pressure in the boiler

$$= (2885{\cdot}02 + 50)$$
$$= 2935{\cdot}02 \text{ lb., or } 1{\cdot}31 \text{ tons per square inch.}$$

It will, therefore, be seen that the accumulated pressure takes place in a period of about $\frac{1}{150}$th second, which will account for the non-arrest of the momentum of the evaporating steam. The time element plays a very important part in all explosions, as you pointed out in your leader on "The Explosion of Heated Water," in your issue of the 15th inst. Thus, gunpowder, although not an explosive in the strict sense of the word, when compared with gun-cotton or nitro-glycerine, deflagrates or burns with great rapidity. It has been found that gunpowder requires a period of about two seconds for the combustion of a pebble of it in free air, whereas the same pebble in the bore of a gun is consumed in about $\frac{1}{200}$th second, the rate of combustion varying largely as the pressure under which the explosion takes place.

It will be seen from the preceding why the evaporating steam appears to lag behind that escaping through the initial vent or opening, and then, after overtaking it, to suddenly, as it were, cause a great increase of pressure within the boiler.

EDWARD J. M. DAVIES.

24, Harrington-square, London, N.W.,
March 23rd.

VENTILATION OF THE LAW COURTS.

SIR,—My attention has just been called to a letter which appeared in your issue of the 26th ult. under the above heading, signed "Interested," in which he mentions that as the volume of air discharged by the fans seems enormous for the sizes and speeds of revolution, as mentioned in your article of the 12th ult., on the ventilation of the Royal Courts of Justice, it would consequently be interesting to have further details, and as inventor and patentee of "Sirocco" fans, I have now much pleasure in replying to the points he refers to.

The fans are fitted in the extraction chambers, and the air was measured at the inflow openings or ducts from the Courts into these chambers. Similar figures to those quoted in your article were obtained in repeated tests.

"Interested" refers to the power required being apparently remarkably high for the low speeds of revolution at which the fans are driven, but in this connection he is evidently taking the ordinary construction of centrifugal fans as the basis of comparison, in which case he is quite correct in his remark that the volume of air discharged per watt is "small for such low circumferential speeds." The "Sirocco" centrifugal fans have, however, the remarkable speciality of discharging the air from the tips of the blades at approximately 80 per cent. higher velocity than that of the tips of the blades themselves. Take, for example, a "Sirocco" centrifugal fan of 25in. diameter—one of the sizes used in the ventilation of the Royal Courts of Justice—at 300 revolutions, the tips of the blades have a speed of 1962ft. per minute, but the actual velocity of the air leaving the blades is 1962 plus 80 per cent., or for round figures, say, 3500ft. per minute; and, therefore, in examining the question of power, the volume discharged, viz., 8000 cubic feet per minute, has to be reckoned for at a velocity of 3500 lineal feet per minute. Taking this velocity into account, as also the resistances against which the discharge is effected, the volume discharged per watt is large, and indicates an unusually high mechanical efficiency for the fan.

Then as regards the very large volumetric capacity of the "Sirocco" centrifugal fan, a further feature to which this is due is that owing to the particular construction and operation of the blades, they act efficiently with an air inlet to them of practically the same diameter as that of the periphery of the fan itself, whereas in centrifugal fans of ordinary construction the diameter of inlet is usually about one-half and seldom exceeds two-thirds that of the fan itself. The inlet opening therefore in "Sirocco" fans is from three to four times larger in area than the centrifugal fans of ordinary construction, and the area of the outlet or nozzle of the fan is only slightly smaller than the inlet, consequently these fans can deal with three or four times more air per revolution, relatively to diameter, than is usually the case.

Should there be any further details or particulars which "Interested" would like to have I will be very pleased to answer any communications which he may address to me personally on the subject.

S. C. DAVIDSON.

Sirocco Engineering Works, Belfast,
May 6th.

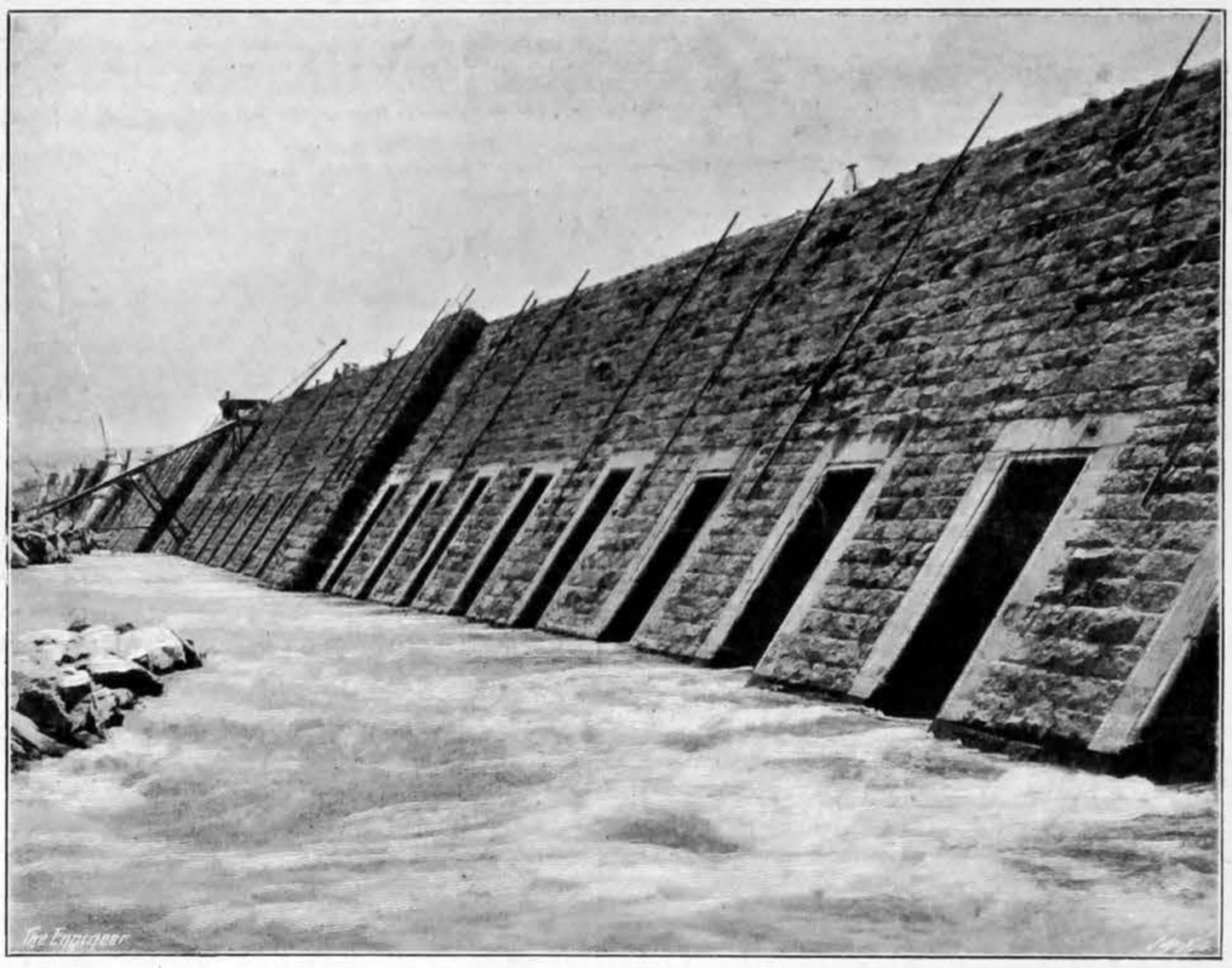
THE ASSUAN RESERVOIR.

SIR,—A few days ago I wrote to you on the subject of doubling the capacity of the Assuân reservoir, and increasing its value to Egypt from £9,000,000 to £18,000,000 by a further expenditure of £250,000. I now enclose the latest photograph of the dam, which gives a very good idea of those of the under-sluices which are completed.

It will be noticed that between every ten under-sluices there is a 12 m. wide buttress. These buttresses seemed to me to give the structure on paper that knottiness which indicated strength. Now that much of the work is in hand these buttresses do not seem to be enough. It is not too late for the engineers in charge of the work to-day to convert four of these buttresses—in the deep part of the work to the left of the openings in the photograph—into special buttresses by giving them a length at base of 25 m., and at the top of 5 m. Such a conversion would cost under £50,000, and add greatly to the rigidity of the work and its power to resist expansion and contraction changes later on. It would, moreover, provide means for descending from the dam to its down-stream side.

W. WILLCOCKS.

Cairo, April 30th.



THE ASSUAN DAM

THE GRAPHICS OF THE GYROSCOPE.

SIR,—I agree with your correspondent, Mr. Hamber Wilson, that a graphic statement of the forces obtaining in a gyroscope is desirable. A somewhat extended acquaintance with the literature of the subject leads to the belief that physicists who understand the instrument lack the power to make others understand it, while there is a great mass of mathematical verbiage in use to conceal the absence of clear thought. Let anyone, for example, turn to the exposition of the theory of the gyroscope in the "Encyclopædia Britannica," and see how far that will make matters clear to him.

An obvious and entirely erroneous explanation is that a body moving under the influence of an impressed force, for example a shot, forcibly resists deflection from a straight line, and in this way centrifugal force, so called, is explained. But, curiously enough, a body moving in a straight line behaves under the deflecting force of gravity just as though it were not moving. Thus, for example, a shot discharged point blank from a gun raised 16ft. above the surface of the earth would fly as far as it could in one second and no further; and leaving out the resistance of the air a shot fired from the gun, and one dropped at its muzzle, would both strike the ground at the same time, although the fired projectile might have flown 2000ft. or so. The theory to which I refer assumes that any molecule in the rim of the rotator moves at any instant in a plane. If the wheel fell the molecule would be deflected from the plane, and would describe a curve instead of a straight line, and this it resists.

There are various phenomena of much interest about the gyroscope, but I have never yet come across an intelligible mechanical explanation of them.

Mr. Jordan's letter is quite incomprehensible, in which respect it partakes of most of the matter which has been written about the gyroscope.

P. W. D.

South Kensington, May 14th.

TUBULAR RAILWAYS.

SIR,—I have read your leader on these with interest, and it puts the case in their favour very clearly. There are, however, one or two points which are open to discussion before I am prepared to admit their truth.

Undoubtedly, both the acceleration and retardation of the trains might be provided for by suitable gradients if nothing goes wrong. The question of stopping between stations on account of safety can—as you remark—be easily settled by proper signalling, but I am not prepared to admit that the risk of accidental stoppage can be so easily dealt with if the motors are not to be capable of largely augmented effort beyond the average. Accidents in my experience are certain to occur sooner or later, and the best we can do is to reduce their frequency, but we cannot abolish them.

Suppose that on a road—laid out in strict accordance with your article and with a locomotive hauled train—an armature burns out, or some other serious difficulty occurs, which occurrence can easily be imagined by an electrician. The engine, even in good order, would be only barely capable of climbing the steep grade by itself, let alone haul the train. An engine sent from behind cannot use the train as a golf ball, therefore the only way of dealing with the breakdown would be to send an engine from the front to haul the cars up to the next station one by one. This would involve serious difficulty in construction, owing to the necessity of providing passing places at each station for each tube, and loss of time as well. I have assumed an electrical fault to be the cause of a stoppage, that being the most probable, but a derailment might also occur, though let us hope it will never happen, for I fear damage to the tube would result as well as to the train.

It would, then, appear as a measure of only common prudence that we should arrange that the gradients should be much flatter than those you indicate, and that the motive power provided should be sufficient to propel itself and a train and broken-down engine up the steepest gradient at a reduced speed. This would put an acceleration load on the power station, but as a set-off we have absolute security, and the peaks on the load curve could be rounded off by the provision of large battery stations.

These battery stations would not require an increase in the capital required for land—a serious item in London—since the batteries could be accommodated in two or more floors of the surface buildings. If necessary each passenger station could be made a battery sub-station, and in that case, if made capable of a high discharge rate, they would not only completely take up the acceleration load, but would also serve as a stand-by in case of the failure of the power-house supply, and enable the trains to be worked through to the nearest station instead of being stuck midway.

GEO. T. PARDOE.

81, Harrow-road, W., May 20th.

[The use of a steel tow rope does not appear to have occurred to our correspondent.—ED. E.]

TESTS FOR PORTLAND CEMENT.

SIR,—Referring to Mr. Patchett's article in your last week's issue on "A Test for Portland Cement," I beg to draw your attention to the absurdity of the test, as well as the method of carrying out the same.

(1) No reliable or even approximate result can be obtained by measuring the volume of oxalate of lime.

(2) Portland cement consists of various loosely combined lime compounds, the most stable of which are to an extent decomposable by water liberating lime—CaO. All Portland cements contain a quantity of "free dissolved" lime which is not dangerous, and on which the hardening of the cement in water depends.

(3) Five hundred cubic centimetres of water dissolve only about ·46 grammes lime—CaO—so that in using 10 grammes cement, when the water is saturated with lime, it will only have dissolved 4·6 per cent. Now, according to the most reliable authorities, there is from 10 to 25 per cent. of free lime in cement. By "free lime," in this case, I mean that which is dangerous, as well as that dissolved in the clinker and not dangerous. As for the estimation of gypsum, by the same method of measuring the $BaSO_4$, precipitated by $BaCl_2$, it is hardly worth notice; but it might be as well to inform Mr. Patchett that very few Portland cements are free from $CaSO_4$, derived from the clay, which would also be precipitated by $BaCl_2$. Has this to be taken as gypsum?

When chemical analysis can be done by Mr. Patchett's method, works, chemists may write "Ichabod" over their door.

W. S. HANNAH, A.I.C.

Cement Works, Newhaven, Sussex, May 20th.

THE GAMBETTA.

MONSIEUR LE DIRECTEUR,—Nous lisons dans le numéro de "L'ENGINEER," du 17 Mai, page 505, une très intéressante comparaison entre les croiseurs cuirassés Français Gambetta et Anglais Drake.

Voulez vous nous permettre de rectifier une légère erreur qui s'est introduite dans l'exposé des caractéristiques du bâtiment Français. Vous indiquez que les chaudières sont du type Normand, alors qu'en réalité elles sont du type Niclausse du dernier modèle 1900.

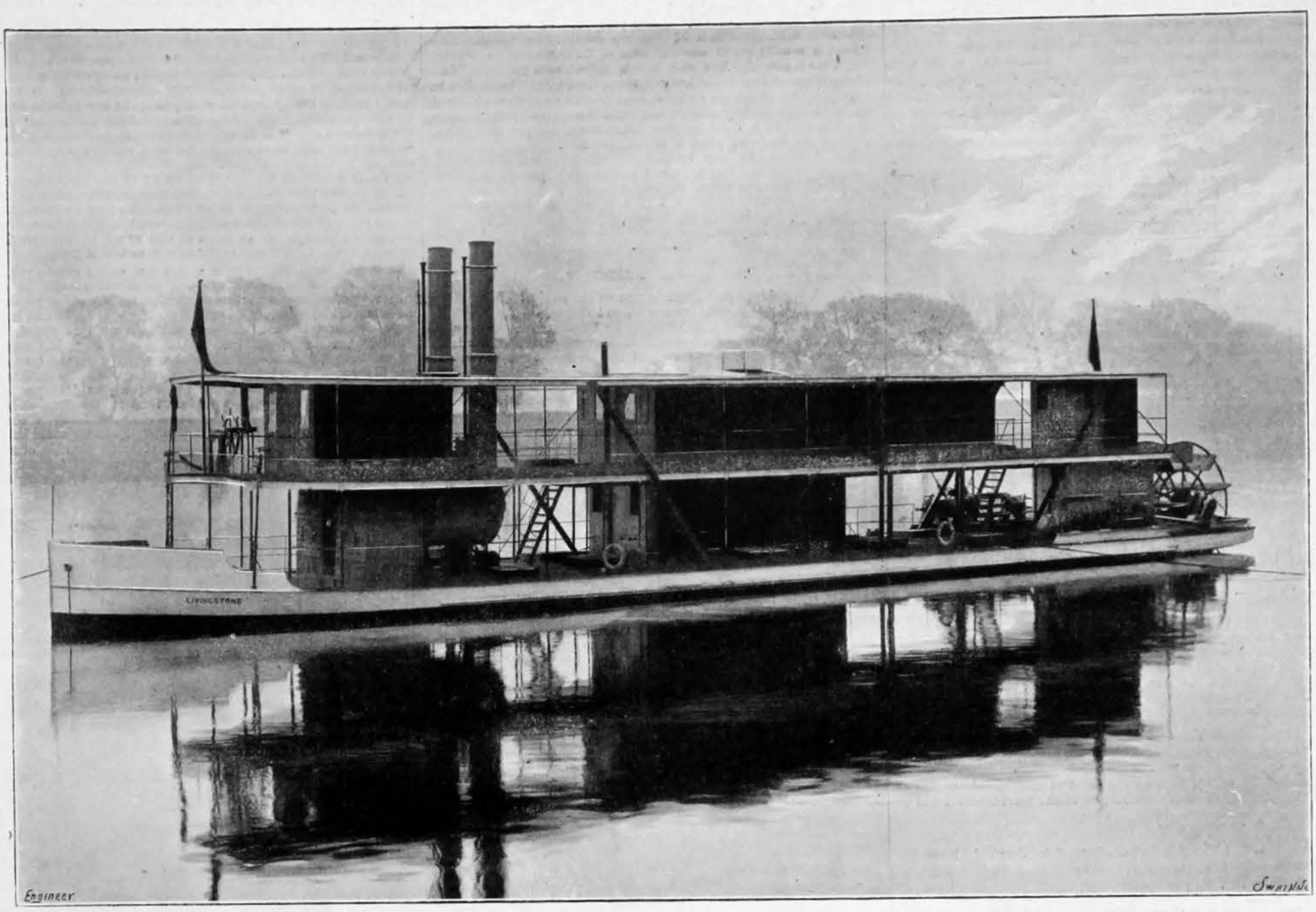
Nous vous serions obligés si vous vouliez bien faire cette légère rectification.

J. AND A. NICLAUSSE.

Paris, 18 Mai.

STERN-WHEEL STEAMER FOR STANLEY POOL

J. I. THORNYCROFT AND CO., CHISWICK, BUILDERS AND ENGINEERS



THE MISSION STERN-WHEEL STEAMER LIVINGSTONE.

MAY being, *par excellence*, the month in the Christian year when the labourers in the mission field foregather in London, opportunity was taken on the seventh of this month by J. I. Thornycroft and Co., of Chiswick-on-Thames, to invite a select party of ladies and gentlemen interested in mission work to inspect on the Thames, between Hammersmith and Kew bridges, the new, capacious, and powerful stern-wheel steamer Livingstone, built by the firm for missionary work in the "Regions beyond Missionary Union."

Our readers will not need to be reminded whence the name given to this, the largest vessel of her type, we believe, yet built in this country, is derived. She is a vessel, the hull of which is constructed entirely of galvanised steel, and has a length over all of 111ft., a beam of 19ft. 3in., a depth under her main deck of 4ft., and a draught, with a load of 20 tons on board, of 2ft. 6in. She is divided into water-tight compartments by seven transverse bulkheads, and one middle line bulkhead from stem to stern.

The propelling machinery consists of two horizontal compound engines—one on each side of the deck—each having 18in. diameter high-pressure and 28in. diameter low-pressure cylinders—placed tandem—with a piston stroke of 4ft. These engines, which are 240 indicated horse-power, drive a paddle-wheel 11ft. diameter, placed at the stern of the vessel, fitted with ordinary radial wood floats, which, with thirty revolutions a minute, give the vessel, when fully loaded, a speed of 11¼ miles an hour.

Steam is supplied to the engines by two locomotive boilers—placed forward—worked at a pressure of 125 lb. per square inch, and adapted for burning wood, the consumption of this fuel being 1280 lb. per hour when the boat is at normal speed.

The vessel has two decks, the main deck being of galvanised steel, and the upper deck of teak wood, there being a height of 7ft. 4in. between them, and 6ft. 9in. between upper deck and awning. The accommodation provided on board consists of five state-rooms on the upper deck, two of them having double sleeping berths. The captain's cabin and dining-room are also on this deck, the latter being fitted with a small lift from the galley on the main deck. Two bath-rooms, with arrangements for heating water by steam; a hospital, and two lavatories are also provided on the upper deck. Each state-room has a folding lavatory fitted with water-supply apparatus; and all the windows in the cabins throughout the vessel are protected by mosquito-proof wire gauze, and wherever wood is brought into use it is teak, it being free from the pest of the white ant and all kinds of insects.

Natives are accommodated on board the Livingstone in a roomy cabin on the main deck.

No attempt at speed was, of course, made while on her brief excursion on the 7th ult., but that named above was the result attained as the mean of six runs on the measured mile at Long Reach, the boat being fully loaded, and burning wood fuel.

The Livingstone will be taken entirely to pieces, packed, and shipped to Matadi, whence she will be transported to Stanley Pool by the new Congo railway, a distance of 200 miles. Her weight, exclusive of packing cases, will be about 76 tons. Arrived at Stanley Pool, she will be re-erected by native labour—which will occupy several months—under the supervision of the engineers of the Missionary Society.

Our illustration shows the Livingstone as she appears afloat, when in loaded trim. The vessel is now on view at the South Quay of the East India Import Dock, Poplar, where she will remain until Whit Tuesday, to give country visitors interested in missionary work an opportunity of inspecting such a vessel.

THE COLOUR OF WARSHIPS.

OUR "Dockyard Notes" last week made some reference to the mild agitation now afoot on the part of certain well-meaning civilians, which has for its object the changing of our warships' colours. We remarked in the column indicated that the chief use of such a change would lie in the abolition of too much hunting after appearances. As, however, undue importance is being attached to this question, we think it will bear some further examination.

The ideal colour, according to the advocates of "war paint," is a particularly ugly neutral grey shade that the Germans economically favour for their ships. German ships have been seen with it at Spithead, and their inconspicuousness there duly noted. Therefore, it is demanded that all British warships should forthwith adopt the same colour. It looks eminently logical; but is it?

The fact is there is no such thing as a war colour at all. There are colours suited for one sea but not for another, and in all cases the best colour for day is not the best for night. The only tint, indeed, that moderately well fulfils the necessary practical conditions is a species of raw umber. But this grey brown, once adopted by the French, has been discarded, and we, who followed it for our first destroyers, quickly discarded it too. It failed to give satisfaction in practice, and under certain lights was far more conspicuous than black. The same applies to greys of colder tint. The German ships at Spithead showed little in the Spithead haze; but on a dark open sea they often show far more clearly than black ships. So, too, in the Baltic, where recently experiments decided the authorities in favour of canary yellow. On the opposite shores, Sweden adopted brown grey, that proves the most inconspicuous colour against their coasts.

At night any light colour, except, perhaps, emerald green, is likely to tell up much more than black; and night is the time beyond all others when a ship needs to be inconspicuous. Unless, therefore, she knows beforehand to a certainty the waters in which she will have to fight, she may damage herself rather than otherwise by selecting a "khaki" tint other than black, which we already have. All that makes black ships conspicuous is the custom of painting the upper works white and the funnels yellow. It is a very small job to smudge these over with black; then the ship has probably the best all-round practical colour. In harbour she may loom very conspicuous; but at sea, in all the varying conditions of atmosphere, she will by day silhouette no more than any other colours against the light, while with the light upon her she will tell less than if she were grey. A ship's masts always tell against the sky and show where she is, so that were an "invisible" colour possible it would have no great advantage. The idea that bits of a ship can be selected for aiming at in battle is responsible for much of the worrying about colour. Actually, of course, this will be quite impossible; and so much is this the case that it is doubtful whether a ship in her gay peace paint is in any way an easier target than a ship in "khaki." Indeed, some have argued that peace colouring might be most serviceable for war, the varied tints distracting the gunner's aim, and rendering it less easy for him to see and think of the ship as a whole.

For all the varied conditions of night work nothing better than dull black has yet been discovered. Under certain conditions some other colour may beat it, but it will not beat it all round. In this all nations seem in accord; even German destroyers are black as coal barges. The "deadly grey torpedo boat" had a very short life, despite the pretty phrase. It was soon all too evident that the deadliness of the grey would be experienced by the crews of craft that colour.

