THE LOCOMOTIVE

RAILWAY CARRIAGE & WAGON REVIEW

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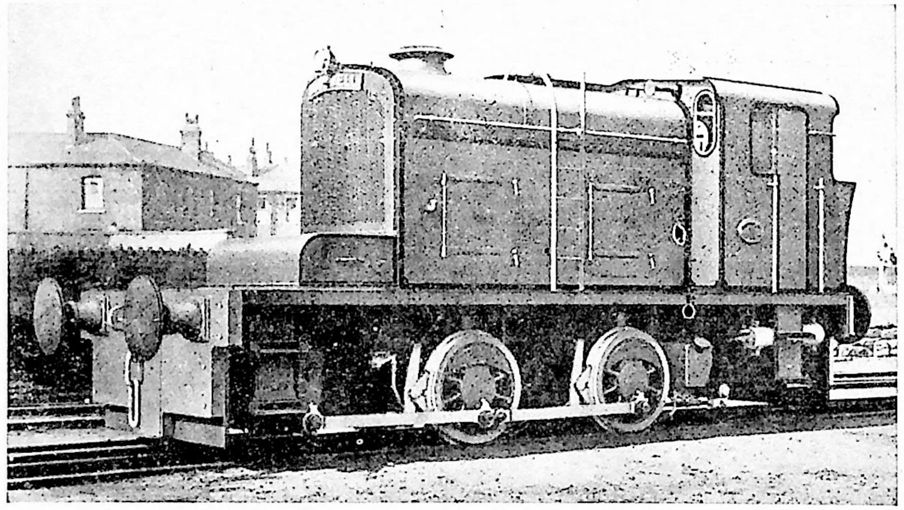

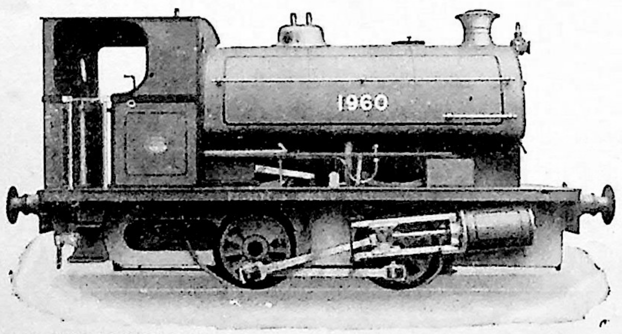
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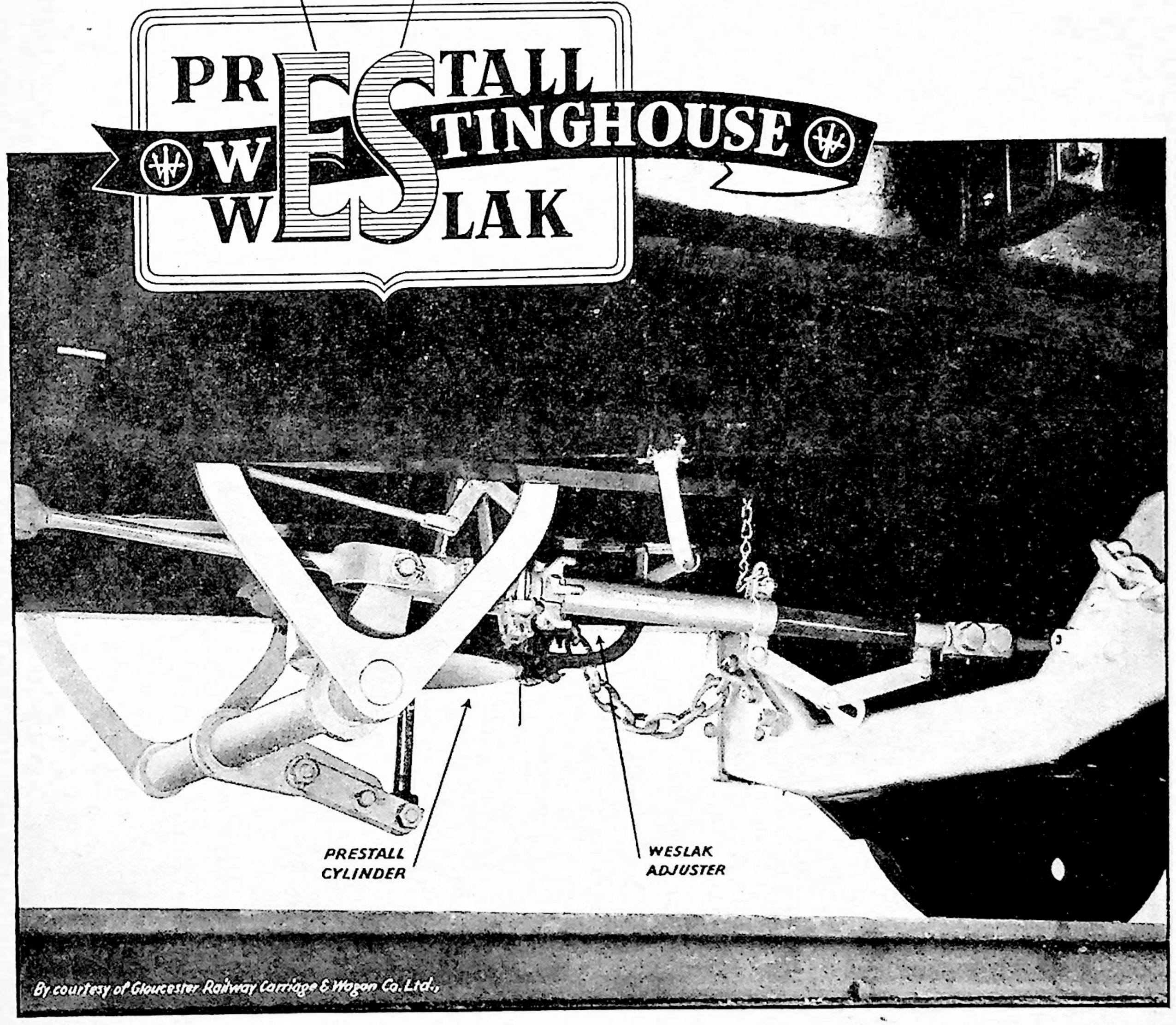
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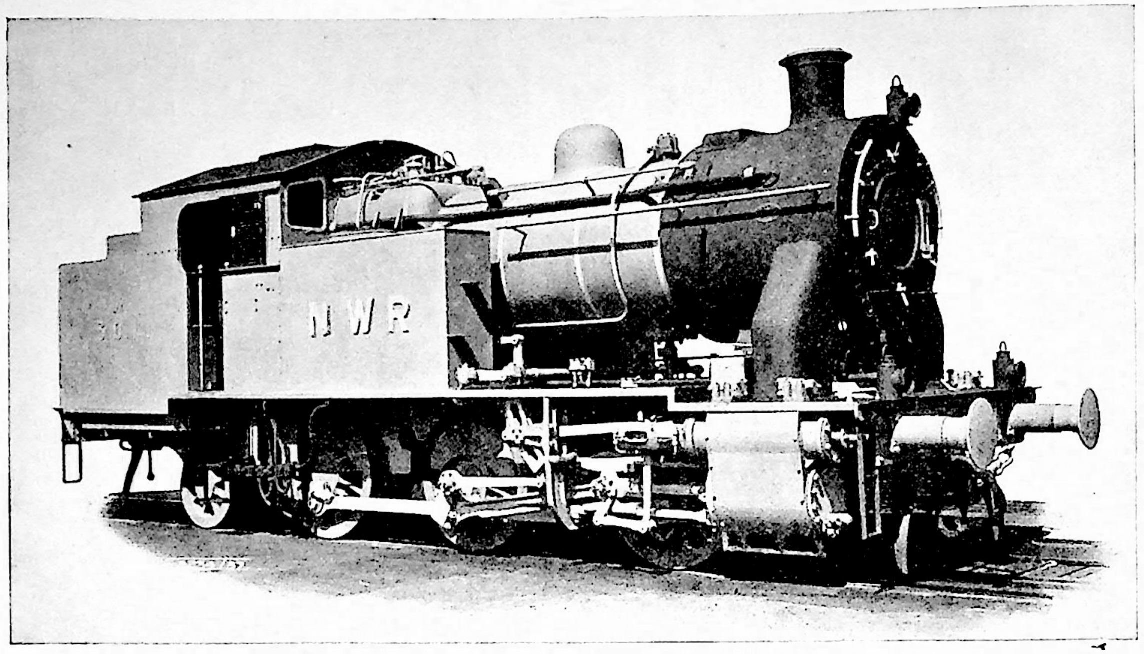

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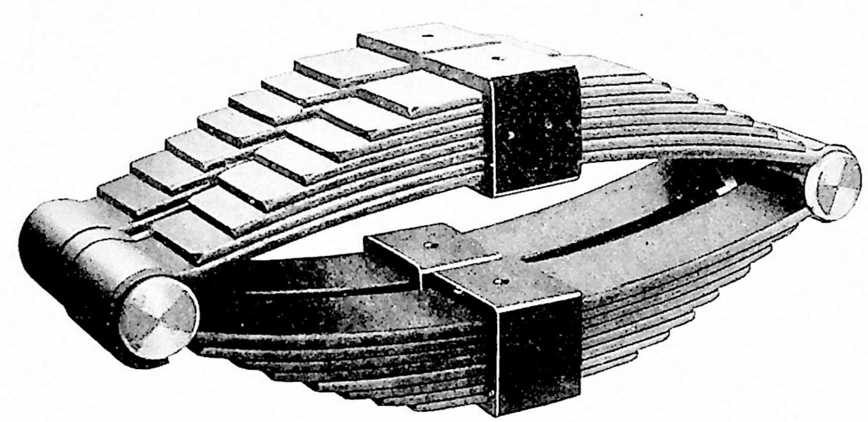

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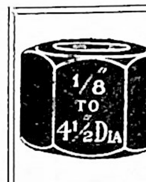

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THE LOCOMOTIVE

MAGAZINE *and* RAILWAY CARRIAGE *and* WAGON REVIEW

88, Horseferry Road, Westminster, S.W. 1 *Telephone: Abbey 2252*

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The Railway Oil Engine

AN interesting survey of the extent to which oil engines have been applied to railway service was presented recently in a paper by Mr. Brian Reed at a General Meeting of the North East Coast Institution of Engineers and Shipbuilders at Newcastle-on-Tyne.

We extract a few of the author's observations which dealt with the future of the railway oil engine and referred at some length to the present status.

Just what number of oil engines is used in locomotives and railcars throughout the world it is difficult to say. There are many thousands of engines of 20 to 85 b.h.p. installed in loco-tractors used by contractors, mines, plantations and industrial works, but if one sets a lower power limit of 100 b.h.p. for locomotives and 65 b.h.p. for railcars, and considers only units owned by public railways, it is probable that 8,000 vehicles powered by about 10,000 engines at the end of 1939 is a good approximation.

These engines cover all types of railway service from occasional light shunting to high speed intensive passenger traffic, but as oil engines of normal patterns must work in conjunction with a transmission system for traction purposes, there is not always the wide variety of type between different duties which one might expect. For example the General Motors 900 and 1,200 b.h.p. engines are fitted to heavy slow-speed shunters, to main-line freight locomotives, and to streamlined passenger trains, the characteristics of the electric transmission and the nature of the auxiliaries being changed to suit. Nevertheless, there are certain well defined classes covering different installations, and nowadays all are more or less special railway types. But in the loco-tractor, shunting, and light railcar fields possibly less modification is required to stationary and road transport engines to suit them for railway duties, with the exception that shunting locomotive engines must be capable of withstanding continuously loads that fluctuate violently and frequently. It is the two very special railway classes to which attention is given more particularly.

The first of these two classes is the lightweight high-speed railcar and fast-train engine of 200 to 750 b.h.p.; the second is the high-power locomotive engine of 900 to 2,200 b.h.p. Again, neglecting North American practice, which is a law unto itself, and is governed by purely technical considerations to an extent no greater than is found elsewhere, modern engines of the high-power locomotive type are limited to two makes, namely, Sulzer and M.A.N. The Sulzer engine is built in two sizes: a single-bank engine of 1,200 b.h.p., and a twin-bank design of 2,200 b.h.p. Only single-bank engines are made by M.A.N., and are limited in output to 1,000/1,050 and 1,300/1,400 b.h.p.; when larger outputs are required two engines are mounted stagger-fashion on a common underbed. Both Sulzer and M.A.N. makes are pressure-charged on the exhaust-gas-turbine principle and run at 700/750 r.p.m.; M.A.N. favours a completely welded steel under frame, crank-case and cylinder block; whereas Sulzer uses a combination of cast steel and welded steel.

The engines already used in up-to-date railcars and high-speed trains are, in general, of the six-cylinder vertical or 12-cylinder V patterns. In their naturally aspirated forms they weigh 11 to 18 lb. per b.h.p. in the dry condition and on the top power setting, run at 1,350 to 1,500 r.p.m., have m.e.p's. of 85 to 95 lb. per sq. in., and have piston speeds of 1,650 to 2,100 ft. per min. Pressure-charging reduces the specific weight to 9/13 lb. per b.h.p., and increases the m.e.p. to 110/125 lb. per sq. in. Two-stroke opposed-piston engines now run at 1,500 r.p.m., with a m.e.p. of 80 lb. per sq. in., and on a dry weight of 9¼ lb. per b.h.p. The upward range of these big railcar engines was being extended at the time the war began, and it was only the over-running of France that prevented the installation of two Paxman engines of the 16-cylinder four-stroke V type with a top output of 900 b.h.p. in powerful luggage vans for the Algerian Railways.

Signs have not been wanting that a widespread change may be made in the build of engine used for railcars and high-speed trains. The engine is merely part of a traffic machine, and it is essential that the maximum amount of floor space should be devoted to revenue earning. To that end, horizontal engines were developed, and although they had not been used to a very large extent prior to the war, a good many of the problems associated with their satisfactory operation and maintenance had been solved by the end of 1939, and there are indications, such as the recent delivery of 22 railcars with 275 b.h.p. horizontal engines to the National Railways of Colombia, that the use of the "Flat" or "Pancake" or "Boxer" engines, to give them their various appellations, will spread rapidly after the war.

