benches, in front of which, arranged on trestles, the processes of marking out and fitting up the frame plates of engines and tenders are in operation. In the centre of the illustration an excellent view of one of the walking cranes is to be had. On the right-hand side, and in the foreground of the illustration, a large multiple drilling machine stands, which is employed almost exclusively in drilling frame plates two at a time, while slotting machines, not seen, are at work shaping out seven of these plates simultaneously. In this machine shop there are over 400 machines for all purposes. Our readers will be well aware of the general kinds of tools to be found in shops of this description, and we shall therefore only refer at length to one or two special machines. It should, however, be stated that, as is to be expected in a works of such long standing as those at Derby, there are a great many old-fashioned tools doing work of which their original designers never could have conceived them capable. Some credit for this must be given to an enterprising management, and more particularly to the chief of the department, who, by means of numerous ingenious devices, has probably saved such machines in several instances from the scrap-heap. Credit must also be given for a well arranged and stocked gauge and template stores, where the hand can be put at once upon the desired article. All the gauges, template dies, and stocks are made and hardened in this shop, while there is also provided testing apparatus for steam, automatic vacuum and Westinghouse brakes, having its own special boiler.

Returning to the machine tools, possibly the most interesting in the shop is a milling machine, designed and constructed at Derby—shown in Fig. 16, page 588—for cutting out to the required size the portholes of the engine cylinders. This is a movable appliance which can be bolted to the cylinder casting, and is driven from the shop shafting by rope gear. The main frame of the machine is provided with a horizontal transverse slide, upon which can be moved, automatically or by hand, the headstock shown. The headstock carries a protruding arm, through which runs a horizontal shaft, carrying at one end the rope pulley and at the other bevel gearing, by means of which the milling cutter is caused to rotate. The method of finishing out the ports is practically a copying process, the template and guide screw which control the movement of the arm being secured upon an entablature above the arm, as shown. When one port is milled out all round its edges the machine is set for the next port, and so on. Owing to the very hard nature of the iron employed in the cylinder castings, the cutter is made to rotate very slowly, actually making only about thirty turns per minute, and the teeth of the cutter are arranged obliquely instead of vertically, so as to allow the cuttings to free themselves more easily, and so prevent the burring of the port edges. Although the milling cutter is driven at a comparatively slow speed, the machine must be considered economical in labour, as it does not require a man's sole attention, the attendant dividing his time between this and a planing machine. Six cylinder boring machines are kept in constant work with only a single attendant. These tools, besides boring, also face up the cylinders, and the whole process is done in two operations, the first comprising three cuts and the second one finishing cut.

Three interesting emery grinding tools are employed for imparting a finish to the insides of holes and slots of case-hardened steel motion gear. These are shown in Fig. 27 of our illustration on page 591. For cleaning out circular holes the emery wheel is driven by rope gearing at a peripheral speed of 3000ft. a minute, and by an ingenious arrangement of mechanism on the spindle, rotates excentrically with the axis of the hole being operated on. To allow of this the wheel has, of course, to be correspondingly smaller in diameter than the hole. The feed of the spindle vertically is automatic, while the headstock can be moved laterally by means of gearing. For finishing the slotted links an arrangement shown in the foreground of the illustration is shown. The table carrying the link is caused to reciprocate through an arc of a circle corresponding to the radius of the link by means of suitable gearing driven from the shop shafting overhead, the correct radius being obtained by means of a rod with a movable pivot which can be adjusted along a slide bar bolted to the frame of the machine, while the emery wheel is rotating at a high speed. These machines are the manufacture of Messrs. Beyer, Peacock, of Gorton, in Manchester, the eminent locomotive building firm. In addition to the locomotive work all the stationary engines and hydraulic pumps are made in this department, which employs about 550 hands.

Running parallel with the machine is the fitting shop, in which some 190 men are employed on detail work such as motion fittings, cylinders, pistons, axle-boxes, connecting and coupling rods, before being transferred to the adjacent erecting shop. This shop is also provided with two walking cranes, and a portable hydraulic riveter with its own pumps and accumulator, but otherwise calls for no special remark.

THE ERECTING SHOPS.

There are two of these, the principal one shown in the illustration on page 586 being a very fine shop, 450ft. long, comprising three 50ft. bays, each with three pits, and is capable of accommodating altogether about 108 engines. Two rope-driven travelling cranes, capable of carrying a weight of 25 tons individually, are provided for each bay.

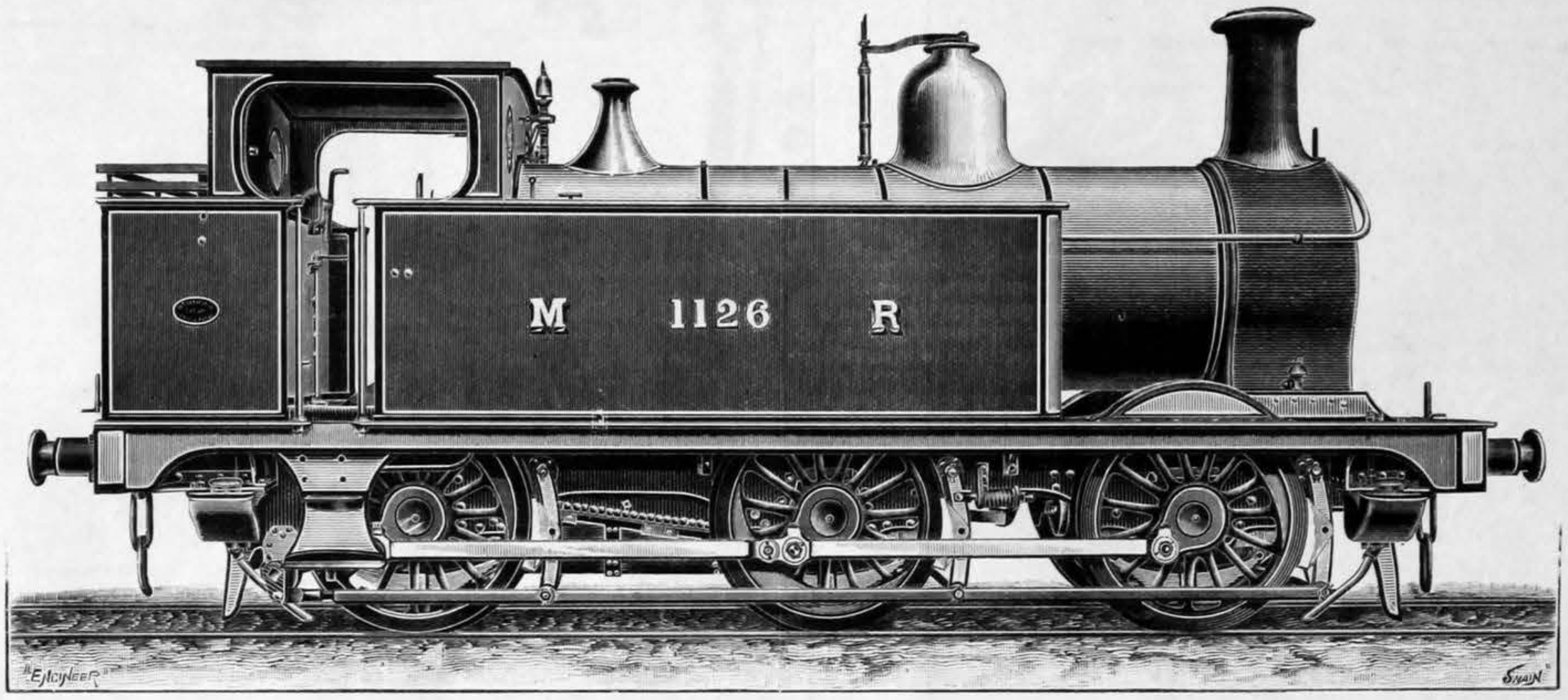

Fig. 20—SIX WHEELS COUPLED TANK ENGINE

These cranes traverse longitudinally at a speed of 50ft. per minute, and transversely at about 16ft. in a similar period, while two speeds for lifting and lowering are arranged, the highest being at the rate of 9ft., and the lowest 6ft. per minute. The driving rope, 1in. diameter, runs at a speed of 2000ft. per minute. The number of hands at work in this shop at the time of our visit was 409. The total output for 1894 was 850 engines, comprising forty new engines and eighty "rebuilds," the remainder being under heavy or ordinary repairs. A system of piecework is in vogue in this department. Usually a gang of four men and two lads work together on each engine, the leading hand contracting to complete his job for a fixed amount, that is, as regards labour only. While the work is in progress, the hands receive a fixed weekly wage, and this is supplemented when the engine is finished by the division of the balance, if any. All engines having been on the road a certain period, varying, we are informed, between three and five years, and not requiring heavy repairs, are brought into this shop and tested under steam with a view to finding out defective tubes and joints. The method of procedure in erecting a locomotive must, of necessity, be generally the same in all shops, but for the benefit of such of our readers as have not had an opportunity of following the complete process, we may briefly describe it. The frames, which are of steel, one inch thick, after having been machined, are fitted with their hornblocks before entering this department. When brought into the erecting shop, the motion brackets, angle irons, &c., for carrying the platform and boiler, are bolted or riveted on before the frames are placed in position to receive the cylinders, which are squared with the driving hornblocks, and then fastened in position. The next process is to set and rivet the