TEXTILE BELTING.

BRANCH works have been erected at Fleetwood by Fleming, Birkby, and Goodall, Limited, of Halifax, with special plant for the manufacture of the patented composite textile belting known as "Teon." On Saturday last a number of trade and Press representatives were present, by invitation, at the opening of the new works. The foundation of Teon belting is the best duck cloth procurable. The composite covering composition, or cement, is kept secret; it has much the appearance and elasticity of rubber, but one of the advantages claimed for the belting is that it is free from rubber composition. The first process of manufacture is to pass the cloth through a powerful calender of special design. This machine, which weighs about 22 tons, has three hollow steel-tube rolls, 22in. diameter, heated by live steam, and cooled by water as the temperature requires to be varied. As the cloth passes through the calender, the cement or composition is fed between the rollers by hand, and a varying speed that is given to the rolls causes a sort of friction movement, so that the composition is not merely pressed, but is practically ground or keyed into, and thoroughly rubbed through both sides of the cloth, which is delivered from the calender at the rate of three yards per minute. The cloth then passes on to a machine, also specially designed, in which, by a very simple process, it is folded into the different thicknesses and widths of the required belting, and thence passes through a series of sewing machines—arranged tandem fashion—each machine doing its own particular seam, so that the belt comes out in one operation completely sewn. The final process is the compression or cementing of the belt into its compact permanent form. For this purpose it is first put through pressure rollers, and next into a powerful hydraulic press, an ingeniously-devised stretching apparatus, taking out all stretch from the belt. The press, which has six rams, 12in. diameter, exercises a pressure of 2000 lb. to the square inch, and after this process the belting only requires the ordinary painting and varnishing for the market. The two main points claimed for the Teon belting are its non-liability to stretch when in use, and that the special composition renders it impervious to the action of dry heat up to 230 deg. Fah., and steam up to 200 deg., as well as damp, water, and open-air exposure, whilst it also resists the action of oil, grease, alkalies, and of acids, with the exception of bi-sulphide of carbon and chloride of sulphur.

Lieut.-Col. R. Vacy Ash, the inventor of the process, subjected samples to various tests—by exposure to jets of steam and boiling water taken from the boilers, and by immersion in various acids, without any appreciable effect being produced.

THE WACHUSETT DAM, U.S.A.

(*Concluded from page 476.*)

RETURNING now to the main works, we have in Fig. 6 cross sections of the dam and weir. The dam will have a heel wall some 30ft. deep, and its maximum width at the base will be about 176·3ft. From this base width the face has a batter of 1 in 4 to the level of the bottom of the reservoir, above which it is vertical. The rear has a slope of 1 to 1 to an elevation of 260, from which it is curved on a radius of 355ft. to elevation 300, which is that of the finished surface of the ground. Above this the curve compounds to 789·8ft. radius, and then 248ft., finishing off with 90ft., which brings it to the narrowest section, 22½ft., at the springing of the cornice. The width over the top is 25¾ft., and there will be a concrete and asphalt roadway, with an ornamental iron fence on each side. The cornice coping stones are anchored shown in section A A. On the face of the masonry will be noticed the channel iron guides for the stop planks, and the sections show the arrangement of the masonry at the ports. In Fig. 10 are shown horizontal sections through the valve chamber at the base of the shaft A, and also through the two sluice gates B and B¹ opening into the main shaft C. There are also vertical sections at the base of this latter shaft, showing the closed end of the pipes to the face of the dam, and the deflector to guide the water into the discharge pipe D, and so prevent pounding and disturbance at the turn at the base of the shaft.

The earth excavation will first be made to the bottom of the valley, with slopes of 1½ to 1, to uncover the rock for the whole width of the dam, the slopes not to reach within 10ft. from the upstream, or 5ft. from the downstream face of the dam at their intersections with the rock surface. The trench for the core wall will be made with vertical sides, supported where the roller cannot be used. If the clay is free from large lumps it may be shovelled into water, no rolling or ramming being then required. On the upstream side of the waste weir the filling will be of earth in 6in. layers, watered and rolled or rammed, covered with 4ft. of gravel on the face. The filling of the trench for the core wall will be deposited in 4in. layers, wet, and thoroughly rammed, the sheeting and lining being carefully removed as the trench is filled. The filling behind retaining walls will be of porous gravel, in 6in. layers, watered and thoroughly rammed.

The cement used in the masonry will include the best quality of Rosendale natural cement and American Portland cement, of brands satisfactory to the engineer. A sufficient quantity of the cements must be kept at the work to allow time for twenty-eight day tests without delaying the construction, and must be kept in separate lots of not more than 200 barrels, so that lots rejected or requiring further tests can

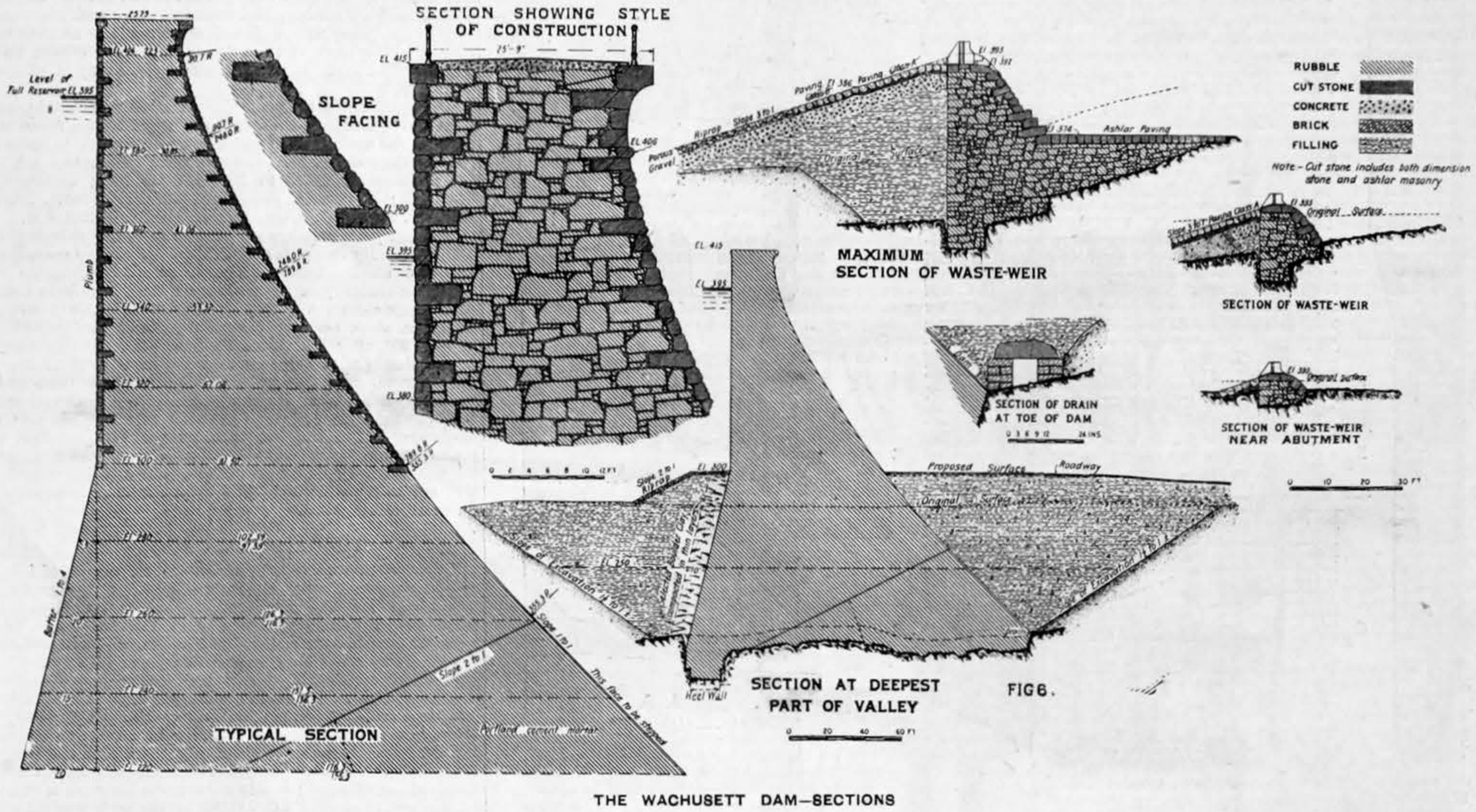


FIG 6.

THE WACHUSETT DAM—SECTIONS

well back in the masonry. The battered part of the front face will be covered with a 10ft. layer of boulder clay compacted in thin layers, and the bottom of the reservoir against the face will have stone pitching. At the toe of the dam will be a rectangular drain to carry off any water passing through the earth filling of the excavation. The weir will have a vertical fall for the masonry, with a bank built against this face, and covered with clean gravel and stone paving. It has already been explained that the south-east end of the dam will be tied to the hillside by a masonry core wall embedded in an embankment. This is shown in Fig. 7, from which it will be seen that the wall is a continuation of the upstream face of the abutment wall.

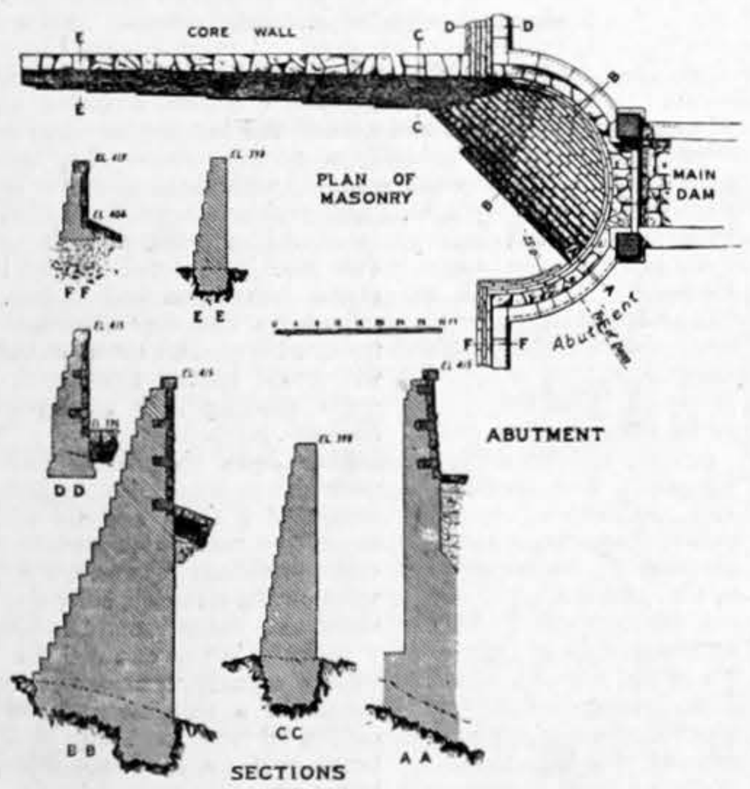
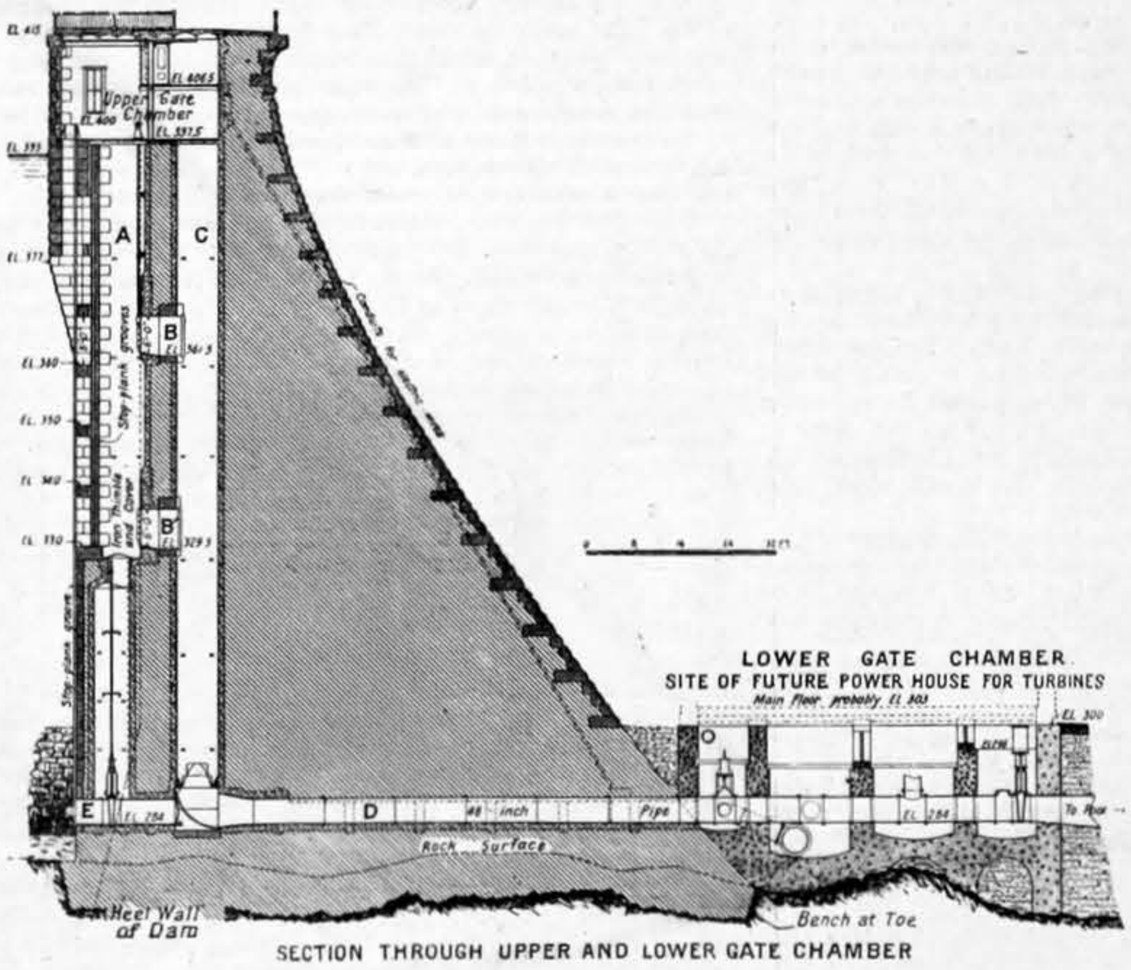


FIG. 7. ABUTMENT AND END CORE WALL.

The general arrangement of the gate chambers and the pipe connections is clearly shown in Fig. 8. Water entering the ports in the face of the gate chamber fills the upper part of the shaft A, the lower joint of which is closed by an iron thimble and cover, and contains the valve on the 48in. pipe. From the intake shaft the water is admitted by means of two sluice gates, B and B¹, at different levels, to the main shaft C, down which it flows to the 48in. pipe D, which passes through the dam to the lower gate chamber. At this point the flow is distributed to the aqueduct or to the river channel as required. At E is the pipe through the face of the dam, which is closed by a valve, and has its inner end also closed with a bolted cover fitted with a drain cock. This opens into the base of the main shaft C.

The upper gate house or gate chamber, Fig. 9, projects from the face of the dam, and has a series of rectangular openings or ports into four intake shafts, while at the bottom are the four 48in. iron pipes embedded in the masonry. These are



SECTION THROUGH UPPER AND LOWER GATE CHAMBER

Fig. 8—THE WACHUSETTS DAM

by sheeting and bracing. The earth excavated may be deposited in spoil banks or used at once in dressing and trimming slopes, all stumps and roots of over ½in. and stones of over 3in. diameter being removed, while only material free from organic matter will be deposited below the water-line of the reservoir. All rock excavation must be taken out to the neat lines of the required cross section, care being taken not to disturb the rock outside of these lines, but all loose rock must be removed. When blasting is liable to injure the rock upon or against which the masonry may be built, the excavation must be carried on by wedging and barring. The trench for the heel wall will have nearly vertical sides, and special care must be taken to leave its sides solid and unbroken. When required, all dirt and loose rock will be removed to expose the surface, which will then be thoroughly washed and cleaned—using steam to melt snow and ice if necessary—and all water then removed from depressions, so that the whole surface of the rock can be inspected, to determine if seams or other defects exist.

The refilling and embanking within 10ft. of the upstream face of the dam will be of boulder clay, from which all stones over 3in. in size have been removed. This will be deposited in layers not more than 4in. thick, and thoroughly compacted by rolling with a heavy grooved roller, or thoroughly rammed

be readily identified. Clean sharp sand will be used, and if the mortar is mixed by hand, the ingredients must be evenly spread, and first thoroughly mixed dry; a moderate quantity of water is to be added afterwards to produce a paste of the proper consistency, the whole to be quickly and thoroughly worked with hoes. Mortar which is not used within half an hour after it is first wetted may be rejected. In preparing mortar and concrete, the cement is to be measured as if compacted, so that 300 lb. of dry natural cement, or 380 lb. of dry Portland cement, will have a volume of 3·6 cubic feet. The sand and stone are to be measured when not packed more closely than by throwing them in the usual way into a barrel or box.

The stone masonry is to be of sound, clean, strong, and durable granite. For rubble stone masonry, the granite must be such as will split to form even beds and furnish blocks of suitable size and shape. For the top and downstream face, the ashlar and dimension stone masonry must be of uniform colour and texture, and be free from all the defects which would injure its appearance. All joints are to be entirely filled with mortar. Where grout is required for filling the joints of ashlar and dimension stone masonry the engineer may require a less proportion of sand to be used than that in the mortar. Water must not be allowed to rise on any masonry until the mortar has had at least twenty-four hours to set. No masonry is to be built from November 15th to April 1st, except by special permission or direction, as in the event of satisfactory progress not having been made. If built in very cold weather, the water, sand, and other material must be heated, salt must be added to the water, or the place of work must be heated. Unfinished masonry at the end of the season must be protected to prevent damage from freezing. Except during the colder months, the masonry must be kept wet by sprinkling water until the mortar has become thoroughly set and hard enough to prevent its drying and cracking. The whole work must be carried up together, the maximum difference in elevation allowed for the masonry being 24ft. in a distance of 100ft., or 45ft. in the whole length of the dam. No racking must be more than 12ft. high. In joining new work to old, or in laying masonry upon the rock, the surface of the old masonry or the rock must be thoroughly cleaned and a coat of grout of neat Portland cement applied. The solidity of the masonry will be tested from time to time, as by striking it with an iron

rod to determine if a hollow sound indicates defective work.

The main part of the dam will be composed of rubble-stone masonry, laid in mortar of one part natural cement and two parts sand. Large stones are to be used to the greatest extent consistent with obtaining full and water-tight bed joints, sufficient space being left between the large stones to permit of filling the joints with mortar and small stones. The average and maximum size of the large stones will be fixed by the engineer during the progress of the work; the former will be about 5000 lb., and the latter is not to exceed twice the average. The following is an extract from the specifications in regard to the construction of this part of the work.

The large stones shall have even beds which may be either flat or slightly convex, and not less than three-fourths of these stones shall each have a top with an area not less than half the area of the bed, and varying from a parallel with the bed not more than 3in. in a foot. No large stone is to be used whose top area, as nearly parallel with the bed as above stated, is less than 2 square feet if the area of the bed exceeds 4 square feet.

Before laying, each stone shall be cleaned and washed, and all irregular projections and feather edges shall be hammered off. Each stone shall be laid upon a thick prepared bed of mortar or of mortar and thin spalls, and forced into the bed in such manner as to ensure that the bed joint shall be completely filled with mortar. To aid in the proper preparation of the bed, the contractor may be required to lower each stone upon the bed before it is fully prepared as a guide to its final preparation, and to remove the stone to complete the preparation of the bed. After the stone has been set, if there is any doubt about having obtained a completely-filled bed joint, and occasionally, as a test of the quality of the bedding, the engineer may require that a stone shall be raised to ascertain if the bed joint has been completely filled, and such stone shall be re-bedded in a thorough manner. The side and end joints between the large stones shall, if so required, be made large enough to permit the laying of small stones between them, and every stone, of whatever size, shall be laid in a bed of mortar. No more levelling up shall be done than is necessary. Grouting of joints will not be permitted.

The stones shall be thoroughly bonded horizontally. Care shall be taken to avoid making regular layers, and to permit a portion of the stones to project above others so as to provide a vertical bond, and resist any tendency of the dam to slide. Towards the top of the main dam the strongest bond shall be made lengthwise.

The masonry in certain parts will be laid in Portland cement mortar, with 1 part of cement to 2, 2½, or 3 parts of sand. The former proportion will be used in the part immediately above the rock and wherever there are springs, and Portland cement mortar may be used for work liable to be effected by freezing. From the bottom of the valley up to a plane striking the down-stream side at elevation 260—see Fig. 6—and inclined downward 1 in 2 towards the up-stream side, the masonry will be laid in Portland cement mortar 1 to 2½. Of this masonry, the portion between the down-stream face and the middle of the dam will be of a better class, with stones approximately rectangular, so as to permit the use of fewer small stones for filling the joints and levelling, thus securing a more perfect bond. These stones will be laid with bed joints inclined upwards 1 in 4 towards the down-stream face. In certain other parts the bed joints may be similarly inclined 1 in 6, for which an extra price will be paid.

The exposed faces of the stones on the up-stream face of the dam must be nearly rectangular, of not less than 6 square feet area, smaller stones being allowed to a limited extent to fit in between the larger ones. The aggregate area of face stones having an area of less than 1 square foot must not exceed 10 per cent. of the area in which these stones are laid. The face joints between such stones and the larger stones must not exceed ¾in. in thickness, and no face joints may exceed 1in. in thickness for a depth of 2in. back from the face. The joints will be raked out 2in. deep before the mortar is laid, and will then be jointed with Portland cement, neat or mixed with sand, so as to fill the joints thoroughly with water-tight mortar. On the down-stream side the stones will be built in steps, and not to a sloping line—see Fig. 6.

In retaining walls, the rubble stones will be laid as in the dam, with a mortar of 1 part natural cement to 2 parts sand. The exposed faces will be built of approximately rectangular faced stones, not less than 2 square feet area. Few pinners will be allowed, and they must show even faces.

Ashlar masonry will in general have bold rock faces on the exposed face, free from holes or tool marks, and laid in cement mortar similar to that of the rubble masonry against which the ashlar is built. Face joints must not exceed ½in. in width, and must be raked out and pointed as in rubble masonry. The face laid must be not less than 18in. between stretchers, and 10in. between headers and stretchers. Beyond the limit of the ½in. joints, headers may taper not more than 6in. in thickness. The faces of the headers must have an average width of not less than 25 per cent. more than the rise of the course, the minimum width being equal to the rise, and the maximum one and a-half times the rise. On the down-stream face of the dam, the rise of the courses may vary from 20in. to 28in., but must average not less than 22in.

Stretchers will be not less than 6ft. long, with an average depth of at least 1ft., and cut for a ½in. joint, 4in. deep. Headers not less than 4½ft. long will be placed in every second course, and every second or third stone in a course. On this side of the dam the face stones will have rock faces projecting 2in. to 5in. from the neat lines, and will be laid in Portland cement mortar, 1 to 2½. On the up-stream face the courses must average 24in. in height, with a minimum of 18in. The stretchers will be 5ft. long. Where the work is thin, as in the faces of the bastion and abutment, headers at least 4ft. long are to be placed as frequently as in the faces of the main dam Curved stones must be at least 14in. deep at the middle and 8in. at the ends. The projecting and re-entrant angles of ashlar masonry dam to elevation 380 in the up-stream face of the dam, will be defined by 1½in. chisel draught on each face.

Dimension stone, or cut stone masonry, will be cut for ½in. joints, ⅜in. for steps, the joints to be raked out and pointed as in rubble masonry. The stones upon which the flash-board standards of the waste weir are to rest must be so placed that joints will be at least 6in. from the bolt holes. Nearly all of the dimension stones, and a small part of the ashlar stones, are to have the faces rough-pointed, fine-pointed, or six cut.

Brick masonry must be of hard-burned bricks, which when dried and immersed in water for twenty-four hours will absorb not more than 15 per cent. in volume of water. In lining the wells of the upper gate chambers special care must be taken to make the brickwork water-tight.