The oil engine as it has been known up to the present is inherently unsuitable for direct application to railway vehicles. It is a constant-torque machine without ability to start under load, and needs a transmission system between it and the wheels to make it a practical proposition. There are several important desiderata which govern the design; some of these, such as extreme reliability and ability to work for long periods or high mileages without being withdrawn from service, are common also to marine and stationary practice; but others such as bulk, weight, rotational speed, and continuous operation under sharply fluctuating loads and varying atmospheric conditions, assume proportions altogether different from what they are in the stationary and marine fields.

As to the inherent advantages of the oil engine for railway work, they boil down from the plural to only one, namely, the possibility of obtaining greatly improved power-weight and power-bulk ratios; practically every other *general* advantage of oil-engined vehicles is a corollary of this feature. Possibilities of much better power-weight and power-bulk proportions are not inherent in the oil engine alone; it is simply the fact that at the present time they are better in this respect than other prime movers that makes them so popular for railway work. And they will have a future restricted to areas where *special* conditions are found just as soon as some other prime movers—steam engines, methane engines, combustion-gas turbines or the like—get ahead of them as regards weight, bulk, and power

Briefly, any future improvement in the oil engine for railway work must be under one of three headings. First, by the evolution of an oil engine that will enable transmission systems to be eliminated. Secondly, by improving existing types of engines, as engines, through advances in speed and m.e.p., and reduction in weight and bulk. Thirdly, by progress in construction, a better understanding of power limits, and advance in the general standard of maintenance technique to permit of greatly increased mileage between repairs. It will be realized to what a degree the first two of these headings mean little else but an improved power-weight ratio for the whole vehicle, be it locomotive or railcar.

In conclusion the author suggests that the high-speed railway oil engines of post-war years will be more or less standardized as four-stroke pressure-charged or two-stroke Kadenacy types, burning heavy fuels, and that although vertical and V models will continue to be built, the use of horizontal models will become more and more extensive. Neglecting the models up to 150/200 b.h.p. which are derived more or less from road-transport practice, it is suggested that the most popular power ranges will be 250/300 b.h.p., 500/700 b.h.p., and 900/1,000 b.h.p., all with m.e.p's. of 120/130 lb. per sq. in., a rotational speed of 1,500 r.p.m., a piston speed of 1,700/1,800 ft. per min., and a specific dry weight of 9 to 12 lb. per b.h.p. The order of flexibility required will be economical operation from 500 to 1,500 r.p.m., with a fuel consumption over this speed range and with a load variation of 4 to 1 never exceeding 0.40 lb. per b.h.p.hr. with light Diesel oils, or about 0.44 lb. with heavy oils, and with respective ¾-load to full-load consumptions of 0.36 and 0.40 lb. per b.h.p.hr. Such engines will have to run at least 100,000 miles between general overhauls, or a million miles if the travelling-fitter system of maintenance is used.

As regards main-line locomotive engines, the present single-bank and twin-bank four-stroke pressure-charged vertical build is likely to be perpetuated, although the use of Kadenacy two-stroke models of the same general type, running at 700/1,000 r.p.m. and with 12-in. cylinders, should be attended with no difficulties. Speed is likely to increase from the present 700/750 r.p.m. to 900/1,000 r.p.m. without any increase in total weight or any decrease in m.e.p., which will not only reduce the specific weight of the engine but will also bring a better transmission, and will result in engines giving 3,000 b.h.p. or more becoming practical propositions and simplifying the design of many main-line locomotives. Despite certain attractions, it is not likely that any form of direct drive will be used in more than isolated cases in the immediate post-war years.

The Steam Locomotive in Traffic

By E. A. PHILLIPSON, Assoc.M.Inst.C.E., A.M.I.Mech.E., M.I.Loco.E.

(Continued from page 60)

Testing for Blows.

It is advisable, before attempting to locate a suspected valve or piston blow, to make certain that the blow does not emanate from a joint in the smokebox. A piston blow is clear but intermittent, as it occurs only between the points of admission and cut-off for each stroke. The blow from a defective valve, on the other hand, is muffled but continuous whilst the regulator is open. It should be noted that piston valves may blow slightly when they are cold but not defective.

When locating blows it is preferable to test each cylinder separately. To test for piston blow, set the crank on the top centre, place the lever in full fore gear, open the cylinder drain cocks and then the regulator. If the piston head is not steam tight for any reason, steam will exhaust through the front cock and up the blast pipe, whilst live steam will discharge through the back cock. A loose piston head will cause a loud knock once per revolution when the head strikes the nut; little or no noise is made when it forces itself on to the taper at the return stroke.

To test for valve blow, set the crank on the top centre, place the lever in mid-on gear and open the cylinder drain cocks. Both ports should then be closed to admission steam. If, however, on opening the regulator, there is a blow at the back cock, this indicates that the back lap of the valve or port bar, or back head of the piston valve, as the case may be, is defective. A blow at the front cock similarly denotes that one of the items mentioned is defective with reference to the leading end.

A fractured port bar will give a similar blow to that caused by a defective piston. To differentiate, test as for the latter in full fore and back gears. If the piston is defective, it will give a blow in both gears, whereas a fractured port bar will give a blow in one gear only, viz. a fractured front port bar in back gear and vice versa. In running a fractured port bar gives one blow per revolution, whilst a defective piston head causes two blows per revolution.

A fractured slide valve cavity and a slide valve off its face both give a similar indication, i.e., a continuous heavy blow at the chimney whilst the regulator is open. To distinguish them, set the crank on top centre and open the regulator with the lever in mid-on gear and the cylinder drain cocks open. If the valve is off its face, steam will discharge at both cocks and also at the chimney, whereas with a broken valve cavity there will be a blow at the chimney only. Both defects occur rarely, but should they arise the loss of steam in both cases is generally sufficient to make the engine a total failure.

When a regulator valve is blowing, steam discharges at the blast pipe and cylinder drain cocks when the engine is in full gear with the regulator closed, and in some cases the quantity of steam passing may be sufficient to start the engine.

Temporary Treatment of Failures on the Road.

The knowledge of enginemen on this subject must be sufficient to enable them to move a disabled engine from a running road to a siding with the minimum of delay to their own and other trains. The actual method of dealing with a failure is of course governed by the design of the class of engine concerned, the relative extent of the disability, and other factors, such as the comparative facility and rapidity with which assistance may be obtained and the density and importance of traffic on the running road blocked by the failure. Some varieties of failure, similarly to the location of blows, call not only for an accurate knowledge of the positions of the valves relative to those of the cranks and the reversing lever, but also for the ability to apply this knowledge in a logical manner to the case under consideration.

Some methods of dealing with specific failures and defects, as regards temporary treatment, will now be quoted.

Fractured crank axle. Bring the train gently to a stand, in order to avoid derailment, and send for assistant engine or breakdown train. Remove coupling rods. Insert packing under driving boxes. Lift engine and insert packing on top of other coupled boxes. When lowered the engine may be hauled away, care being taken that the chimney, dome and cab roof are not foul of the gauge.

Fractured tyre. Proceed with caution, taking care, if a coupled wheel is affected, to avoid slipping. Remove brake blocks before attempting to start engine. Give up engine as soon as possible.

Damaged piston head, piston rod or crosshead. Place engine in mid gear, apply brakes fully and open cylinder drain cocks. Disconnect valve at spindle and secure at half travel. Take down affected connecting rod and also, if concerned, eccentric rods. Otherwise, disconnect the affected motion; in the case of rocker driven valves, this may be done at the pin joint of the valve connection with the rocker arm. Secure piston at front end of cylinder. It is important to note that in all cases of this kind the valve should be secured as soon as possible; the risk of the engine moving owing to a possible blow through the regulator or for any other reason is then minimised.

Valves may be secured by driving wooden packing between the spindle and the gland studs or by clamping. Pistons may be secured either by placing packing between the slidebars or clamping the latter in the immediate vicinity of the crosshead. The position of the valve at half travel may be determined by comparison with that of the valve for a sound cylinder when its crank is on the top or bottom centre with the lever in mid gear.

Damage of this nature frequently leads to damage of the cylinder cover in addition, and may therefore lead to total failure.

Fractured connecting rod. Proceed as for damaged piston head, removing that portion of the rod which is attached to the big end.

Defective piston rings. Continue to run with increased oil feed. If breakage is suspected, give up engine as soon as possible; broken portions of ring are capable of causing extensive damage to the cylinder.

Hot big end. Clear oil way if blocked with white metal or other foreign matter. Slack cotter back and, if worsted is used, reduce trimming. Lubricate freely, including the sides of the brasses, and work the engine at caution with a restricted regulator opening and late cut-off, thus advancing the normal fluctuations in the piston load throughout the revolution.

Hot coupled box. Lower the wedge. If wedges are not provided, cool the box gradually with water; it may be necessary to run the wheel concerned over a fishplate or other packing to free the box. Renew and reduce worsted trimmings, the addition of a little crushed washing soda is efficacious for heated bearings. Lubricate freely both the bearing and the horn surfaces. Work the engine as with a hot big end. In both cases the relative intensity of heating determines whether the engine shall be worked to destination or given up at the first suitable opportunity.

Defective coupling rod or crank pin. Remove rods concerned, also corresponding rods on other side of engine. If the engine has outside cylinders, collars may be required to prevent the big ends working off the crank pins.

Defective reversing rod, lifting link or weighbar shaft arm. The engine may be reversed if necessary by lifting the motion with a pinch bar, part of the weight being taken with ropes, if assistance of this nature is required. To secure the weighbar shaft tin or other packing is placed between it and its bearing caps, the latter then being bolted down as tightly as possible.

Defective eccentric strap, eccentric rod or expansion link. Secure valve at half travel. Disconnect connecting rod and secure piston. If the engine has inside link motion, is running in fore gear and a fore gear rod is defective, both eccentrics and rods on the defective side should be disconnected. If in fore gear and a back gear rod becomes defective, disconnect the latter and pack up expansion link with wood, taking care that no part of the motion will foul. When it is desired to move an engine, having link motion with a defective fore gear eccentric rod, and there is a siding adjacent to the blocked running road, remove the affected rod and work the engine in full fore gear. There is no need to remove the expansion link or intermediate valve spindle when eccentric rod or strap is defective.

With Walschaerts gear, take down the defective rod or strap, secure the valve at half travel, open the cocks of the cylinder concerned and allow its piston to travel, having lubricated it freely.

Defective crosshead arm, union link or combination lever. Remove the defective detail concerned and proceed, giving up the engine as soon as possible.

Valve spindle fractured inside steam chest. Secure valve in forward position. Uncouple connecting rod at big end, push piston rod and connecting rod forward and secure. It will be observed that the disabled cylinder becomes virtually an extension of the steam chest.

Valve spindle fractured outside steam chest. Secure valve at half travel. Uncouple eccentric straps and rods concerned. Lubricate the piston freely and allow to reciprocate with the cylinder drain cocks open.

Inside admission piston valve spindle broken between heads. Uncouple spindle, and remove any parts of the valve gear likely to foul it when running. Open the regulator gently to move heads to ends of steam chest. Allow piston to reciprocate with ample lubrication.

Outside admission piston valve spindle broken between heads. Set the crank on top or bottom centre with the lever in mid gear. The back head is then in its central position. Open the regulator sufficiently to bring the front head also to the central position, demonstrated by lack of discharge from the cylinder drain cocks. Uncouple spindle and remove any parts of valve gear likely to foul it when running. Run with drain cocks open on defective side only, lubricating the piston freely.

Seized die block. Treat similarly to valve spindle fractured outside steam chest.

Fractured piston gland. Secure valve at half travel. Disconnect motion, also connecting rod at big end. Secure piston rod and connecting rod in forward position.

Piston gland studs broken. Secure the gland with stout wire, through the stud holes and around the slidebar front bolts.

Slide valve off face. Reverse the engine sharply with the regulator open, tap the valve spindle, or bump the engine with another and then apply the brake suddenly.

Fractured spring. Jack up, or lift by running wheel on to a fishplate or other packing, and then pack the axlebox affected; then work forward. If the top plate only is fractured, this may be clipped temporarily.

Fractured regulator valve spindle. If the fracture occurs whilst the regulator is open, the engine may be worked home entirely by adjustment of the reversing lever, the cylinder drain cocks always being opened and the lever placed in mid gear before making a brake application and also whilst the engine is standing.

Fractured firebar bearer. Raise fractured parts and support ends with bricks or stones. If the firebars break, the affected portion of the grate area must be covered with bricks or clinker, the engine being given up at the earliest opportunity. If possible the ashpan should be flushed with water occasionally.

Collapsed brick arch. If the distance to be run is short, continue without stopping. Otherwise, stop and throw out the bricks before proceeding.

Deflector plate in fire. Minimise admission of air through firehole door.

Tube or stay leakage. Keep fire bright and hot; minimise opening of firehole door and keep boiler "warm" while engine is standing. Run with water level higher in boiler than usual.

Mud door or plug blowing. This may be caused by cross threading or the threads stripping and, if the resultant blow is extensive, usually leads to a total failure. The fire must then be thrown out and the boiler pressure reduced by applying the feeds and closing the dampers.

Joint blowing in smokebox. Keep blower well on in order to divert jet of steam, which is discharging from the faulty joint, away from the tube plate.

Superheater element blowing. Work the engine lightly with restricted regulator opening and early cut-off, keeping the firebox temperature as high as possible.

(To be continued.)

Welding Opportunities in Rail Vehicle Design

ALTHOUGH the craft of welding was formerly peculiar to the blacksmith, in modern times the bulk of engineering welding has no connection whatever with the forge. Actually, much of it is looked on in no friendly fashion by the smith, as in its present application it cuts out work which otherwise would be diverted to that shop, and many of the remaining items are finished products which in pre-welding times a plater and anglesmith would have combined to make.