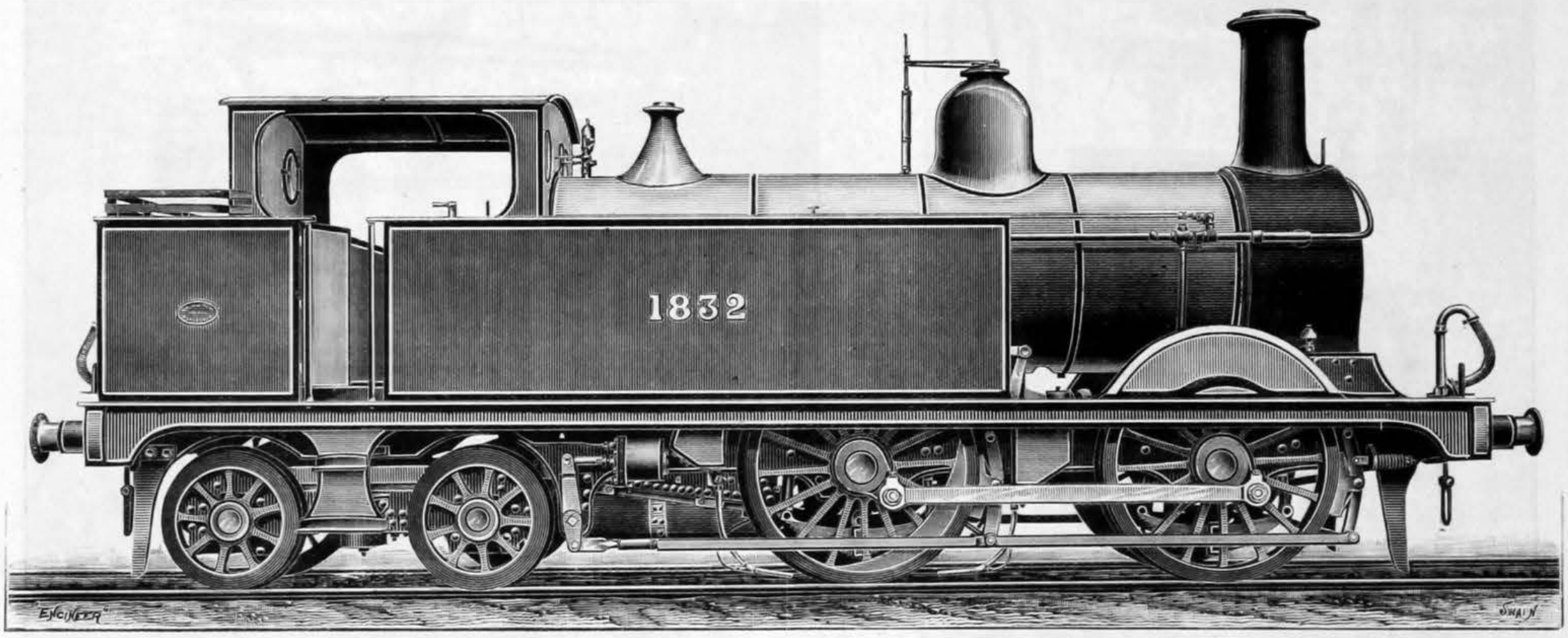

Fig. 21—FOUR WHEELS COUPLED BOGIE PASSENGER TANK ENGINE

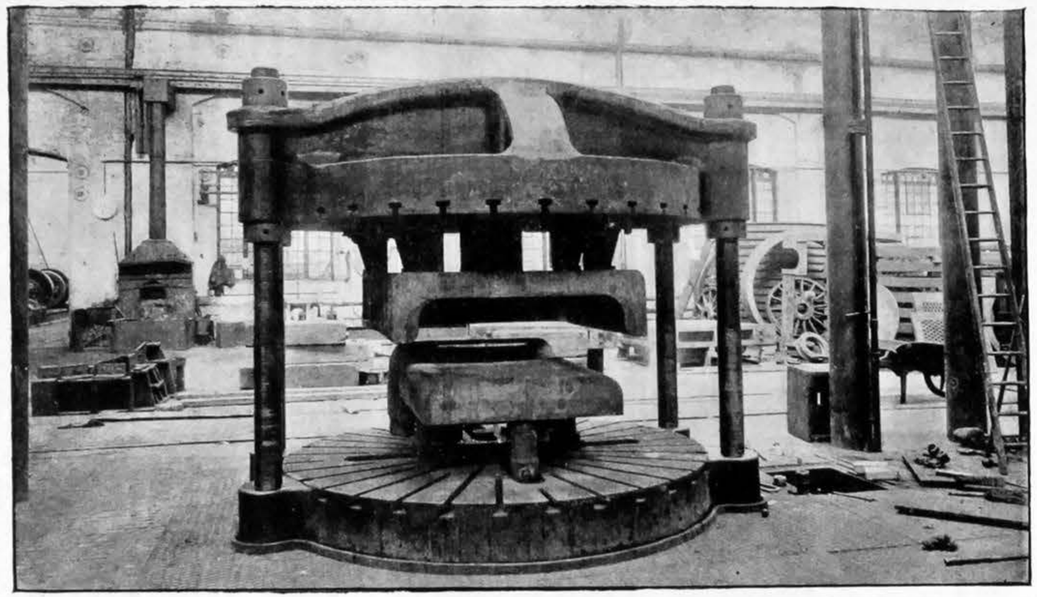

Fig. 22 - HYDRAULIC FLANGING PRESS

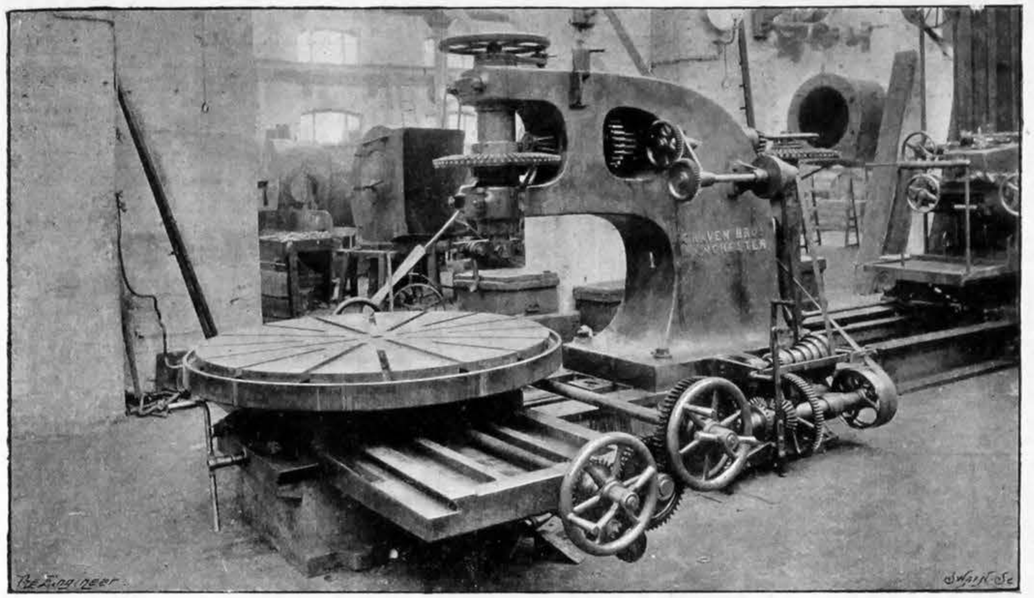

Fig. 23—OVAL HOLE CUTTING AND MILLING MACHINE

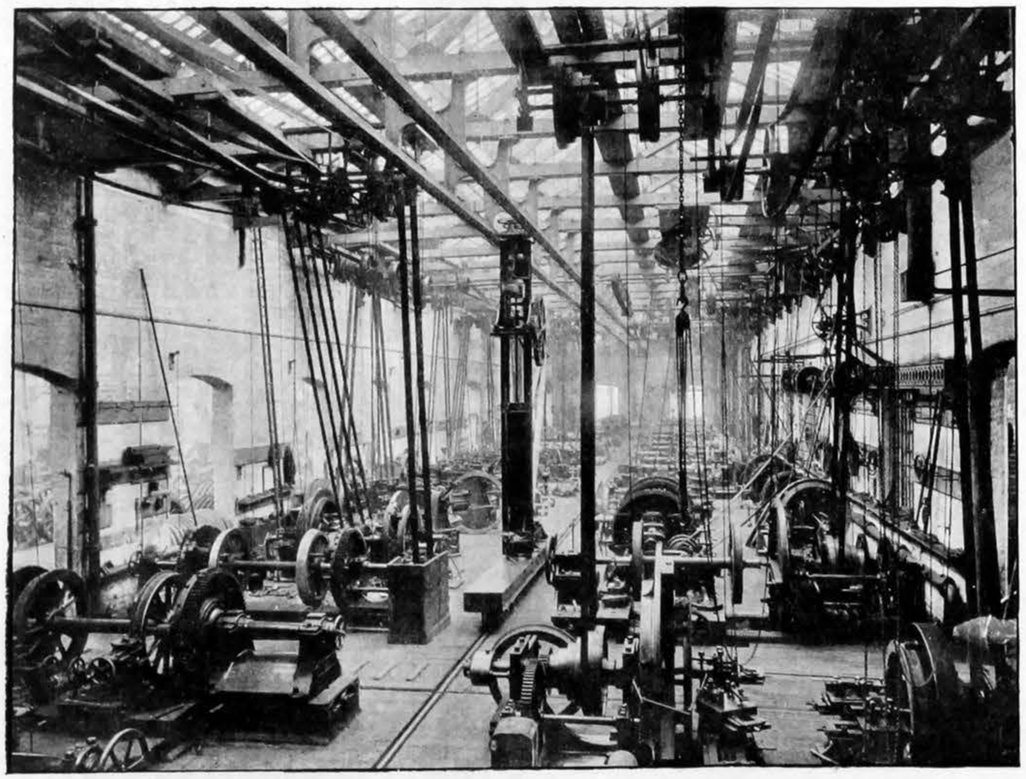

Fig. 24—WHEEL SHOP, SHOWING WALKING CRANE

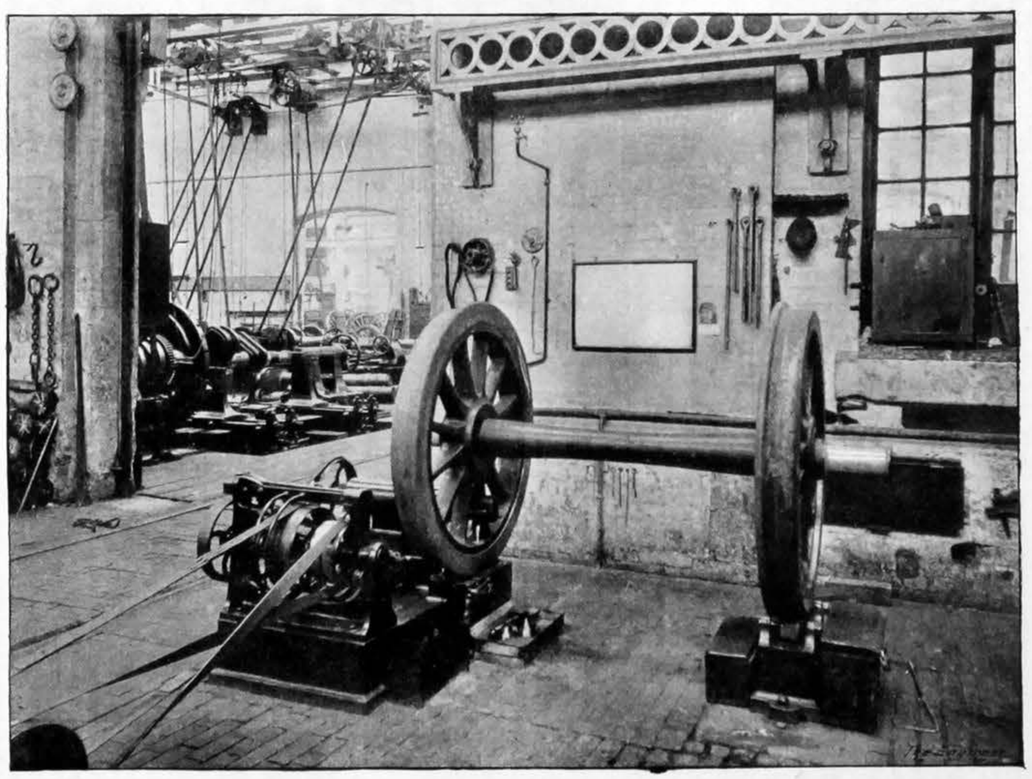

Fig. 25—WHEEL RIM AND TIRE DRILLING AND TAPPING MACHINE

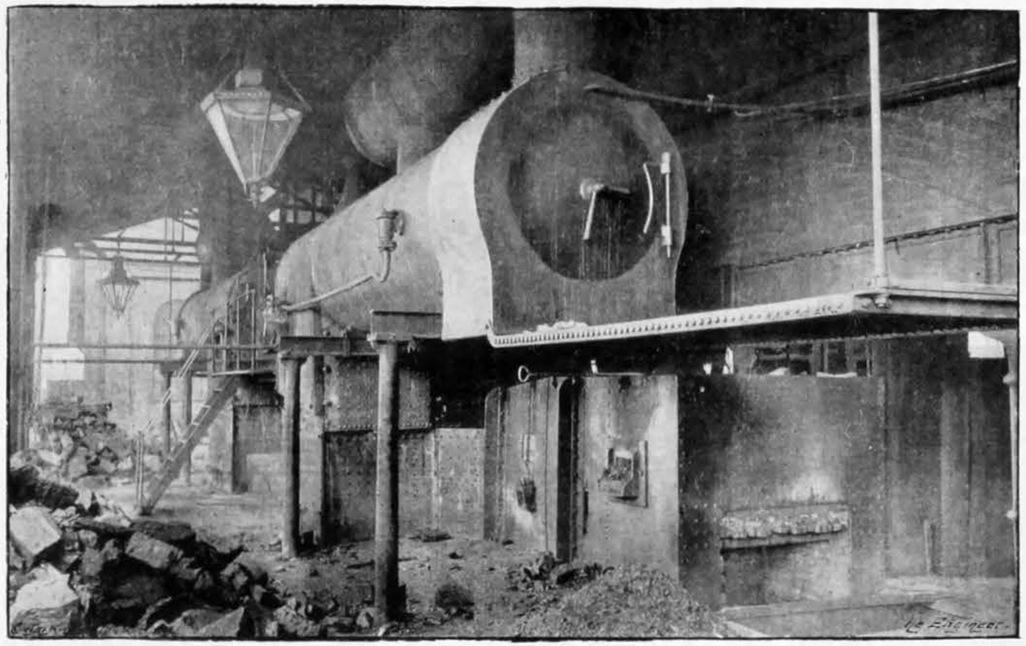

Fig. 26—LOCOMOTIVE BOILERS HEATED BY WASTE GASES FROM SCRAP FURNACES

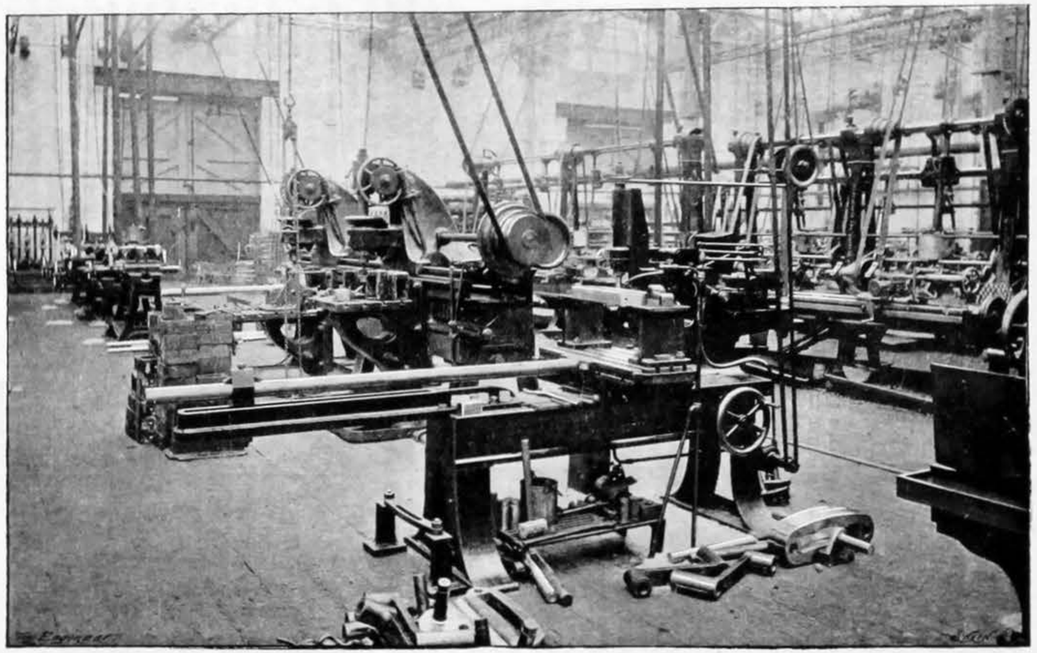

Fig. 27—EMERY MACHINES FOR FINISHING SLOTTED LINKS

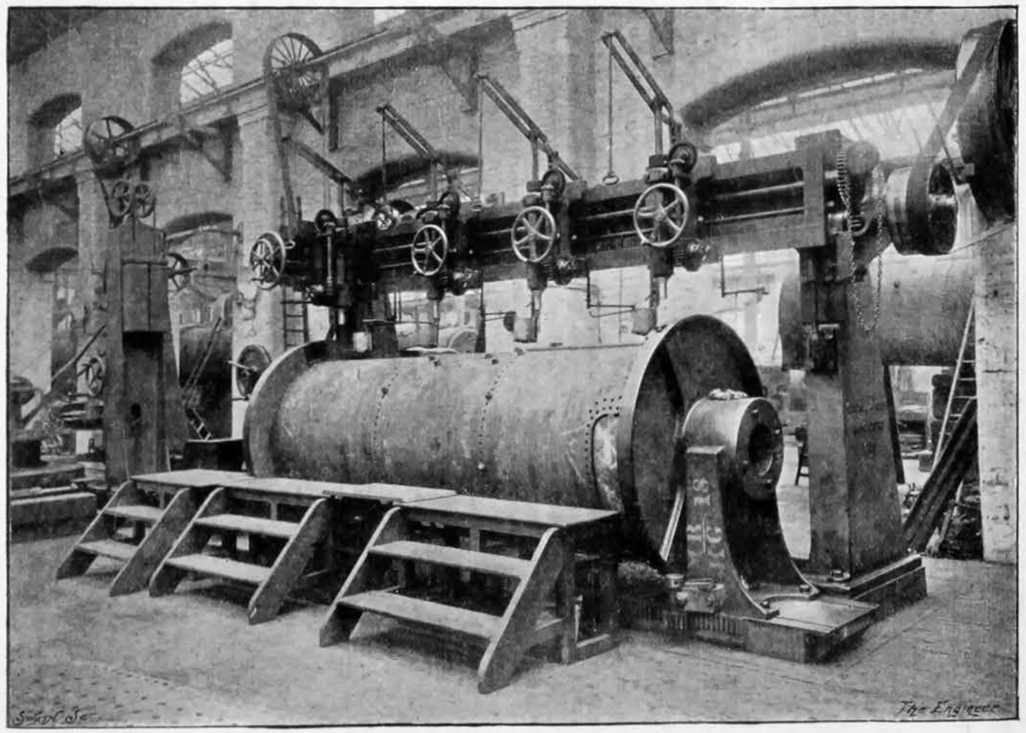

Fig. 28—BOILER SHELL PLATE DRILLING MACHINE

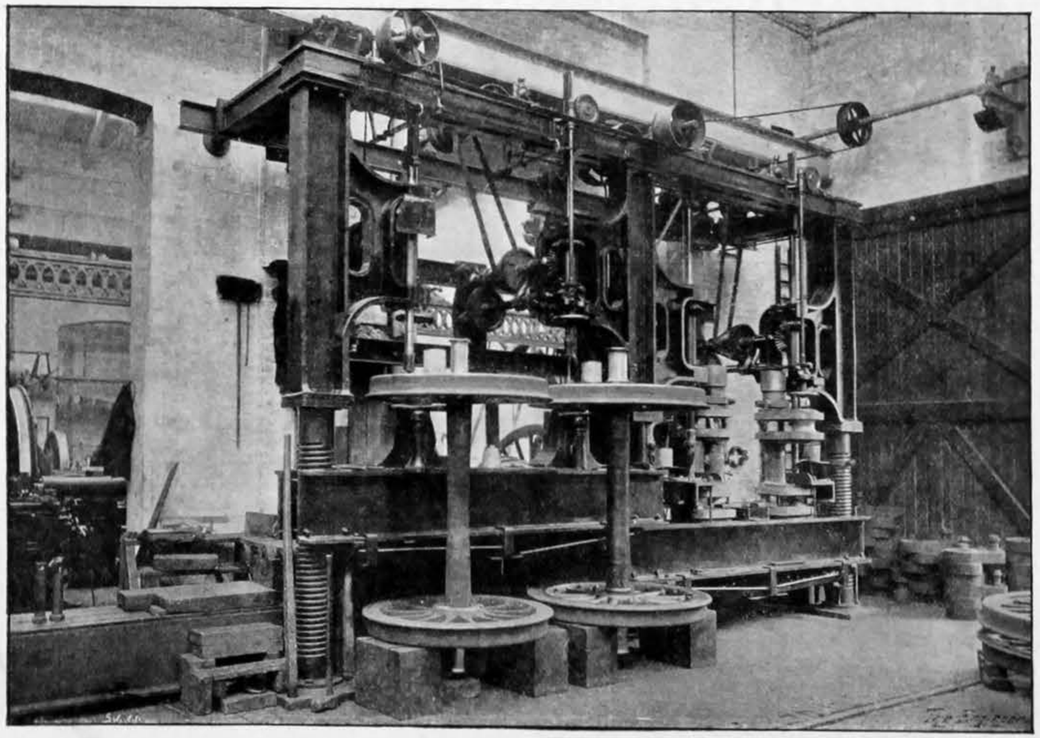

Fig. 29—CRANK AXLE DRILLING MACHINE

steel motion bracket plate previous to the fastening of brackets and angle irons for the reception of the boiler. The latter being placed, the slide bars, motion bracket and reversing shaft are then adjusted, the running board riveted down, and splashers fitted and riveted. In the case of a bogie engine, the centre pin casting, which is of steel, is then secured in its place between the frames and under the cylinders, after which the engine is ready to receive its wheels. The bogie frames are fitted in the fitting shop in like manner to the engine frames, and are then transferred to the erectors, who fit the slide brackets for the bogie casting in position. The steel centre casting is next fitted to the slides, and the frames are then ready to receive the wheels, which have previously had their axle-boxes, &c., supplied and secured. After