Concrete masonry made with Portland and natural cement will be used in certain portions of the work. It will be made of broken stone or gravel stone. The former need not be screened if the amount of fine material passing a ⅜in. screen does not exceed 10 per cent. of the volume screened. The gravel must, however, be thoroughly screened. The Portland cement concrete will be comprised of 1 part cement, 2½ parts sand, and 4½ parts stone, or 1 part cement, 3 parts gravel, and 6 parts stone. The natural cement concrete will be composed of 1 part cement, 2 parts sand, and 5 parts stone, or 1 part cement, 3 parts sand, and 6 parts stone. Soon after material of the lagging, the interior surface of the concrete will be covered with a skin coat of neat Portland cement, applied as a plasterer's finish coat. On top of the dam, and in the floors of the gate chamber, bastion chamber, and pool, the surface of the concrete will be finished with a 1in. course of mortar composed of 1 part Portland cement and 1½ parts coarse screened and washed sand. This must be applied within an hour after the concrete is laid.

Parts of the slopes of the waste weir and other portions of the work will be paved with granite blocks bedded in broken stone, the joints being filled with fine stone and the faces of the joints with pinners. No stones must have an area of less than 2 square feet, and the joints must not exceed 2in. in width. The broken stone for bedding will vary in size from ¼in. to 2½in.

In regard to the progress of the work, the contract provides that the Water Board reserves the right to maintain water against the main dam at elevations and periods as follows:—During September, 1902, elevation 292; during October, 1902, 296; November, 1902, to March, 1903, 302; during April, 1903, 310; May to October, 1903, 315; November, 1903, to October, 1904, 350; after October, 1904, full level, 395.

Further provisions are also made as to the carrying on of the work. By December 31st, 1900, all earth excavation to the rock surface must be completed. By November 15th, 1901, the masonry of the main dam must have been built to an average elevation of 280; and portions of the lower gate chamber, pool, and other structures built as directed. By June, 1902, all works must be completed for diverting the water through the 48in. waste pipes, so that the flume can be removed. By September, 1902, the main dam and all work up stream from it must be completed to elevation 300; by November 15th, 1902, the dam must be completed to elevation 315. Not less than 62 per cent. of the total value of the work must be completed by August, 1903; 76 per cent. by November 15th, 1903; 90 per cent. by August, 1904; and the whole work must be completed by November 15th, 1904.

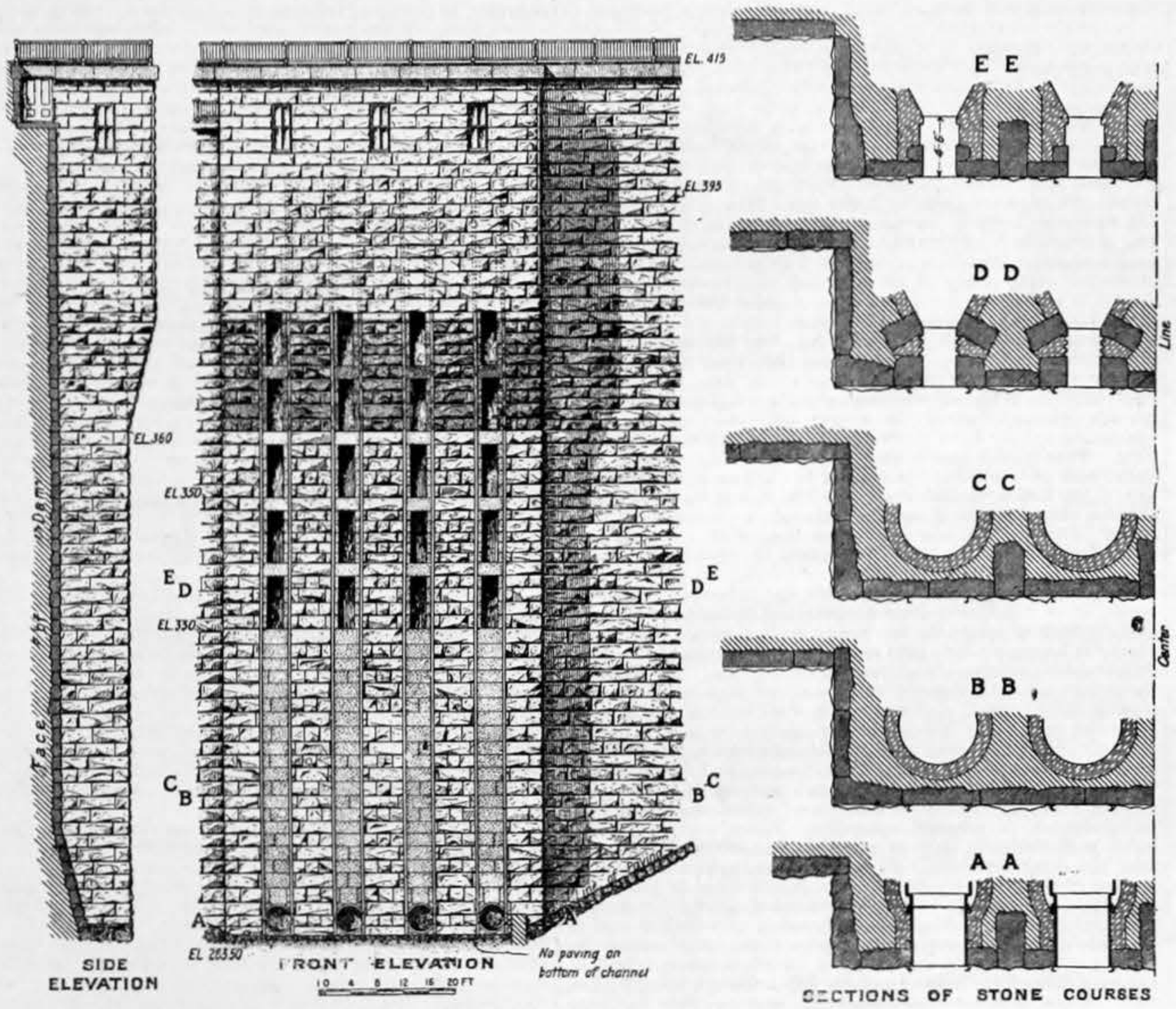


FIG. 9. UPPER GATE CHAMBER—THE WACHUSETTS DAM—DETAILS

THE WACHUSETT AQUEDUCT.

In connection with this great dam, it may be of interest to give some particulars of the aqueduct—already completed—which will carry the water from the reservoir to the existing water-supply system of the city of Boston. It is twelve miles in length, comprising seven miles of closed aqueduct, a tunnel two miles long, one-tenth mile of bridge, and three miles of open channel. The tunnel commences at the dam, and is 12ft. 2in. wide at the springing line, and 10ft. high. The arch radius is 6ft. 1in., and below the springing the sides curve inward to a radius of 14ft., the invert having the same radius. The character of the lining varies with the material penetrated. The arch ring, invert, and sides have three to four courses of brick; but in some parts the work is of Portland cement concrete, 14in. thick in the arch, the sides and invert being lined with a single course of brick. The tunnel is on a long curve, and has a gradient of 1 in 5000.

Beyond the tunnel is an arched channel, 10½ft. high and 11½ft. wide, built of concrete, partly in trench and partly in embankment. This is built on land purchased by the Water Board, and has a gradient of 1 in 2500, with curves of 320ft. to 1910ft. radius. Various forms of section of the exterior are adapted in different materials. The embankments are very carefully built, and were carried up in 3in. layers, well watered and rolled, to the level of the base of the aqueduct, and then left for at least six weeks before the construction of the aqueduct was commenced. The banks were wetted so thoroughly that water would stand on the surface. The base of the aqueduct was 20ft. wide, the exterior faces sloping inward to give a thickness of 24in. at the springing, and 14in. at the crown of the arch. The side filling was laid in 6in. layers, watered and rolled or rammed. A thick layer of black soil was then laid upon the slopes and top, and the whole surface sown to grass. In laying the concrete, a facing of sand and cement was first laid against the lagging to form a smooth surface, and any voids found on the interior after the lagging was removed were pointed with neat cement or cement and sand as required. The drainage across the line of the embankment was provided for by brick and stone culverts. The closed aqueduct terminates by a bell mouth entering a masonry chamber, fitted with grooves for movable weirs, and having three arch-ways opening into the open channel.

This open channel is 20ft. wide on the bottom, with side slopes of 3 to 1, and in soft earth it is faced with gravel or stone pitching. A berme, 10ft. wide, is left on each side, and above this the slopes are 2 to 1. Two dams in the channel prevent a scouring current, and maintain a minimum depth of 6ft. of water. They have long overflows, so as to cause but little fluctuation in the height of water in the channel, as varying quantities are admitted through the gate chamber from the reservoir. This channel ends by a connection with a lower reservoir on the water supply system. The most interesting structure on the line of the aqueduct is the masonry bridge carrying it across the Assabet River. This is 390ft. long, with seven arches of 29½ft. span. The stone is a grey granite, and the bridge has a very handsome appearance. The aqueduct section here is nearly rectangular. Above the invert the sides slope outwards slightly and then continue vertical to the top, carrying a roof of brick jack arches on transverse rolled steel joists. Above this is a concrete filling and an asphalt roadway. The lining is a single course of brick, with an outside shell of steel to make it perfectly water-tight. Around this shell is the solid concrete filling between the masonry side walls.

All the work on the dam, aqueduct, and other parts of the

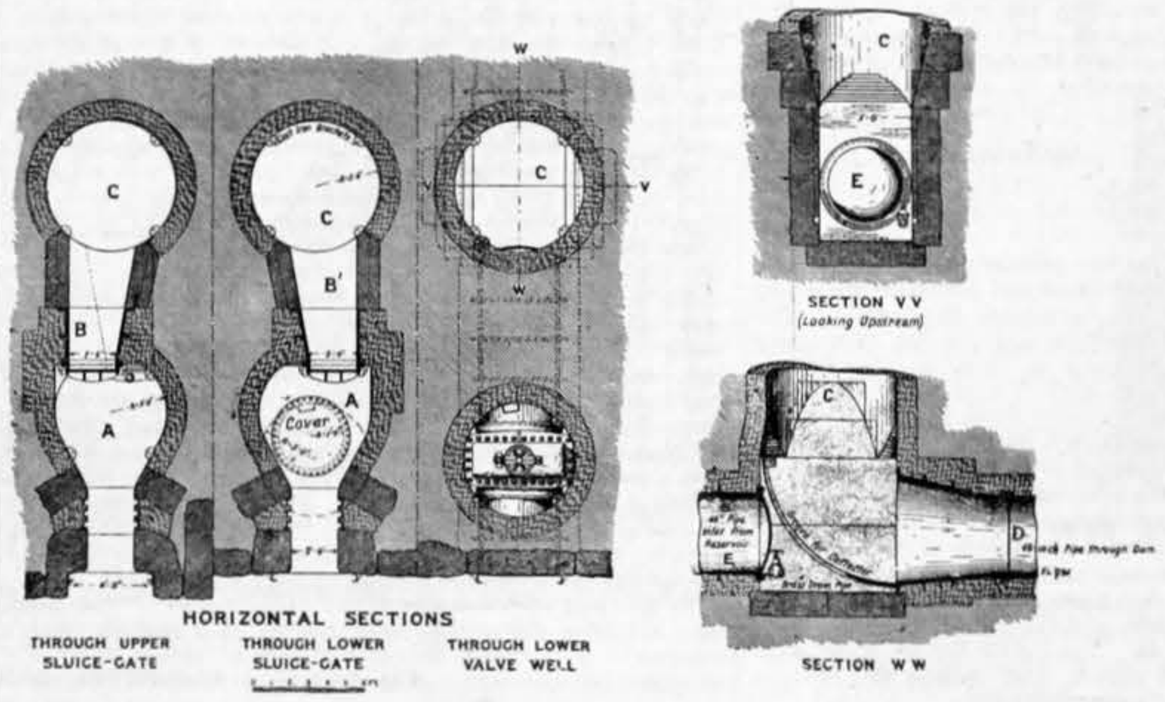


FIG. 10. THE WACHUSETTS DAM—DETAILS

water supply system is under the direction of Mr. F. P. Stearns, chief engineer of the Water Board. Mr. T. F. Richardson is the resident engineer at the dam. The contract for the dam, already described, has been let to MacArthur Brothers at their total tender of £321,727. As it may interest many of our readers to know the contract prices on this great piece of work, we give below a list of the items, quantities, and prices from the official specifications and published tenders.

Details of Work and Prices on the Wachusett Dam, U.S.A.

			£ s. d.
Earth excavation, A—			
1	Class A, above elevation 250	6,000 cu. yds.	0 2 1
2	,, B, below elevation 250	20,000 ,, ,,	0 2 9
3	,, C, trench for core wall	1,300 ,, ,,	0 4 2
4	,, D, south-east end	54,000 ,, ,,	0 2 1
5	,, E, waste weir	30,000 ,, ,,	0 2 1
6	,, F, waste channel	65,000 ,, ,,	0 1 8
7	,, G, surface soil	30,000 ,, ,,	0 2 3½
8	,, H, pile of tunnel *débris*	8,000 ,, ,,	0 1 8
9	,, I, borrow pit	15,000 ,, ,,	0 1 0½
10	,, J, miscellaneous	38,000 ,, ,,	0 1 5½
Rock excavation—			
11	Class A, below elevation 250, with blasting	13,000 ,, ,,	0 3 11½
12	Class B, below elevation 250, without blasting	2,400 ,, ,,	0 8 4
13	Class C, above elevation 250, with blasting	17,000 ,, ,,	0 3 9
14	Class D, above elevation 250, without blasting	3,000 ,, ,,	0 8 4
15	Class E, dam and waste weir, with blasting	19,000 ,, ,,	0 5 0
16	Class F, dam and waste weir, without blasting	5,000 ,, ,,	0 10 0
17	Class G, inclined shaft or tunnel	600 ,, ,,	0 16 8
18	,, H, waste channel	40,000 ,, ,,	0 4 2
19	Extra price for hauling excavated material more than 1000ft., equivalent to 600,000 cu. yds. hauled 100ft.	—	0 0 0¼
Rubble stone masonry—			
20	Class A, in the dam, natural cement	215,000 ,, ,,	0 15 10
21	Class B, Portland cement mortar, 1 to 2	17,000 ,, ,,	1 0 0
22	Class C, Portland cement mortar, 1 to 2½	24,000 ,, ,,	0 18 11½
23	Class D, Portland cement mortar, 1 to 3	5,000 ,, ,,	0 17 6
24	Class E, in retaining walls, natural cement	4,000 ,, ,,	0 16 8
25	Extra price for face work	5,400 ,, ,,	0 1 8
26	Extra price for Classes A to D, made with better shaped stones, and beds inclined 1 in 4	13,000 ,, ,,	0 0 10
27	Extra price for Classes A to D, with beds inclined 1 in 6	50,000 ,, ,,	0 0 7½
Ashlar masonry—			
28	Class A, up-stream face of dam	4,000 ,, ,,	2 8 4
29	,, B, down-stream face bastion, &c.	4,900 ,, ,,	2 10 0
30	Class C, down-stream face of waste weir	1,400 ,, ,,	2 14 7
Dimension stone masonry—			
31	Class A, cornice and coping	2,100 ,, ,,	3 6 3
32	,, B, all other work	800 ,, ,,	4 0 0
33	Face dressing of rough pointed work	18,000 sq. ft.	0 1 8
34	,, ,, fine pointed work	30,000 ,, ,,	0 2 1
35	,, ,, six-cut work	4,000 ,, ,,	0 2 6
Brick masonry—			
36	In Portland cement mortar, 1 to 1	800 cu. yds.	3 0 0
37	,, ,, ,, 1 to 2	200 ,, ,,	2 16 8
38	In natural cement mortar, 1 to 1	100 ,, ,,	2 12 6
39	,, ,, ,, 1 to 2	200 ,, ,,	2 8 4
Portland cement concrete masonry—			
40	1 to 2½ to 4½	5,600 ,, ,,	1 6 3
41	1 to 3 to 6	2,000 ,, ,,	1 2 1
Natural cement concrete masonry—			
42	1 to 3 to 6	400 ,, ,,	0 19 8
43	1 to 2 to 5	300 ,, ,,	0 15 6
44	Granolithic surfacing in concrete	5,000 sq. yds.	0 1 8
45	Slope paving, Class A	1,200 cu. yds.	1 4 2
46	,, ,, B	1,500 ,, ,,	0 13 7
47	Broken stone, laid in place	2,300 ,, ,,	0 2 6
48	Laying 48in. cast iron pipe	1,000 lin. ft.	0 2 6
49	Hauling and erecting ironwork	1,000 tons	2 16 8
50	Roadways and paths	10,000 sq. yds.	0 0 10
Vitrified pipe drains, including gravel surrounding—			
51	5in. pipe	1,500 lin. ft.	0 0 7½
52	8in. pipe	1,000 ,, ,,	0 1 3
53	10in. pipe	700 ,, ,,	0 1 8
54	12in. pipe	200 ,, ,,	0 2 3½
55	15in. pipe	300 ,, ,,	0 3 4

THE IRON AND STEEL INSTITUTE.

PRESIDENTIAL ADDRESS.*

(*Concluded from page* 516.)

The production of pure pig equal to best Swedish.—The demand for Swedish pig for high-class steel exceeds the supply. Why not, then, in this country produce, as they are doing at Johnstown, in America, pure pig to meet this demand? The method used is Bell's washing process, using hematite pig and conducting the operation in a Pernot revolving furnace. By this means a material is made very low in silicon, manganese, sulphur, and phosphorus, and may be used for the same purpose as Swedish. This subject of problems in metallurgy has been but touched upon in the foregoing, and those more intimately acquainted with the needs of steel manufacture than I am, could no doubt point out many more such problems, and none of our young metallurgists need despair of finding something to work at for the future development of our industry.

The pure iron ore supply.—By far the greater part of our steel in this country is made by the acid Bessemer and Siemens processes, requiring a pure pig iron as low in phosphorus as possible. The question, then, of the supply of pure ore to make this class of pig iron is one which will have to be faced by us in the near future. Our only native supply of pure ore of the Cumberland district is rapidly approaching exhaustion. In many works the ore now used is of very much lower yield of iron than it used to be, and Spanish and other foreign ore is being imported in increasing quantities to help out the local supply. On the east coast and in other hematite iron-making districts, nothing but foreign ore is used, the greater part coming from Bilbao. We often hear reports of the near exhaustion of this famous deposit, and recently it was stated that the end would be seen within a few years' time. I have no means at hand for verifying this estimate, and the Bilbao exports of the last five years do not enlighten us. These statistics are taken from C. E. Muller and Co.'s annual report, and include the ore also shipped from north Spanish ports near Bilbao:—

	Tons.
1896	5,047,000
1897	4,959,803
1898	4,633,241
1899	5,864,174
1900	5,268,429

Though there was a steady decrease from 1896, there was a sudden increase of over one million tons in 1899, the highest export on record. Last year showed a decrease of 600,000 tons, but whether due to diminished supply or diminished demand we cannot tell. But with regard to the "quality" of the ordinary Bilbao ore which goes by the name of Rubio, I can speak more definitely from personal experience. The percentage of iron is steadily decreasing, and if the decrease goes on at the present rate it will not be long before this ore will be too poor in iron to pay cost of carriage and smelting. Briefly, it may be stated that whereas the average composition for 1890 was:—

	Per cent.
Iron in dry state	55·50
Moisture	9·00
Iron in the ore as received	50·50
Silica in the ore as received	7·10

The average for 1900 was:—

	Per cent.
Iron in dry state	52·80
Moisture	9·10
Iron in the ore as received	47·99
Silica in the ore as received	10·09

This decrease of 2·5 per cent. in the iron, and increase of 2·99 per cent. silica in the ore as received, may not at first sight appear very alarming, but if the effect on the weight of raw materials used in a year's working is considered, the seriousness of the difference is more apparent.

To make a ton of pig iron, 1·821 tons of ore of the composition shown for 1890 would be required, but in 1900 it would be 1·917 tons. Our make at Thornaby approximates 125,000 tons of pig iron yearly, made from a mixture of which Bilbao Rubio ore forms half to two-thirds; but in order to more fully illustrate the deterioration of this ore we will suppose nothing but Rubio is used. Then, to produce 125,000 tons of pig there would be required 227,625 tons of ore in 1890, but in 1900 the weight of ore would have to be increased to 239,625 tons to make the same weight of iron, an increase of 12,000 tons. The comparison does not end here, however, for practically the whole of that 12,000 tons is increased earthy matter which would have to be fluxed and passed as slag. The silica in 1890 was 7·10 per cent., and in 1900 10·09 per cent, giving 16,160 tons and 24,178 tons of silica respectively in the weights of ore quoted above. This is an increase of 8018 tons. The proportion of silica to lime in a hematite slag—when the alumina is 12 to 14 per cent., and the magnesia 4 to 6 per cent.—is 1 to 1·45, so that this 8018 tons of silica would require 11,626 tons of lime, equal to 22,360 tons of limestone. This extra limestone and resulting extra slag would need more coke for the decomposition of the former and fusion of the latter, amounting to over 1 cwt. to the ton of pig, or 7500 tons for the year. Thus the decrease in the yield of the ore for 1900 as compared with 1890, causes an increase of 12,000 tons in the weight of ore, 22,360 tons in the limestone, and 7500 tons in the coke, a total increase of 41,860 tons in the raw materials to produce the same weight of iron. Naturally, such a condition of affairs would mean either very much increased rate of working, or, what is more likely, a diminished output.

In the light of such a showing as this, one naturally turns to the possibility of there being other deposits near at hand to help off or even become a substitute for Rubio ore. I myself, in the past twelve to fourteen years, have tried several different kinds of ore from various countries with this object in view. The value of these analyses lies in the fact that each one represents the composition of a "cargo," and not just a small sample, and in some cases the results are the average of several cargoes. They are thus all of full practical value. The countries represented are Sweden, Norway, South Spain, Italy, Greece, and North Africa. Though many have been very useful as a mixture for Rubio ore, it must be confessed that in no case have I found one which could be considered an efficient substitute. Either the composition, mechanical condition, costs of carriage, or insufficient supply has been the stumbling-block. When it is remembered that the total exports from Bilbao and other ports in North Spain to the north-east coast of this country last year totalled 1,708,167 tons, and from all other parts, South Spain included, only 655,829 tons to the same district, it is evident that unless these other sources are capable of very much increased output, insufficient supply will be the main difficulty in the event of the Bilbao district being worked out. In the last few years magnetic concentration has been brought more prominently forward as a possible means of solving this question of the pure ore supply. The concentration of iron ore by this method has been successfully accomplished in Sweden and in the United States, but before the concentrates can be used in the blast furnace they must be made into briquettes, as the separated ore is in a dead fine condition, in which state it would be impossible to use it in the furnaces. This must add to the cost considerably, and only under most favourable conditions will it be possible to look for help in magnetic concentration. The improvements in the basic open-hearth steel process that have already taken place, and further improvements in the near future, will soon make this class of steel cheaper than any other. Thus, in order that the acid process may compete with it, it will be necessary to supply hematite pig at cheaper rates. Any one, therefore, who carefully considers what I have shown with regard to the supply of pure ore, must see that the possibilities of a cheaper hematite pig are not very hopeful, but rather the other way, and the only conclusion we can come to is, that this country will be compelled at no very distant date to adopt increasingly the basic process, and the use of native ore more extensively.

The Bessemer process.—At the May meeting last year, in the discussion on the Talbot open-hearth continuous process, Sir Lowthian Bell gave expression to an opinion which somewhat startled the metallurgical world, and caused many of us to regret that we could not have the late Sir Henry Bessemer with us to give his view of the matter. Briefly, Sir Lowthian stated that, from his wide experience as one connected with a large railway company, the irregularity of the ordinary Bessemer steel rail was such, that in his opinion the time was not far distant—if it had not already arrived—when the Bessemer process would have to be abandoned, and the open-hearth steel process substituted to satisfy present-day requirements. When we consider the almost incalculable benefits conferred on mankind in the progress of the last century, in which Bessemer's great invention played so very large a part, none of us can think of the abandonment of the process without regret. But sentimental considerations cannot, of course, be allowed to rule and guide us in such a matter, and, if it be found that the Bessemer process can no longer satisfy the requirements of the time, it will have to make way for better and more reliable methods of manufacture. In this connection it is interesting to recall a personal incident which took place many years ago. At the council meeting of this Institute on October 11th, 1881, I sat beside the late Sir William Siemens. Discussing the merits and respective costs of the Bessemer and Siemens steel processes, Sir William remarked to me, "I may not live to see the day, but you may—you are a young man—when Siemens steel will be made nearly as cheaply, and much more reliable than Bessemer steel." We shook hands and parted, little thinking that that was the last time he would be with us. It is a touching memory, and one possessing great interest to myself.