The fabrication of plate and other structures by electric welding processes is a fascinating study, and has big gains to its credit; material can be saved and the product turned out with a lighter form of construction than previously, yet equally effective. This is a boon to a designer who has a high power unit to produce on a low weight basis, and in post-war days the writer is confident the structures of many vehicles, road and rail, will be produced by utilisation of the welder's skill much more extensively than hitherto. It can, however, become an obsession if not watched, and instances are known where draughtsmen have shown brackets, etc., welded from separate plates where the same article could have been obtained much more easily from one of the rolled sections.

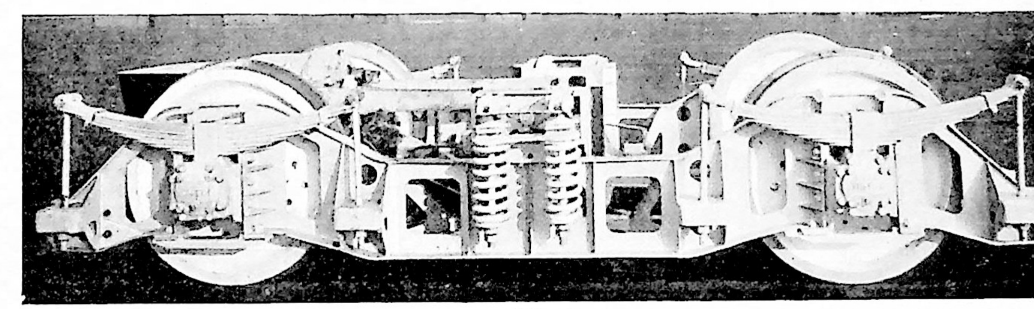


FIG. 1.

A few examples of components which were produced at a low cost by welding will illustrate the advantages more effectively than much descriptive matter, and those referred to below are taken at random from numerous examples regularly occurring in the manufacture of rail rolling stock.

Bogie Frames. On railway coaches these have been designed in several ways since this type of vehicle took the foremost place in passenger transport, and possibly the best known frame is the pressed box pattern introduced by the Leeds Forge Ltd. In this, the design follows the normal outline of bogie frame, but by pressing in "dies" the resulting unit has part of the plate folded at right angles to the body, the flange so formed extending virtually all round the frame profile, and giving a strong channel section to the finished frame with extreme strength at vital sections, and therefore possessing a long life. The chief drawbacks, however, are the high cost of press blocks, and the high power hydraulic press in which these operate, and, further, the impossibility of utilising such economically unless the quantity required justifies the process.

In welding, however, once the equipment is purchased—and, unlike the big hydraulic press, a welding outfit can be adapted for a big variety of jobs—it can be called in for service if but a single coach be required, and its advantages reaped irrespective of the number of units to be supplied. Admittedly, a large order will permit the use of jigs and fixtures that a small requisition would not cover, but the latter still gains appreciably by welding.

Fig. 1 shows a bogie frame as designed and built by the Birmingham Railway Carriage and Wagon Co., Ltd., for some high-powered (but low weight) diesel trains for the San Paulo Railway, Brazil, and the technical reader will notice at once many interesting and original features which could only be obtained by welding. The guides are formed of plates shaped and built up to give an equivalent to the usual cast guides—iron or steel—bolted or rivetted to the frameplates. (These details alone save much weight, time and labour, not to mention delays due to faulty castings and inspection.) Spring supporting brackets are likewise easily formed on a fabricated structure, and an interesting design of headstock is shown in Fig. 2.

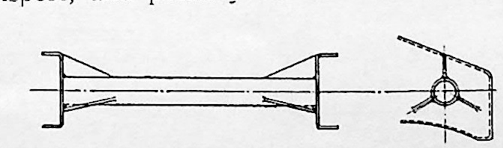


FIG. 2.

Generating Set Carriage. For diesel units two other details are shown in Figs. 3 and 4, the former being a carriage on which the engine is mounted, and the latter the silencer for engine unit. The carriage referred to is employed chiefly for rail cars with engine powers not exceeding 150 B.H.P., the engine, with all its auxiliaries, being mounted on its support in the erection bay and, after testing,

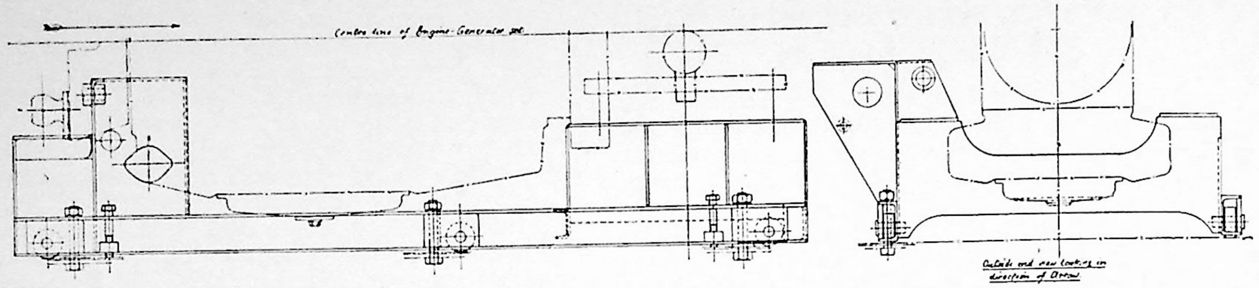


FIG. 3.

run on six rollers into its separate compartment on a special track.

Silencer. The silencer mentioned in the foregoing paragraph is a straightforward fabrication of steel plates suitably designed to baffle the gases in their flow to the atmosphere, and is remarkably light in weight, as well as efficient in service. This design is employed with engine units of from 600 to 900 B.H.P.

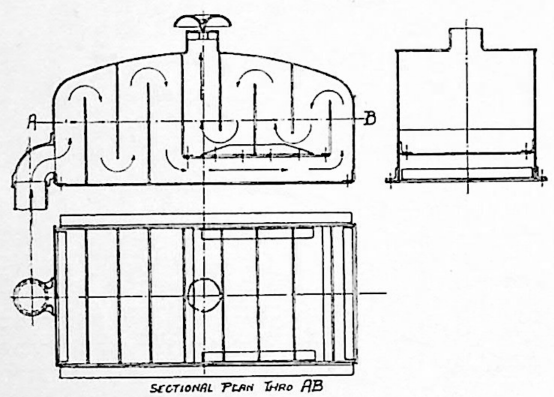


FIG. 4.

Brake Shaft. One of the vital details in operation on every rail vehicle is the shaft which transmits the brake power, whether hand-operated or by steam, or air, power from a cylinder to the road wheels. The importance of the shaft to the security of the travelling public cannot be over-estimated, yet many of these are now fabricated from plate and bar sections, and function no less effectively, or reliably, than those which are forged. Fig. 5 shows a typical shaft, and it is a curious fact that the strength from a welding view-point is nearly twice that of the material in the plain shaft or its levers, assuming these to be designed suitably for the forces to be transmitted.

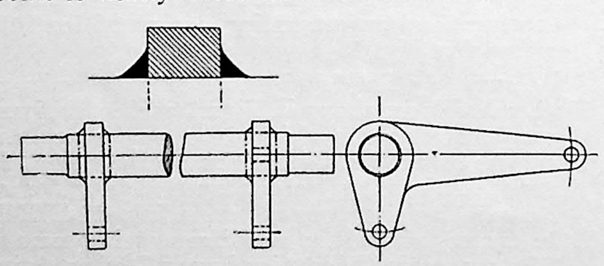


FIG. 5.

Wheels and Axles. The latest design of wheel for rail vehicles—carriages or wagons—is of welded form as shown in Fig. 6, and it will be noted that in order to reduce the weight in every

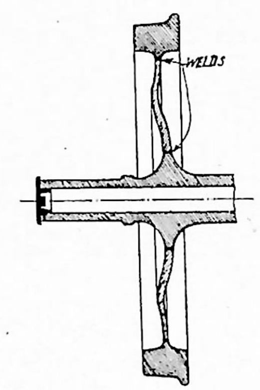


FIG. 6.

direction possible, the axle has its centre bored out, and its outer surface turned to afford a suitable juncture at each side for welding to the wheel centre. The tyres are bored to give the section required for welding to the dished centre plate, the latter being welded as shown to the axle; the wheel

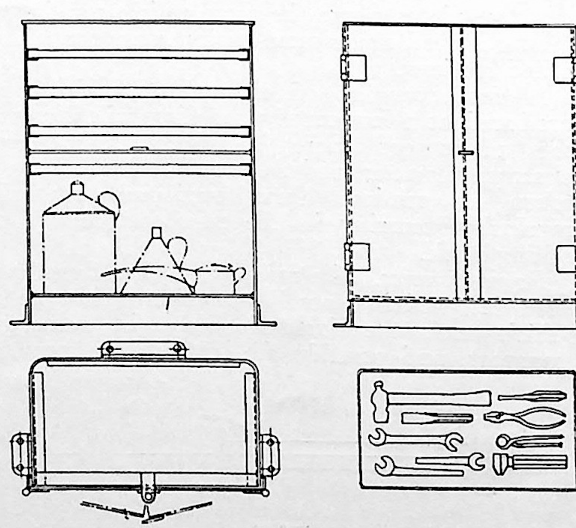


FIG. 7.

profiles are then turned to the correct tyre gauge and true to the axle journals.

Tool Boxes. On most rail prime movers tools are carried to enable vital adjustments, etc., to be effected quickly without causing any traffic hold-up, and to this end a toolbox or chest is necessary. On steam locomotives the practice has been to provide a chest in which the tools are kept without any special provision for quick location, but on the modern diesel unit, a steel cupboard, provided with shelves fitted to house every tool and spanner, is regarded as an essential. This naturally makes for more rapid servicing, and a typical design is shown in Fig. 7. The illustration calls for little comment, but it may be stated in passing that each shelf—a light steel plate with flanged edges welded at each corner—has a wooden insert with separate pockets carved out to accommodate the different forms of spanners, chisels, punches, etc. Fittings like Tecalemit greasers will be clipped inside the doors.

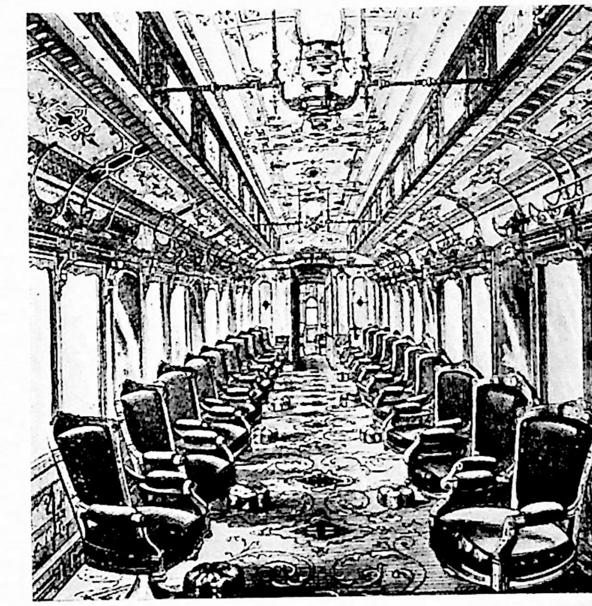
SOUTHERN RAILWAY. "Merchant Navy" class 4-6-2 locomotive No. 21C5 is named *Canadian Pacific*. This engine is painted black and is the first of the series to appear in the war-time livery. Mr. F. W. Mottley, acting European Manager of the Canadian Pacific Railway named the engine at Waterloo Station on March 27th.

All-Car Trains on the Midland Railway, 1874-1878

By CANON R. B. FELLOWS.

THE earliest experiment in Great Britain in providing trains composed exclusively of Pullman cars or of cars of the Pullman type was made by the Midland Railway Company in 1874. In that year the Company put on a train made up partly of the Pullman Palace Company's cars and partly of cars of a similar type which had been built in America for the Midland Railway. The cars were sent over to England in sections and were put together at the Railway Company's works at Derby. The experiment was the outcome of a journey which was made in Canada and in the United States of America in 1872 by the then General Manager of the Midland Railway, Mr. (later Sir) James Allport. So favourably impressed was he by the comfort of the cars provided on the railroads in those countries that he determined to introduce them on his own Company's system. The upshot of the matter was that at the half-yearly meeting of the Midland Railway Company on February 18, 1873, the Chairman (W. P. Price, M.P.) introduced George Mortimer Pullman in person to the shareholders and explained that it was hoped very soon to have Pullman Cars running on the Midland Railway and, he added, "I ought to say that it is not proposed that we should bring over bodily the carriages now running on the Canadian and American railways, because probably they would not be altogether adapted to our service; but that carriages specially adapted to our requirements will be constructed upon the Pullman principle and as early as possible will be tried, I ought to say at his (Mr. Pullman's) own risk, upon our railway."

The first run by the all-car train to which the public were admitted was made on Saturday, February 21st, 1874, from St. Pancras to Bedford and back. The passengers, some eighty in number, were the guests of the Railway Company. Four cars were run on this occasion and at least one of them had a kitchen and buffet; the train was the first to be run in this country on which refreshments were obtainable. On June 1 of that year an all-car train was put into regular service for Leeds and Bradford, it left St. Pancras at 12 midnight and reached Bradford, via Derby, at 5.50 a.m., returning from Bradford at 8.30 a.m. and due at St. Pancras at 2.5 p.m. The train



A PULLMAN PARLOUR CAR ON THE MIDLAND RAILWAY IN 1874.

left London ten minutes earlier in July and was correspondingly earlier at Bradford, but on the up journey the time was improved by 20 minutes, Bradford dep. 9.20 a.m. St. Pancras arr. 2.35 p.m. via the Erewash Valley line. The Time Table stated that the train consisted of the celebrated American Pullman drawing room, sleeping and ordinary cars. That first, second and third class passengers were conveyed at the usual ordinary fares and that first class passengers could avail themselves of the Drawing Room and Sleeping Cars on payment of a small additional charge. It will be noticed that no extra payment was required for travelling by the all-car train if passengers kept in the ordinary American cars.