this the carrying springs and Timmis springs are placed in position, the whole of the wheels put under the frame, and the slide valves set. It may be pointed out that the Timmis is a helical spring employed horizontally on either side of the bogie centre-pin to take up the lateral play of the bogie. Similar springs, placed vertically, are now employed under the driving axles of express engines in place of the usual carrying springs, it having been found that they are much more sensitive than the former. The arrangement of these springs will be seen on the illustration of the engine No. 2199, given on our four-page supplement. The injectors, valves, steam brake cylinder, brake hangers and blocks being supplied, the engine now receives a coat of paint, known as "priming," before being sent for trial under steam, and finally to the paint shop. We noticed that in the building up of the frames of bogie engines, in order to allow of the lateral play at the leading end, each frame is built up of two plates, put together with a lap joint, about 2ft. 8in. long, just

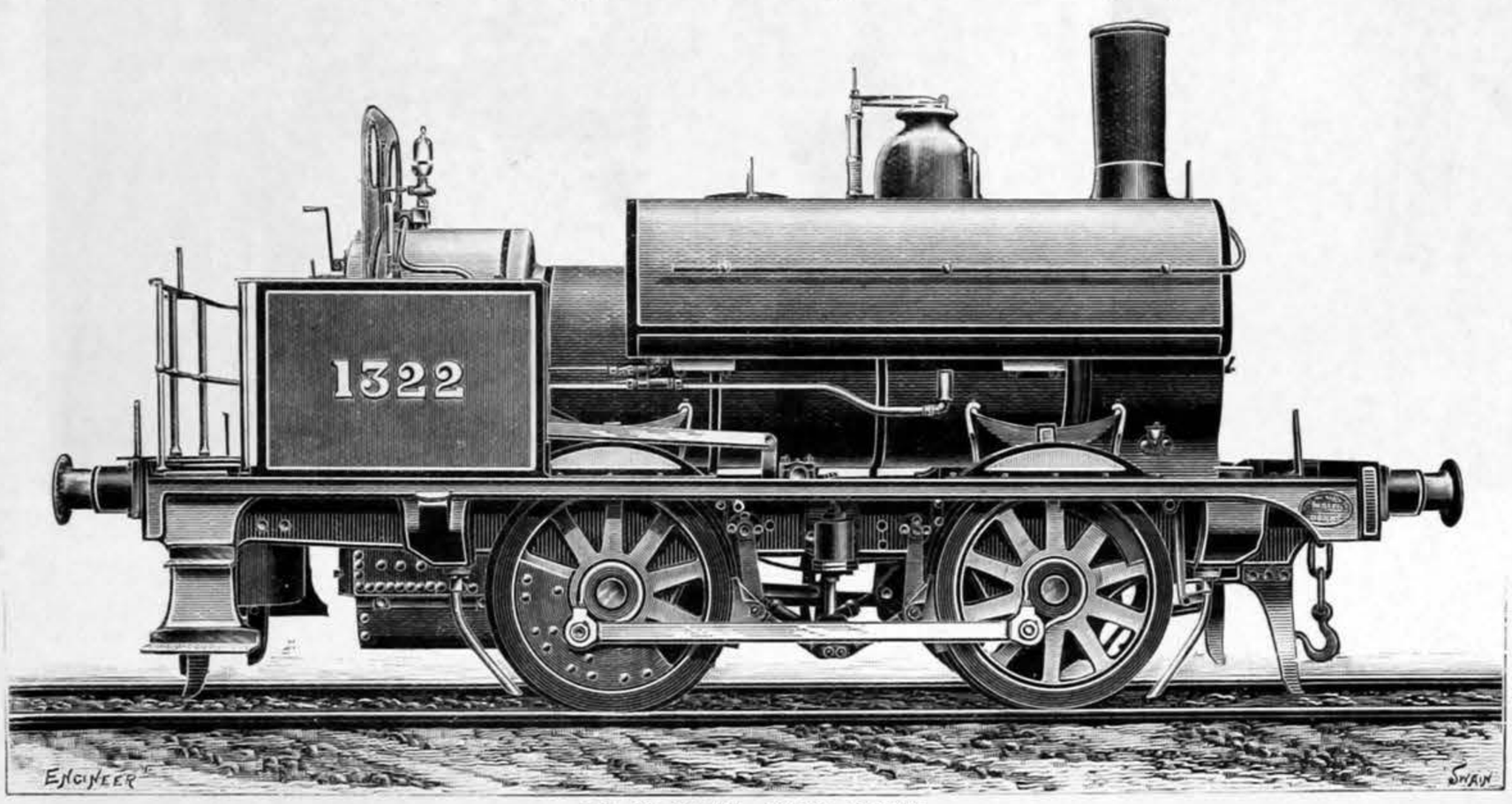

Fig. 30—SMALL YARD ENGINE

behind the motion plate, and secured by eighteen 1¼in. bolts. The plates are 1in. thick, and the ends for the lap joint are planed from ⅛in. to nothing; this keeps the joint to its full strength and gives 1¾in. more space between the frames for the cylinders. Another feature in the construction of the frames, the importance of which will be obvious, is the rounding off of the edges of the plate in the recess for receiving the driving wheel axle-box, where the chief stress due to the jarring caused by uneven roads is felt. The smaller erecting shop employs about 100 men, and has eleven pits capable of holding altogether fourteen engines. It is chiefly occupied in repairs and rebuilds.

TENDER SHOPS.

These shops strike one somewhat disappointingly after the excellent buildings devoted to the boilers, machine and erecting shops. Altogether they find work for ninety-five men, and provide space sufficient for the erection of twenty-nine tenders. Each shop is provided with a rope-driven overhead travelling crane of 20 tons capacity, and there is sufficient head room to lift a tender and carry it above its fellows. One of the most noteworthy jobs which we witnessed in this department was the alteration of the situation of carrying springs. These used formerly to be placed within the frames, where they were very inaccessible. In all new tenders and "rebuilds" these springs are now situated outside the frames. From the tender shops we enter the lagging shop, so called because all the clothing for the boilers is provided here. The cutting out of steel plates for the construction of the weather cabs is also done in this shop, like cutting up so much paper with a pair of scissors. It is done with great rapidity upon a pair of circular shears by a couple of men. The shears are driven by power, and the plates are previously marked out to the desired shape. The boilers of Midland locomotives are lagged with silicate cotton, otherwise known as "slag wool," which is incombustible. This is laid on the boiler to the extent of several hundredweights, and is kept in place with zinc sheeting. The whole is then covered with smooth steel plates and hoops.

THE PAINTING SHOP.