At this point a few words on the development of the Bessemer steel industry during the last quarter of a century may be of interest. In the early seventies the manufacture of steel by the Bessemer process was confined chiefly to South Wales, Sheffield, and Barrow, and the product was used almost entirely for railway material, chiefly for rails and tires. In those days it was the custom to re-melt in separate cupolas each charge of carefully selected hematite pig iron, which, when melted, was run into the converter by means of a spout. This method of melting was exceedingly costly, not only on account of the large amount of coke required, but also by reason of the high labour cost, and the slow speed of working. At this time an output of 600 or 700 tons was considered a fair week's work for a pair of converters; the methods then in use for changing and repairing the bottoms of the converters involving a great amount of delay, and it was on this account almost impossible to work at a greater speed. By-and-bye improvements were gradually introduced; at works where blast furnaces formed part of the plant, molten iron was taken direct from the furnaces to the converters. At other works dependent upon cupolas, the cupolas were improved in their construction and charged continuously, so that melting was carried on at a quicker rate, and the adoption of what is known as the Holley bottom, or some modification of it, brought about a very large increase in the productive capacity of the converters. Up to this period the process was acid only. None but the purest hematite could be used. Then came the discovery of the Bessemer basic process and its rapid subsequent development. This process rendered available for steel-making purposes not only the ironstones of Cleveland and Lincolnshire and the huge cinder heaps of the Midlands, but it also enabled our continental friends to open out and utilise for steel-making purposes their large deposits of very suitable phosphoric ores on a scale which up to that time had never been dreamt of. It is due to the basic process that the continental steel trade has made such strides in recent years. The production of basic steel on the Continent last year was about 7½ million tons, against about 800,000 tons only in Great Britain.

That the basic process has not been adopted more generally in Great Britain is accounted for by the fact that before its discovery a large acid steel industry had been established; many important plants were engaged upon it, and much capital had been invested, not only upon the works themselves, but also in securing large supplies of the necessary hematite ores, both in Cumberland and in Spain. This was not the case on the Continent, where the steel industry up to that period was of comparatively small proportions.

With the advent of the Bessemer basic process there was gradually developed a very large demand for soft steel or ingot iron, a quality of metal softer and more suitable for a variety of purposes than had up to that time been produced in any large quantity by the Bessemer acid process. This demand for soft steels has now grown to very large dimensions, replacing, as it has done to a very large extent, puddled iron; it is now being produced by both the basic and the acid process. In connection with the basic process the utilisation of the slag must not be overlooked. At a very early stage the late Sidney Thomas was so greatly impressed with its value as a fertiliser that he was once heard to say that it would not surprise him if the steel became the by-product. The difficulty in the first instance was how best to apply the slag so that the land could derive the fullest value from its manurial properties. After many experiments it was found that the cheapest and best method was to grind it into an impalpable powder; that when so ground and applied to the land the results compared very favourably with those obtained from superphosphates. That this basic slag or Thomas phosphate is now a very important industry is evident from the fact that during 1899 the production of Europe was estimated at 1,493,000 tons. The figures for 1900 are not yet available, but it is believed that the production for that year will prove to be much greater.

After the introduction of the slag industry, the next development of importance was the adoption of the Darby method of carburising for hard and medium hard steels. This method effected a considerable improvement in the Bessemer basic process, as by it far greater regularity can be obtained in the adding of the carbon, and re-phosphorisation, which occasionally took place on the addition of the molten spiegeleisen, has been obviated.

Lastly, the introduction of a large metal mixer between the blast furnaces and cupolas, and the converters, has ensured a degree of regularity not only in the supply, but also in the composition of the metal to the converters that was not possible when the molten iron was taken direct.

Notwithstanding all that has been done, chiefly in the direction of securing larger output and greater regularity in the product, the waste in the Bessemer process remains practically the same as it was in the early days. Although the purposes for which Bessemer steel—acid and basic—is now being used have increased enormously—fully one half the make in this country being used for other purposes than railway material—it seems probable that by reason of cheaper methods of producing steel, the Bessemer processes will have in future much more serious competition than has been the case in the past. The recent modifications of the open-hearth process by Bertrand-Thiel and by Talbot, aided as they are certain to be by the labour-saving appliances already in successful operation, seem to indicate that we are now on the verge of effecting still greater economies in our steel-producing methods, and unless some means can be devised of reducing the waste in the Bessemer converters, the Bessemer processes, which have served the world so well in the past, are likely to be superseded.

Open-hearth acid and basic steel.—For regularity and reliability of product the Siemens acid steel process stands pre-eminent. By far the greater part of the open-hearth steel in this country is made by this process, owing to the facilities for obtaining a cheap and efficient supply of hematite pig iron, and so long as such conditions continue to exist it will undoubtedly hold its own. But the basic open-hearth process is advancing with rapid strides, and is seriously challenging the position of the acid process as regards the cheapness of its product; and this fact, coupled with what I have already said on the question of the pure ore supply, would seem to point to the conversion of many of the acid hearths into basic at no very distant date. In the developments of the iron and steel industries in the future the basic Siemens process will no doubt claim most attention. The great desideratum of the process would be its adaptability to any class of pig iron within reasonable limits, so as to avoid making a special pig for it. This ideal state of affairs has not yet been reached, but the improvements that have already taken place have considerably widened its scope, and if the promises held out by the facts given in recent papers before this Institute on the use of fluid metal direct from the blast furnace, by James Riley, Talbot, and Monell, are fulfilled, we may soon get much nearer the ideal than we are at present, and make good steel in any district from local ores. In Cleveland our goal has always been to make from the local pig iron steel of high quality for structural purposes; and though good steel has been made by the basic Bessemer process from Cleveland pig alone, up to within a few years ago a "special" basic pig has generally been made, costing more than Cleveland pig, from a mixture of the local stone, puddlers' tap cinder, and some manganiferous material, either in the form of ore or spiegel slag. Sir Lowthian Bell, one of the earliest adventurers in the Cleveland iron trade, and now the Nestor of the industry, directed much attention to the development of the application of the local ore, in the hope of obtaining steel from Cleveland pig iron. His experiments and researches, culminating in the invention of his washing process, are all widely known, and were published in two papers before this Institute, and will be found in its *Journal* for 1877. By this washing process, in 7½ minutes he removed 10 per cent. of the carbon, 97 per cent. of the silicon, and 95 per cent. of the phosphorus. By prolonging the washing process a material was made containing under 0·3 per cent. phosphorus, which, when rolled into a bar 3in. by ⅜in. in thickness, bent close double in the cold. The energetic dephosphorising effect of fluid oxide of iron was thus clearly demonstrated, and in an interesting experiment at the Tudhoe Works of the Weardale Iron Company, in which fluid oxide of iron was added to a partly blown charge of Cleveland pig, the action was so violent that a large quantity of the contents was driven out of the vessel. In a furnace known as Price's, and used for puddling, a more intense heat was obtained than in the usual form of the furnace employed in producing malleable iron. This proved sufficient to melt steel, and thus a considerable quantity of steel was made from Cleveland pig iron at the Royal Arsenal, Woolwich, not later than 1877. Other questions delayed further trials until late in the eighties, when a small open-hearth furnace was erected at the Clarence Works. This afforded results which led in 1899 to the construction of four furnaces, each having a capacity of 40 tons. In these six different qualities of steel are now produced with the greatest regularity from Cleveland pig iron, using the Saniter desulphurising process. By the use of the desulphuriser it is now possible to make good steel from pig iron containing up to 0·3 per cent. of sulphur, and if need be a pig containing 1 per cent. of this element could be successfully treated, though, of course, at increased cost. The percentage of silicon that may be present in the pig is up to 1·5 per cent. To obtain this in Cleveland iron, without exceptional working and cost, it is necessary to use forge

* Delivered May 8th. Slightly condensed.

iron quality, in which the sulphur varies from 0·10 to 0·20 per cent. Whether some cheap and effective plan will be devised in the future to deal with more siliceous pig than this remains to be seen; it is a problem for our metallurgists to work at, and so further widen the scope of the basic process. It is interesting to note that the prejudices of engineers and Lloyd's surveyors against basic steel are fast giving way, and the latter now accept this steel for shipbuilding purposes as long as it complies with all tests, which it does most satisfactorily. I have often heard it said that steel made from Cleveland pig iron would "never" make plates. Whether they considered there was some peculiar and special evil spirit in Cleveland stone very hard to kill, or what, I do not know; but "never" is a long time, and the above results at the Clarence Works prove that it is not wise to be too emphatic in one's prophecies.

I should just like to say a few words on the subject of technical education in so far as it concerns our use of it in the works of this country. It is being incessantly dinned into poor John Bull's ears by the Press, and from public platforms, that he must educate, educate, or be hopelessly left behind by his more energetic rivals. The matter is undoubtedly being taken up more zealously than formerly; but the question is—Are we using that education to the best advantage in our industries, or letting much of it go to waste, and the mental abilities of our staff to rust? In an address to the Cleveland Institution of Engineers, our latest Bessemer medallist, Mr. J. E. Stead, brought forward a suggestion which, I think, is worthy of notice. He is of the opinion that in all our free libraries there should be a technical department containing the standard works on the particular industries followed in the town. Better still, he considers that all our big works should possess such a library of standard works on the manufacture in which they are engaged. Periodicals, reviews, home and foreign, and proceedings of technical societies should also find a place there, and the head of each department should read up and review all current literature bearing on his particular branch of the industry, and point out to the head manager anything he may find which he considers would be an improvement on their methods. It is a true saying that he is a wise farmer who occasionally takes a peep over the fence to see what his neighbour is doing. A glance at the abstracts of English and foreign papers relating to iron and steel, published in the volumes of the Institute's *Journal*, will show what a great mass there is of metallurgical information stored up in journals and reviews at home and abroad, which many of our heads of departments and men under them never see, nor have a chance of seeing. They cannot be members of all technical societies, nor subscribe to all the journals; and the result is that many useful papers full of information are lost to thousands to whom they would be of the greatest use. This is a matter which our manufacturers must put right as soon as possible, and so make sure that the technical education given to our workers is not lost, or only indifferently used. That we shall have to fight much harder in the future to retain our proud position is inevitable, and all of us will be required to put forth our very best energies. Therefore let it not be said by posterity that in the battle for commercial supremacy we sent our workers into the fight inefficiently equipped in technical knowledge.

WATER-TUBE BOILERS.

In our last week's issue we published in full a paper on water-tube boilers recently read by Mr. Griffith before the North-East Coast Institution of Engineers and Shipbuilders. We now give a summary of the discussion which this paper produced at three of the meetings held respectively at South Shields, Sunderland, and Newcastle.

Mr. Dowsen opened the discussion on Mr. Griffith's paper. He said that while the Scotch type of forced-draught boiler in use in the mercantile marine had about 5 cubic feet of space for combustion for every square foot of grate area, the express, or small water-tube type of boiler, had only about 1¾ cubic feet. In his opinion, it was out of the question to expect water-tube boilers of the small tube type to give satisfaction for ordinary use at sea, owing to the great attention required to keep the water free from all foreign matter. The question was what would be the best diameter for the tubes in future large water-tube boilers. Mr. William Allan, jun., made some remarks in connection with the historical question of water-tube boilers.

At the meeting held at Sunderland Mr. Heck said that at present he considered the ordinary Scotch boiler the best suited for merchant vessels, and that it would make the most money. There appeared a general opinion in the mercantile marine that the Scotch boiler was more economical and would last longer. The grate area in water-tube boilers was too large to be properly fired for long periods. He considered that, just as flame will not pass through wire gauze, so in water-tube boilers, where the tubes are very close together, and especially when they get covered with soot, economical results could not be expected. He considered that any water-tube boilers for the mercantile marine should be large for the work to be done; there should be greater sub-division of grate area; a much larger volume of water in the boiler was required in order to lessen the necessary attention to the water level; larger steam and water drums should be fitted, so as to increase the area of water level, and thus lessen any priming; and, lastly, very much better arrangements for clearing the tubes of soot and dirt were necessary. With regard to the durability of water-tube boilers, he considered that the scantling of the tubes and all the details should be considerably increased; and although the water from the hotwell was usually pumped into the boilers through filters, still a small quantity of foreign matter passed and got into the boilers. He therefore considered that it was necessary to filter and purify the water actually in the boiler; and one way of doing this was to have a small pump to draw the water from the boilers and pump it through extra filters back again into the boiler, or a small pipe could be led from the boilers to admit a small quantity of boiler water back again into the hotwell or between the suction and delivery valves of the feed pump for the same purpose.

Mr. A. Gray said he had had six years' experience in running water-tube boilers, in particular the Babcock boiler. He quite agreed with Mr. Griffith about the difficulty of keeping salt water out of water-tube boilers; therefore, such boilers should be so made that they could be cleaned, or their life would be short. No matter how rapid the circulation, they still got scale in the tubes. In regard to the size of the tube, they had experienced least trouble with large tubes, and they could be easily examined internally—the tubes could be readily cleaned inside, provided the scale was not allowed to get hard. All their boilers were fitted with steam drums, and not with separators; and they had no trouble with priming. Economy depended on the firing; when they had grates of 50 to 60 square feet, a thin fire was necessary. The men usually pile on coals and make thick fires, and thus waste coals. Oil and air passing into the boiler with the feed-water were the greatest enemies of water-tube boilers. He had found quite thick salt in the tubes—not so bad as an oily scale, however; the tubes sometimes had blistered and burnt into holes. By experiment he had found that quantities of oil and other matter passed the feed filter. He had tried for some time a plan to extract such injurious matter from the feed-water after it had entered the boiler and before it mixed in the boiler water. Mr. Gray produced two bottles containing oil, water, and sediment collected from boilers, and also gave an expert's analysis of the water taken from the boilers. He also stated he had invented a mechanical device for intercepting or extracting the oil and finer impurities from the boilers, and described the plan by means of a diagram. He further stated it was quite evident now that they could not run a water-tube boiler containing six or seven tons of water under the same condition as an ordinary boiler with twenty-five or thirty tons of water. In their vessels having water-tube boilers they used no oil except for swabbing the rods, and it was a mystery where the oil and sediment found in the boiler came from. He was afraid water-tube boilers could not be run with success by the old system of treatment. Some such plan as he had shown them, or some similar or perhaps better plan, was necessary to prevent a dangerous deposit inside the tubes. Since the apparatus which he had explained had been fitted to the boiler no trouble had been experienced.

Mr. J. R. Fothergill, in the course of his remarks, said that on various occasions he had ventured, both by papers and discussion, to support the water-tube boiler, and he still had the temerity to believe it had a future, and this more especially so since Mr. Gray had impressed them by his remarks, that, after all, it was principally a question of manipulation, care, and attention, to ensure success. Messrs. Wilson, of Hull, appeared to run the Babcock and Wilcox boiler successfully, although they had failed to do so with the Belleville. He ventured to think the water-tube boiler offered facilities for complete combustion that could not be obtained where the ordinary furnace was used. He—Mr. Fothergill—admitted there might be practical difficulties to be overcome, but he considered that a brick arch could be sprung over the fire and under the tubes, the effect of which would be that when the fire was burnt down the brick arch would by radiation of heat from the fire become hot, and thus the hydrocarbon gases, after fresh firing, would by contact with the arch be heated up sufficiently to combine with oxygen so as to complete the combustion and prevention of smoke, soot, and small ashes. This, he thought, would remove the difficulty referred to by Mr. Heck, in which he pointed out the inefficiency due to the tubes being close together and being blocked with soot. He also agreed that it was a difficult matter to stoke properly grate areas above 5ft. 6in. in length. Their chief difficulty was want of good firemen who knew their work. He felt sure if steamship owners fully realised the economy, not only in coal, but in increased speed, a really good fireman meant, they would endeavour to evolve a practical scheme for training such men.

Mr. Atkinson said he did not agree with Mr. Heck that there was any loss of efficiency through the tubes being placed close together. He also gave some particulars *re* the performance of water-tube boilers of the Babcock and Wilcox type.

Mr. A. Hamilton, in a communication, stated that he found that if air was present in the feed-water and with superheating, the corrosion was much worse, and that in triple engines fitted with Weir's heater and fittings for clearing water of air, the life of boiler tubes is doubled.

J. S. White and Co., in a communication, stated that they considered the small tube express type superior to any large tube boiler made, and felt sure that the water-tube boiler of the future would contain more of the express and less of the existing large tube features. Deposits are found when the boiler is stewing, or steaming slowly, because of the sluggish circulation under these conditions. As the life of the boiler in the Navy probably contains on an average about 80 per cent. of its steaming days under less than its full power, it is therefore necessary to be careful not to increase the size of the tubes next the fire too much, so as not to induce a sluggish circulation in these rows, and so cause deposit.

Mr. Griffith, in his reply, stated he did not agree with Professor Capper that in the best water-tube boilers the highest efficiency was coincident with the highest rates of evaporation, as the furnace arrangements did not admit of the highest output being obtained economically, nor did he admit that drowned tubes were the victims of prejudice, as he believed the Admiralty had given them a fair trial, and he thought their present attitude in the matter was more the result of experience than bias. In reference to Mr. Heck's remark that thorough combustion could not take place in water-tube boilers owing to the wire-gauze action of the tubes, he did not think this view was borne out by experience, as the economical results that have been obtained in some cases under favourable conditions indicate that at such tests the combustion must have been very thorough. He was in favour of small furnace units. He agreed with J. S. White and Co.'s remarks that the hottest tubes should be only just large enough to enable the maximum output to be obtained without injury, any increase of size beyond this—excepting a small margin—being a mistake. He considered, however, that the tubes more remote from the fire might with advantage be made smaller, so as to increase the rate of flow through them, and thus reduce the risk of deposit. He concurred with Mr. Dumas's remarks on this point, and he quite recognised the practical objection to tubes of varying size. On the general question of size of tube he thought that steep tubes should be small, but horizontal tubes must be fairly large. He trusted that the mud trap designed by Mr. Gray would prove effective; but he suggested that it would be better to treat the feed-water in a separate vessel outside the steam drum, but connected with it. In conclusion, he supported his statement in the paper that naval engineers would be compelled to persevere with water-tube boilers, but he thought that at present we are not justified in adopting any water-tube boiler for ocean-going vessels, unless experimentally, though the time seemed ripe for considering their claims for use in high-speed Channel steamers.

UNIVERSITY OF BIRMINGHAM.

It has been proposed that a Commercial Faculty shall be formed by the University of Birmingham. We cannot better explain the nature of the scheme than by using the words of Professor Oliver Lodge:—

Proceeding upon the basis of the admirable report of the Advisory Committee on Commercial Education, it is clear that what we have to aim at is the education, not of a clerk, but of a chief, and we must look to supply not only the needs of a trading district, but also the needs of the expanding English-speaking Commonwealth—the needs, that is to say, of the Home Government, of the Colonies, and of the British Empire in its dealings with foreign countries. We should aim at providing the education which, with the increase of local self-government, is increasingly needed for the efficient discharge of public duties, both at home and abroad. More especially, if our country is to keep pace with others, we have to provide in every port a highly-educated man, skilled in many business relations, as consul, whose duty it shall be to understand the conditions of each trade, to realise how it may be improved or increased, and to make annual or more frequent reports, either to the Board of Trade or to local chambers of commerce, or both. The country has also to supply, in smaller number, skilled administrators of various dependencies and provinces—chief officials and subordinate officials, all competent and properly trained men.

To this end the demands made in the report of the Advisory Committee are none too high, and it is clear that our commercial education must centre round a great school of economics, understood in its largest sense; that is to say, the subjects of economic science, of commercial history, and commercial law must be its backbone. Geography and modern languages must by no means be omitted; and inasmuch as we shall have to train students aiming at a great variety of work, we must have a lecturer in accountancy who shall be able not only to "open a complete set of books for a merchant's or manufacturer's office," but likewise so to organise the accounts that profit and loss in every department of such a business can be traced and analysed. He should also be able to draw up the documents necessary for a new trading company, or even for the financial administration of a district.

In the commercial faculty there will doubtless be students of all grades, but the highest degree should only be open to educated men, who have taken a reasonably full course in what are generally considered "arts" subjects, and are likewise familiar with the fundamental principles of physical science. The preparatory training, in fact, should be a wide and comprehensive one, including a little science as well as a good deal of arts. General history appears to me essential, and it is so necessary for other departments of the college that I cannot help urging that two new chairs, economy and history, be started as soon as possible. Until the history chair is started it will be necessary to divide that subject between the professor of economics and the professor of literature, an unsatisfactory division. Geography in its various aspects will be divided between the professors of history, of economics, and of geology.

As to the innumerable other subjects which will have to be dealt with in the commercial faculty, I should like to see developed a system of visiting lecturers somewhat on the plan of the medical school. In a city like this there are experts in medicine and surgery willing to give some of their time and energy to the training of youth. Similarly, in this city there are men of business skilled in finance, in banking, in exchange, great organisers and administrators, experts in various lines of commerce, who may be willing to devote some portion of their time and energy to the training of youth. It is probable that if the attempt were made it would be found interesting by those who undertook it, and not only interesting but instructive, since there are few things more truly educative than the attempt to put one's ideas in conscious order and to teach. A university in a city like this should aim at drawing the best out of the community, and making it available for all. It does this already in medicine; it must do it in commerce. If it does it will be a success, but if it depend solely on endowed and imported professors its scope will be limited, and it will lack much of stimulating interest and vitality.

The Council of the University are prepared to appoint a professor in connection with the faculty to organise the establishment of a suitable system of training. The proposed stipend is £750 per year. Applications to be addressed to the Secretary of the University before the 20th of June.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, May 15th.

THE collapse in stocks last week threatened to involve the entire country, but the prompt action of the banks in advancing an unlimited supply of money at 6 per cent. put a quick stop to all danger. The leading brokers are bulls again, and another stock jobbing movement, but of reasonable proportions, will probably soon set in. Unreasonable fright took possession of the market last week. The monetary situation is sound. The bankers are again lending money freely on good collateral, and out-of-town banks are offering large blocks. Business conditions are sound. Perhaps the most active branch of the steel trade at present is the demand for sheet. The mills are making 20 dols. more per ton than under the independent system. The present output of the sheet mill combination is 2000 tons per day. The attention of capitalists has been drawn to this fact. At the present time nearly a dozen concerns in Western Pennsylvania and Eastern Ohio are putting up additions as fast as machine shops and foundries can furnish the equipment. Large additions are being made to some of the large steel works in Eastern Pennsylvania. The capital of the Pencoyd Steel Works at Philadelphia is to be doubled. The Midvale Steel Works, same city, will make extensive improvements. The industry is exceptionally vigorous, and an immense volume of business is in sight, but its placing at this time it is feared would impart a speculative turn to prices, which all people desire to avoid. The steel rail makers have an abundance of work for the summer, and urgent buyers are bidding above the present market price to get supplies. Several railway companies are in the market for engines and rolling stock. The entire railway system is being put in a better physical condition.

The bar mills are all crowded with work, and the remarkable oil developments in California, Texas, and elsewhere have stimulated demand for tubing enormously. Plants supplying mines are also crowded, and car works turning out freight and coal cars are booking orders for delivery next autumn. The stock markets are quieter, and both sides are claiming to be in control of the Northern Pacific, the objective point being to head off the Burlington from entering the Pacific Coast field to the threatened disturbance of rates. The natural gas companies in Indiana and the window glass interests have combined to control the principal sources of gas supply for several Western cities. The glass people have thirty factories in that State.

The spirit of combination is growing. Since January 1st the consolidations in excess of 1,000,000 dols. companies foot up 2,586,000,000 dols., which is double the entire total for 1900. The above figures include pending combinations. Should a monetary stringency arise, an effective check will be given to the fever of capitalisation. All the window-glass works of the United States have been shut down for four months.