From contemporary descriptions it appears that the train was normally made up—as regards passenger accommodation—of six cars of the American type, two of which were the Pullman Drawing Room and Sleeping Cars. The Sleeping Car was of a convertible type and by day became (to quote the *Railway News*) " an elegantly fitted boudoir." This car had a kitchen and buffet, and meals were served in it, and in consequence of the different uses to which this type of car was put it was called in America an " Hotel Car." These convertible cars were first put into service by the Pullman Company in 1867 on the Great Western of Canada Railroad. The " Parlour Car " of the 1870's was very different in its furniture from the modern type. A contemporary illustration reproduced from Williams' " History of the Midland Railway " (1878 edition) shows the interior of one of these early Parlour Cars.

The cars of which the trains were composed were of the following dimensions:—length of body 51 ft. 6 in., outside width 8 ft. 10 in., inside width 8 ft. 2 in., height inside 8 ft. 6½ in. Each car ran on two 4-wheel bogies, bearing distance from centre of one bogie to the centre of the other 41 ft. As the Pullman vestibule had not been invented there were small open platforms at the end of the cars " for smoking and outdoor promenade." The cars were fitted with the Westinghouse brake. It is stated in Ahrons' " British Steam Locomotive " (p. 191) that these trains were worked by Matthew Kirtley's 2-4-0 engines, " 890 class," and for this purpose tenders were fitted with central buffers of the American pattern.

The experiment of the all-car train was not a success, passengers clamoured for the old compartment carriage, and after a trial of nearly two years the train was withdrawn. But before this train was withdrawn another all-car train had been put on to run between St. Pancras and Liverpool (Central) from April 1, 1875. It left St. Pancras at 4 p.m. and was due at Liverpool at 9.40 p.m. and a corresponding but slightly faster train left Liverpool at 10.30 a.m. and was due at St. Pancras at 4.5 p.m. As second class had been abolished on the Midland Railway at the beginning of 1875, the train was made up of 1st and 3rd class American cars which passengers could use without extra payment and Pullman drawing room cars available for first class passengers at a supplementary charge. Local traffic generally was not conveyed by the all-car trains. After a trial of some thirteen months the American cars were withdrawn and compartment stock substituted to run with the Pullman drawing room cars on these Liverpool trains.

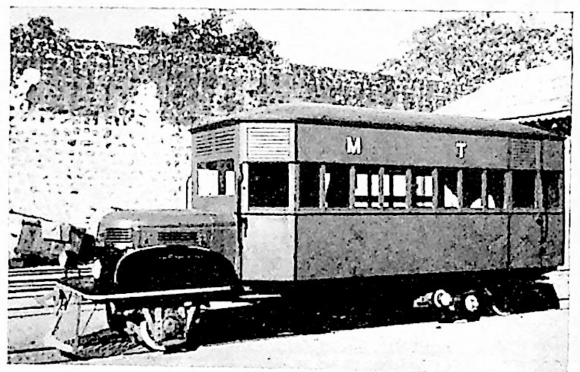
A final experiment was made with another all-car train in March, 1878, between St. Pancras and Liverpool and Manchester, but again owing to the demand for compartment carriages the cars were speedily withdrawn.

There was, however, some demand even in those days for Pullman accommodation, but this was sufficiently met by distributing the Pullman Company's own cars among the existing expresses for the use of 1st class ticket holders who were willing to pay a supplement. In May, 1878, the extra charge from St. Pancras to the following towns was as follows: — Leicester 1s. 6d.; Derby 2s.; Sheffield 2s. 6d.; Leeds or Manchester 3s.; Liverpool 3s. 6d.; Carlisle 4s.; Glasgow or Edinburgh 5s.

Rail Motor Coach for the Morvi State in Kathiawar

A NEW design of Rail Motor Coach for the narrow gauge section of the Morvi Railway in Kathiawar has just been completed in the works at Morvi. It is intended to serve the busier and more populous parts of the State.

Built to the design and specification of Mr. C. O. B. Morgan, Locomotive and Carriage Superintendent, this Rail Motor Coach is unique in that it has a 2-4 wheel arrangement and the differential is carried by the leading end of the bogie, instead of by the main frame. This innovation has necessitated a special type of bogie with a counter-weight at the further end to balance the weight of the differential.



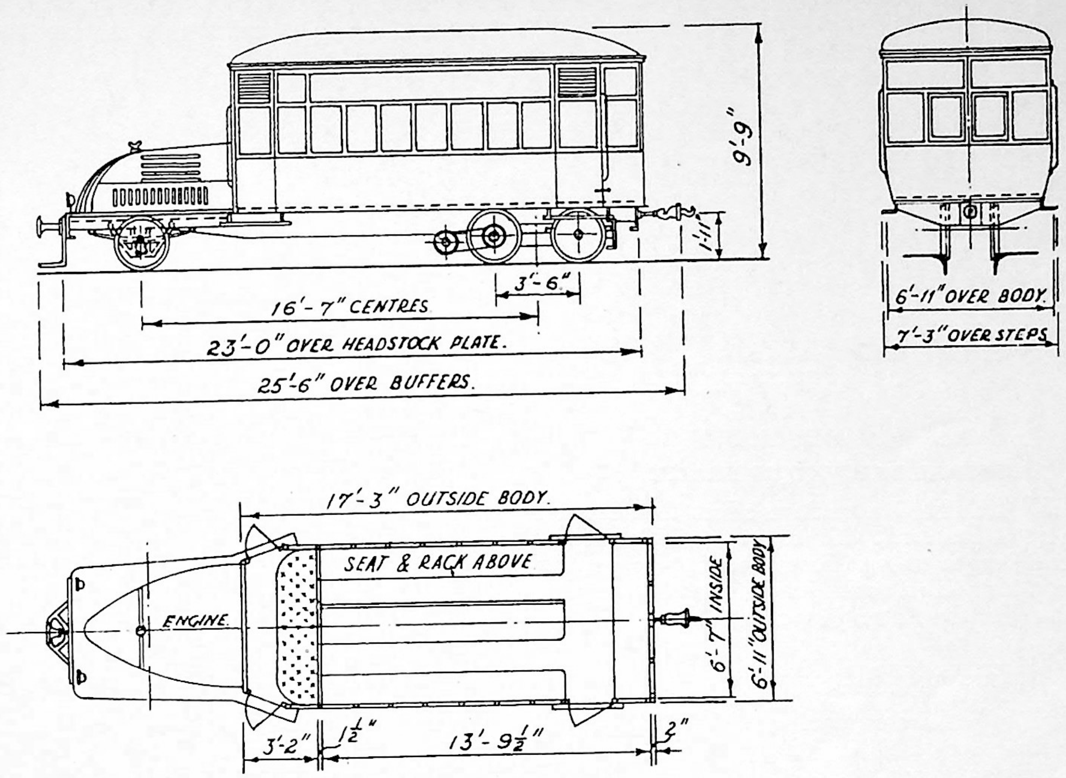
RAIL MOTOR COACH, MORVI STATE RAILWAY.

The differential which has its shaft prolonged at each end carries the sprockets which are connected by chain drive to the leading bogie wheel. The engine is a Dodge 6 cylinder of 36 B.H.P. and the propeller shaft is connected direct to the differential.

The wheel arrangement gives a maximum of flexibility and enables the coach to negotiate 23 degree curves with ease in spite of its length.

Speeds averaging 18 miles per hour were attained on the trial runs on a ruling gradient of 1 in 100 and notwithstanding sections of road had track laid with old rails of light poundage the coach ran very smoothly and with a complete absence of bumping or oscillation.

The body is designed to carry 26 passengers and has novel features. The main members are constructed of teak and the interior, including seats is mainly of plywood. The exterior is finished in Masonite with narrow teak mouldings.



RAIL MOTOR COACH, MORVI STATE RAILWAY.

Southern Pacific Lines

4-8-4 CLASS G.S.4 WITH BOOSTER.

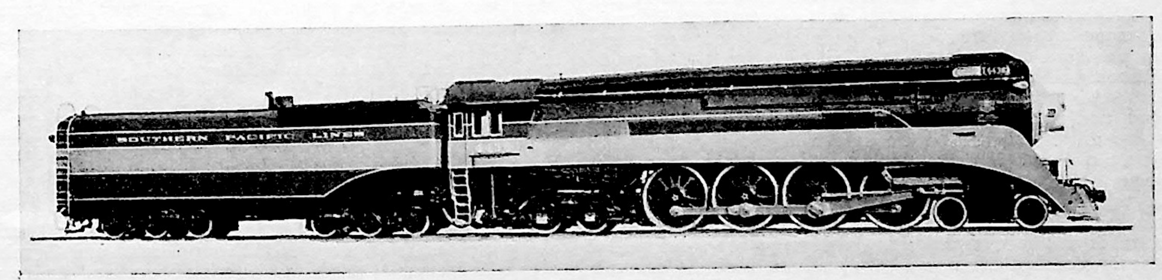
THE " Twin Daylight " streamliners of the Southern Pacific lines, operating between San Francisco and Los Angeles, are hauled by specially designed steam locomotives of the 4-8-4 type. These oil fired locomotives built by the Lima Locomotive Works are known as the Golden State type and are capable of high speeds on the level and can adequately handle heavy trains over mountainous grades.

The trains afford luxurious means of travel and each consists of 14 splendidly appointed passenger cars.

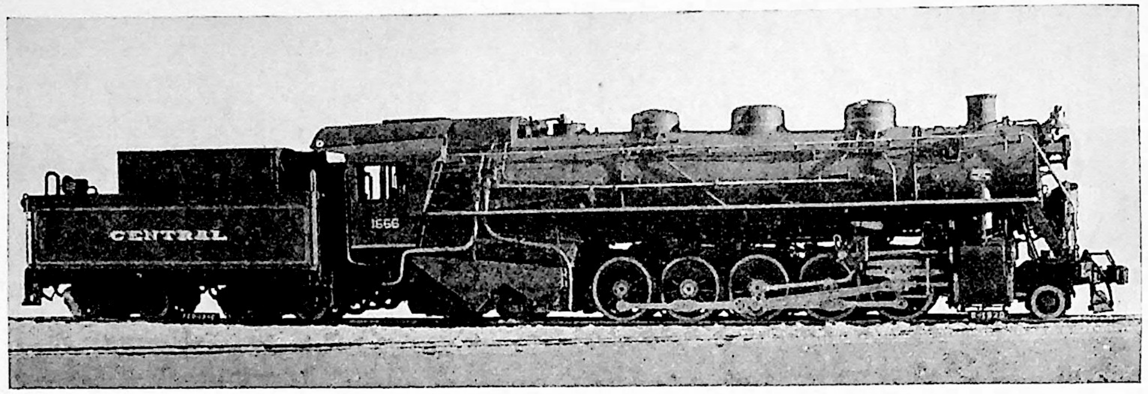
There are twenty engines of the G.S. 4 class Nos. 4430 to 4449 all having twelve wheel tenders. The driving wheels are 6 ft. 8 in. diameter and the cylinders have a diameter and stroke of 25½ in. and 32 in. respectively. The boiler has a diameter (outside) of 7 ft. 2 in. and carries a pressure of 300 lb. The firebox is 10 ft. 7⅛ in. long and 8 ft. 6¼ in. wide. The wheelbase of the engine is 47 ft. 8 in. and of engine and tender 96 ft. 3 in.; the driving wheelbase is 21 ft. 6 in. The total heating surface is 4,887 sq. ft. of which 4,502 sq. ft. is contributed by the tubes and flues and 385 sq. ft. by the firebox and combustion chamber. The grate area is 90.4 sq. ft. The total weight of the engine in working order is 237½ tons of which 137¾ tons is on the drivers.

The tender which carries 23,300 gallons of water and 5,880 gallons of fuel oil weighs when two-thirds loaded, about 156 tons.

The tractive force is 64,760 lb. (with booster 77,760 lb.) and the factor of adhesion 4.26.



SOUTHERN PACIFIC LINES, No. 4436, CLASS G.S. 4—4-8-4.



CENTRAL RAILWAY OF BRAZIL, No. 1666, 2-10-4 LOCOMOTIVE.

2-10-4 Locomotive

CENTRAL RAILWAY OF BRAZIL.

DEVELOPING a tractive effort that exceeds 41,100 lb. and with a considerable weight and length of wheelbase this engine permits an easy individual axle loading and adequate flexibility for the metre gauge track of the Central Railway of Brazil.

The cylinders have a diameter and stroke of 20 in. and 24 in. respectively, while the valve gear is of the Walschaerts type. The driving wheels have a diameter of 4 ft. $0\frac{1}{4}$ in.

The driving wheelbase is 17 ft. 4 in. and the total 37 ft.—engine and tender 64 ft. 10 in.

The total weight of the engine in working order is $118\frac{1}{2}$ tons distributed as follows :—leading axle $8\frac{3}{4}$ tons, driving axles $82\frac{1}{2}$ tons and trailing axles $27\frac{1}{4}$ tons. The 8-wheeled tender weighs approximately 58 tons when in service with 11 tons of fuel and 4,755 gallons of water.

The boiler has an inside diameter of 5 ft. $6\frac{1}{16}$ in. and carries a working pressure of 243 lb. The firebox is 10 ft. $0\frac{3}{8}$ in. long and 7 ft. $0\frac{1}{4}$ in. wide with a heating surface of 240 sq. ft. The combined evaporative heating surface is 2,250 sq. ft. and grate area 70.3 sq. ft. The large grate area is necessary on account of the low grade fuel used. Brazilian coal has a heat content of about 8,200 B.Th.U. per lb. It is necessary to burn up to 3 tons of coal per hour to maintain the maximum power output.

BEIGHTON ACCIDENT, L.N.E.R. On February 11th a north-bound troop train, travelling under clear signals, at about 35 miles m.p.h., on the down line between Killamarsh and Beighton stations, on the Nottingham-Sheffield main line, came into contact with a heavy steel plate projecting over the side of a plate-wagon which was stationary in Holbrook colliery sidings. The plate, which had become dislodged during shunting, was lying almost flat on the wagon and penetrated deeply into the sides of several of the coaches of the troop train, and in the case of the sixth and, to a lesser extent, the seventh, the partitions were displaced laterally forcing out portions of the opposite sides. The train was carrying nearly 400 naval and military personnel. As far as is known the sailors escaped injury, but it is to be regretted 14 soldiers were either killed instantly or died later, while 35 others were so severely injured that they had to be detained in hospital; in addition a number of others received minor injuries, but were able to continue their journey later with the rest of the troops.