The last, but by no means the least, important as regards size, is the painting shop, which comprises two bays 45ft. wide and 450ft. long, and will hold about fifty engines of different types. Provided with its own paint mills and steam boiler for the heating apparatus, by the latter of which a constant temperature of about 70 deg. is maintained in the winter months, this shop is independent of extraneous aid from other departments. In addition to an average annual turn-out of 650 completely newly-painted locomotives and a large number of engines which receive only partial treatment, a large amount of work is done of a general nature. When a new engine comes into this shop all rust and scale is thoroughly cleaned off, prior to its receiving two coats of lead-coloured paint. After this, all defective surfaces are stopped or filled up with a mixture of gold size and dry white lead before being thoroughly rubbed down with pumice-stone and water to obtain a perfectly smooth surface. The engine then receives four coats of purple brown or chocolate colour, and finally one coating of a mixture of paints of crimson lake and purple brown colour, which gives the standard Midland tint. After being lined or picked out with black and yellow, and having had the brake work, platforms, &c., painted black, five coats of varnish are applied. The engine is then allowed to dry for from four to six days previous to being removed.

THE RUNNING SHEDS.

There are four running sheds at Derby, the largest and most modern of which is shown in our illustrations on page 586. This shed contains two turn-tables, round each of which radiate twenty-four pits, two of these being provided with sheer legs. The other sheds are smaller, and contain only one turn-table each. The number of drivers registered in this department at Derby alone is 167, and about a similar number of firemen are found continual employment. If additional drivers are required, as frequently happens, these are drawn from the firemen, some of whom have passed examinations qualifying them for the duties, while their places, again, are filled by cleaners who have qualified for firing duties. The engines are cleaned every trip, and a staff of fitters is employed in inspecting them at similar periods. When the boilers require washing out—a process which they undergo at certain various intervals—they have their fires withdrawn, and are first allowed to stand for about a couple of hours, so as to prevent the liability of damaging the joints by unequal expansion and contraction. About three hours is allowed for the raising of steam before the engine leaves the shed, and, starting with a cold boiler, this involves the consumption of 4 cwt. of coal. Of course, with engines in regular work, the boilers are only allowed to become really cold when being washed out. When booking off duty, each driver enters on a sheet the quantity of coal, oil and cotton waste he was supplied with, and the mileage made during his trip. He is also supposed to report any repairs required to his engine, together with any unusual circumstance which may have happened on his journey. As will be readily imagined, it is no easy task to divide equally the hours of labour of engine drivers and firemen, whose journeys are of such different lengths, and a system in which a hard-and-fast line can be drawn giving a fixed number of hours per diem to each, has yet to be discovered. It rests with the foreman of the running department, therefore, to divide out the work in as equitable a manner as possible. Connected with the running department is a coal stage for supplying the fuel to the engines. On page 594 we are enabled to give a view of this stage, which, it will be seen, is divided longitudinally by a wall, and has a line of rails on each side. Two lines of rails, with "blind" ends, pass through it at an incline of 1 in 25, and up this incline two trains of coal trucks are run and braked, so that they can be run down by gravity as required. The coal is taken from them by hand, and placed in small hand trucks on the platforms 11ft. 6in. above the rail level, and from these platforms the coal is tipped from the hand trucks into the tender below. As each truck of the coal train is emptied, it is allowed to run down the incline, and a fresh one brought in.

GENERAL.

In the yard, near the offices, a multiple platform weighing machine is provided for ascertaining the weight on each of the wheels on a locomotive. This is done simultaneously by running the engine on to a divided platform, each division of which has its own machine. We were struck by the nicety with which the weights could thus be taken. For instance, an engine is brought on the machine and the weights on the different steel-yards adjusted until a perfect balance is effected. An attendant then proceeds with a hammer, and by tapping the pins of the carrying springs of the engine, to bring them to a normal state, causes a final redistribution of the weights, which is at once shown on the yards, rendering a further adjustment necessary.

Most of the water used in the works at Derby is obtained by the company's own pumping engines from the river Derwent, and undergoes a softening and purifying process in a plant capable of treating 30,000 gallons per hour. This apparatus is the combined patent of Messrs. Archbutt and Deeley, but is made by Messrs. Mather and Platt, and has been at work since 1892 with successful results. As we had occasion to give some particulars of the process in a recent number of The Engineer, in connection with some experiments made on plant erected near Manchester, it will be unnecessary to give more than a general description of the apparatus employed at these works. It may be stated that the water, before treatment, is very bad, as the following table of its analysis will show:—

	Grains per gall.	
Calcium carbonate	9·74	Containing CaO = 7·78 grains.
Calcium sulphate	5·64	
Magnesium carbonate	2·45	Containing MgO = 1·62 grains.
Magnesium sulphate	1·35	
Sodium sulphate	3·41	
Sodium chloride	2·81	
Silica	0·34	
	25·74	
Calculated hardness	17·9 deg.	

After treatment by the Archbutt and Deeley process, the hardness is reduced to about 4 deg. The reagents employed for Derwent water consist of lime and sodium carbonate, with about ⅜ oz. of alumino-ferric per 1000 gallons of water. The water to be treated is introduced into a large tank, into which are afterwards admitted the chemicals in the form of a boiling solution, the whole being thoroughly mixed by means of a steam jet arrangement called a "trajector." The proper admixture of the chemical solution and the hard water only requires a few minutes, and the trajector is put out of action. Subsequently, to expedite the clarification process and cause the precipitate to fall rapidly, jets of air are blown into the water from below by means of a number of perforated pipes and a steam jet, so as to stir up the accumulated mud. After the blower has been in operation for about fifteen minutes the steam is shut off and the water allowed to rest for another thirty minutes, when the precipitate will have settled and the water can be drawn off. Although rendered soft and clear enough for most practical purposes by the above process, it has been found that a soft, sticky deposit formed in the feed valves, injectors and pipes, which was quite as objectionable as the formation of scale in the boilers by the water in its original condition. To prevent this the water, in being drawn off, is carbonated by causing fuel gas from a coke stove to mix with it by an ingenious device. This addition to the apparatus has the effect of rendering permanently soluble the trace of hardening matter retained by the water.

LOCOMOTIVES.

The locomotives built by the Midland Railway are of six standard types, as follows:—(1) Express passenger engines, with a single pair of driving wheels and bogie in front. (2) Express passenger engine, with four wheels coupled and bogie. (3) Four wheels coupled bogie passenger tank engines. (4) Six wheels coupled goods tender engines. (5) Six wheels coupled goods tank engines. (6) Four wheels coupled small goods engines.

By the courtesy of Mr. Johnson we are enabled to give illustrations of one of each type of engine. The four wheels coupled bogie passenger engine, fully illustrated in our supplement, is representative of the engines which undertake the heaviest passenger work on the main line, Full particulars will be found in the following table:—

Four Wheels Coupled Express Passenger Engine, Cylinders 18½in. by 26in. stroke.

Boiler—		Ft. In.
Telescopic, mean diameter outside		4 2
Length of barrel		10 4
Fire-box casing, outside		6 6
Working pressure		160 lb.
Heating surface—		Sq. ft.
Tubes 240, 1⅝ in. outside diameter		1106
Fire-box		117
Total		1223
Grate area		19·6 sq. ft.
Wheels—		Ft. In.
Bogie, diameter		3 6
Driving, diameter		7 0
Trailing, diameter		7 0
Tractive power		12,712 lb.
Weights.—Engine—		Tons cwt. qr.
Bogie		14 8 0
Driving		16 15 0
Trailing		13 2 2
Total		44 5 2
Tender—		
Total weight in working order, including 3250 gals. of water and 5 tons of coal		37 0 0
Total weight of engine and tender		81 5 2

The other express passenger engine, No. 1868, shown on page 596, has a single pair of 7ft. 6in. driving wheels, and a bogie in front. It was specially constructed to the

designs of Mr. Johnson, for the express service between London, Nottingham and Leeds, booked at 53½ miles an hour, and drawing from nine to thirteen coaches; the average coal consumption of these engines for several years has been between 20 lb. and 23 lb. of coal per mile. Full particulars of this engine are appended. The four wheels

Express Passenger Single Engine, Cylinders 18½in. by 26in. stroke.

Boiler—		Ft.	In.
Telescopic, mean diameter outside		4	2
Length of barrel		10	4
Fire-box casing, outside		6	6
Working pressure		160 lb.	
Heating surface—		Sq. ft.	
Tubes 240, 1⅝in. outside diameter		1106	
Fire-box		117	
Total		1223	
Grate area		19·6 sq. ft.	
Wheels—		Ft.	In.
Bogie, diameter		3	6
Driving, diameter		7	6
Trailing, diameter		4	4
Tractive power		11,864 lb.	
Weights.—Engine—		Tons	cwt. qr.
Bogie		14	10 1
Driving		17	10 0
Trailing		11	13 2
Total		43	13 3
Tender—			
Total weight in working order, including 3250 gals. of water and 5 tons of coal		37	0 0
Total weight of engine and tender		80	13 3

coupled bogie passenger tank engines, of which No. 1832 on page 589 is an example, carry 1270 gallons of water and twenty hundredweights of coal. They are employed for working "shuttle" trains on branch lines where the runs are short and frequent. Similar engines to these, fitted with apparatus for condensing exhaust steam in tunnels, are used for working some of the Midland trains on the Metropolitan line.

Four Wheels Coupled Bogie Passenger Tank Engine, Cylinders 18in. by 24in. stroke.