ACCIDENT TO SHAMROCK II.—We regret that Shamrock II., Sir T. Lipton's new yacht, was dismasted off the Isle of Wight on Wednesday in a squall. The King was on board and placed in some danger, but happily escaped. Sir Thomas Lipton has our sympathies. Those of our readers who are interested in yachting will find three articles on the Strength of Spars in our impressions for January 5th, 12th, and 19th, 1900, in which the whole problem is very fully discussed. There is reason to believe that the value of steel tubes as compared with timber masts has been somewhat overrated.

JOHN I. THORNYCROFT AND CO., LIMITED.—The prospectus will be issued in the course of a few days of John I. Thornycroft and Co., Limited, which has been formed for the purpose of acquiring the well-known business of John I. Thornycroft and Co., of Chiswick, builders of torpedo boats and other craft. The business was established in 1864, and the object of a conversion into a limited company is for family reasons and for further developments. The present issue of capital will consist of £160,000 6 per cent. preference shares, and £80,000 ordinary shares. The net profits are certified to have averaged £53,849 annually for the five and a-half years to June 30th last. The whole of the ordinary shares will be taken by the vendors, directors, and officers of the company and their friends.

AMERICAN COMPETITION.—Some suggestive comments upon the American competition question were made this week by Mr. E. Parkes, M.P., chairman of Wm. Roberts, Limited, Tipton, pig iron makers and engineers. The Americans had, he said, exploited this country during the last six or nine months in a way they had never done before, and he, the chairman, was not one of those who were prepared to poo-poo the idea of American competition. He believed it would now be always a factor the English iron and steel trade would have to reckon with. At the date of their keenest competition last year the American ironmasters were getting their coke at 10s. to 12s. per ton, and in this country the price was about 35s. American railway rates to the coast were also something like one-fourth those of England. Unless, therefore, English ironmasters were put on the same footing as the Americans the competition could not, nor would not, be met successfully. Three things were wanted on this side—cheap fuel, much lower railway rates, and adaptability of the workmen to an altered state of things, a readiness to welcome instead of oppose new ideas and labour-saving machinery. He often asked himself whether the coal trade in England was to flourish and all other trades which depended upon it so greatly to be destroyed. He believed that the bulk of the community were coming to the opinion that this should not be.

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

(*From our own Correspondent.*)

THE more cheerful tone observable in this district last week is upheld, though it must not be supposed from this that anything very definite in the way of improvement has appeared. The circumstance, however, that one or two branches are taking on a better front is encouraging to the rest of the trade, and less pessimistic views are being expressed. The hope of an improvement would seem to be shared by the Unmarked Bar Association. This important body have just met, and the official statement furnished at the conclusion of the proceedings represents that the question of prices was discussed, and that "the general opinion was that they had been unduly depressed." It was the direct opinion of members that prices were at date below their correct level, bearing in mind costs of raw materials, and it was resolved, the official statement continues, "that care should be taken not to make new forward contracts except at an improvement in price."

The next wages ascertainment is being anxiously awaited by ironmasters as likely to have considerable bearing upon the early future of trade. Though it is still full early to anticipate the figures, the belief is growing that a further reduction of wages will take place, in which event ironmasters' position will be improved.

The recent reduction in marked bars has resulted in an expansion of business, and the list houses are now better employed than they were. Export as well as local consumers are ordering more freely, as they seem to believe that with marked bars at £8 10s., and unmarked at £6 15s., there is not much risk in forward buying. Marked bars are this week quoted at £8 10s.; Earl of Dudley's brand, £9 2s. 6d.; good merchant bars, £7 10s.; common unmarked ditto, £6 10s.; and North Staffordshire bars, £6 10s. to £6 15s. Sales are this week mentioned of good-sized parcels of unmarked bars at as low as £6 7s. 6d.

In respect of the export trade, Australia may son be expected to become a good customer of local ironmasters and engineers, as considerable public works in the shape of railways and engineering and water enterprises are understood to be under way in some of the principal Australian cities.

Staffordshire sheet ironmasters speak more satisfactorily of demand. There has been a decided revival in the galvanised branch during the last two or three weeks, and the black sheet branch is participating in the betterment. Buyers show a greater disposition to enter into contracts, and prices are currently reported to be 2s. 6d. to 5s. better than a week ago. The price of galvanised sheets is also firmer, the result mainly of a substantial advance in spelter. Sheets of 20 W.G. are quoted £7 7s. 6d. to £7 12s. 6d. in the block state; 24 W.G., £7 10s. to £7 15s.; and 27 W.G., £8 2s. 6d. to £8 7s. 6d. Galvanised corrugated sheets are £11 f.o.b. Liverpool or equal. Sheet iron production has been increased by the re-starting of a works at Tividale, near Dudley, recently closed. The works have passed into new hands.

The pig iron trade is strong, all things considered, and makers are fairly well satisfied. Demand is good, and no iron is coming on to the market that is not quickly bought up. Prices of most qualities of metal are a shade higher, and there is less reluctance on the part of consumers to buy forward. Open market quotations continue at:—Common Staffordshire forge metal, 45s. to 46s.; part-mine, 48s. to 50s.; and all-mine, 52s. 6d. to 60s. Northampton forge pigs are quoted 46s. to 48s.; Derbyshires, 48s. 6d. to 50s.; and North Staffordshire, 49s. 6d. to 50s. 6d. per ton.

In the Birmingham machinery and engineering trades some improvement is this week to be noted, and this remark is especially applicable to the electrical department. The steam-boiler trade also, notwithstanding the recent marked extension of demand for gas engines, appears to be in a fairly active and prosperous state. Copper metal rollers and brass and copper tube and wire drawers report business quiet and competition keen; but there has been rather more doing of late in yellow metal for India, and in brass and copper sheets for Egypt and Turkey. The wages strike in the local wrought iron tube fittings and socket-making branch continues without much prospect of settlement.

A very pleasing item in heavy engineering circles this week is the annual report of the Patent Shaft and Axle-tree Company, Limited, Wednesbury, which again shows good results. A profit is announced of £32,342, which added to £6700 available from last year, leaves a negotiable sum of over £39,000. Out of this it is proposed to pay a 5 per cent. preference dividend, a 10 per cent. ordinary dividend, to add £10,000 to reserve, and to carry £5846 to next year's account. The shareholders are to be congratulated upon such an excellent statement.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—The more hopeful tone, to which I have previously made reference, continues a noticeable feature in the engineering and iron trades of this district. Some of the engineering firms are in a much better position as to work than they were a month or two back. Finished iron makers have a larger weight of orders on their books than they have had for a considerable time past, and the present limited output of pig iron at the local and district furnaces continues to move away freely. Buyers and consumers, however, maintain an exceedingly cautious attitude as to the future, and a want of confidence is still evident from the fact that there are still very low forward sellers. Buying has undoubtedly been going on with more freedom recently, but where orders of any weight have been placed, the temptation to buyers has usually been some specially low quotations, and current rates are only, as a rule, being got on small hand-to-mouth parcels.

At the Manchester Iron 'Change meeting on Tuesday business, taking it all through, was only slow, buying being restricted as much as possible until after the holidays. The market, however, presented no very material change as regards prices, although there was some irregularity in quotations. In pig iron a fair amount has been passing through, only, however, at low cut figures, and prices in the open market vary considerably, according to quantity and delivery. Lancashire makers have no difficulty in selling their present small production of foundry iron, and they are quoting 56s. to 56s. 6d., less 2½, delivered here, which are rather better figures than were ruling a short time ago. The same applies to Lincolnshire brands, for which, owing to the very small number of furnaces just now in blast, makers have been able to stiffen up somewhat in their prices. Delivered Manchester, 50s. net has become a very general quotation; 49s. 6d. is, however, the official basis, and there are still sellers at this figure, while merchants would readily book forward at 49s. net. Derbyshire brands are similarly maintaining a steadier tone, but here, again, quotations vary from about 53s. 9d. and 54s. to 55s. and 55s. 6d. net, delivered Manchester.

Some considerable sales have recently been reported in forge iron, but these do not appear to have at all improved prices, which remain quite as low as ever at about 49s. 6d., less 2½, Lancashire; 48s. 2d. to 48s. 8d. net Lincolnshire; and 47s. 6d. to 48s. net quoted for some brands of Derbyshire delivered Warrington. One or two fairly large parcels of American forge iron are just now on the market open to offer, and tend to unsettle buyers, but the prices which the holders seem prepared to take are not likely to bring them into keen competition with either local or district brands. Middlesbrough foundry iron is barely maintaining the improvement reported during the past fortnight. One or two makers of special brands are holding out for advanced quotations—in some instances as high as 55s. 4d. net by rail Manchester; but open brands are to be bought without difficulty at 54s. 1d. to 54s. 4d. net. Scotch iron is easy at about late rates, and delivered Manchester docks could be bought at 59s. 6d. to 59s. 9d. net Eglinton, and 60s. 3d. to 60s. 6d. net Glengarnock.

Finished iron makers are kept fairly well engaged on bar orders, but other descriptions of manufactured material are extremely quiet. The basis quoted rates for bars remain at £6 10s. Lancashire, and £6 10s. to £6 15s. North Staffordshire, but there are, in some instances, special concessions on these figures, and merchants are offering forward at considerably under makers' prices. Sheets and hoops are without quotable change. Nut and bolt makers state that there is only an indifferent sort of business coming forward, and prices are gradually easing down on the list basis rates.

The position in the steel trade remains much as last reported. In some descriptions of structural material a fairly good business is being done, but only at low figures, and the market prices generally continue irregular. Hematites range, according to brand, from about 67s. to 68s., less 2½ for No. 3 foundry; local made billets are quoted £4 15s. to £4 16s. 3d. net; steel bars average from £6 10s. and £6 12s. 6d. to £6 15s. and £6 17s. 6d.; common steel plates £6 2s. 6d. to £6 5s., with £6 10s. the general minimum basis quotation for boiler plates, but some special sales are reported to have been put through in this district at considerably less.

An improvement is reported in some branches of engineering, but this would seem to be in large measure connected with the equipment of new works approaching completion, or the introduction of new and more modern plant into some of the older works. Boilermakers are full of orders, but the bulk of these have had to be taken at very low figures. Builders of electric overhead travelling cranes also report a large amount of work giving out. Locomotive and railway carriage builders continue exceptionally busy on contracts both for home and abroad, and in all branches of electrical engineering there is still the pressure of orders that has been referred to recently. In the general run of engineering, however, the position is not altogether satisfactory. It is exceptional where machine tool makers are booking new orders sufficient to replace those running out, and the textile machine trade remains exceedingly depressed.

The usual monthly returns of the Amalgamated Society of Engineers show no material change in the condition of employment. The proportion on out-of-work benefit throughout the society is about 2⅔ per cent., and locally it remains at 3 per cent. The organising delegate reports that there is no improvement in the textile machine trade of the district, and that while the position of the general engineering and tool trade is fairly satisfactory, there is not the same call for members as there was some few months ago.

From most of the Lancashire districts reports are unsatisfactory as to the position of the coal trade, and in South-west Lancashire an effort is being made to bring about a general restriction of work to four days per week to prevent any unnecessary competition with surplus supplies being pushed upon the market. The demand for house-fire qualities is falling off considerably; at many of the collieries stocks are now accumulating somewhat heavily, especially under load on the pit sidings, and notwithstanding the near approach of the Whitsuntide stoppages, some of the pits are this week being put on short time. Prices are nominally without quotable change, but competition from outside districts is forcing on concessions, here and there, and it is practically certain that with the close of the month there will be a general reduction in present basis rates. Common round coals are becoming increasingly difficult to move, and in these the competition from outside districts is being felt much more keenly than in the better descriptions. As a result, list rates are little more than nominal, and it is exceptional where above 10s. 6d. to 11s. 6d. is being got for ordinary qualities of steam and forge coals at the pit mouth. Further negotiations have been going on with respect to the locomotive fuel contracts, with the result that the railway companies have declined to entertain the basis of 9s. 6d. per ton referred to last week, and have intimated that 9s. is the maximum figure they are prepared to pay. So far nothing in the way of contracts for the ensuing year has been arranged, and the settlement of these would seem to be dependent upon the acceptance of the railway companies' terms. Some of the more important gas coal contracts are at present under consideration, but it is anticipated that these will probably be settled upon the basis of about 10s. 6d. to 11s. for good screened gas coal, at the pit mouth. Slack, especially as regards the inferior sorts, is becoming a drug upon the market, with surplus supplies from Derbyshire, Staffordshire, and Yorkshire pushed for sale at all sorts of prices. In fact, to a large extent prices are just now regulated more according to quantity, and the particular market, than by a reference to the supposed list basis, and it is difficult to get any really definite quotations. Lancashire slack is quoted from about 6s. 6d. and 7s. for common and medium sorts to 8s. and 8s. 6d. for better qualities, whilst slack from other districts is offering at almost any figure from about 4s. and 5s. upwards, at the pit.

Only a very quiet shipping trade is reported generally, and much lower prices are being taken for cargoes than for inland sales, special clearances of slack being made at about 7s., with steam coal to be bought as low as 10s. 6d. to 10s. 9d. delivered Mersey ports, and although the general run of quotations is, perhaps, 1s. per ton higher, the above figures may be regarded as indicating to some extent the tendency of the market.

Coke meets with a rather more active inquiry, with prices steadier at about 23s. to 25s. for good Lancashire foundry cokes, and 12s. 6d. to 13s. for good washed Lancashire furnace cokes at the ovens.

Barrow.—The hematite pig iron trade of this district is steady in tone, and orders are coming in with more freedom for forward delivery than for some time past. There are 35 furnaces in blast, as compared with 42 in the corresponding week of last year, but it is expected one or two additional furnaces will be lighted after the Whitsuntide holidays. The make of the district is still below the consumptive demand, with the result that warrant stocks have been further reduced during the week by 1038 tons. Prices are very steady, with Bessemer mixed numbers at 58s. to 60s. net f.o.b., and warrant iron at 57s. 7d. net cash sellers, 2d. less buyers.

Iron ore is in quiet demand, and some of the lower grades of metal are not in large inquiry. Prices are steady at 12s. per ton net at mines for good ordinary sorts, and 16s. for best descriptions. Spanish ores are in quieter demand at about 14s. or 15s. per ton net at West Coast ports.

Business in the steel trade shows an improvement. Orders are coming to hand more freely for steel rails, plates, and general merchant classes, and makers already are fairly well sold forward. The trade, however, has to be done at a comparatively low rate of prices, for which foreign competition is responsible. There are prospects of marked improvement in the steel trade in the early future.

Shipbuilders and marine engineers are busily employed on old orders, but are in need of new work. The past week has been a very busy one in regard to warship movements in Barrow. First of all, the first-class British cruiser Hogue and the Japanese battleship Mikasa were removed from the Ramsden Dock basin into the Devonshire Dock to receive their complete outfit. This was able to be done now that the Ramsden Dock sill has been lowered. Then the Vengeance first-class battleship was brought out of the dock and sailed for Portsmouth on her maiden voyage on Tuesday, and on the previous day the armoured cruiser Euryalus was launched from the yard of Vickers, Sons, and Maxim. She is expected to be ready for sea in the autumn.

The export shipping trade is very quiet. During last week the total shipments of iron stood at only 5076 tons and steel 3029 tons, as compared with 15,085 tons of iron and 15,030 tons of steel in the corresponding week of last year, a decline in iron of 10,009 tons, and in steel a decline of 12,001 tons. The shipments this year represent 136,564 tons of iron and 176,320 tons of steel, as compared with 326,200 tons of iron and 169,317 tons of steel in the corresponding period of last year, a decline in iron of 189,636 tons, and in steel an increase on the year of 7003 tons.

Coal and coke are cheap in price, and in full supply, coke for blast furnace purposes being especially cheap at present.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THE discussion about the coal tax seems to have died down. It does not appear that the volume of trade is likely to compare unfavourably with that of any ordinary year. The question, however, as to who is going to pay the tax remains undecided, and is naturally dependent on the conditions of the home markets, as well as of those of foreign competitors.

The demand for house coal is well maintained for London as well as for the Eastern Counties, but local requirements have fallen off very considerably. Best Silkstones, however, may be quoted at 14s. to 15s. per ton, Barnsley House 13s. to 14s. per ton, nuts 12s. 6d. to 13s. 6d. per ton.

In steam coal there is rather more doing, although the season can scarcely be said to have yet fully commenced. Inland demand is sustained, while the tonnage to the Humber and other ports for export is well up to the average. Railway companies may congratulate themselves on getting their contracts placed at 9s. per ton, as no further business has been done at this figure, the current rate now being 10s. per ton for Barnsley Hards. In engine fuel sellers are competing pretty keenly in the market. Although values are easier owing to heavy supplies from Derbyshire pits, general quotations do not appear to have altered much. Nuts make 8s. to 8s. 6d. per ton, screened slack from 5s. 6d., pit slack from 2s. 6d. per ton. Several contracts which have recently been made show a remarkable decline in values for engine slack. In one instance, which concerns very heavy quantities, engine slack has been contracted for at 5s. 6d. per ton. The firm paid 9s. 6d. per ton under their previous contracts. It is stated that the coke trade is rather firmer in tone, but we cannot find that much business is being done.

In the iron trade things are a little brighter. The idea that bottom prices had been reached seems to have been fairly correct, and any change in respect to pig iron or finished material is looked for to be of an upward tendency. This improvement, however, is not likely to come very rapidly, as the work in hand is not adequate to keep the establishments fully employed. Fuel has become cheaper, and this will in course of time have a beneficial effect on the iron trade, but it is not yet apparent in consequence of many of the contracts now running having been taken when higher values ruled. Quotations are somewhat difficult to give, as they seem to vary considerably as furnished by buyers or sellers. West Coast hematites may be stated at 65s. 6d. to 67s. 6d. per ton, East Coast 63s. 6d. to 64s. 6d., Lincolnshire No. 3 Foundry 48s. to 49s., forge ditto 46s. to 47s., Derbyshire No. 3 Foundry 51s. to 52s., forge ditto 46s. to 47s., bars £6 15s. to £7, sheets £8 12s. 6d. to £8 17s. 6d.

There is no improvement to report in the steel trade. Although all classes of open-hearth steel are still being largely consumed in the heavy departments, there is no corresponding demand for crucible steel. The principal manufacturers in this important industry are restricting their output, while at other establishments the men have to be content with diminished employment. The business which is now being done is practically limited to day-to-day requirements. Holders of raw material find no forward buying. There appears to be a general impression that prices may yet go lower, and this is having the effect of keeping back large orders. In railway material a little more work is coming to hand for axles, springs, tires, and other railway accessories. Preparations are being made for an immense business with South Africa, where it is expected that hostilities cannot be much further prolonged. Very heavy demands are expected when the mines and other sources of industrial energy can be opened. Makers of railway material are particularly hopeful. A similar state of feeling extends to engineers' tool makers, as well as to the various excavating and mining departments, which can always look for a good business in the development of countries such as the Transvaal, where under previous conditions trade could not possibly be as brisk as the wealth and resources of the country could afford with British rule.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

THE iron market continues in a healthy and satisfactory condition, but business has been quieter this week than for some time past. The price of Cleveland pig iron is kept by the makers at 46s. per ton for early f.o.b. delivery, and less would not be taken; but some few sales have been made by second-hands at 45s. 10½d., a figure, however, unheard of since Tuesday. The heavy demands from Scotland for No. 4 foundry iron have made this quality scarce, though a few weeks ago it was almost a drug upon the market. Under these circumstances it should be nearer No. 3 in value than it is; producers should be getting for it 45s. 6d., whereas the figure is 44s. 3d., and it has this week been as low as 44s. Scotland has taken this month more than two and a-half times as much Cleveland pig iron as was reported in May, 1900, and nearly all the iron sent was of No. 4 foundry quality. Grey forge is realising 43s. 9d., mottled 43s. 3d., and white 43s.

The hematite pig iron trade is firm and satisfactory, there having been no easing as in the case of Cleveland iron. Demand exceeds supply, though the latter has been increased. There is very little stock in the hands of makers, and that in Connal's warrant stores is only 6645 tons, a quantity which has remained stationary nearly all the month. Deliveries of East Coast hematite pig iron to Sheffield have increased, makers in this district having been more successful in their competition with the West Coast producers, as they are now asking 2s. to 3s. per ton less. For mixed numbers of East Coast hematite pig iron 56s. 6d. per ton at least has to be paid, and some makers have put up their prices to 57s., while others quote 58s., and certainly the last-named figure has to be given for forward delivery. No. 1 hematite pig iron is not under 57s. 6d., and forge under 51s. 6d. Producers have thus maintained all the rise that has been reported since prices began to advance, the aggregate gain being 1s. 6d. per ton. The cost of production has increased during the last few weeks at least 3s. per ton, both ore and coke having gone up substantially in value, certainly in greater proportion than the pig iron itself. The figure now for Rubio ore delivered c.i.f. Tees is up to 15s. 9d. per ton, owing as much to the rise in freights as to the increase in demand. There has been a total advance this spring in the freight from Bilbao of 1s. 6d. per ton, and that expresses the extent of the increase in the price of ore.

The exports of pig iron from the Cleveland district this month have been good, though they fall short of those of last month, owing to a slackening in the oversea deliveries this week. The total up to the 22nd was 81,051 tons, against 91,306 tons last month, and 71,251 tons in May, 1900, to like date.

The demand for manufactured iron and steel is fair in most branches, works are generally well employed, and prices steady, except that rails and angles are cheaper this week. Makers of heavy steel rails have reduced their quotation to £5 net at works, but Bolckow, Vaughan, and Co., Limited, Middlesbrough, have taken an order for 12,000 tons of steel rails for New South Wales at £4 14s. per ton f.o.b. Middlesbrough. They will also supply 898 tons of fish-plates at £6 14s. per ton f.o.b. Middlesbrough. The competition is very keen in the rail trade, especially with South Wales and Germany. Iron and steel ship angles have been reduced to £5 15s., less 2½ per cent. f.o.t. Steel ship plates are maintained at £6, less 2½ per cent. f.o.t where the plates are to be delivered to North of England yards, but the syndicate does not prevent firms taking less where export orders are in question. Iron ship plates are at £6 12s. 6d., less 2½ per cent., the number of makers being very limited.

Sir W. G. Armstrong, Whitworth, and Co., Limited, Elswick-on-Tyne, have made an arrangement which will enable them to make armour plate by the Krupp process up to any thickness. They have a process of their own, but as the British Admiralty seem disposed to confine themselves to the Krupp process, the Armstrong Company desire to put themselves in a position to supply plates manufactured according to that process if called upon to do so. Only four firms in this country so far use the Krupp process—three Sheffield firms and one of Glasgow.

The shipbuilding industry shows some improvement, and the yards all are kept in full operation.

The coal trade has been very brisk this week in view of the holidays; collieries have been run as fully as possible, and exports are on a large scale. There is not much coal available for sale either this month or next, and prices are very strong, more particularly for steam coal, the quotation for best qualities having risen to 13s. 6d. per ton f.o.b., and very little has been obtainable at less this week. Gas coals also are tending upwards in value, some firms quoting 10s. 6d. f.o.b., and there are ready buyers at 10s. Ordinary unscreened bunker coals are up to 10s. 3d. per ton. Coke is advancing in value both for export and for home consumption. Foundry coke realises 17s. 6d. to 18s. per ton f.o.b., and average quality furnace coke has gone up to 15s. per ton, delivered at Middlesbrough furnaces or equal thereto. Some sales at 15s. 6d. are reported this week, but only for lots for immediate delivery.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE raw iron market has been comparatively flat during the last few days. The demand for pig iron warrants is slow, and while there has not been much change in prices, the tendency has been rather easier. Business has been done in Scotch warrants from 54s. 3d. to 54s. 1d. cash; at 54s. 1d. for delivery in twenty-one days; and 54s. 2½d. to 54s. 0½d. one month. Cleveland warrants have sold for delivery at different times from eleven to eighteen days at 45s. 11d., and some business has also been done at 45s. 9d. and 45s. 8½d. cash, and 45s. 11d. one month. Hematite iron has been very quiet, Cumberland warrants being quoted nominally at 57s. 5d. for cash and one month.