Damage to the vacuum brake pipe caused the train to be brought automatically to a stand, with the rear van some 600 yards from the point of impact and 280 yards beyond Beighton signal box, which is at the east end of the station. Appropriate steps for the safety of the line were promptly taken by the staff concerned; but within a few seconds of the accident, and before any action could be taken to stop it, a mineral train went by on the up line, striking the protruding side of the sixth coach of the troop train. Although several of the men had evidently fallen from this damaged coach into the six-foot space between the main lines, there were only slight marks on the engine and first wagon to indicate that the mineral train had been in contact with any of the men on the ground. It is considered, therefore, that the passing of this train did not materially affect the number of casualties, and it is most fortunate that it did not go by a few minutes later when, undoubtedly, some of the injured men on the track would have been picking themselves up, and others alighting.

The report of the Inquiry into the circumstances of the accident by Mr. J. L. M. Moore, Director General, Ministry of War Transport, has been issued. Tests established responsibility for the accident and revealed that a surprisingly slight impact moved the plates in the wagon.

After careful consideration, it was agreed that there was no practicable means of making secure loads carried in this manner, and there was no alternative but to recommend the immediate discontinuance of the existing practice.

EXPLOSIVES BY RAIL. Thousands of tons of explosives have been carried by the British Railways since the war began, the few mishaps have all been caused by enemy action.

Gunpowder vans, specially built for carrying explosives will take a load of 10,000 lb.; for other types of vehicles which have been pressed into service varying weight restrictions are imposed.

Some 163 kinds of explosives are listed under 10 classifications; explosives belonging to different families must not normally be mixed together in the same van and in some cases must not be conveyed on the same train. Special conditions must be observed; some must not travel unless they are accompanied by a " Conductor "; others must not be loaded in a van that has any rubber about it.

Awards of George Medals and other decorations have been made to railwaymen for dealing with munition trains damaged by enemy action. In one case, when a direct hit was made on such a train, ten men worked right through the night dragging truckloads of explosives clear of danger and all the time explosions were occurring in the damaged trucks and bombs were falling all round them.

L.M.S.R. (G. & S.W. SECTION). On and from March 2, the passenger train services between Girvan and Turnberry was withdrawn. Certain unadvertised workers' trains will, however, continue to run over this section of line.

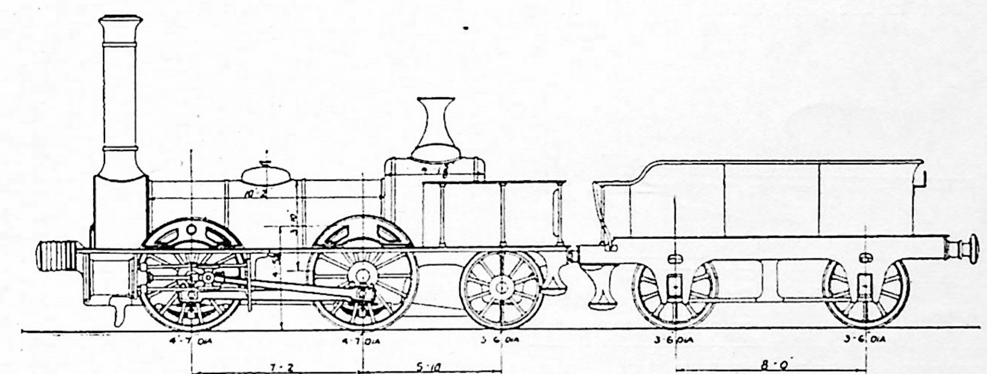
The Locomotives of the Caledonian Railway

By JAS. F. McEWAN.

(*Continued from page* 37)

The goods locomotives were of the 0-4-2 type similar in details to the Caledonian Railway lot described in the issue for October, 1940. The cylinders were 16 in. diam. by 18 in. stroke, driving wheels 4 ft. 7 in., and trailing wheels 3 ft. 6 in. diam. respectively.

The tenders were similar to those on the passenger engines. In all 14 goods engines were ordered and as already noted four were taken over by the builders. It is known with certainty that Scott, Sinclair & Co. were not the builders but only surmise can be made as to the name of the actual makers concerned. It will be recollected that the Vulcan Foundry Co. supplied the Liverpool, Crosby and Southport Railway with three similar engines (maker's Nos. 318 to 320) and it is most likely that these were three of the engines which were probably fairly well under way in construction and against which the S.C.R. paid a sum to as the tender had been involved in a serious mishap which required the provision of a new tank and axleboxes. In October, 1857, a more interesting experiment was tried when the engine was not long out of the shops, and in fairly good condition. A blast pipe of Fenton's Patent Extension type was fitted and a modified form of feed pump fitted at the same time. Both of these fittings appear to have been successful for they were not removed for some considerable time. No. 45 was fitted with new brasses in April, 1853, in which a new " patent " metal was used. At the rebuilding these were trimmed up and were not removed until March, 1857, when a further set of similar boxes was fitted. In December, 1856, an interesting alteration was made to the heating surface which was reduced by the plugging of 54 tubes. Exactly what Allan tried to ascertain by this means is not known. No. 46 was fitted with volute spring buffers in January, 1854, but as the springs failed several times within the space of fifteen months they were withdrawn and although the others of the class got cast iron buffers, No. 46 got a set of new leather buffers. Subsequently a set of Brown's patent buffers were fitted. No. 46 was given a very heavy overhaul



0-4-2 GOODS LOCOMOTIVE FOR THE SCOTTISH CENTRAL AND LIVERPOOL, CROSBY & SOUTHPORT RAILWAYS, 1848.

the builders to cancel the order, the fourth being hardly started. The L.C. and S. was taken over by the Lancashire & Yorkshire Railway in 1855 when one of the engines was sold to the Whitehaven and Furness Joint Committee becoming their No. 11.

All the engines in this class were, when rebuilt, fitted with a cast iron balance beam, under footplate, weighing 11 cwts.

No. 23 was involved in a pitch-in and had both frames broken, it was repaired and heavily rebuilt in 1860 and sold to the Banff, Portsoy and Strathisla Railway (later Banffshire Railway) becoming their No. 3 and subsequently G.N. of S. No. 39, and withdrawn in May, 1868.

No 26 was fitted with brass pistons in November, 1857, and five months later cast iron piston rings were fitted.

In April, 1869, No. 44 had to go into the shops by the C.R. in 1872 when a set of 16 in. by 20 in. cylinders was fitted. The old link motion was retained. When rebuilt the engine was put to work on the Lochee (Dundee) goods but in 1873 had to return to the shops with broken frames. These were renewed but two years later the engine came in again with broken frames which on this occasion were patched but when in 1877 the frames again broke the authorities sent the engine straight to the scrap yard. In October, 1871, the tender was badly damaged at Denny when the engine was involved in a collision. The engine was repaired but the tender was scrapped and an old spare one from Dundee was fitted in lieu.

No.	Maker	Mak. No.	New	Rebt.	C.R. No.	W'drn.
21	Vulcan Fdy. Co.	311	1848	10/1855	374	1870
22	,,	312	,,	4/1854	373	1869
23	,,	313	,,	2/1855		Sold 1860
24	,,	314	,,	2/1855	375	1869
25	,,	315	,,	4/1857	372	1870

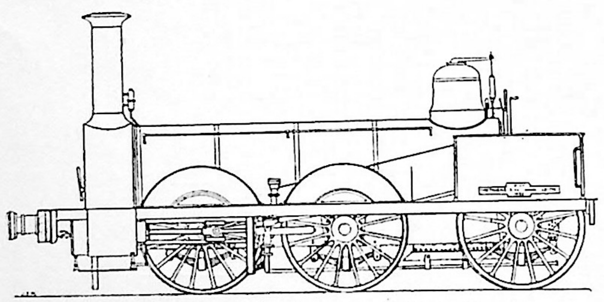
No.	Maker	Mak. No.	New	Rebt.	C.R. No.	W'drn.
26	Scott, Sinclair & Co.	17	1849	12/1854	369	1868
44	"	13	1848	7/1857	377	1870
45	"	14	"	1/1855	376	1870
46	"	15	1849	12/1854	371	1877
47	"	16	"	3/1855 4/1868, Perth	370	1876

When Allan came to Perth in 1853 he found that these small engines were in bad repair owing to the heavy loads which they had to handle and took them into the shops as soon as convenient and had them all overhauled. In view of the slow development of the traffic on the line it was not until 1853 that further engines were required.

The first alteration which Allan made was the progressive fitting of a spherical ball joint between the engine and the tender which idea was later partly superseded by a coiled joint permitting a slight difference in the level of the engine and tender feed pipes while running without any strain on the actual joint.

A very welcome innovation at Perth was the coaling stage which Allan erected in 1854. The coaling time was reduced by two-thirds. The time for loading the boxes was the same as that for loading from platform to tender.

During the period of the "pool" six locomotives were added to the joint stock, while another

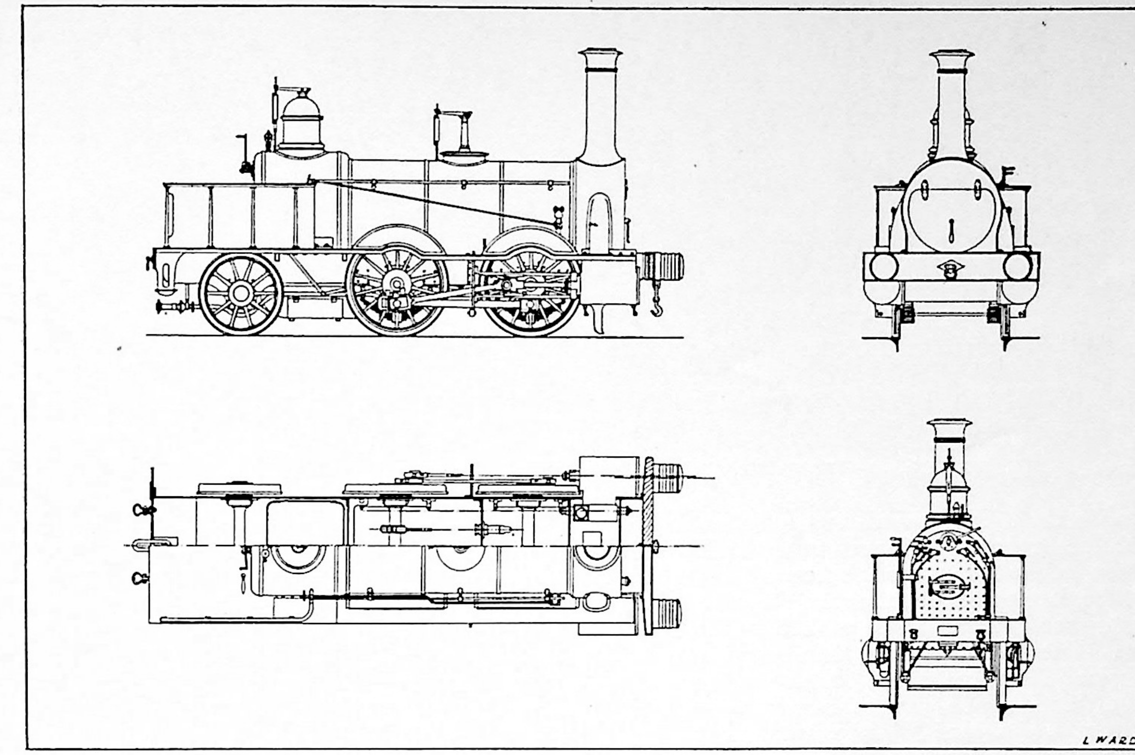


HAWTHORN'S 0-6-0 S.C.R. 48 AND 49 (1854).

four were under order when the pool was terminated. Four of the pool engines, Nos. 77 to 80 were transferred to the Aberdeen Railway stock and those with "pool" Nos. 75 and 76 were taken over by the S.C.R. who renumbered them either late in 1854 or early 1855 to their Nos. 48 and 49. The two engines of the S.C.R. were six coupled six wheeled tender type made by Hawthorns of Leith in 1853. These were got for the fast goods trains which had been introduced by the pooled lines, operating between Perth and Aberdeen and were the beginnings of a service which has lasted until to-day. The engines had outside cylinders and inside framing. The cylinders were 18 in. diameter by 20 in. stroke. Coupled wheels 5 ft. 6 in. diameter. Wheelbase 5 ft. 6 in. plus 8 ft. 3 in., total 13 ft. 9 in. The boiler barrel was 11 ft. 9 in. long by 4 ft. diameter with 165 tubes. The firebox had a midfeather of Allan's design the first of a series of experimental designs. The engines weighed 32 tons 15 cwt. in working order. Tender wheels were 3 ft. diameter.

By 1857 both engines had become the worse for wear, and Allan had them taken into the shops. They were light on the rear axle and frequently came off the road. Cast iron balance beams were added under the footplate, although balance weights appear to have been added to the wheels late in 1854. In 1857 the leading wheels of No. 49 were badly shaken and were exchanged with the trailing coupled wheels. No. 48 had lost two feet off the leading driving wheel rim and the flanges were chipping while the leading tyres were reported as being "very shakey." New tyres and wheels came from Hawthorns soon afterwards. The C.R. numbered them 368 and 367 respectively in 1865. In 1870 No. 368 got the tender from No. 145. This tender had new framing and tanks and the journals were fitted with new patent metal boxes. In 1875 both engines were withdrawn. There is some doubt as to whether these engines received rebuilt flush topped boilers sometime about 1865. They finished their days at Forfar and Arbroath respectively.