Boilers—		Ft.	In.
Telescopic, mean diameter outside		4	2
Length of barrel		10	6
Fire-box casing, outside		5	6
Working pressure		150 lb.	
Heating surface—		Sq. ft.	
Tubes 244, 1⅝in. diameter, outside		1141	
Fire-box		110	
Total		1251	
Grate area		16·1 sq. ft.	
Wheels—		Ft.	In.
Leading, diameter		5	3½
Driving, diameter		5	3½
Bogie, diameter		3	0½
Tractive power		13,470 lb.	
Weights—		Tons	cwt. qr.
Leading		15	5 3
Driving		16	16 2
Bogie		21	4 0
Total weight in working order, including 1270 gals. of water and 40 cwt. of coal		53	6 1

Engine No. 2094—illustrated on page 596—having six wheels coupled, and a tender capable of holding 3250 gallons of water and five tons of coal, is for express goods traffic. The cylinders are 18in. diameter, with a stroke of 26in., and wheels 5ft. 2½in. diameter.

Six Wheels Coupled Goods Engines, Cylinders 18in. by 26in. stroke.

Boiler—		Ft.	In.
Telescopic, mean diameter outside		4	2
Length of barrel		10	6
Fire-box casing, outside		5	11
Working pressure		150 lb.	
Heating surface—		Sq. ft.	
Tubes 244, 1⅝in. diameter outside		1141	
Fire-box		110	
Total		1251	
Grate area		17·5 sq. ft.	
Wheels—		Ft.	In.
Leading, diameter		5	2½
Driving, diameter		5	2½
Trailing, diameter		5	2½
Tractive power		14,826 lb.	
Weights.—Engine—		Tons	cwt. qr.
Leading		12	15 0
Driving		14	13 2
Trailing		11	7 0
Total		38	15 2
Tender—			
Total weight in working order, including 3250 gals. of water and 5 tons of coal		37	0 0
Total weight of engine and tender		75	15 2

The six wheels coupled tank engines, of which No. 1126 is an example, have 17in. cylinders, 24in. stroke, and wheels 54½in. diameter; the wheel base being 15ft.

Six Wheels Coupled Goods Tank Engine, Cylinders 17in. by 24in. stroke.

Boiler—		Ft.	In.
Telescopic, mean diameter outside		4	2
Length of barrel		10	0
Fire-box casing, outside		5	0
Working pressure		140 lb.	
Heating surface—		Sq. ft.	
Tubes 213, 1⅜in. diameter outside		1024	
Fire-box		91	
Total		1115	
Grate area		14·5 sq. ft.	
Wheels		4ft. 6½in.	
Tractive power		15,244 lb.	
Weights—		Tons	cwt. qr.
Leading		13	16 0
Driving		16	2 0
Trailing		14	10 1
Total weight in working order, including 800 gals. of water and 20 cwt. of coal		44	8 1

These engines are used chiefly for shunting purposes, but are also employed in working goods and mineral traffic over branch lines with exceptionally steep gradients. No. 1322 engine has 13in. cylinders, 20in. stroke, and wheels 3ft. 9½in. diameter. Having only a short wheel base, this type of engine is useful in yards where sharp curves are met with.

All Midland trains are fitted with a combined automatic steam and vacuum brake; the steam brake being fitted on the engines and tenders, and automatic vacuum brake on the trains. As we may have occasion to refer to this combined brake at some length in a future impression, the following brief description will suffice for the present. The large ejector, with its steam valve and stop back valves, is fitted on the smoke-box end of the boiler barrel, the steam valve being operated by a rod from a lever in the cab. The small ejector and blower is fitted in the cab, and maintains a constant vacuum in the brake cylinders on the train—and in the train pipe except when the brakes are applied—while the other valve fitted in the cab is a combined arrangement, called the driver's disc valve, by means of which the steam brake on the engine and the vacuum brakes on the train are simultaneously applied. This is a remarkably ingenious and sensitive appliance, comprising two distinct valves, one for admitting air to the train pipe for applying the vacuum brakes, and the other for admitting steam to the steam brake cylinder. A single movement of the handle, shown from right to left, is the only operation required of the driver to apply the brakes, and the reverse movement to release them.

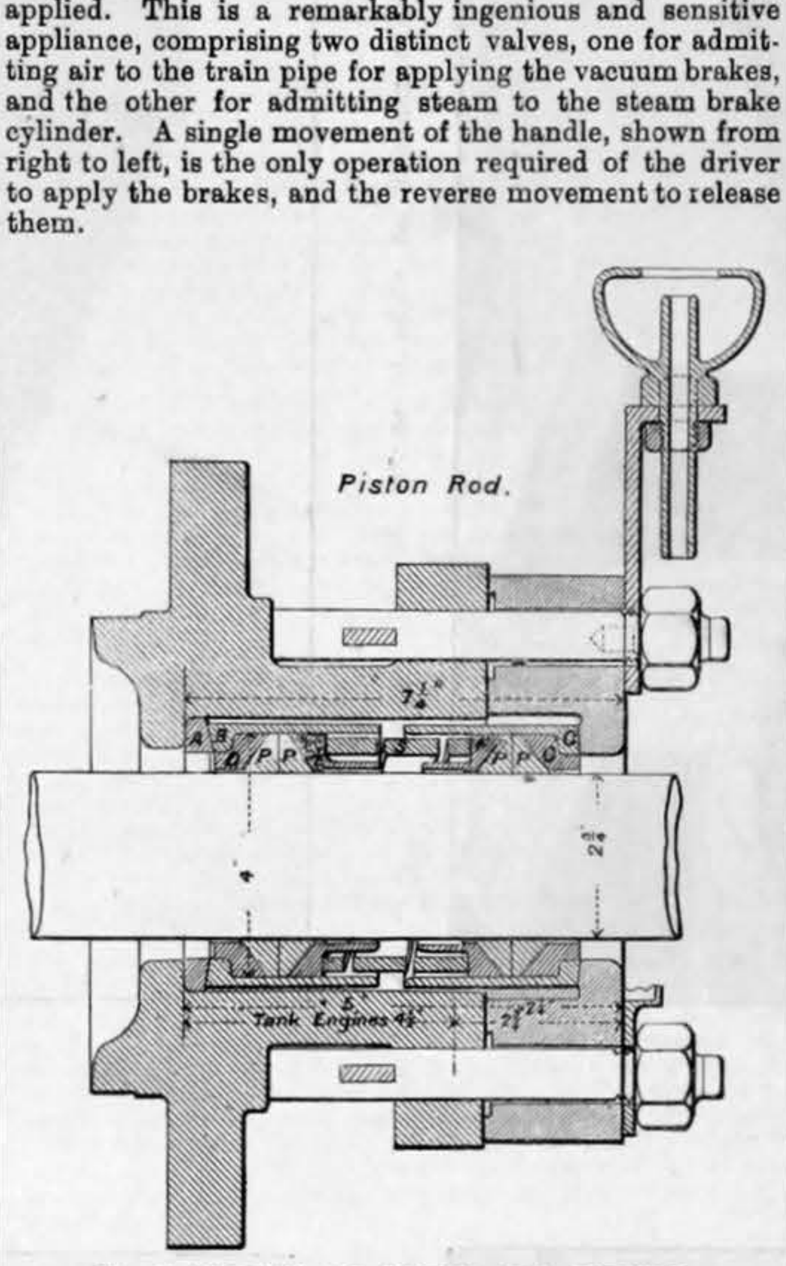

Fig. 31—SECTION OF PISTON ROD PACKING

The Midland Company has for some time used only metallic packings for the piston and valve rods. Figs. 31 and 32, herewith, represent sectional views of this packing applied to both purposes. In Fig. 31 of these illustrations, the rings P, P are of white metal, made in halves; the seating rings D, E, F, G, are of brass, also made in halves; while the parts A, B, and C, are made of solid brass. A helical spring S of flat steel held in compression serves to make a steam-tight joint. This packing, which is made by the United Kingdom Packing Company, has given very satisfactory results.

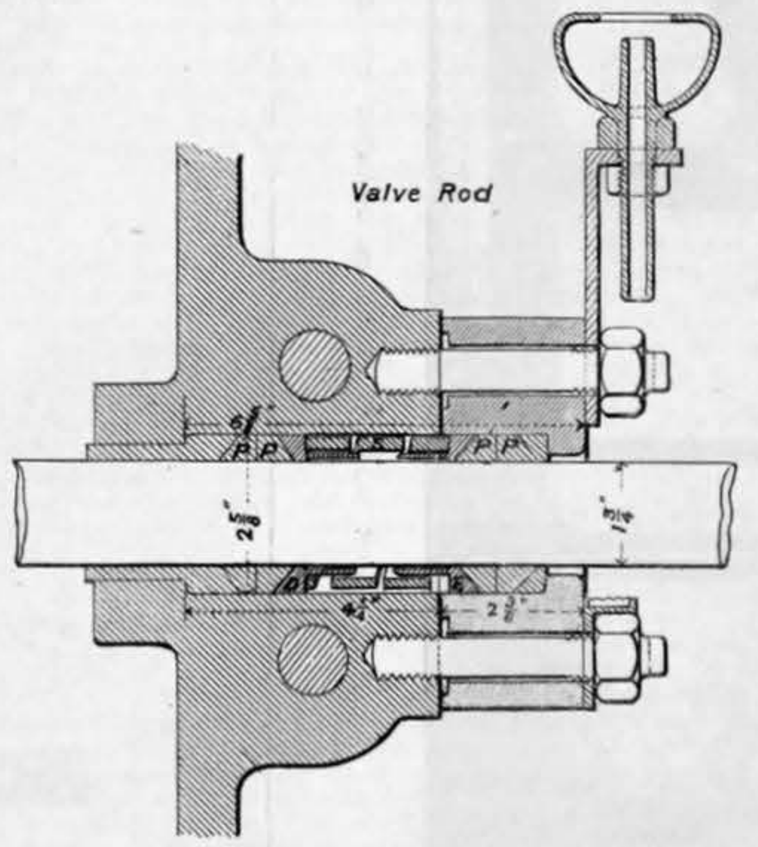

Fig. 32—SECTION OF VALVE ROD PACKING

In addition to the types of engines above referred to, the Midland Company has now in course of construction several express single passenger engines with 19½in. cylinders, having a stroke of 26in., and 7ft. 9in. wheels. A notable feature about these engines is the provision of piston valves placed below the cylinders, a departure which Mr. Johnson made some time since with a view to obviate the accumulation of condensed water in the cylinders. The working of these locomotives will be awaited with some considerable interest.