There has been a little more appearance of business in Scotch hematite pigs, which merchants continue to quote at 61s. for delivery at the steel works.

Since last report the number of furnaces in blast has been increased by five. An additional furnace has been lighted at Carron, and four have been re-lighted at Glengarnock, three of the latter being put on hematite and one on basic iron. The Carron furnace has been placed on ordinary pigs, and four furnaces are now producing that class of iron at the Carron Works.

A little iron is again going out of store, but the quantity is not such as to cause any material reduction in stocks.

Foundry iron is in comparatively good request, and it is stated that the iron recently imported into the Clyde from Canada has given such satisfaction that further arrivals may be expected. The quantity of Cleveland iron used in Scotland is also increasing, and the imports since the beginning of the year show an increase of 54,900 tons.

The exports of Scotch pigs are smaller, the shipments of the past week amounting to 4430 tons, compared with 7208 in the corresponding week, and there has been a total decrease since 1st January of 42,872 tons.

Taking into account the reduced volume of trade the prices of Scotch makers' iron keep wonderfully steady. Govan, f.o.b. at Glasgow, No. 1, is quoted 56s., No. 3, 55s.; Carnbroe, No. 1, 56s. 6d.; No. 3, 55s.; Clyde, No. 1, 66s. 6d.; No. 3, 56s.; Gartsherrie, No. 1, 67s.; No. 3, 56s. 6d.; Langloan, No. 1, 68s.; No. 3, 57s.; Summerlee, No. 1, 70s.; No. 3, 57s.; Coltness, No. 1, 74s.; No. 3, 57s.; Glengarnock at Ardrossan, No. 1, 66s.; No. 3, 56s.; Eglinton at Ardrossan or Troon, No. 1, 56s. 6d.; No. 3, 55s. 6d.; Dalmellington at Ayr, No. 1, 57s.; No. 3, 56s.; Shotts at Leith, No. 1, 70s.; No. 3, 57s.; Carron at Grangemouth, No. 1, 67s. 6d.; No. 3, 57s. 6d.

The coal trade has evinced a good deal of activity in the last few days. Shipping business that was deferred during the agitation regarding the coal tax is now proceeding, and the quantity of coals despatched from several of the ports shows a marked increase. The total shipments were 216,384 tons, compared with 210,632 tons in the preceding week, and 224,879 tons in the corresponding week of last year.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

A COLLIERY man, with a thorough knowledge of the coalfield and its possibilities, tells me that the Chancellor of the Exchequer has missed a golden opportunity. If he had levied a tax of 3d. per ton on the output it would have been so broadly placed that no one would have felt aggrieved, and the income would have been enormous.

Very little is now said about the tax, except at the various ports, but evidently there will be a good deal of discussion later on. There is a firmness about the trade which is very satisfactory, and for some time ahead fair prices are assured. This condition is very evident in the Cardiff and Newport districts. Not so in the Swansea or Western district, where the contrary state continues.

As will be seen in the column devoted to labour troubles this week, fully twenty collieries are idle in the Western district. Coal-owners of second-class or through coal are suffering from the high wages demanded.

Statements are current that America is endeavouring to secure Marseilles as a depôt for their coal. Not much reliance is placed on this. One fact can be given, that Welsh coal is in strong demand there. Last week and this, large consignments were sent from Cardiff, one of 4000 tons to the port direct, another of 4000 for the Persian Gulf. On Monday over 5000 tons were sent, and six cargoes to other French ports. Newport, too, has been busier, and with larger cargoes. At the close of the week six vessels were despatched with nearly 1600 tons, including one of 5000 tons for Bombay, and on Monday another fine cargo of 5000 tons left for Alexandria. Swansea sent about 20,000 tons to France last week. To all quarters 52,000 tons, Germany, Italy, and Cape Town figuring well.

One of the most important coal contracts of the week placed in Cardiff has been with the Brazilian Railway for 70,000 tons. The specification was "good ordinary Cardiff or Monmouthshire coal," and this fact must be kept in mind in considering the price agreed upon, which was 34s. 9d. c.i.f., including tax. The successful tenderer was Mr. Lage, Rio. Taking the rate at 13s.—if it will keep to that—leaves a fair price for coal, which is now varying between 18s. and 18s. 6d.

The maintenance of prices, in face of a holiday week at Whitsun, may be taken as certain. On Monday there was a good deal of animation on 'Change, Cardiff. This slackened by mid-week, and it was noticeable that prices in some quarters were easier, but that for best, and best seconds, there was no change. Smalls suffered, and the hot weather told on house coal. The fact was that dock men who are in close touch with the colliers, having made their arrangements for the holiday week, intend that next week shall be a quiet one for themselves as well.

It will be seen from my list of closing prices that all best brands are firm at late figures. Best steam coal, 18s. to 18s. 6d.; best seconds, 17s. 3d. to 17s. 6d.; ordinary seconds, from 16s. 6d.; drys, 15s. 6d. to 16s. 6d.; special smalls, 9s. to 9s. 6d.; best ordinaries, 8s. to 8s. 3d.; seconds, 7s. 6d. to 7s. 9d.; inferior sorts, from 7s.; best Monmouthshire semi-bituminous, large, 16s. to 16s. 6d.; seconds, 15s. to 15s. 6d.; other sorts, 14s.; best households, 16s. 6d. to 17s.; No. 3 Rhondda, 16s. to 16s. 6d.; brush, 13s. to 13s. 6d.; smalls, 10s. 6d. to 11s.; No. 2 Rhondda, 13s. to 14s.; through and through, 10s. to 11s.; smalls, 8s. to 9s.

Patent fuel shows a distinct advance of 6d., price is now 15s. to 16s.; furnace coke, 14s. 6d. to 15s. 6d.; foundry, 17s. to 17s. 6d. This shows but little change.

Pitwood is on the up grade, and late prices are 19s. to 19s. 3d. Cargoes are coming from Risoer, l'Orient, and Bordeaux. Some of the Cardiff firms do good expeditious work by chartering steamers, such as the Hawthorn, for coal to France, and pitwood by prompt return. This, like coal to Bilbao, and ore by return, is looked upon in calm weather as red-letter business.

Swansea coal quotations this week are as follows:—Anthracite: Finest hand-picked, 21s. 6d. to 22s.; seconds, 18s. to 18s. 6d.; best large, 17s. to 17s. 6d.; red vein, 13s. to 14s.; rubbly culm, 5s. 3d. to 5s. 6d.; steam, 17s. to 18s.; seconds, 15s. to 16s.; bunkers, 11s. 3d., varying according to quality; small, 8s. 6d. to 9s. House coals: No. 2 Rhondda, 14s.

Patent fuel is in strong demand; over 12,000 tons exported last week; prices 13s. 6d. to 14s. 6d. Coke, furnace, 13s. 6d. to 14s.; foundry, 17s. 6d. to 18s. Pitwood, 19s.; into trucks, 19s.

The condition of the iron and steel trades is fairly good. The re-start of a furnace is always a healthy sign, and I am glad to hear at Dowlais that there is a likelihood of No. 19 being again in work. This is one of the most important and latest, and has been disused for at least six months. In all directions there are indications that the American scare has practically died out. Not a bar comes in, but ironmasters are busy importing ore from Bilbao. This week Ebbw Vale received some very large consignments, and there is news in the air of substantial steel rail requirements for the Colonies, one for Queensland in particular which may be expected to engage attention in this quarter. Foreign and colonial orders are in hand at present; tin and merchant bar, billets, angles, and small goods are being turned out regularly. Ebbw Vale busy. Blaenavon continues affected by the furnacemen's strike, and now by the colliers. Swansea Exchange invariably yields a fair criterion of the character of trade. This week the attendance has been large, and it was remarked on several occasions that buyers for raw materials were numerous—always a good sign. Prices for finished iron and steel were reported firmer, and no abatement considered off tin-plate bars. Following quotations to be regarded as firm. In some cases, taking these as a basis, a small advance even has been made for prompt delivery. Pig iron: Glasgow warrants, 54s. 2½d., 54s. 1d. cash; Middlesbrough, No. 3, 45s. 9d., 45s. 9½d.; other numbers in proportion. Hematite warrants, 57s. 7d. for mixed numbers f.o.b. Cumberland, according to brand. Welsh bars, £6 5s. to £6 7s. 6d.; angles at usual extras f.o.t.; sheets, iron and steel, £7 5s. to £7 15s. at works. Steel rails, heavy, £5 5s. to £5 7s. 6d.; light sections, £6 7s. 6d. to £6 10s.; sleepers, angles, &c., according to section and specification. Bessemer steel, tin-plate bars, £4 15s.; Siemens, best, £4 15s.; all delivered in district, cash. Tin-plates: Bessemer steel cokes, 12s. 9d. to 13s.; Siemens, coke finish, 13s. to 13s. 3d.; ternes, per double box, 28 + 20 C., 24s., 25s., to 27s. 6d.; best charcoal, 14s. 6d. to 14s. 9d.; big sheets for galvanising, 6ft. by 3ft. by 30 g., per ton, £9 5s. to £9 10s.; finished black plate, £9 2s. 6d. to £9 5s. Block tin, £127 10s. to £127. Spelter, £17 15s. Lead, £12 7s. 6d. Copper, Chili bars, £69 17s. 6d. to £70 7s. 6d.

In the tin-plate district a good deal of interest is centred upon the new wage sheet. I am enabled now to state that the conference between employers' and workmen's representatives is arranged to take place on the 1st June. Works are going with a good deal of regularity, and the make is large. Last week 71,784 boxes were turned out. The shipments were a little under 50,000 boxes. Present stocks 93,265 boxes. Good loadings are assured, the fine vessel, the Knight Commander for South America, Brooklyn City for New York, and good cargoes to China, Japan, &c.

Bar iron from home works is still coming to hand in deficient bulk, and the query is often heard, What about the American business? America is putting in strong demands for black plate—a fact discussed assatisfactory on 'Change. The works producing corrugated sheets are well employed.

I note that the Bryngwyn Steel Company are importing pig iron and ingot moulds from Ulverstone. London and Sheerness are sending steel scrap to Swansea. Bristol is receiving its sheet iron cargoes from Newport, and Somersetshire its steel rails. A fine cargo of manganiferous ore came into Newport from Huelva this week.

In the Swansea Valley the sulphate works of Porteous and Co. are doing well. Spelter refiners are busy. The Pentrepoeth Oxalic Works are reported to be ready, and progress and vigour continue to characterise the Mannessmann tube works.

Mr. J. B. Miller, of the secretary's department, Barry Railway Company, has been appointed to the accountant's department, Cape Government Railways, and on his departure received a handsome testimonial from his old colleagues.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

THOUGH the general condition of the iron business in Rheinland-Westphalia and in Silesia is better than it has been for several months, there are still many branches that complain of being but very irregularly and, for the most part, unremuneratively occupied, as only small contracts are placed for the present, and quotations, if firmer than a few weeks ago, are still comparatively low. Crude iron is in moderate request, but the trade in manufactured iron continues to improve, and inquiries have increased considerably since last week. The Union of Rhenish-Westphalian hoop mills raised the basis price for hoops M. 2·50 p.t., so that for sales of less than 10 tons M. 132·50 p.t. is quoted; for orders of 10 to 50 tons, M. 130; and for orders of more than 50 tons, M. 127·50 p.t. is noted, free Dortmund.

Prospects in the building department are favourable, and the next month is likely to bring a fair amount of fresh work to all the shops and factories connected with the building and engineering trades.

The production of pig iron in the eastern districts of Germany is officially stated to have been, for April of present year, 31,006 t. forge pig, against 34,015 t. in March of present year; 1137 t. spiegeleisen, against 260 t.; 2561 t. Bessemer, against 1904 t.; 14,271 t. basic, against 15,250 t.; and 14,846 t. foundry pig, against 15,441 t.; total output thus being 63,821 t., against 66,870 t. last month. During the period from January to end of April of present year 253,379 t. were produced, against 275,105 t. for the corresponding period last year.

The Austro-Hungarian iron market remains quiet, but firm, the principal branches being tolerably well supplied with fresh work, and consequently in pretty regular occupation. Hoops and plates are, on the whole, in better request than girders and sectional iron, which have been languid. The Hungarian Minister of Commerce has given out orders for 2000 goods wagons, the contracts being divided among the five Hungarian wagon shops, which had been kept going very irregularly for some time past, and were decidedly hard up for fresh work. Ganz has got 652, the Weitzer Company 600, the Raab machine factory 375, Schlick 255, and Danubins 118 wagons. The prices for these cars, which have to be delivered in 1901 and 1902, have naturally been influenced by the somewhat depressed condition of the iron market, and manufacturers had to accept quotations that leave hardly any profit. Most of the wagon factories have been, and are still, financially in a precarious state, the amount of work secured during the past year having been so very small. Ganz and Co., for instance, have been compelled to reduce their working staff, and to restrict operations generally; and the Weitzer wagon shops have, last year, closed their accounts with a loss of 996,000 crowns. The ironworks of the Austro-Hungarian State Railways in Reschitza have, a short time ago, entered into negotiations regarding the supply of rails for Turkey. As German rail works are, however, also competing keenly for the same order, and are, moreover, somewhat favoured by the Turkish Government, the Austro-Hungarian shops will doubtlessly experience some difficulty in securing the contract.

The slight improvement in the Belgian iron industry, to which reference was made in former letters, has continued all through last week, but there is still little business done generally, only the tendency all round is showing a little more firmness.

Stocks in pig iron are heavy, amounting, it is said, to about 20,000 t. at the Providence Works, 18,000 to 20,000 t. at Monceau, 6000 to 8000 t. at Thy-li-Chateau, 3000 to 4000 t. at Sud de Chatilineau.

The Russian Government has granted to the Milowice Ironworks the concession for building an ironworks in Sosnowice.

Import in iron, machines, and metal articles to Russia last year, and in the year before, was as under:—

	1899.	1900.	1899.	1900.
	1000 pud.		1000 roubles.	
Pig iron from—				
Germany	1257	763	650	462
Great Britain	4747	1348	2,489	830
Belgium	714	270	365	167
Finland	784	581	390	349
Manufactured iron from—				
Germany	7898	2859	9,022	4,517
Great Britain	3467	1880	3,952	2,900
Belgium	3159	424	3,479	667
Finland	384	228	425	391
Steel from—				
Germany	804	451	812	528
Great Britain	1074	377	1,131	431
Belgium	480	131	526	148
Tin from—				
Germany	27	23	404	496
Great Britain	105	129	1,734	2,620
Lead from—				
Germany	647	772	1,535	2,045
Great Britain	818	676	1,839	1,766
France	120	242	266	641
Belgium	172	110	383	286
Zinc from—				
Germany	571	528	1851	1709
Belgium	29	12	88	41
Copper articles from—				
Germany	104	144	1,722	2,863
Great Britain	12	11	258	202
France	5	3	199	126
Austria-Hungary	12	13	266	290
Castings from—				
Germany	512	351	2,111	1,732
Great Britain	231	82	5.0	386
Hardware from—				
Germany	760	776	5,088	4,994
Great Britain	506	267	3,389	1,549
France	38	43	321	296
Austria-Hungary	44	41	247	272
Belgium	234	49	1,088	197
Tin articles from—				
Germany	141	153	1 583	1,710
Great Britain	35	21	293	197
Austria-Hungary	37	37	379	446
Wire from—				
Germany	224	185	2,205	1,551
Great Britain	109	54	611	308
Wire articles from—				
Germany	119	119	2,012	1,938
Great Britain	32	36	435	409
Scythes, sickles, spades, &c., from—				
Austria-Hungary	159	108	589	487
Machines and apparatuses from—				
Germany	5182	3792	43,909	31,558
Great Britain	3019	2191	28,092	21,046
France	151	112	1,317	793
Austria-Hungary	577	378	3,921	3,037
Belgium	626	273	3,426	1,535

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

STEAM coal in good demand, and prices keep firm. House coal is a little easier. Exports for week ending May 18th were:—Coal, foreign, 43,712 tons; coastwise, 16,609 tons. Imports for week ending May 21st were:—Iron ore, 6300 tons; pig iron, 1130 tons; manganese, 900 tons; cement, 390 tons; pitwood, 2371 loads.

Coal: Best steam, 16s. 3d. to 16s. 6d.; seconds, 14s. 6d. to 15s.; house coal, best, 17s.; dock screenings, 8s. 6d.; colliery small, 7s. 6d. Pig iron: Scotch warrants, 54s. 1d.; hematite warrants, 57s. 8d. f.o.b. Cumberland prompt; Middlesbrough, No. 3, 45s. 8d. Iron ore: Rubio, 14s. 6d.; Tafna, 15s. to 15s. 6d. Steel: Rails—heavy sections, £5 5s. to £5 7s. 6d.; light ditto, £6 5s. to £6 7s. 6d. f.o.b.; Bessemer steel tin-plate bars, £4 12s. 6d. to £4 15s.; Siemens steel tin-plate bars, £4 15s. to £4 17s. 6d. All delivered in the district, cash. Tin-plates: Bessemer steel, coke, 12s. 9d. to 13s.; Siemens—coke finish—13s. to 13s. 3d. Pitwood, scarce. London Exchange Telegram: Copper, £69 13s. 9d.; Straits tin, £126 5s. Freights firm.

THE SHIPPING TRADE OF GENOA AND MARSEILLES.—The *Moniteur Officiel du Commerce* publishes a report by the French Consul-General at Genoa with regard to the shipping trade of these ports. It appears that the port of Genoa is undergoing a rapid development, while the shipping trade of Marseilles is declining. Still, the volume of trade at Marseilles is ahead of that of the Genoese port, for while during 1900 13,602 vessels, of a total tonnage of 9,728,045 tons, entered the port of Genoa, 17,974 vessels, of a total tonnage of 12,296,254 tons, entered the port of Marseilles. But that year happened to witness the development of Genoa and the backwardation of Marseilles, for during 1899 there was an increase of 745 vessels at Marseilles, and a decrease of 632 at Genoa.

PUMPING BY ELECTRICITY.—The South Durham Iron and Coal Co. has arranged with Ernest Scott and Mountain, Ltd., of Newcastle-on-Tyne, for the installation at the Eldon Colliery of what is stated to be the largest electric pumping plant in the North of England. The plant consists of a compound horizontal engine of 450 horse-power, with a generator of 25 kilowatts capacity, the electromotive force at the terminals being 500 volts. The generating plant will be situated at one of the company's pits, about 800 yards from the pit at which the pumping is required. The current will be conveyed overhead by conductors on poles, and subsequently taken down the shaft by heavily-armoured cables to two sets of three-throw horizontal pumps, each set of pumps delivering 500 gallons per minute, or collectively 1000 gallons against a head of 400ft. Each pump will be driven by a motor of 1200 effective horse-power by means of cotton ropes.

LAUNCH OF H.M.S. TEAL.—On Saturday, 18th inst., the shallow-draught twin-screw gunboat Teal, built to the order of the British Government, was launched from Messrs. Yarrow's new works at Poplar. The Teal, like the Moorhen, is constructed on a system which enables a large screw propeller to be used in combination with a very shallow draught, of which type of vessel Yarrow and Co. have made a speciality. The draught of these gunboats fully equipped is estimated at 2ft. 3in., and the speed at 13 knots. All the vulnerable parts, such as the machinery space, &c., are completely encased by Chrome steel rifle-proof plates. The vessels are constructed in floatable sections—a system introduced by the Poplar firm many years ago, by which means the tedious process of riveting together and launching abroad is entirely avoided, the various sections being simply lowered into the water and bolted together. The launch took place with steam up, and immediately after the vessel was afloat a short preliminary run was made.

CONTINENTAL NOTES.

THE Prefect of Novara, Italy, has accorded a concession to Antonio Beltrami and Son for a catchment of water on the Strona River at Omagna, for the development of motive power.

MR. LUIGI MURISIER, of Turin, Italy, has presented an application for a derivation of water from the Cursaglia torrent for the development of electric energy for the working of his iron and manganese mines in the vicinity. The proposed head of water is 52½ m., giving a force of 1390 horse-power.

A RECENT issue of a German contemporary contains an interesting article of the coal region of the basin of the Ruhr, showing the enormous importance of this district from a coal-mining point of view. The basin of the Ruhr comprises an area of about 2000 kilometres square, including no less than 400 pits. The number of persons occupied in these mines reaches nearly one million. The industrial fillip given to the district by such a population may be easily imagined. Canals are numerous, and the railway system presents one of the closest networks in Europe. A few figures will prove interesting, if not curious. The timbering of the mines absorbs upwards of one million tons of wood annually, while the consummation of explosives costs six million marks for the same period. There are 10,000 horses employed, drawing sufficient coal to fill about 19,000 wagons daily, or 5,700,000 in the year—one-fourth of the total annual transit of the German railways.

THE *Echo des Mines* states that it is in a position to announce the formation of a large American trust, comprising the Eureka, New River, Pocahontas, Sterling Powelton, and other coal mines of the United States, for the exportation of American coal to the Mediterranean. According to this journal the minimum price per ton has been fixed at two dollars f.o.b. at Philadelphia, Baltimore, &c., with a margin for a 10 per cent. reduction if deemed desirable. "The Mediterranean district in regard to the supply of combustibles," says the *Echo*, "at present belongs to the English; they are, however, about to be ousted by the Americans; this will hardly effect any change from an industrial point of view as far as we are concerned, but we will have the satisfaction of being able to reply to Sir Michael Hicks-Beach—who has been pleased to make us pay for the Boer war—with a boycott of English coals."

A PROJECT is at present on foot for the construction of a railway from Nieigles to Prades au Puy through the valleys of the Ardèche and Loire. The length of the proposed line is 92 kiloms., the estimated cost per kilometre in the Loire district being 405,000f., and in the Ardèche 495,000f.

THE Engineer Saverio Cucciniello has presented to the municipalities interested a project for the construction of an electric tramway between Avellino and Naples, to be constructed by the shortest route. The construction of the new line is estimated to cost 8 million lires.

THE French Chamber has passed a vote of 50,000,000f. for the execution of various extensive port works in Algeria and Tunisie, which are to be executed within eight years.

M. MOSER, engineer of the 12th Arondissement of the Paris-Lyons-Mediterranean system, has just finished the study of a third line to be constructed between Terrenoire and Rive de Gier. The estimated cost of the necessary works is 2,301,100f. The adjudication is expected to be announced at an early date.

THE Naples Piedmont d'Alife Railway Company has presented an application to the Italian Minister of Public Works for the concession of a derivation of water from the Volturno for the generation of electric current for the traction of their line as well as for lighting and industrial purposes. The power canal would traverse the communes of Dragoni, Alivagnano, and Ruvionosur, and have a length of about 11 kilom. The catchment would be effected above the Régina Margherita bridge and below the conflux of the Torano, at a point 77½ metres above the level of the sea. The supply of water would be at the rate of 18 cubic metres per second. The force is calculated at 6000 horse-power. The estimated cost of the central power station is 1½ million lire.

THE INSTITUTION OF JUNIOR ENGINEERS.

ON Monday evening, May 20th, the members of this Institution paid a visit to the works of the Renewable Electric Lamp Company, at Brunswick-place, City-road, London. They were received by the managing director, Mr. H. E. Kershaw, who also occupies the position of Mayor of Shoreditch. The processes carried on were shown in operation.

In addition to the renewing of old lamps by the introduction of a new filament, the company are manufacturers of incandescent lamps, the filament being prepared in a special way. Its consumption of current is as low as 2·7 watts per candle-power, and it is guaranteed to burn a thousand hours. In the renewal process the bulb is re-opened, the old filament is detached, and a new one inserted, thus avoiding the wastage of the bulb, the cap, the platinum, leading in wires, &c. In the glass-blowing room, where the bulbs are expanded, and the filaments inserted, both the Ediswan and the American methods were shown. Entering the mechanical exhausting room, the members saw the system employed for exhausting the bulbs of air and permanently sealing them; and in the laboratory the filaments were seen in process of manufacture. The flashing of the filaments by being overrun 50 per cent. beyond their nominal candle-power, and the jointing of the platinum and filament by electrolysis were shown, as was also the process of jointing the platinum to the copper wire. The apparatus for exhausting by means of the mercury pump was also seen at work. The concluding operations of capping, &c., each lamp produced, having been inspected, the method of testing was fully explained and demonstrated.