In 1855 the four goods tender engines Nos. 81 to 84 ordered by the "pool" were delivered. The first two came with the numbers 81 and 82 but were almost immediately altered to Nos. 51 and 50 respectively. These engines were the products of the Vulcan Foundry Co. Two somewhat similar engines were built at Perth one of which, No. 55, was fitted with a Beattie type coal burning firebox. In this engine the combustion chamber was much shorter than that usually employed and according to reports of the coal burning tests which were carried out, the shorter combustion chamber was shown as having several advantages over the longer ones. It is possible, however, that the Scotch coal used had a higher calorific value and was probably specially picked. The cylinders of all the six engines were outside and single frames were used. The boilers were of the typical Allan design having raised firebox casing, a pillar safety valve on the boiler barrel and Salter type safety valve on the firebox. It was in this class that Allan introduced his straight link valve gear, whereby the slotted link and the valve rod moved in opposed directions concurrently, giving a comparatively straight line as the resultant trace of the two opposed arcs. Excellent steam distribution was given. When renewed the cylinders were made 17 in. diameter with a stroke of 20 in. Details are tabulated giving a comparison of the two variations in the class. When rebuilt flush topped boilers were fitted with standard pattern fireboxes and they gave a heating surface similar to the Vulcan Foundry lot when delivered. Reversing was effected by moving the reversing shaft by rack and pinion operated by a vertical hand wheel.



S.C.R. 0-4-2 Nos. 50-55.

Maker	V. F. Co.	S. C. R.
Cylinders	16 × 20	16 × 22
Diameter of		
Driving wheels	4 ft. $7\frac{1}{4}$ in.	
Trailing wheels	3 ft. $7\frac{3}{4}$ in.	
Wheelbase—		
Total	13 ft. 0 in.	
Coupled	6 ft. 0 in.	
Boiler—		
Length of barrel	10 ft. $3\frac{3}{4}$ in.	
Diam. of barrel	3 ft. 11 in.	
Tubes—		
Number	212—$1\frac{7}{8}$ in. diam.	
Length	10 ft. 7 in. (a)	
Heating surface—		
Tubes	1,100.4 sq. ft.	984 sq. ft. (b)
Firebox	64.6 sq. ft.	65 sq. ft. (b) (c)
Total	1,165.0 sq. ft.	1,049 sq. ft. (b)
Grate area	11.82 sq. ft.	11.0 sq. ft. (b)
Working pressure	120 lb.	125 lb.
Tender	4 wheeled, each wheel 3 ft. 6 in. diam. Coal capacity $2\frac{1}{2}$ tons, water capacity 1,200 gallons.	

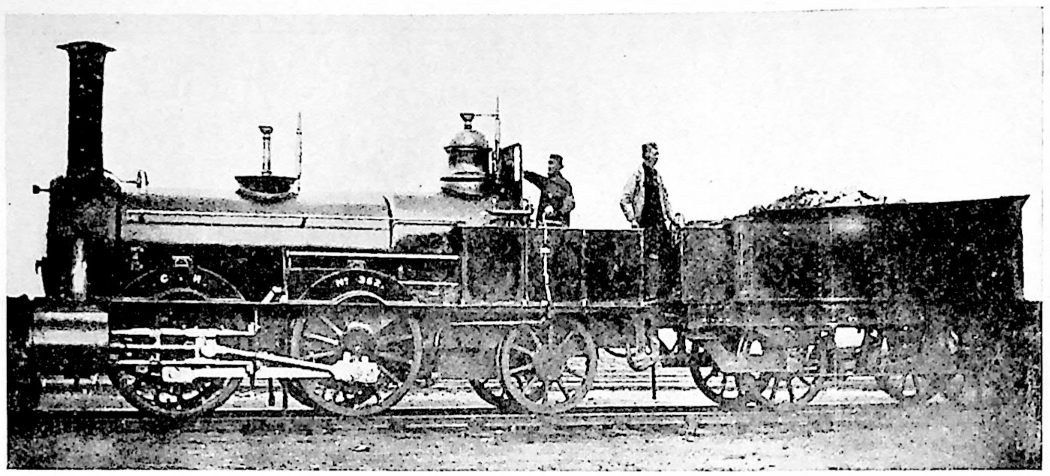
Notes:—(a) except No. 55; (b) refers to No. 55 only; (c) includes combustion chamber.

In May, 1857, No. 52 was fitted with Allan's patent springs, although it would appear from one note that these were fitted to the tender, for No. 30 is referred to in August, 1857, as having been fitted with four Huntsman's patent springs and these were fitted to the engine. At the same time tenders were exchanged for trial purposes. In 1858 No. 52 was fitted with Huntsman's springs on the coupled axles. In May, 1857, No. 53 was fitted with special patent cylinder tallow cocks instead of suet lubricators. At the same time brass pistons were fitted, and in December, 1858, brass piston rings were put in. No. 51 got brass pistons with cast iron rings in August, 1858. No. 54 ran with an old tender until July, 1857, when a new tender was made for the engine, and at the same date the tyres on the driving wheels were exchanged with those of the leading coupled axle. When built the engine was fitted with Ramsbottom patent piston valve rings for 16 in. cylinders.

No.	Maker	Date	Mak. No.	Rebuilt	Renumbered	W'drn.
50	V.F. Co.	3/1855	404	1877	C.R. 366 in 1865 366A in 1887	1888
51	"	"	403	1875	C.R. 365 in 1865	1885
52	"	4/1855	405	1880	C.R. 364 in 1865 364A in 1887	1888
53	"	"	406	1859P. 1873	C.R. 363 in 1865 363A in 1887	1888
54	S.C.R.	12/1856	1	1879	C.R. 362 in 1865 362A in 1885	1888
55	"	5/1857	2	1877	C.R. 361 in 1865	1885

(P) denotes rebuilt at Perth this year, following a derailment at the turntable. It appears that the table either was left unlocked or was in course of repair when the accident happened.

On June 17, 1857, Neilson & Co., delivered their No. 396, an 0-4-2 type goods engine. This is described as "being of the latest improved model for coal combustion and giving the minimum of smoke." Unfortunately no details of the boiler can be found by the makers, and in all probability was similar to the 50 to 55 class in external appearance. The boiler pressure was 130 lb. per sq. in. In October, 1857, the engine was taken into the works at Perth and was fitted with a Fenton Patent blast pipe. At the same time



S.C.R. No. 54—C.R. No. 362. Built at Perth, 1856. Note vertical screw reversing gear.

a warming cock was added and a firebrick arch put into the firebox. The arch consisted of seven bricks six inches thick supported on a bar attached to the tubeplate three inches above the firebars and sloping upwards at an angle of about twenty-five degrees. The cylinders were then bored out from the original diameter of 16 in. to 16½ in., and the slide valves which were of cast iron were lined up with brass on Mr. Allan's instructions. The old piston was retained for four new piston rings were made and when finished these were to compress to a diameter ½ in. greater than the diameter of the piston, and without springs.

The cylinders were outside and were originally 16 in. diam. by 22 in. stroke. The coupled wheels were 5 ft. diam. and the trailing wheels 3 ft. 6 in. diam. The coupled wheelbase was 6 ft. 3 in. and the total wheelbase 13 ft. 6 in. The S.C.R. No. was 56 and C.R. No. 360. The engine was given an overhaul in June, 1871, at Perth. In November, 1879, the engine was taken from traffic and scrapped.

About the time this engine was fitted with the warming cock other engines were being fitted with tallow lubricators so that it is possible that the fitting of tallow lubricators was becoming general on the line. These lubricators were initially warmed by steam until the cylinder radiated heat sufficient to make the tallow flow normally.

(To be continued.)

COLOUR IN THE WORKSHOPS. Black-out conditions tend to make some shops very sombre and this, combined with long hours of work, has led the L.M.S. Railway to endeavour to increase the brightness and general visibility without increasing the intensity of the lighting.

As an experiment machines and metal work in one of the L.M.S. shops were painted a light buff colour, and the results were so satisfactory that the policy has now been adopted as standard. Workpeople are pleased with the change and cases of eyestrain due to long hours of work under artificial light, have decreased.

Over 500 machines have so far been treated. Walls of shops are whitewashed, except for a five feet black band at the bottom. Steel work in roofs and cranes are painted a light stone colour.

Locomotive Performance on the G.W.R.

PART III.—THE "CASTLE" CLASS 4-6-0s.

By O. S. NOCK, B.Sc., A.M.I.Mech.E.

THE "Castle" design was prepared at a time when loading of the principal expresses on the West of England, and Birmingham routes was definitely increasing and a more powerful locomotive type than the "Stars" was becoming necessary. In the hands of the top-link men at Old Oak, Laira, and Newton Abbot Churchward's famous 4-cylinder 4-6-0s had proved able to work punctually the heaviest of trains then operated, but the margin of power in such cases was small. In the "Castles" all the salient characteristics of the "Stars" were retained, and the enlarged engines had a tractive effort of 31,625 lb. against 27,800. Following the 10 locomotives of the first batch, built in 1923-4, construction has continued right down to 1939, and the class is now about 130 strong. Prior to the outbreak of war they were being used on every main line of the G.W.R., including that route so long banned to 4-6-0 locomotives, Birmingham to Bristol, via Cheltenham.

This widespread use, over roads having greatly varying physical characteristics, has made possible a very comprehensive survey of their work; and from the observed performance of 50 engines of the class it has been possible to prepare a graph showing drawbar horse power plotted against speed, based on the Author's personal observations. This curve appears to correspond fairly closely to a constant rate of evaporation, and represents the power output that might be normally expected. Examples of considerably harder work are included in the present article, but these records were obtained under circumstances demanding exceptional locomotive effort. Before proceeding, however, to a consideration of individual performances the graph in Fig. 1 is of

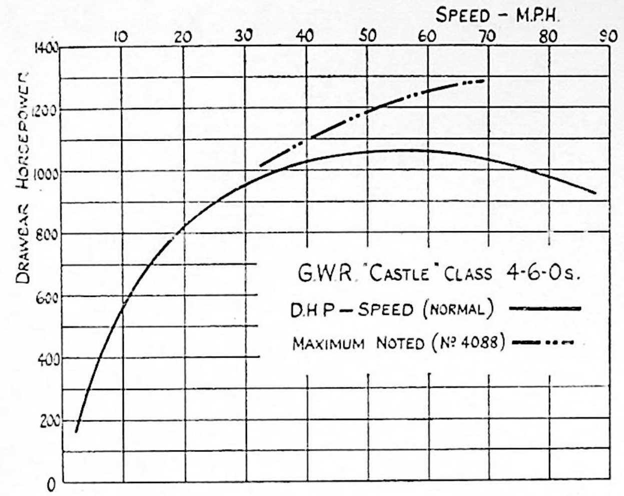


FIG. 1.

particular interest when related to the published test results obtained with No. 4074 *Caldicot Castle*, in 1924. On the long stretch of level road between Bristol and Taunton, a drawbar horse power of 1,000 was sustained for about 30 miles on end, at a speed that averaged 65 m.p.h. The cut-off throughout this spell was 23 per cent. This gives a point lying very close to the curve in Fig. 1. Then from the dead start at Taunton, after the initial linking up, 30 per cent. cut-off was used throughout the ascent to Whiteball, at speeds varying from a maximum of 54 m.p.h. to a minimum of 35. The use of so long a cut-off as 30 per cent., with full regulator, at 54 m.p.h., is reflected in a D.H.P. of nearly 1,200—well above the curve; though the final figure, as the summit was reached and speed fell to 35 m.p.h. would appear to represent normal working on a heavy gradient, and the D.H.P. of 1,000 does indeed lie almost exactly on the curve.

A selection of characteristic feats of sustained speed, each involving a D.H.P. corresponding closely to the general curve, is given in the accompanying table.

Speed (m.p.h.)	Engine No.	Load (Tons)	Gradient.	Location.
18¾	4075	285	1 in 41 rising.	Hemerdon bank.
25½	4094	360	1 in 70 rising.	near Doublebois.
29½	5028	335	1 in 80 rising.	near Chacewater.
35	4096	400	1 in 115 rising.	near Burlescombe.
56	5082	500	1 in 754 rising.	near Challow.
67	5019	540	1 in 1140 (falling).	Moreton-on-Lugg.
76	5084	405	1 in 754 (falling).	Steventon.
85	5018	230	Level.	Slough.

The correspondence of the test results from No. 4074 give a fairly good indication of how the engines were worked, cut-offs being reduced from 30 per cent. at 30-35 m.p.h., to 20-23 per cent. at 65 m.p.h. Above this latter speed some easing seems usual; in one particular instance where a D.H.P. of 1,120 was recorded at 85½ m.p.h. the engine was being worked at 21 per cent. cut-off and full regulator—well above normal for that speed.

The D.H.P. required for the operation of high-speed trains clearly shows the margin of power in reserve on normal loadings. "The Bristolian," for example, was booked to average 78 m.p.h. over the 76 miles from Swindon to Westbourne Park; with the usual load of 245 tons this called for continuous output of 740 D.H.P. On the famous run of the "Cheltenham Flyer" on June 6, 1932, when the Swindon-Paddington journey was made in 56 min. 47 sec. start to stop, a distance of 70 miles was run at an average speed of 87 m.p.h.; with a load of 195 tons this involved a D.H.P. of 790. As an instance of the higher power-output of which the "Castle" engines are capable at speeds in excess of 80 m.p.h., a further run on the "Cheltenham Flyer" may be quoted; on this, recorded by the Author, speed

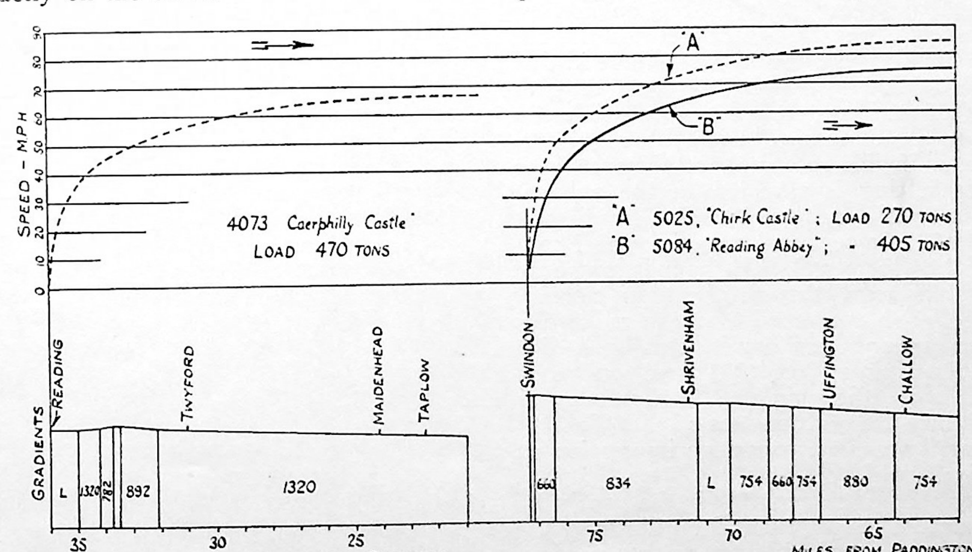


FIG. 2.