We ought not to omit to mention that the whole of the excellent photographs from which our illustrations have been made were taken for us in the company's photographic department.

Our notice would be incomplete without a few words concerning the master mind ruling the whole. On page 581 we give a portrait of Mr. Johnson, from a photograph by Mr. W. W. Winter, of Derby.

Mr. Samuel Waite Johnson, M. Inst. C.E., vice-president of the Institution of Mechanical Engineers, chief locomotive engineer of the Midland Railway Company, was born at Bramley, near Leeds, and received his education at the Leeds Grammar School. He commenced his career as a pupil under the late Mr. James Fenton, at the large engineering works of Messrs. E. B. Wilson and Company, Railway Foundry, Leeds, where the manufacture of locomotives, stationary engines, and general engineering work was carried on. He afterwards was engaged as manager of workshops for repairing engines at Peterborough on the Great Northern Railway, under Mr. Archibald Sturrock, and from there became works manager of the locomotive carriage and wagon works of the Manchester, Sheffield, and Lincolnshire Railway Company, under the late Mr. Charles Sacré, for five years. From thence he obtained his first appointment as chief locomotive engineer of the Edinburgh and Glasgow Railway, and remained in that position after the absorption of that line by the North British Railway Company as locomotive superintendent of the Western Division for two years, until 1866, when he received the appointment of chief locomotive and carriage and wagon superintendent of the Great Eastern Railway, which he held for seven years, and during this time he first introduced express four-wheels coupled bogie passenger tender engines. In 1873 he was appointed to his present position on the Midland Railway, being also locomotive engineer to the Somerset and Dorset Joint and Midland and Great Northern Joint Railways. He has had an extensive and varied experience in designing, manufacturing, and maintaining all kinds of railway rolling stock, probably more varied than that of any engineer holding a similar position in this country. Mr. Johnson has successfully introduced the various types of engines now in use on the Midland Railway. His four-wheeled coupled express bogie engine Beatrice took the gold medal at the Saltaire Exhibition in 1887; and his single driving-wheeled engine No. 1853, with bogie in front, was accorded the Grand Prix at the Paris Exhibition in 1889. The latest type of four-wheeled coupled express bogie passenger engine we illustrate in our present number.

In conclusion we have to express our appreciation of the extreme courtesy manifested by Mr. Johnson and every member of his staff, a courtesy indeed which never tired or flagged, notwithstanding our exacting demands for information.

FIRING TRIAL OF ELSWICK CRUISER BUENOS AIRES.

WE give herewith the details of the firing trial recently carried out on board the Buenos Aires, built at Elswick, for the Argentine Government. The scope of gun-fire and its ease of execution is of special importance in this class of vessel where the power of attack has been so greatly developed. Vessels have been constructed in which the batteries are so crowded that the fire of one gun interferes with another; in fact, cases have arisen where warning with a bugle has been thought desirable, to ensure the men of one gun's crew being uninjured by the firing of another. It is important to observe then that quick fire enables guns to deliver the great volume of fire—noticed in our issue of November 29th—without crowding, and it may be noticed that the guns have a remarkable scope in direction, including horizontal fire fore and aft along the keel, and also they have great elevation and depression.* The programme was carried out without any hitch or incident to report.

Programme of Firing Trials of Buenos Aires, Friday, 29th November, 1895.

No. of round.		Gun.	Elevation.	Training.	Remarks.
1	Starboard	8in. aft †	Max. dep.	Port bow	
2		,, ,,	Horizontal	Line of keel	
3		,, ,,	Max. elev.	Starboard bow	
4		6in. No. 5	,,	,,	Broadside
5		4·7in. No. 4	,,	,,	
6		,, No. 3	,,	,,	
7		,, No. 2	,,	,,	
8		6in. No. 1	,,	,,	
9		,, No. 5	Horizontal	Starboard beam	
10		4·7in. No. 4	,,	,,	
11		,, No. 3	,,	,,	
12		,, No. 2	,,	,,	
13		6in. No. 1	,,	,,	
14		,, No. 5	Max. dep.	Starboard quarter	
15		4·7in. No. 4	,,	,,	Broadside
16		,, No. 3	,,	,,	
17		,, No. 2	,,	,,	
18		6in. No. 1	,,	,,	
19		8in. fore	,,	,,	
20		,, ,,	Max. elev.	Port quarter	
21		6in. No. 5	,,	,,	
22		4·7in. No. 4	,,	,,	Broadside
23		,, No. 3	,,	,,	
24		,, No. 2	,,	,,	
25		6in. No. 1	,,	,,	
26	Port	,, No. 5	Horizontal	Port beam	
27		4·7in. No. 4	,,	,,	
28		,, No. 3	,,	,,	
29		,, No. 2	,,	,,	
30		6in. No. 1	,,	,,	
31		,, No. 5	Max. dep.	Port bow	
32		4·7in. No. 4	,,	,,	
33		,, No. 3	,,	,,	
34		,, No. 2	,,	,,	
35		6in. No. 1	,,	,,	
36		8in. fore†	Horizontal	Line of keel	
37		—	—	—	
38		—	—	—	
39		—	—	—	
40		—	—	—	

8-pr. guns, three rounds per gun as convenient. Max. elevation, Max. dep., and horizontal.

* The maximum elevation for the 8in., 6in., and 4·7in. guns are respectively 15°, 18°, and 20°, and the maximum depressions 5°, 7°, and 7° respectively.

† The 8in. guns actually fired two rounds fore and aft on the day of trial.