At the conclusion the thanks of the Institution for the highly interesting visit which had been made were expressed by the chairman, Mr. Percival Marshall, and Mr. Kershaw responded.

LAUNCHES AND TRIAL TRIPS.

BARWON, steamer; built by, The Blyth Shipbuilding Company, Limited; to the order of, Ruddart Parker and Co. Proprietary, Limited, of Melbourne; dimensions, 337ft. long; engines, triple-expansion, 24in., 40in., and 65in. by 42in. stroke, pressure 180 lb.; constructed by, Blair and Co., Limited; trial trip, May 15th.

PERUGIA, steel screw steamer; built by, David and William Henderson and Co., Limited; to the order of, the Anchor Line—Henderson Bros.—Limited; dimensions, length 390ft., breadth 47ft., depth 30ft. 6in., with a gross tonnage of about 4500; engines, triple-expansion; constructed by, builders of vessel; the vessel is intended for the Mediterranean and New York trade, and is a duplicate of the Calabria; launch, May 16th.

MARGARETHE, wooden cargo steamer; built by, Brunchorst and Dekke, Bergen, Norway; to carry, 850 tons deadweight; engines, triple-expansion, 12½in., 20in., 32in., by 26in. stroke; constructed by, the Laxebaags Engineering and Shipbuilding Co., Bergen; speed of 10½ knots attained; trial trip, May 14th.

SOESTDYK, steel screw steamer; built by, Furness, Withy, and Co., Limited, Hartlepool; to the order of, the Holland America Line, Rotterdam; dimensions, 413ft. long; engines, triple-expansion, 28in., 46in., and 77in. by 48in. stroke, pressure 180 lb.; constructed by, Richardsons, Westgarth, and Co., Limited; vessel will have a measurement capacity of 13,000 tons, and takes Lloyd's highest class; she is of the three-deck type and has cellular double bottom; launch, May 18th.

METEOR, steel petroleum and cargo steamer; built by, R. Craggs and Sons, Middlesbrough; to the order of, Russian Steam Navigation and Trading Company, Odessa; dimensions, 361ft. long, 47ft. beam, and 30ft. deep.; mean speed of 11 knots on six runs over 10-knot course; trial trip, May 15th.

DEUX CHARENTES, steel screw steamer; built by, Wood, Skinner, and Co., Limited, Bill Quay-on-Tyne; to the order of, A. D'Orbiguy, Fauston, and Co., La Rochelle; dimensions, length, 250ft.; breadth, 37ft.; and depth, 18ft. 3in.; to carry, a deadweight of 2300 tons; engines, 20in., 33in., and 54in., by 36in. stroke, pressure 160 lb.; constructed by, North-Eastern Engineering Company; trial trip, May 20th.

TRADE AND BUSINESS ANNOUNCEMENTS.

MR. H. ROSS CLYNE, owing to his present office being required for improvement purposes, is today removing to 27a, Victoria-buildings, Manchester.

THE WATERPROOFING COMPANY, Limited, of Barrhead, near Glasgow, intimate that they have appointed M'Kerrow and Co., 38, Victoria-street, Westminster, London, S.W., as their sole London and foreign agents.

LOWE'S PATENT SANITARY PIPE JOINT SYNDICATE, Limited, Dashwood House, New Broad-street, E.C., have recently effected an arrangement with J. Stiff and Sons, of Lambeth, whereby this firm become their sole agents for London and suburbs.

CATALOGUES.

THOMAS LUMSDEN, Coulthard's-lane, East-street, Gateshead-on-Tyne. Illustrated 1901 catalogue and price list of engineers' machine tools and appliances.—It would be difficult to suggest a type of machine likely to be useful to the engineer which is not shown in this comprehensive catalogue.

GILBERT GILKES AND CO., LIMITED, Canal Ironworks, Kendal.—This is a tastefully-executed book, containing illustrated descriptions of some of the electrical installations carried out by this company, chiefly in country mansions. The quality of the illustrations and letterpress leaves nothing to be desired.

DAVIES, KENT, AND STEWART, Berners-street, London, W.—Illustrated catalogue of electric light fittings, fans, batteries, and bells.

DORMAN AND SMITH, Ordsal Works, Salford, Manchester.—Illustrated catalogue of electrical apparatus, such as switches, circuit breakers, fuses, ceiling holders, lamps, &c.

JOHN COCHRANE, Barrhead, near Glasgow. Illustrated catalogue of steam hammers.—The illustrations given represent tools giving maximum blows of 2½, 5, 15, and 30 cwt. and upwards. The book is neatly got up, and the wood engravings deserve special praise.

THE Herbert-Frood Company, 10, West Mosley-street, Manchester. Circular respecting Frood's patent cycle stand and list of users.—The arrangement appears to combine the qualities of simplicity and effectiveness.

ROBERT W. BLACKWELL, AND CO., LIMITED, 59, City-road, London. Illustrated circular of "reverse current" I.T.E. circuit breakers.—This instrument has been designed to protect generators which are working in parallel from the disastrous effects which may result from one machine reversing into the other.

BIRMINGHAM ASSOCIATION OF MECHANICAL ENGINEERS.—On Saturday last a party, numbering about forty members, paid a visit of inspection to the Whiteacre Waterworks. They were received by Mr. Crowther, the resident engineer, who kindly showed them round. The action of the filter beds was explained in detail, and then the party visited the engine-houses, and made a thorough examination of the varicus pumping engines, boiler-houses, and the reservoir. A vote of thanks to Mr. Lees was proposed by Mr. J. Cox for the permission to visit the works, and also to Mr. Crowther for the courtesy shown to the members during the visit.

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.

8th May, 1901.

9530. TRANSPARENT GUARD for HATS, C. C. Keech, Peterborough.
9531. HOLDER-STAND for MACHINES, C. Bamford, Belfast.
9532. MOTOR-STARTING SWITCHES, F. J. A. Matthews, Marple, Cheshire.
9533. BANDOLIERS, J. Black, Glasgow.
9534 VEHICLES, A. A. Wade, Leeds.
9535. NEEDLE-SELECTING ATTACHMENT, H. Thomson, Glasgow.
9536. AERATED WATER APPARATUS, J. Ettles, Burnham-on-Crouch, Essex.
9537. COTTON MACHINERY, T. R. Marsden and Platt Bros. and Co., Limited, Manchester.
9538. JEWELLERY, J. H. Maden, Manchester.
9539. CHANGE-SPEED MECHANISM, The Wolseley Tool and Motor Car Company, Limited, and H. Austin, Wolverhampton.
9540. RAILWAY COUPLINGS, S. B. Foden and P. Oakes, Burnley.
9541. COAL-WASHING, &c, APPARATUS, N. McLellan, Durham.
9542. POROUS CARBURETTER, E. Price, Portsmouth.
9543. ADJUSTABLE ANGLE BRACKET, A. I. Grainger, Aberdeen.
9544. METAL WINDOW SASH FRAMES, W. H. Luther, Glasgow.
9545. COUPLINGS for ROLLING STOCK, G. A. C. Schenley, Southampton.
9546. BREAD-CUTTING MACHINES, J. Chalton, Liverpool
9547. STOP MOTIONS of DRAWING FRAMES, T. Chadwick, Halifax.
9548. CONTROLLING STRAP FORKS, B. G. Smith, Halifax.
9549. BEARINGS for BARROWS, G. P. Jones, Loughborough.
9550. APPARATUS for PRINTING, F. G. Highfield, Manchester.
9551. INCANDESCENCE BODIES for LAMPS, S. Saubermann, Vienna.
9552. METAL-EXPANDING CHANNELS for FLOORS, H. Cooley, Leicester.
9553. PARAFFIN LAMPS, T. Finney, Glasgow.
9554. CABINET HANDLES, E. A. Allen, Perry Barr, near Birmingham.
9555. DRIVING TUNNELS, A. Gobert and J. H. M. Togston, Acklington, Northumberland.
9556 PRODUCING FAST COLOURS, C. Dreher, Berlin, Germany.
9557. SAFETY ELEVATORS, E. Brucksch, Görlitz, Germany.
9558. BELT-SHIFTING GEAR, L. and T. Hill, Willenhall, Staffordshire.
9559. FREE WHEELS for BICYCLES, H. Keys, Birmingham.
9560. COUPLINGS, G. Westinghouse, London.
9561. VENETIAN BLINDS, P. L. le Duc, London.
9562. SOLIDIFIED MILK, L. W. Broadwell and W. T. Birch, London.
9563. BEEHIVES, R. Baldwin, London.
9564. DRAINAGE INTERCEPTOR, R. F. and H. J. Houghton, London.
9565. PROCESS for the TREATMENT of VEGETABLE FIBRES, Ogilvy and Co., Limited, and J. J. Anderson, London.
9566. TREATMENT of COCOA-NUT FIBRE for STUFFING, Ogilvy and Co., Limited, and J. J. Anderson, London.
9567. LOCKING DEVICE for STRAP BUCKLE, R. Spurway, London.
9568. ABRADING MACHINERY, J. A. Thacker, London.
9569. EXTRACTING OIL from EXHAUST STEAM, I. S. McDougall, London.
9570. "COMPOUND LIQUORICE POWDER" TABLETS, J. H. Long, London.
9571. BOOKBINDING MACHINE, A. I. Jacobs and the Smyth Manufacturing Company, London.
9572. RAILWAY COUPLINGS, S. A. Schlegelmilch, London.
9573. EXTRACTING PERCUSSION CAPS from CARTRIDGE CASES, W. Souls, Warwick.
9574. TESTING MATERIAL in BULK, C. V. Drysdale, London.
9575. ADVERTISING, F. A. Jones and D. N. Samson, London.
9576. APPARATUS for INDICATING SPEED, F. M. Staunton, London.
9577. APPARATUS for TRANSPORTING FRUIT, A. K. Finlay, London.
9578. SPRING BUCKLE, L. Barnett, London.
9579. HAIRPIN, C. Anderson, Swindon.
9580. TOBACCO PIPE, E. Rolfe, London.
9581. HANDLE-BAR for BICYCLES, F. A. Wheeler, London.
9582. EXPLOSIVE, C. Helchè, London.
9583. MECHANICAL TOYS, E. B. Wedmore, London.
9584. MOTOR VEHICLES, W. Norris and T. Coulthard and Co., Limited, London.
9585. FURNACES, B. Oertel, London.
9586. EXTENDING RANGE of WIRELESS TELEGRAPHY, F. Lacon and A. Foster, London.
9587. INSECT TRAP, J. Milner, London.
9588. TIRES for ROAD VEHICLE WHEELS, L. Stadler, London.
9589. TREATING PEAT FIBRE, A. Follak and C. Esser, London.
9590. COIN-OPERATED TALKING MACHINE, B. G. Royal, London.
9591. TOY ARROW, L. Wild, London.
9592. WRIST EXERCISER for PIANISTS, M. Tabor, London.
9593. ELECTRIC SWITCH, Siemens Bros. and Co., Limited, and M. Hird, London.
9594. BOLTED RIFLES, C. and T. H. Ryland, Birmingham.
9595. SECURING TELEGRAPH WIRES, Q. Austen, Hove, Sussex.
9596. DEVICE for HOLDING THREAD, A. Wooltorton, London.
9597. BICYCLES, Rudge-Whitworth, Limited, and J. V. Pugh, Birmingham.
9598. DIARY, E. F. Rönneberg, London.
9599. LOWERING APPARATUS, A. J. Tenow and J. E. Flodström, London.
9600. SNAP HOOK, F. Wood, Liverpool.
9601. DELIVERING and TRANSPORTING GRAIN, G. Jäger, Liverpool.
9602. ROTARY STEAM ENGINES, M. Jönssen, Liverpool.
9603. ORGANS, C. Stollewerk, London.
9604. MANUFACTURE of METAL DRUMS, W. Noakes, London.
9605. CONSTRUCTION of SWEEPING MACHINES, J. Davis, London.
9606. BOILER FURNACES, J. R. Richardson, London.
9607. METAL ROOFING, F. Green, London.
9608. FASTENINGS for PETTICOATS, &c., G. Abrahams, London.
9609. STEAM GENERATORS, J. W. Holst, London.
9610. ELECTRICAL EXERCISING MACHINES, H. H. Lake.—(*A. W. Courtney, United States.*)
9611. TROLLEY HEADS for ELECTRIC TRACTION, A. Metcalfe, London.
9612. VEHICLE-DRIVING MECHANISM, J. and H. Lindner and A. Heller, London.
9613. INDIGO, J. Y. Johnson.—(*Badische Anilin and Soda Fabrik, Germany.*)
9614. DRIVING GEAR of MOTOR-CARS, F. C. Blake, London.
9615. IGNITION PLUGS for EXPLOSION ENGINES, F. C. Blake, London.
9616. ELECTRICAL TIME SWITCHES, W. Rausch, London

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9617. DAMPING and MIXING CEMENT, A. C. Davis Cambridge.
9618. SMOKE BURNER, G. Brierley, Pendleton, near Manchester.
9619. CONVEYING ELECTRIC CURRENT, J. Iron, Dover.
9620. FLOUR BAG, B. Kershaw, Manchester.
9621. MEAT BAG, B. Ke shaw, Manchester.
9622. INTERNAL COMBUSTION ENGINE, E. S. Bond, Birmingham.
9623. STEAM GENERATORS, E. Makin, jun., Manchester.
9624. BATHS, T. Pickup and J. Bradley, Burnley.
9625. JAR LID, W. West, Birmingham.
9626. HEALING OIL, G. Norsa, Manchester.
9627. PREVENTING TIRES PUNCTURING, J. Wheeldon, Sheffield.
9628. MOTORS, T. and C. H. Deakin, Coventry.
9629. CHECKING CASHIERS' RECEIPTS, G. W. Gregory, Manchester.
9630. CAMERA, H. W. James, Birmingham.
9631. STOVES, J. R. Crosthwaite, Stockton-on-Tees.
9632. FLY-CATCHER, T. Kay and Kay Brothers, Limited, Stockport.
9633 BUTTONS, K. B. Sharman, Edinburgh.
9634. STEAM BOILERS, R. Richardson and F. Matheson, Glasgow.
9635. CUTTING PILES under WATER, G. Halliday, sen., Glasgow.
9636. FINISHING CABINET HANDLES, E. A. Allen, Perry Bar, near Birmingham.
9637. VARYING RADIUS of CRANES, H. Shoosmith, Erith, Kent.
9638. FIRE-LIGHTERS, J. and A. Gledhill, Leeds.
9639. MACHINING PLATES for BOILERS, A. E. Muirhead, Glasgow.
9640. YARN-WINDING MACHINES, A. J. Tonge and E. Taylor, Manchester.
9641. COOKING RANGES, R Pritt, Lancaster.
9642. APPARATUS for BURNING FUEL, E. Dyson, Manchester.
9643. BURNER for GAS COMBUSTION, W. Hancock, London.
9644. ENGINES, R. W. Muir, Glasgow.
9645. ACCESSORIES relating to STOVES, J. Jackson, Coventry.
9646. FURNACES, H. Schofield and O. P. Macfarlane, Ware, Herts.
9647. COMPRESSION COCK for ENGINES, J. Hinchley, London.
9648. FOOD PREPARATIONS, A. E. Cressall, London.
9649. PHOTOGRAPHICAL CASKET for FILM ROLLERS, W. Beutler, Berlin.
9650. CONTRIVANCES for LIGHTING, M. Schmidt, Magdeburg, Germany.
9651. PROTECTION from ELECTRIC CURRENTS, C. J. R. Le Mesurier, London.
9652. SOUNDING INSTRUMENTS, W. Moseley and J. L. Crawford, London.
9653. PROCESS for PRESERVING FOODS, W. Manasse, London.
9654. COOKING STOVES, I. Gould and G. Dixon, London.
9655. PNEUMATIC TIRES, W. F. Hinton, London.
9656. FASTENING SIDES of RAILWAY WAGONS, H. Penn, London.
9657. FASTENING DOORS of RAILWAY WAGONS, H. Penn, London.
9658. INCANDESCENT GAS MANTLES, F. S. Kennedy, London.
9659. JEWELLERS' EYE GLASSES, A. W. May, London.
9660. GAS APPARATUS, J. H. Stevens, London.
9661. GAS IGNITOR for GAS STOVES, J. H. Stevens, London.
9662. DOORS, O. Francke, London.
9663. ACETYLENE LANTERN, F. and C. Schmitt, London.
9664. GENERATING ACETYLENE GAS, F. Schmitt London.
9665. ATTACHING PNEUMATIC TIRES, J. A. Score, London.
9666. VESSEL for RETAINING HEAT, E. A. Filby, London.
9667. RAILWAY SIGNALLING APPARATUS, E. A. Filby, London.
9668. LUBRICATING AXLE BEARINGS, J. Abbott, London.
9669. BRUSHES, R. Aldrich, London.
9670. BREECH MECHANISM of ORDNANCE, C. Holmström, G. A. Köhler, and A. Bremerg, London.
9671. RAILWAY BRAKES, The Westinghouse Brake Company, Limited, and L. G. Stone, London.
9672. APPARATUS for SPRAYING LIQUIDS, H. E. Matthews, London.
9673. APPARATUS for COUNTING COINS, S. L. Hart, London.
9674. ELECTRIC ARC LAMPS, The Jandus Arc Lamp and Electric Company, Limited, A. D. Jones, and B. M. Drake, London.
9675. REGULATING MECHANISM. The Jandus Arc Lamp and Electric Company, Limited, and A. D. Jones, London.
9676. ELECTRIC SMELTING PROCESS, The British Aluminium Company, Limited.—(*A. H. Cowles, United States.*)
9677. BAKERS' OVENS, W. E. Storey, London.
9678. STOPPERS for BOTTLES, F. Reddaway and M. M. Dessau, London.
9679. ARTICLES, F. Reddaway and M. M. Dessau, London.
9680. GRINDSTONES, J. O. Schmidt, London.
9681. ACETYLENE LAMPS, H. Lucas, London.
9682. SANDWICH STANDS, W. G. Harris, Beckenham, Kent.
9683. SPINNING BAITS, W. and J. J. Hardy, London.
9684. TRANSPORTING GRAPES, R. R. Blandy, London.
9685. ANTISEPTIC BANDAGES, H. H. Lake.—(*Maamloose Vemootschap Fabrick van Verbandstoffen, Voorheen Ulermöhlen and Co., Holland.*)
9686. STATIONARY CABINET, J. T. Steele, London.
9687. SEWING MACHINES, J. C. Moore, London.
9688. WINDING BOARDS, &c., J. and H. J. Riddett, London.
9689. COUPLING TRUCKS, S. Vestey and T. Ritchie, London.
9690. BOILER ANTI-INCRUSTATION LIQUID, G. Salpietro London.
9691. COMPOUND for PRESERVING WOOD, R. J. Stalker, Liverpool.
9692. UNDERGROUND RAILWAY SYSTEMS, C. Haggenmiller, Liverpool.
9693. PORTABLE FANS, W. L. Wise.—(*H. Baer and E. Kilchmann, Switzerland.*)
9694. COLOURING MATTERS, J. Y. Johnson.—(*The Badische Anilin and Soda Fabrik, Germany.*)
9695. TREATING COTTON, W. H. Perkin, jun., and Whipp Bros. and Tod, Limited, London.
9696. SECURING the DOORS of ROOMS, R. P. Bovey, London.
9697. TELEGRAPHIC SIGNALLING, J. C. Bose and S. C. Bull, London.
9698. CIGARETTE-PACKING MACHINES, H. Rankin London.

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9699. SOLE-MOULDING MACHINES, A. R. Timson, C. W Bullock, and C. S. Barber, Leicester.
9700. DUPLICATING APPLIANCES, J. L. Young, London
9701. KNIVES for PILE-CUTTING MACHINES, F. H Gosling, Bury.
9702. ARC LIGHTS, F. G. Notley, London.
9703. BRACKET, J. S. Frampton, Bath.
9704. REEDS, A. M. Milne, Dundee.
9705. CAR SAFETY GUARD, A. Booth, Bradford.
9706. ALCOHOL STILL, F. C. J. Bird, London.
9707. VAPORISING DEVICE, F. W. Hudlass, Liverpool.
9708. COMBING MACHINE, I. Hey, Bolton.
9709. ENVELOPES, T. Webster, Nottingham.
9710. SLATE REST, J. Whyte, Glasgow.
9711 TIGHTENING WIRE, J. M. Ralston, Glasgow.
9712. SUPPORTING SOCKS, G. F. Binley and C Taylor Birmingham.

9713. VALVE SEATS, G. M. Marchant, Huddersfield.
9714. EXHIBITING ANIMATED PICTURES, W. Wilkinson, Manchester.
9715. PRODUCTION of MOTIVE POWER, R. Bell, Newcastle-on-Tyne.
9716. COLLAPSIBLE LIFEBOAT, H. McLean, Govan.
9717. VENTILATORS, W. S. Laycock, Sheffield.
9718. HEATING APPARATUS, A. Eckstein and C. H. Archer, Manchester.
9719. SCREW-CUTTING MACHINE, D. Lake and E. W. Crellin, Manchester.
9720. DYEING APPARATUS, R. Illingworth, J. T. Mazey, and G. Naylor, Manchester.
9721. ARTICLE, I. C. Koch, Manchester.
9722. MACHINE for COVERING WIRE, W. Jordon.—(*C. C. Baldwin, United States.*)
9723. ATTACHMENT for BICYCLES, J. H. Burridge, Birmingham.
9724. CAPS for BAMBOO WORK, T. J. Bonell, Birmingham.
9725. DAMP ADJUSTER for CHIMNEYS, B. J. Woods, London.
9726. ICE, A. J. Boult.—(*L. Engelhorn, United States.*)
9727. GRAPHOPHONES, W. C. Runge, London.
9728. ENGINES, C. E. Inglis, London.
9729. RAILWAY COUPLINGS, E. B. Lupton and J. M. Porter, London.
9730. APPARATUS for DISPENSING LIQUIDS, J. H. Nolan, London.
9731. LIGHTING LAMPS, W. Patterson, Manchester.
9732. EAR-PIERCING APPLIANCES, G. W. Barrett, London.
9733. INCANDESCENT GAS MANTLES, W. K. Dickson, London.
9734. EYEGLASSES, J. Alexander, London.
9735. SAFETY LINKS, W. W. Crawford, London.
9736. INCANDESCENT FURNACE, J. Taylor, London.
9737. STEREOTYPING, W. A. Lawton and W. Matthews, London.
9738. SIGHT MOUNTINGS, H. Grubb and A. T. Dawson, London.
9739. SLAKING LIME, F. A. Beny and J. Heinrigs, London.
9740. CEILING SWITCH, A. Reckenzaun, London.
9741. REGISTERING APPARATUS for TRAMCARS, W. Weber, London.
9742. BRICKS, J. Ashworth, London.
9743. AUTOMATIC CABINET BED, C. M. Hamilton and H. Hunt, London.
9744. FRAME for METAL-CUTTING SHEARS, H. John, London.
9745. ELECTRIC CURRENT CIRCUIT BREAKERS, E. F. Moy and P. H. Bastie, London.
9746. BOOT HOLDER, W. Garrett, London.
9747. REFRIGERATORS, L. Mantell and W. J. Prim, London.
9748. BARRELS, F. L. and R. L. Roeckner, London.
9749. VENTILATION of CARDING MACHINES, A. J. Boult.—(*V. Huglo, France.*)
9750. GUARDS for GAUGE GLASSES, A. J. Boult.—(*F. P. Schreier, Germany.*)
9751. SPADES, H. S. Dean, London.
9752. ROUSER APPARATUS for BREWERS' VATS, S. Briggs, London.
9753. PRINTING PRESSES, R. E. Phillips.—(*J. W. Williams, United States.*)
9754. MOTOR VEHICLES, G. Taylor, London.
9755. WAXING APPARATUS of SEWING MACHINE, W. and B. Hill, London.
9756. SEWING MACHINE ATTACHMENTS, A. Glück, London.
9757. COUPLINGS, E. J. Hill and Edward Hill's Patent Coupling Brake and Wagon Safety Appliance Company, Limited, London.
9758. COUPLINGS, E. J. Hill and Edward Hill's Patent Coupling Brake and Wagon Saf ty Appliance Company, Limited, London.
9759. FIRE GRATE, A. Eddowes, London.
9760. THREADING MACHINE NEEDLES, J. A. Hewitt.—(*K. North-Row, India.*)
9761. TROUSERS PRESS, B. S. G. Watts and A. Best, London.
9762. FLY PRESS, E. J. Gebler and M. Schmidt, London.
9763. PICTURES in RELIEVO on METAL, W. Ohse, London.
9764. BICYCLES, A. J. Fredrikson, London.
9765. SUPPLYING LIQUIDS on DRAUGHT, W. Nicholls, London.
9766. PAPER, J. Turner, London.
9767. BOTTLE STOPPER, S. Myer and G. Nayler, London.
9768. METAL-WORKING MACHINES, A. B. Tenney, London.
9769. ELECTRIC CURRENT COLLECTORS, H. H. Lake.—(*McElroy-Grunow Electric Railway System, United States.*)
9770. FIRING CHARGES in ENGINES, A. C. Brown, London.
9771. MANUALLY OPERATED BRAKES, D. M. Murrow, London.
9772. AUTOMATICALLY OPENING DOORS, J. Wiesbader, London.
9773. PRODUCTION of FISH GUANO, J. Carstairs, London.
9774. ACYLATED DERIVATIVES, J. Y. Johnson.—(*The Badische Anilin and Soda Fabrik, Germany.*)
9775. SPINNING and TWISTING MACHINES, J. A. A. Imbs, London.