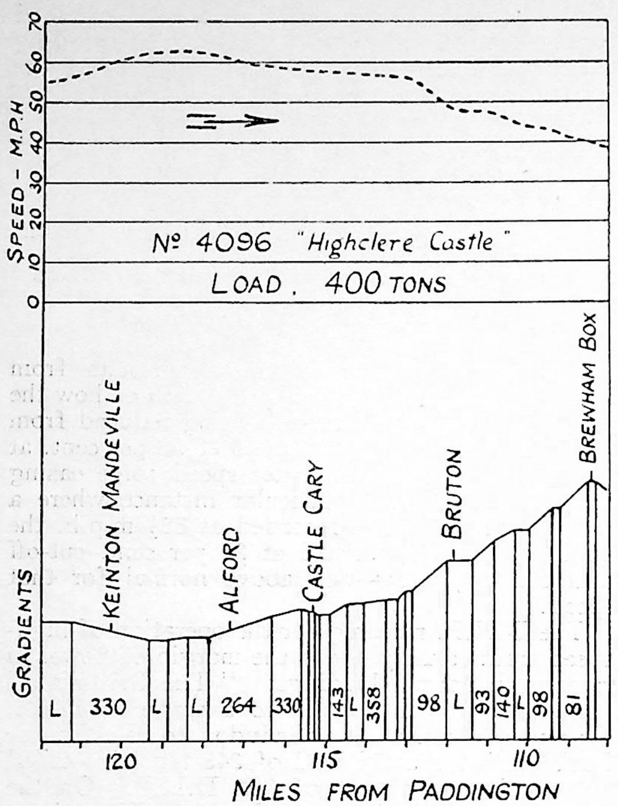


FIG. 3.

averaged 81.3 m.p.h. for 30 miles east of Reading with a 270-ton load requiring a continuous output of 950 D.H.P.

The normal cut-offs used on the " Castle " class locomotives when working heavy trains are, by present standards, longer than usual with long-travel valves and a well designed front-end; but the degree of superheat used is only moderate, the steam temperature being about 500°F on leaving the superheater. Certain other features of the design have been largely adopted elsewhere in this country; the layout of steam passages, to give direct and unrestricted flow made possible an average steam-chest pressure, with full regulator, of 93 per cent. of boiler pressure, and the excellence of the valve setting is revealed in the exhaust pressure of only 3 lb. per sq. in. when running at 65 m.p.h. on 23 per cent. cut-off. The coal consumption of 2.83 lb. per D.H.P. hour is low, even by present standards, though the high calorific value of the Welsh coal used tends to make this overall figure appear better than it actually is. But at the time the trials of No. 4074 were conducted the overall thermal efficiency of 8.22 per cent. was unsurpassed, and the performance of the "Castle" engines generally made a very deep impression on the locomotive world.

Coming to some examples of the work of individual engines, Figs. 2A and 2B illustrate the acceleration from rest with trains of varying weight on the even-grading of the London-Bristol main line. The smoothness of these curves, and their form, show clearly that the locomotives were being most competently handled, for all three approximate to a constant output from the boiler. The work of the pioneer engine, No. 4073 *Caerphilly Castle*, as given in Fig. 2A is of particular interest as this acceleration leads up to a steady speed corresponding almost exactly with that run on trial by No. 4074 between Bristol and Taunton with a 480-ton load. It will be seen that with the 470-ton load in Fig. 2A 50 m.p.h. was attained in 3 miles from the start, and 60 m.p.h. in 6 miles. Fig. 2B gives details of two eastbound starts from Swindon on slight falling gradients; here, with a 405-ton load, 70 m.p.h. was attained in 8¼ miles, while engine No. 5025 *Chirk Castle*, working the " Cheltenham Flyer," reached 80 m.p.h. in 8½ miles from the start.

The lower range of uphill speeds quoted in the table on page 77 may tend to give a wrong impression of the way in which the heavy grades of the West of England main line are climbed. As was explained in the second article of this series, in connection with the work of the " Star " class 4-6-0s, the worst inclines are composed of somewhat broken grading, so that a driver making the best use of impetus can surmount them without unduly heavy pounding of his engine. An interesting example of this is shown in Fig. 3, which relates to the work of No. 4096 *Highclere Castle*, on the 6.28 p.m. non-stop from Taunton to Paddington, in the ascent of the Bruton bank. The approach gradients, beginning near Alford Halt, were at first taken under easy steam; but from Castle Cary the speed was well sustained to rush the mile at 1 in 98 to Bruton station. Rapid acceleration followed, after which, with no undue opening out, the heaviest part of the bank was mounted at a minimum speed of 38½ m.p.h.

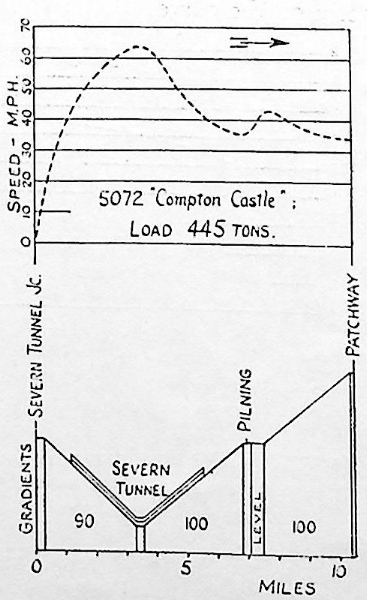


FIG. 4.

A more severe test of hill-climbing ability is illustrated in Fig. 4, forming part of a through locomotive working from Shrewsbury to Newton Abbot on the morning Liverpool and Manchester-West of England express. Impetus played some part in the climbing of the first stage of the ascent from the Severn Tunnel but nearing Patchway the speed had fallen practically to a sustained figure. The uphill work of this engine had, throughout from Shrewsbury, been of great merit, speeds of 33 to 34 m.p.h. having been sustained in every case on gradients of 1 in 100, at Church Stretton, Red Hill Junction, Llanvihangel, and finally in climbing from the Severn Tunnel. This running was all the more remarkable since it was made under war conditions, in the period when speed was limited to a maximum of 60 m.p.h. In a successful attempt to make up lost time the driver was getting an uphill performance from the locomotive considerably above the general standard shown in Fig. 1; at 33 m.p.h. the drawbar horse power was 1,142. As indicating the trying conditions existing at the time this excellent run was made it may be mentioned that the train was later delayed by an air raid.

(To be continued.)

New 0-6-0 Freight Engines

SOUTHERN RAILWAY.

THE first of a new class of 0-6-0 superheater locomotives designed by Mr. O. V. Bulleid, M.I.Mech.E., has recently been completed at the works of the Southern Railway.

The engines are being built to cope with the heavy wartime traffic, and were designed to meet the special requirements of the Southern Railway system.

The weight had to be restricted so that the engines could work over practically the whole system. By the reductions referred to later and by careful attention to the design of all frame members, etc., the weight of the engine built and in working order is 51 tons 6 cwt. The weight of the tender has been brought down to 38 tons 0 cwt., i.e., a total weight of 89 tons 6 cwt., and in consequence the engine can work over 93 per cent. of the Company's lines, the 7 per cent. from which it is excluded representing unimportant sections with little traffic.

As the existing 0-6-0 locomotives had shown that additional boiler capacity was desirable, it was decided to provide the largest possible boiler within the weights allowed and within the restricted load gauge. The boiler, as regards its firebox, is based on that of the "Lord Nelson," the same press blocks being used for the throat plates and back plates. This is the largest firebox in cross section that can be accommodated consistent with providing suitable look-outs for the enginemen with the restricted cab width imposed by the composite loading gauge. The length of the firebox was arranged to give a grate area of 27 sq. ft.

The diameter of the barrel at the throat plate is 5ft. 9 in. and at the smokebox 5 ft. There are 21 flue tubes 5¼ in. outside diameter for the superheater elements, and 209 small tubes 1¾ in. outside diameter. Although the barrel is short, it will be noticed that the total evaporative heating surface is good, being 1,472 sq. ft., which, with the superheating surface of 218 sq. ft., gives a total of 1,690 sq. ft. The firebox heating surface is no less than 170 sq. ft. Monel metal stays are fitted to the firebox. The weight of these boilers carrying a pressure of 230 lb. per sq. in., is 21 tons 5 cwt. with 5 tons of water so that special steps had to be taken, even to the extent of discarding all details not essential to efficient working of the engine if the total weight was to be less than the prescribed maximum.

These boilers are lagged with Idaglass lagging, a home produced material. As it was thought preferable that this material should not carry any load, instead of the ordinary lagging and clothing bands, the casing plates are carried off the frame independently of the boiler. As the casing is merely a covering it was possible to fabricate it from very thin plate. The shape of the casing was governed by the contours of the cab firebox and smokebox, by the maximum boiler diameter, and by manufacturing conditions, e.g., all the ribs of each section are alike instead of varying with the shape of the boiler over which it is fitted so that only two patterns have to be manufactured.

The casings project sufficiently far over the wheels to make it unnecessary to fit the usual running boards and this made it possible to save 17 cwt. of steel.

A further saving of 6 cwt. in weight was obtained by fabricating the cab from 22g. steel sheet suitably reinforced by rolled U sections.

The absence of running boards has made the inside motion and, in fact, the whole of the engine unusually accessible.

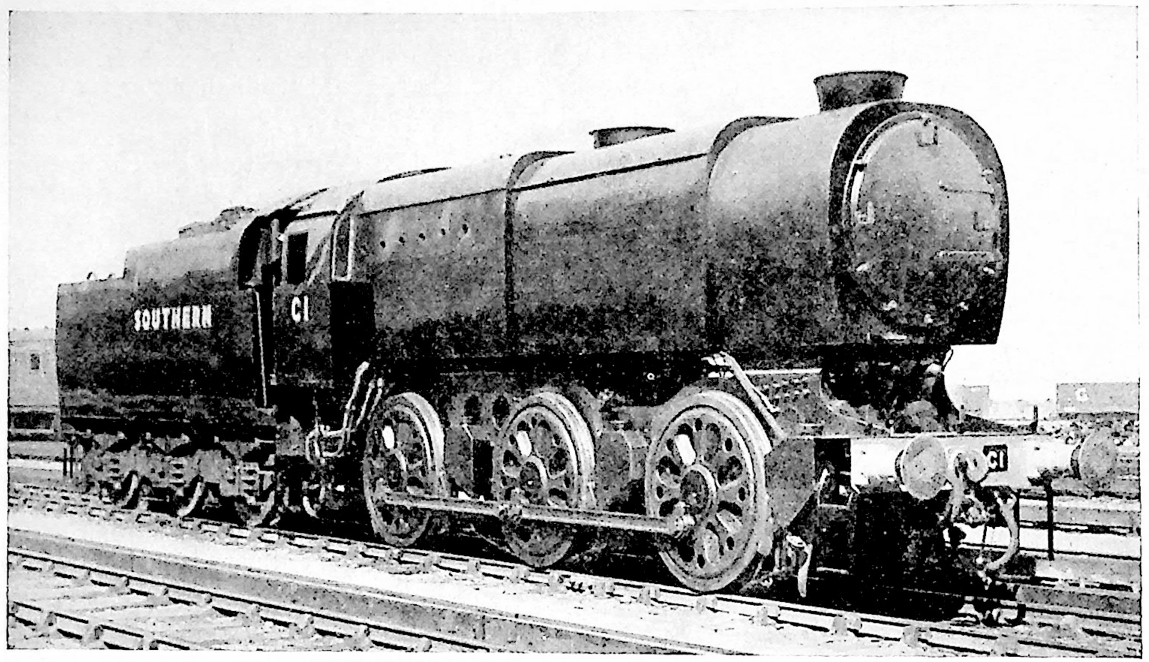
The engine has inside cylinders with overhead piston valves with outside admission, the leading dimensions being shown in the accompanying diagram. Special attention was given to the cylinder passages so that the engines can be used for passenger train working, if required.

As is usual with this type of engine the middle pair of wheels are the drivers. The connecting rod big ends are a modified marine type which has given very good results. The white metal lining is only 1/32 in. thick.

The piston valves are operated through rocking shafts by two sets of Stephenson link gear, the valve travel being 6⅝ in. and the lap 1⅝ in. The piston rods are fitted with U.K. cast iron packing. The reversing gear is steam operated.

The solid bronze axleboxes are lined with white metal, the oil being fed through the crown.

Owing to the outside admission of steam to the cylinder, the exhaust steam has a very free and direct passage through the blast pipe. The blast pipe is fitted with the multiple jet exhaust (five



SOUTHERN RAILWAY 0-6-0 FREIGHT ENGINE, No. C 1.

nozzles being used) with the wide chimney which has been found so successful on the Southern Railway. The blower is fitted below the blast pipe cap and is used when the regulator is closed to prevent any vacuum forming in the exhaust cavity. The blower has five jets set to blow centrally through the exhaust nozzles of the cap.