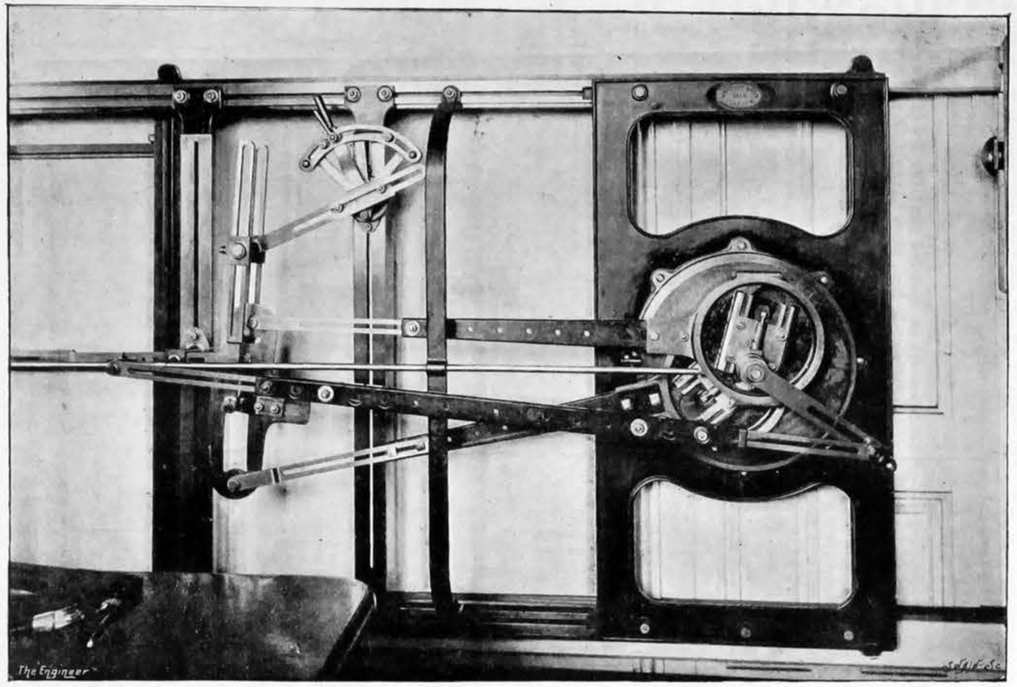

Fig. 33—LINK MOTION MODEL IN DRAWING OFFICE

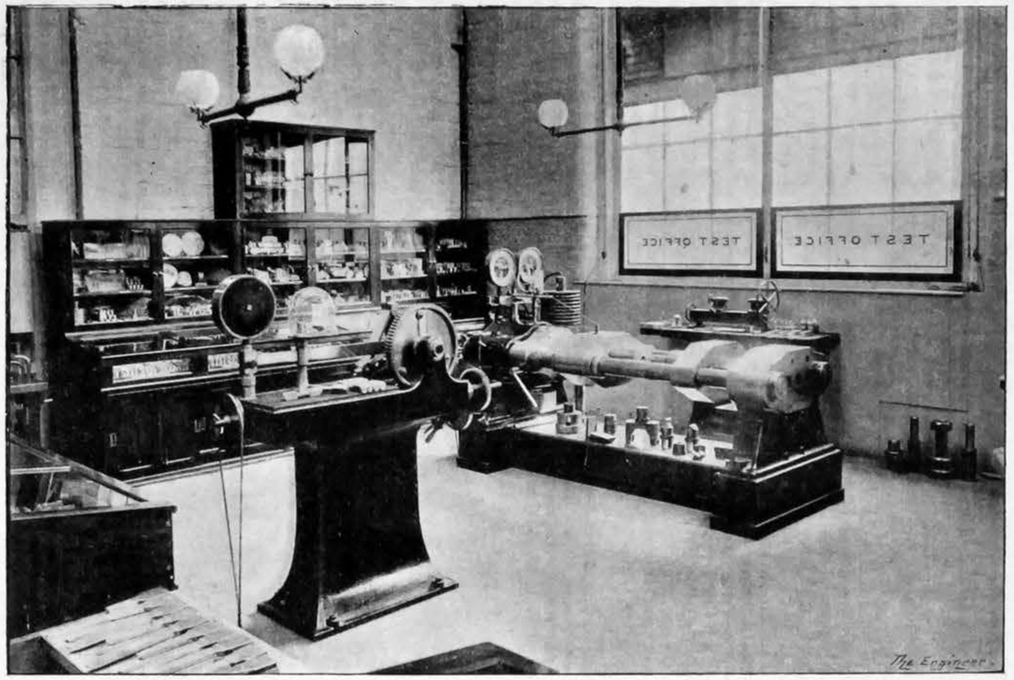

Fig. 34—INTERIOR OF TESTING OFFICE

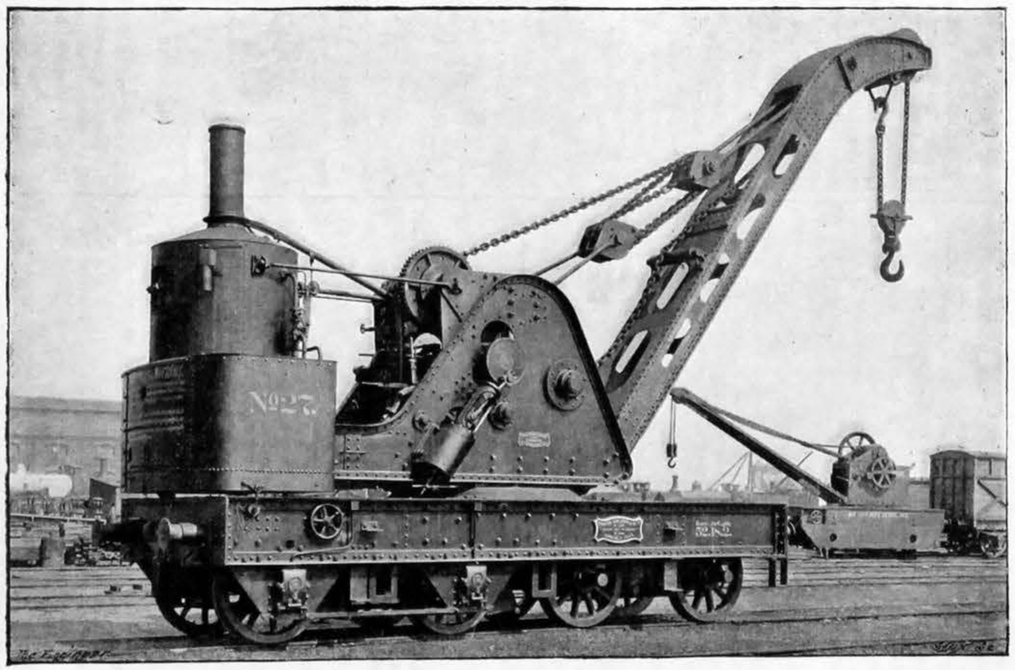

Fig. 35—BREAK-DOWN CRANE

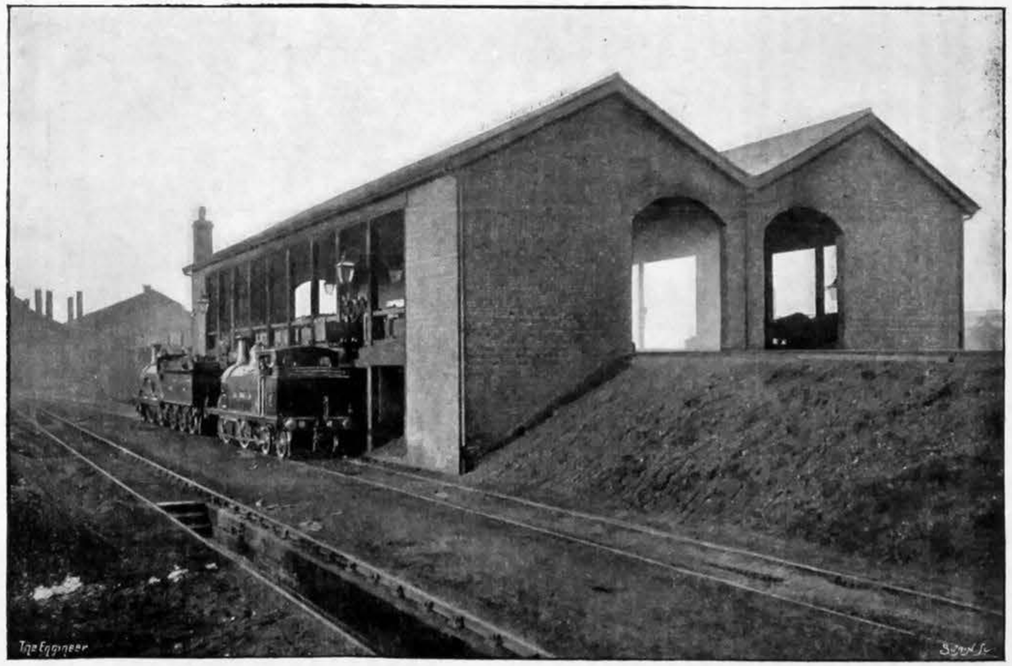

Fig. 36—COAL LOADING SHED

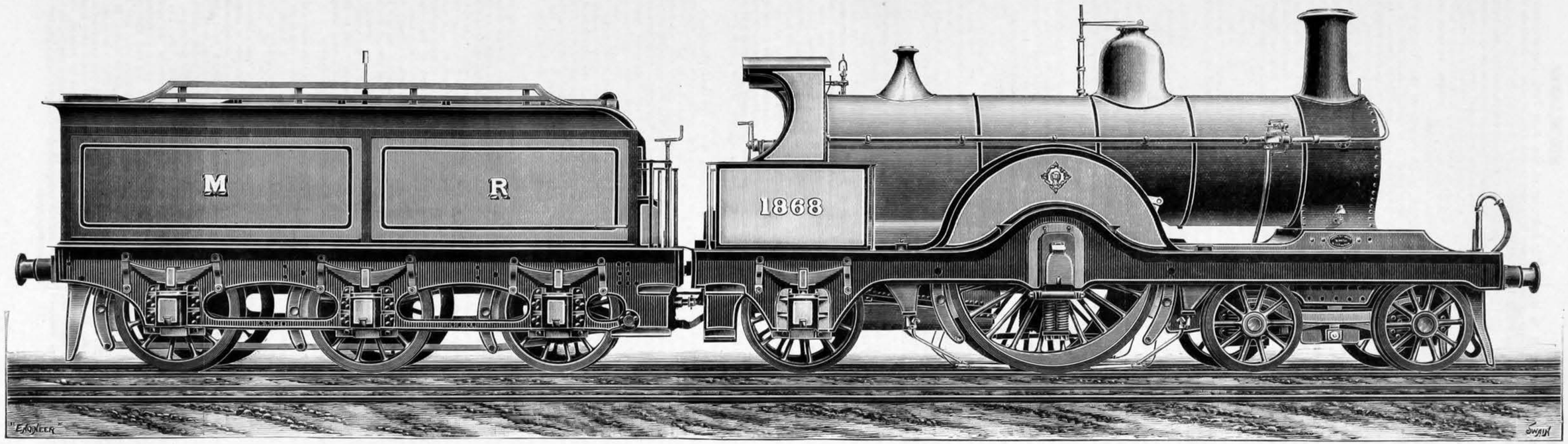

Fig. 37—SINGLE WHEEL EXPRESS PASSENGER ENGINE

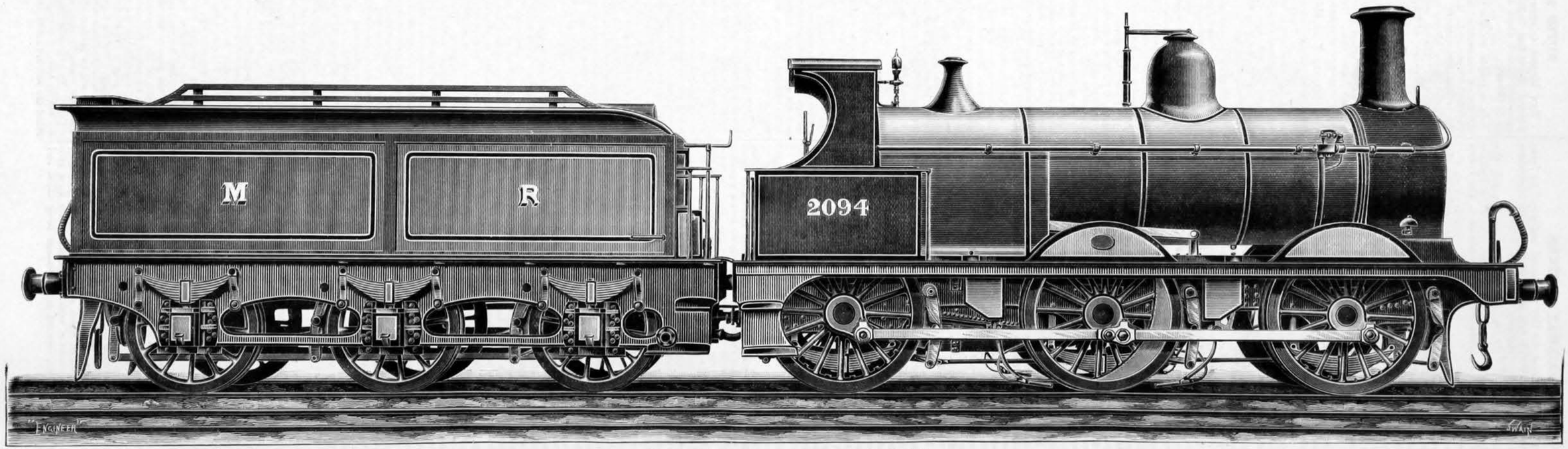

Fig. 38—SIX WHEELS COUPLED GOODS ENGINE