11*th May*, 1901.

9776. FRY-PANS, H. Norfolk, London.
9777. FOUNTAIN INK-WELL, R. W. Davies, Braintree, Essex.
9778. TURNING PULLEY RIMS, F. L. Croft, T. A. Perkins, F. Croft, and E. Townson, Bradford.
9779. HAND-BRUSHES, H. Stainsby, Birmingham.
9780. MUD GUARD for VEHICLES, G. W. J. Allen, Birmingham.
9781. INSULATOR, R. C. Quin and J. B. Smith, Fleetwood.
9782. HYDRAULIC PRESSES, B. G. Smith, Halifax.
9783. LAMPS for HEATING PURPOSES, A. W. Turner and J. Adie, Birmingham.
9784. ATTATCHABLE SOAP DISH, M. Rough, North Shields.
9785. REVERSING APPARATUS, R. J. Hughes and A. B. Shaw, Kingston-on-Thames.
9786. DRESS SHIRTS, J. McMaster, Glasgow.
9787. CENTRIFUGAL DRESSING MACHINE, J. McDonell, Limerick.
9788. FURNITURE CASTORS, J. T. Petford, Liverpool.
9789. BEDSTEAD LEG, J. T. Petford, Liverpool.
9790. BELT GEARING, J. T. Petford and J. Bates, Liverpool.
9791. SELF-PROPELLED ROAD GUARD, G. S. Dodman, Liverpool.
9792. SACK HOLDERS, J. T. and G. E. Gott, St. John's, Lincs.
9793. DRAWING COMPASSES, L. Myers, Birmingham.
9794. METALLIC and COMPOSITE BOXES, P. S. Brown, Glasgow.
9795. SPEED GEAR MECHANISM for CYCLES, J. H. Coffey, Manchester.
9796. LUBRICATING COMPOUND, C. H. Berry, Manchester.
9797. COLLAR STUDS, F. Hill, Keighley.
9798. GUARD for TRAMCARS, A. Ingram and C. Jones, Liverpool.
9799. MOULDS for ICE-CREAM, R. J. and J. G. White, London.
9800. GUARDS for MOTOR CARS, B. Thackrah, London.
9801. ELECTRIC TELEGRAPHY, S. G. Brown, London.
9802. RUG and CARPET ANGLE, E. G. Richards, London.
9803. PENNY-IN-THE-SLOT MACHINE, P. Wilcox, A. C. Tulk, and J. F. O'C. Wood, London.
9804. FITTINGS for WINDOWS, H. Pickersgill, London.
9805. GUN CARRIAGES, A. Reichwald.—(*F. Krupp, Germany.*)
9806. ASSORTING COINS, J. G. H. Hoch and C. B. Heygate, London.
9807. BOARDS for SPREADING NETS, E. S. Thrower, London.
9808. BOOTS, C. Steinhäuser, Manchester.
9809. RAILWAYS, A. Lehmann, Berlin.
9810. SHEET ENVELOPE, L. Czermak, Charlottenburg, near Berlin.
9811. FLUSHING CISTERNS, E. Jones and J. H. Moore, London.
9812. ELECTRIC MOTORS, J. Bush and M. T. Medway, London.
9813. GENERATORS, E. J. Clubbe and A. W. Southey, London.
9814. STEAM ENGINES, R. W. Barker.—(*P. Bourdiaux, France.*)
9815. ICE SCRAPER, R. L. Crosse, London.
9816. BALLOONS, A. Liwentaal, London.
9817. FLOWER POTS, J. Embleton, London.
9818. INCANDESCENT GAS BURNER, J. Altman, London.
9819. MUSIC RECORDER, A. P. Taylor and W. B. B. V. Neale, London.
9820. KILNS, W. P. Thompson.—(*La Société pour l'Exploitation des Brevets Henri Sturm, France.*)
9821. HORIZONTAL PADDLE-WHEELS, V. Berg, Liverpool.
9822. COKE OVENS, H. Koppers, London.
9823. MALTING RICE, E. C. Schrottky, London.
9824. PLATES for PLANT BOXES, F. J. W. Bush, London.
9825. REGENERATIVE FURNACES, &c., C. Holcroft, London.
9826. MOTOR VEHICLES, J. Chatwin and J. Virtue, jun., London.
9827. SPECTACLES, C. Cox, London.
9828. PROCESS for PRODUCING VARNISH, S. Ammundsen, London.
9829. CIRCUIT BREAKERS, The British Thomson-Houston Company, Limited, and E. B. Wedmore, London.
9830. CONSTRUCTION of ARMOURED WALLS, F. Quester, London.
9831. MUSICAL INSTRUMENT, C. Ullman, London.
9832. RECEPTACLE for BULKY MATERIALS, J. McRae, London.
9833. PUNCHING HOLES, H. S. Wilton and B. S. Weston, London.
9834. MOTORS, C. E. Calloch, London.
9835. KEY CHAINS, H. H. Lake.—(*R. D. Knight, United States.*)
9836. METALLIC BLOCK PACKING, P. Hulburd, London.
9837. LIFE-SAVING APPLIANCES, C. Stephansen, London.
9838. VEGETABLE OILS, A. G. Salamon.—(*A. Verley, France.*)
9839. CASTORS for FURNITURE, W. Grainger, Birmingham.

13*th May*, 1901.

9840. MOTOR INTERRUPTERS for COILS, H. C. Newton, London.
9841. DOUBLE CHAIN for BICYCLES, T. M. O'Connor, Athlone.
9842. COIN-FREED WEIGHING APPARATUS, E. Jackson, Oldham.
9843. THIN PARTITION WALLS, J. J. Thompson, Northwich.
9844. ELECTRICAL TRANSMISSION DYNAMOMETER, C. V. Drysdale, New Barnet.
9845. APPARATUS for CLEANING WINDOWS, H. Baird, Glasgow.
9846. HEAT MOTORS, J. Atkinson, Marple.
9847. DISCHARGING TEXTILE FABRICS, E. Knecht, Manchester.
9848. AUTOMATIC SUPPLY of TOWELS, W. Garlick, Manchester.
9849. CONVERTED OARS for ROWING BOATS, R. Eastham, Preston.
9850. MECHANISM for MOTOR VEHICLES, J. P. Lea, Birmingham.
9851. STOPPER for BOTTLES, R. St. L. B. Chinnery, Manchester.
9852. AGRICULTURAL DRILLING MACHINES, J. Gillies, Glasgow.
9853. HORSE DRILLER for AGRICULTURAL PURPOSES, J. Gillies, Glasgow.
9854. LIFEGUARDS for MOTOR VEHICLES, C. Musker, Liverpool.
9855. BRACKET for SUPPORTING SHELVES, H. J. Leslie, London.
9856. LIFEGUARDS for TRAMCARS, C. Harris, Glasgow.
9857. HAND or STAND CAMERAS, A. S. Watt, Edinburgh.
9858. STEAM BOILERS, R. Warriner, London.
9859. VALVE SEATINGS, J. and A. Baldwin, Keighley.
9860. BOOT-CLEANING APPLIANCE, G. H. Ellis, jun., Pinner, Middlesex.
9861. FURNACES, P. Döhlert, Manchester.
9862. SUPPLYING AERATED LIQUIDS, S. A. Jackson and L. Lang, Manchester.
9863. LOOM PICKERS, G. Howe and G. T. Brierley, Manchester.
9864. SECURING BLADES to KNIFE HANDLES, H. Davies, London.
9865. OPENING ELECTRIC CIRCUITS, J. D. F. Andrews, London.
9866. SOUND CONDUCTOR, H. Budgen, Cardiff.
9867. BINDING HAIR, D. Meyer-Picard and J. Reischmann, London.
9868. UMBRELLA NOTCHES, J. E. Lloyd and G. E. Smith, London.
9869. SAFETY-PIN for FASTENING SKIRTS, E. Close, Crewkerne.
9870. APPARATUS for CUTTING PIPES, P. Winn, Birmingham.
9871. CLIP for HOLDING MATTRESS SPRINGS, J. E. James, London.
9872. SUNSHADE SUPPORTS for CYCLES, S. A. Say, London.
9873. PIN for WEARING APPAREL, R. Reibetanz, London.
9874. HOOK, A. Brockelbank, New York, U.S.A.
9875. ROSES for WATERING-CANS, C. H. Hill, Birmingham.
9876. KETTLE HANDLES, C. H. Hill, Birmingham.
9877. BICYCLE BRAKES, H. King, Nottingham.
9878. PLAYING-CARDS for the BLIND, F. E. Palin, Hounslow, Middlesex.
9879. VIEWING LIVING PICTURES, E. B. Koopman, London.
9880. SAFETY DEVICES for RAILWAYS, E. Parry, Mortlake, Surrey.
9881. SELLING COFFEE BEANS, &c., L. Schweighofer, London.
9882. ARC LAMPS, G. M. Lane, London.
9883. MOTOR CONTROLLERS, A. O. Fox, London.
9884. MATRICES for STEREOTYPE PRINTING, W. M. Rockstroh, London.
9885. INKSTANDS, L. I. Perry, London.
9886. WATER PROPELLERS, W. E. J. Vavasour, Tadcaster, Yorks.
9887. BAYONETS, H. M. Percy, London.
9888. MANUFACTURING CONICAL TUBES, E. Bock, London.
9889. DRIVING MECHANISM for CYCLES, F. T. Roper and E. J. Reeks, London.
9890. TREATMENT of RESIDUE, J. Y. Johnson.—(*The Deutsche Continental Gas Gesellschaft, Germany.*)
9891. APPARATUS for CONCRETE BUILDING, T. C. Farrell, London.
9892. MANUFACTURE of ARTIFICIAL STONE, H. E. Carter, London.
9893. GUN MOUNTINGS, A. T. Dawson and G. T. Buckham, London.
9894. TYPE-SETTING MACHINES, A. J. Boult.—(*F. B. Converse, jun., United States.*)
9895. DIES for CUTTING THREADS, J. A. Wilding, London.
9896. SELF-PROPELLED ROAD VEHICLES, E. Andreas, London.
9897. MANUFACTURE of SOAP, B. Crowther, jun., London.
9898. PRESERVING EGGS, K. E Fryklind, London.
9899. TYPE JUSTIFYING MACHINES, A. J. Boult.—(*F. B. Converse, jun., United States*)
9900. PNEUMATIC TIRES, M. Rath, Anerley, Surrey.
9901. AUTOMATIC GOVERNORS, E. E. Glaskin, London.
9902. FIXING BOLTS in WOOD, J. V. E. Thiollier, London.
9903. VOLATILE ELEMENTS, The British Aluminium Company, Limited.—(*A. H. Cowles, United States.*)
9904. ENVELOPES, A. Roebelen, London.
9905. PAPER MAKING MACHINES, E. Ribal, London.
9906. SMOKE CONSUMERS, J. W. Heaton and E. E. Holmes, London.
9907. CASTING TYPE, H. J. S. Gilbert-Stringer, London.
9908. PIPE COUPLINGS, A. G. Bloxam.—(*C. A. G. Storz, Germany.*)
9909. DEVICE for HOLDING WOOL, &c., F. Digby, London.
9910. LAMPS, P. H. Leach, London.
9911. MINING ENGINES, Sir T. Wrightson, Bart., M.P., and J. Morison, London.
9912. BICYCLE STAND, H. C. E. Newton, London.
9913. MOTORS, A. E. Farrow, London.
9914. MANUFACTURE of CHAIN, L. Wirtz and F. Freeman, London.
9915. ELECTRIC MOTORS, W. H. Flood and A. E. Honey, London.
9916. HOLDERS for DYNAMO MACHINES, W. H. Flood and A. E. Honey, London.
9917. APPARATUS for PROPELLING SHIPS, G. Woodruffe, London.
9918. SKIRT HOLDER, S. Guiterman.—(*A. Messler, United States.*)
9919. WIRE RODS, J. B. Stone, London.
9920. TREATING RUBBER, J. Thame and The South Western Rubber Company, Limited, London.
9921. GAME MARKER, T. A. Hunt, London.
9922. SPEED-CHANGING MECHANISM, A. T. Cooper, London.
9923. PIPE WRENCHES, A. F. Jackson and W. W. Whitehead Company, London.
9924. BOILERS, J. Cowan, London.
9925. PULSATING CURRENTS, H. C. Newton and R. S. Wright, London.
9926. TRANSMISSION DYNAMOMETERS, E. G. Coker, Montreal.

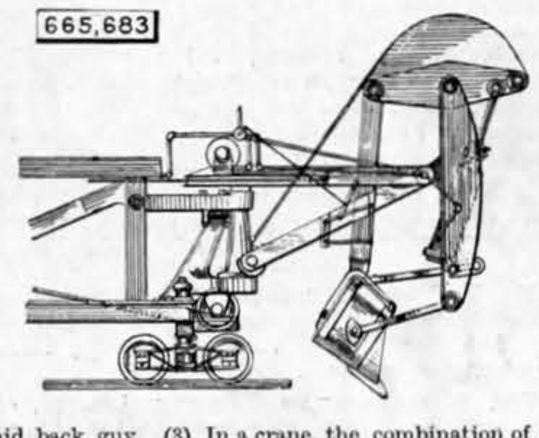
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

665,683. CRANE, *O. Hetlesaeter, Chicago, Ill.—Filed February 8th*, 1900.

Claim.—(1) A metallic frame having a spreading base and an upwardly-projecting stem forming a support for the supporting bearing of the mast of a crane, said frame having also near its lower portion a forwardly-projecting foot forming a lateral brace for the lower part of said mast. (2) In a crane, the combination of laterally-swinging parts forming the crane arm, a mast pivotally suspended and carrying said swinging parts, a back guy wherein said mast is suspended, a mast frame whereon said back guy bears, said frame having means for laterally bracing the lower extremity of said mast, and means for bracing

665,683

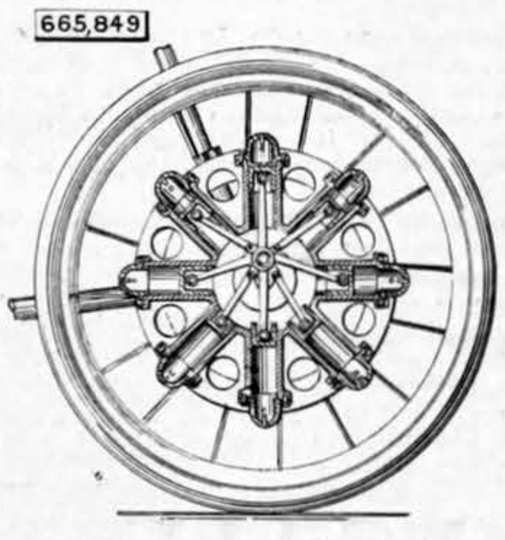


said back guy. (3) In a crane, the combination of a swinging crane arm, a mast for supporting said frame, a back guy for bracing said mast, a mast frame supporting said back guy and adapted to be mounted upon the forward extremity of a supporting structure, a foot extending in a forward direction from said mast frame for laterally bracing the lower extremity of said mast, and braces for said back guy. (4) In a crane, the combination of a mast, a mast frame whereby said mast is supported at a point beyond the structure whereon said frame is mounted, and lugs upon said frame whereby the crane may be laterally braced.

665,849. INTERNAL-COMBUSTION MOTOR, *C. F. Bergmann, Jersey City, N.J.—Filed September 5th*, 1899.

Claim.—An internal-combustion motor comprising a series of rotating cylinders and pistons therein connected with a common crank pin, said motor being provided with ports leading from both ends of the cylinders toward the crank centre, and a valve having ports adapted to communicate with the cylinder ports to alternately connect one end of the cylinders with the supply of combustion mixture, and with the

665,849

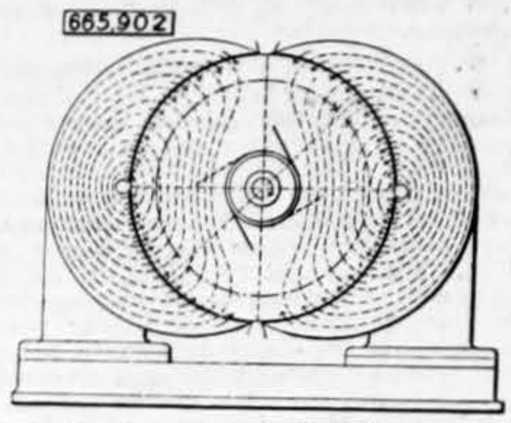


opposite end of one of the cylinders whereby one end of the cylinders is used to compress the combustion mixture and the other for its ignition, means for igniting the mixture in the latter end of the cylinders, and means for shifting the valve and the igniting mechanism to introduce the combustion mixture to and ignite it in the cylinders upon opposite sides of the dead centre, substantially as described.

665,902. DYNAMO-ELECTRIC MACHINE, *H. E. Heath, Windsor, Conn.—Filed June 7th*, 1900.

Claim.—(1) A dynamo-electric machine having unwound pole pieces and a wound armature with the planes of commutation of the armature circuits arranged to intersect the pole pieces in a manner that will create magnetic flux through the armature, and each pole piece of such shape that approximately one-half of the effect of the magnetic flux in one direction between the armature and the pole piece will neutralise the effect of the other half of the magnetic flux in the same direction between the armature and the same pole piece, leaving the full flux in the opposite direction between the armature and that pole piece to exert operative polar effect, substantially as specified. (2) A dynamo-electric machine having unwound magnetically-separated poles and a wound armature with the planes of commutation of the armature circuits arranged to intersect the pole pieces in a manner that will create magnetic flux through the armature, and each pole piece of such shape that approximately one-half of the effect of the magnetic flux in one direction between the armature and the pole piece will neutralise the effect of the other half of the flux in the same direction between the armature and the same pole piece, leaving the full flux in the opposite direction between the armature and that pole piece to exert operative polar effect, substantially as specified. (3) A dynamo-electric machine having unwound pole pieces and a wound armature with the planes of commutation of the armature circuits so arranged that the armature currents create magnetic flux through the armature and each pole piece, the centre of which magnetic flux is approximately midway of the length of the pole piece, substantially as specified. (4) A dynamo-electric machine having unwound pole pieces and a wound armature with the planes of commutation of the armature circuits

665,902

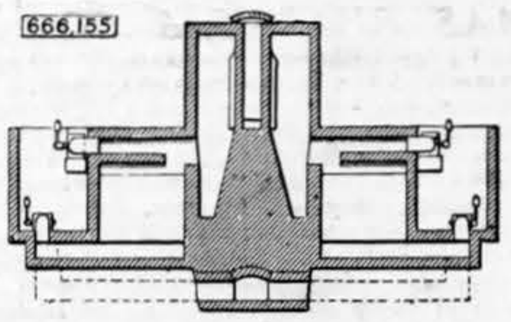


arranged to intersect the pole pieces at approximately one-fourth of their length, whereby equal portions of the armature currents in opposite directions are neutralised by the magnetic flux that is created by the currents in the armature windings in one direction between the armature and each pole piece, substantially as specified.

666,155. METALLURGICAL FURNACE, *A. Reynolds, Sheffield, England.—Filed May 29th*, 1900.

Claim.—A metallurgical furnace having therein a vessel to contain the mineral or metal treated, said vessel having end walls supported against the furnace

666,155

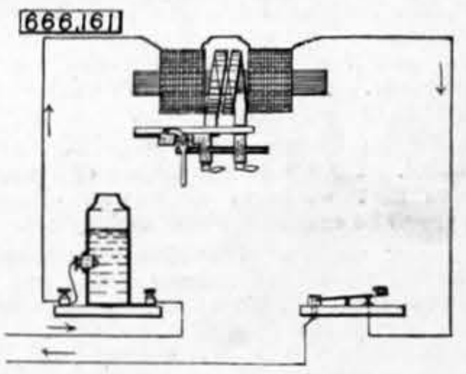


casing, and unsupported side walls which are curved inwardly, and means for directly heating said side walls, substantially as described.

666,161. ELECTRIC METAL-WORKING APPARATUS, *E. Thomson, Swampscott, Mass.—Filed July 3rd*, 1899.

Claim.—(1) In an electric metal-working apparatus, the combination, substantially as described, of a transformer having an open magnetic circuit core and heavy secondary connected to the work clamps, a source of continuous current, and a rapid absolute interrupter included in the circuit of the primary and said continuous-current source, as and for the purpose

666,161

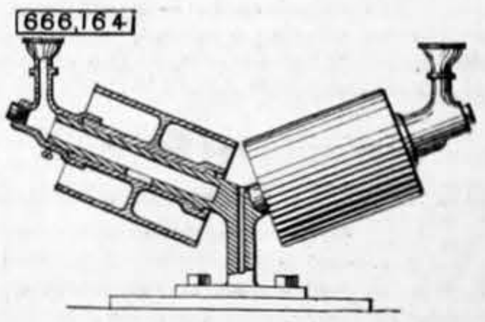


set forth. (2) In an electric metal-working apparatus, the combination, substantially as described, of a transformer having an open magnetic circuit core and heavy secondary connected to the work clamps, a source of continuous current, and an electrolytic interrupter in the circuit of the primary and continuous-current source, as and for the purpose set forth.

666,164. ROLLER MECHANISM for CONVEYOR BELTS, *J. Titus, Oyster Bay, and W. Titus, North Hempstead, N.Y.—Filed May 23rd*, 1900.

Claim.—The combination with a standard having an inclined laterally-extended tubular journal which has a circumferential fillet at its lower end and the bore of which is closed at its lower end and provided with a lateral outlet opening, of a roller the hub of which

666,164

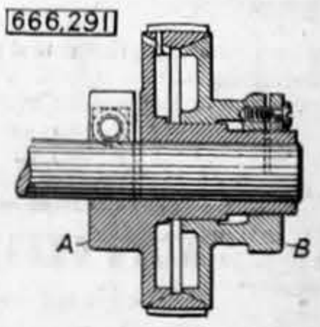


abuts against the fillet and has a collar which is extended over and around the fillet, and fast on the extended upper end of the journal and having an inlet opening, a shoulder which abuts against the upper end of the hub of the roller, and a collar which extends beyond the shoulder over and around the adjacent upper portion of the hub, the whole arranged for joint use and operation, substantially as herein set forth.

666,291. EXPANSIBLE PULLEY, *S. W. Wardwell, jun., Providence, R.I.—Filed June 14th*, 1900.

Claim.—(1) The within-described expansible pulley, comprising two parts having bevelled edges, one adjustable in respect to the other, a split band fitting the bevelled edges of the parts, and connected to rotate therewith, and to be expanded and contracted by the adjustment of the parts, substantially as described. (2) The combination of the section A having

666,291



a threaded hub and an annular bevelled face, the section B adapted to said threaded hub, and with an annular face bevelled in the opposite direction, with means for securing the sections in relation to each other after adjustment, and a split band adapted to said bevelled faces, substantially as described.