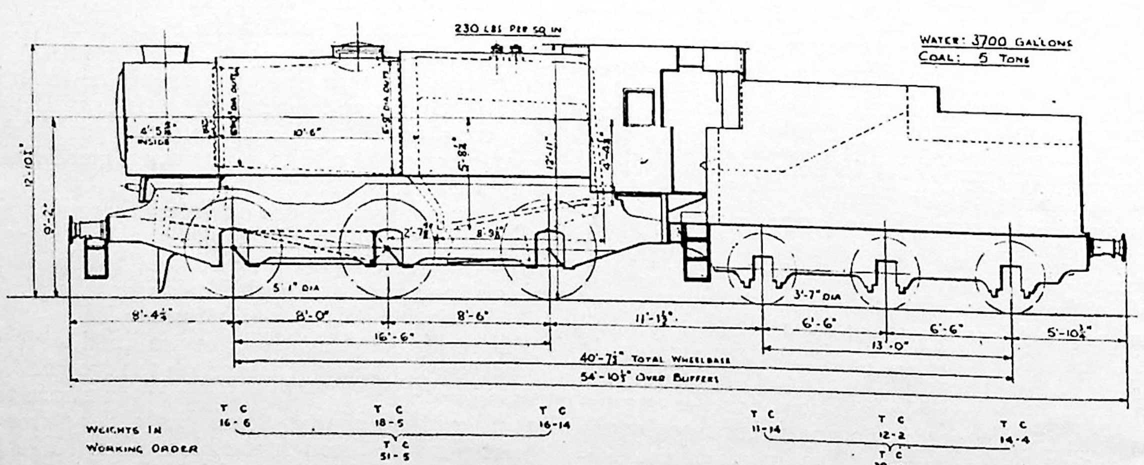
The cast steel driving wheels are of the B.F.B. patent type, similar to those used on the "Merchant Navy" class. Laminated springs are provided for the leading and trailing wheels and helical springs for the drivers.

The 3,700 gallon tender has a tank of welded construction fitted with a self-trimming bunker capable of holding five tons of coal.

Ample cupboard room has been provided for the enginemen on the tender. An extension from the top of the front plate of the tender lineable with the engine cab roof practically encloses the footplate and gives ample protection to the driver and fireman: this extension and the cab roof are connected by a flexible strip. The sides of the cab and the sides of the tender at the forward end have been provided with sliding shutters which can be used effectively during the blackout period. The remaining gap between the engine and tender sides when the slides are drawn is covered with a loose sheet, thus dispensing with anti-glare screens.

The fire irons are carried in a trough on the left-hand side of the tender and this, at the same time, gives the driver an unusually good look-out when running tender first, a condition frequently necessary with this type of engine.

The water filling holes are arranged in the tender cab to make it unnecessary for the fireman to climb to the top of the tender.



SOUTHERN RAILWAY 0-6-0 FREIGHT ENGINE.

The appearance of the engine although unusual, is functionally correct; nothing is hidden or disguised, nor is anything added merely for appearance, but the appearance is the result of designing to meet the requirements. The engine provides an example of the rational use of the tonnage of material available per engine by employing it where it will be most productive as regards haulage capacity: how successful the design has been in this direction can be judged by a study of the leading dimensions.

L.M.S.R. No. 20,002 of the L.M.S. Railway, attains her seventy-sixth birthday this year, and despite her advanced years is still playing a useful part in the nation's war effort. She was built in 1866 to the designs of Mr. Matthew Kirtley, then Chief Mechanical Engineer to the Midland Railway, and it says much for Kirtley's skill as a locomotive designer that this old engine, although now relegated to branch line duties, is still going strong after so long a life. She is not the last of her type, as she has two sisters only one year her junior remaining at work; they are No. 20,008 and No. 20,012. An outstanding feature of these locomotives is the deep solid framing, and this, together with efficient maintenance, may have contributed to their longevity.

The black-out slows up the work in the marshalling yards, even though a certain amount of lighting is permitted to assist operations. The principal difficulty has been the inability to read the chalk numbers placed on the wagons to indicate to the shunter into which siding the wagon has to be placed. Experiments conducted by the L.M.S. Railway have resulted in this particular difficulty being overcome. Recently an important L.M.S. marshalling yard was equipped with ultra violet ray lighting, the beam of which is directed down the hump over which the wagons are shunted, the wagons being marked with a special type of fluorescent chalk. The action of the ultra violet ray on this special chalk activates its fluorescent properties and results in the numbers glowing whilst the wagon is in the ray, thus enabling the shunter readily to read the number and shunt the wagon into the right siding. The experiments have proved so successful that the use of ultra violet rays and fluorescent chalk is being extended to other yards where difficulties in reading chalk numbers exist.

Out of Gauge Loads. The limits for carrying out of gauge loads are governed by the distance between lines, height of bridges and tunnels, the position and height of platforms at stations and the various curves that may have to be negotiated.

There are two ways of handling such traffic. By running an "Out of Gauge" special train or by using special wagons that allow the load to be carried in a well.

The first method is used in the case of such articles as ships' propellers, partly or wholly assembled machines having long projections, girders, etc., and involves, in nearly all cases, careful forethought. It has the inevitable effect of slowing up traffic generally, since all trains in the reverse direction must be side-tracked during the passage of the load. Sometimes, even signal posts have to be taken down and more than once it has happened that the whole line required to be slewed to one side so that a certain bridge or tunnel could be safely negotiated. However, such loads have to be moved and the slackest period of the 24 hours—though slack periods on the Railways these days are unknown—has to be used.

The alternative, is the use of one or other of their specially constructed wagons and of these the four main line Companies now possess a large number. Well trolley, flat trolley and propeller trolley; pulley wagons, wheel wagons and transformer wagons; flat tops, boiler wagons and rectanks; glass wagons, trestle wagons and bogie bolster-fitted wagons; such are just a few of the names by which these elaborate conveyances keep the tempo of the wheels of war in top gear and allow such things as giant steel girders, lifeboats, boilers, electrical gear, cranes, armour plating, heavy guns and tanks to be taken where they are wanted.

When it is realised that the demands of the military, naval and aircraft authorities have increased to such an extent that the railways are now called upon to carry almost as many of these unwieldly loads in one day as they previously carried in a month, the pressure on their organisation will be appreciated. Nor does their responsibility necessarily end with the bare conveyance of the load, for more and more frequently now they have to undertake the task of actual delivery to site and huge boilers, transformers and the like have to be positioned with fractional exactitude. To enable them to do this work, specially equipped tool vans with experienced men follow the loads to their destination and so enable them to be unloaded at places where the task would be quite outside the compass of the average station's equipment.

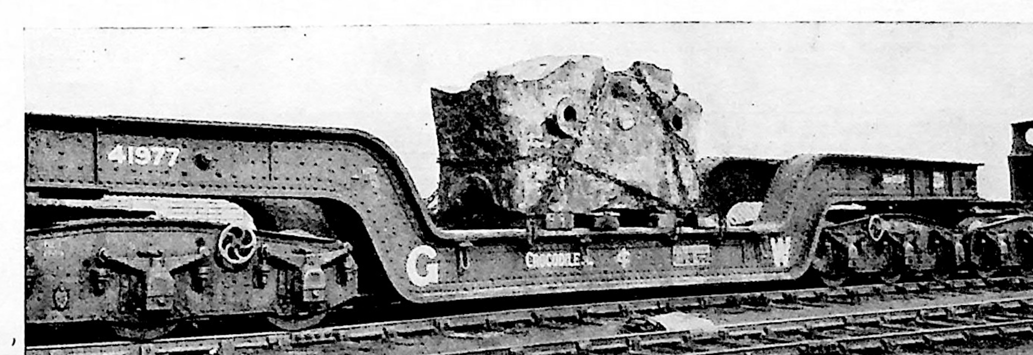
The noteworthy example of the wagon builders' skill is undoubtedly the 150 ton Well Trolley Wagon set. This vast 56-wheeled 5-unit vehicle is able to carry a concentrated load of 150 tons. Examples of the kinds of loads carried by it are electrical stators, turbine castings, large stern frames, marine engines and huge ingots.

A large works near London has just added to the capital's war-scrap collection a giant steam-hammer block—an 85-ton lump of solid steel 12½ ft. long, 8 ft. broad, 6 ft. thick.

To move this load northward was a stiff problem, but rail experts supplied an answer; they called into service the G.W.R. 24-wheeled girder wagon, built with interchangeable centre sections to suit vari-shaped loads. It weighs 82 tons, can carry up to 120 tons, and is illustrated below.

Craning the hammer-block was impracticable, so a small army of skilled loaders had to manhandle it with the aid of portable jacks and baulks of timber. They lifted it from a deep well to ground level, edged it inch by inch along the yard to the track-side, then up into the wagon.

Traffic chiefs plotted a special rail route and checked it mile by mile to guarantee safe clearance past every curve, bridge and lineside structure. It crossed areas where railborne war-freight traffic is densest, but careful train timing manoeuvred the giant through the traffic maze without check.



G.W.R. 120-TON 24-WHEELED GIRDER WAGON WITH 85-TON BLOCK FOR SCRAP.

CORRESPONDENCE

To the Editor of "The Locomotive."
Dear Sir,

"WEBB" COMPOUNDS.

Continuing to read with interest the excellent articles on L. & N.W. compounds, by F. C. Hambleton, I regret that they could not have been consecutively presented for easy reference. There now remains to be described the 5 ft. 4-6-0 machines of 1903—Webb's last compound—they were not very successful by all accounts. C. J. Allen, speaking some years ago to a branch meeting of the Institution of Locomotive Engineers remarked he would not refer to Webb's work—speaking on Compound Locomotives—as the engines were not well designed, though it cannot be said that interest in Webb's work is lacking as recent articles and correspondence show. The L. & N.W. locomotive remained consistently true to Crewe traditions right up to the grouping, a circumstance that can hardly be claimed by other contemporary systems. It is to be regretted that no illustration of Whale's modification to Joy's gear on the "King Alfred" compounds has ever appeared in "The Locomotive" and it will be recollected that the locomotive's appearance was not enhanced by such alterations. The standard tender until the end of Webb's reign was a singular, though attractive vehicle, it differed little from the days of Ramsbottom. The features were snap head rivets, large tool boxes, inclined coal rails and in a few cases towards the end sand pipes to the forward wheels: notable too was the wooden frame. The long continuation of wood brake blocks was remarkable, the hangers of which were in tension, a sound mechanical arrangement, specially on a vehicle whose running was mostly in a forward direction. Another feature of Webb's practice was the combined engine and tender brake actuating gear, whereby a floating lever self compensated both vehicles in exact proportion to their requirements.

Tenders on the late L. & N.W. were separately numbered in the stock of that company, and doubtless they were changed about from engine to engine as required by repairs to either unit from time to time. "Engineering" for 1883, Vol. 37, describes the "Dreadnought" compound, with drawings and a fine woodcut, though no tender is shown, there are also details of the Metropolitan type of 4-4-0 tanks, while the same journal for 1887 contains the correspondence by "Argus" and others, which makes illuminating reading.

Yours faithfully,
JOHN W. SMITH.

Glasgow, March 28th, 1942.

To the Editor of "The Locomotive."
Dear Sir,

W. F. PETTIGREW.

In the obituary notice in your current issue concerning Mr. W. F. Pettigrew you refer to his contributions to the proceedings of the Institution of Civil Engineers and the Institution of Mechanical Engineers, but reference to his principal literary work "A Manual of Locomotive Engineering" published about 1895 is omitted. It was an outstanding work on locomotive practice of the period, was full of useful practical and theoretical information and had a large circulation. In fact no locomotive engineers library was considered complete without it forty years ago.

Yours faithfully,
H. W. DAVIS, M.Inst.C.E.

GREAT WESTERN RAILWAY. The Southall & Brentford branch will be closed for passenger traffic on and from 14th May. It will be recollected that this branch was one of those closed for a time during and immediately after the last war.

SWEDISH RAILWAYS. Locomotives in Sweden are burning wood as fuel, especially on the secondary lines. Wood firing has necessitated the withdrawal from circulation of some of the large and heavier types of carriages.

REVIEWS

THE PHILLIMORE RAILWAY COLLECTION. Catalogue of Sale. Sotheby & Co., 34 and 35, New Bond Street, London, W.1. Price 2s. 6d.

In connection with the sale by Messrs. Sotheby & Co., of the railway collection of the late Mr. John Phillimore on 28th April, an interesting and comprehensive catalogue has been received from that well-known firm of auctioneers. This publication comprises 52 pages in which are listed in detail the 345 items which are for sale, and is illustrated with eight half-tone plates depicting subjects in the collection.

Mr. Phillimore was an assiduous collector of railway material dating from the earliest days, including books, maps, manuscripts, coloured prints, pottery and snuff boxes with representations of trains or locomotives.

There are many items in the collection relating to the Stockton & Darlington, Liverpool & Manchester, London & Birmingham and other pioneer railways.

The coloured prints and also the railway pottery are unique collections.

The George Stephenson collection is worthy of special mention containing as it does numerous autographs, letters, portraits and relics of that great Railway Engineer.

Other subjects included in the collection comprise railway medals and tokens, railway passes in gold, silver and other metals, etc., a selection of passenger tickets covering the years 1832-1873, and time tables issued during the period

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VICTORIAN RAILWAYS. In 1922/23, the Department built at the Newport shops ten light line 2-8-0 engines of the "K" class, numbered 100-109 (Ref. LM. p. 7. 1923).

Though the design was then some 16 years old, the first draft had proved so successful, that further engines of the same class and dimensions, though with modifications, began to be added in 1940 and there are now 29 of the later engines, making with the original ten 39 very useful units. To make one "bloc" of all the "K's," the first ten were renumbered 140-149, and the newer ones bear numbers 150-178 (Ref. LM. p. 120/41).

Work is now being pushed on with in the output of the much larger 2-8-2 "X" class engines and ten of these are more or less on order, though naturally nowadays all output is subject to availability of material. When in running these will be numbered from 46 onwards, there being already 19 of the class in service, though the last eight are a modification of the first 11 of the class 27-37 (Ref. LM. p. 139/29).

H 220, though designed for express running as far as Ararat on the "Overland" to Adelaide, is still prevented by road conditions from taking up this work and is engaged chiefly on fast freight to the New South Wales border at Wodonga/Albury, with an interlotted passenger trip on the same track (Ref. LM. pp. 99 and 164/41).

The official figures as at June 30th, 1941 (and with additions and subtractions they must be still about the same) were—

Steam Locomotives	581
Electric Locomotives	12
Steam Cranes	16
Steam Coaching Stock	1,491
Electric Coaching Stock	856
Rail Motor Passenger Vehicles ...	77
Goods Vehicles	19,669
Service Vehicles	891

L.N.E.R. (NORTH EASTERN AREA). On and from 4th May, High Westwood station on the Scotswood-Blackhill branch will be closed for passenger traffic.

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