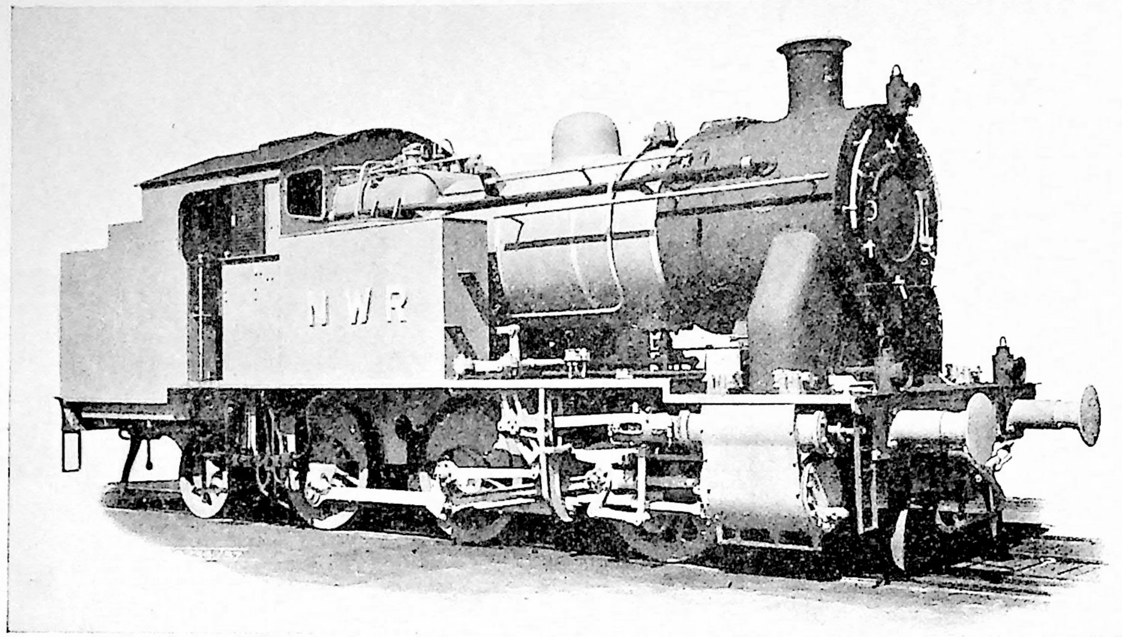
THE LOCOMOTIVE

RAILWAY CARRIAGE & WAGON REVIEW

Vol. XLVIII. No. 600. AUGUST 15, 1942 ONE SHILLING



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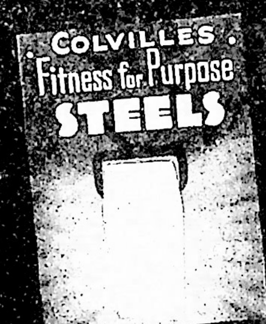

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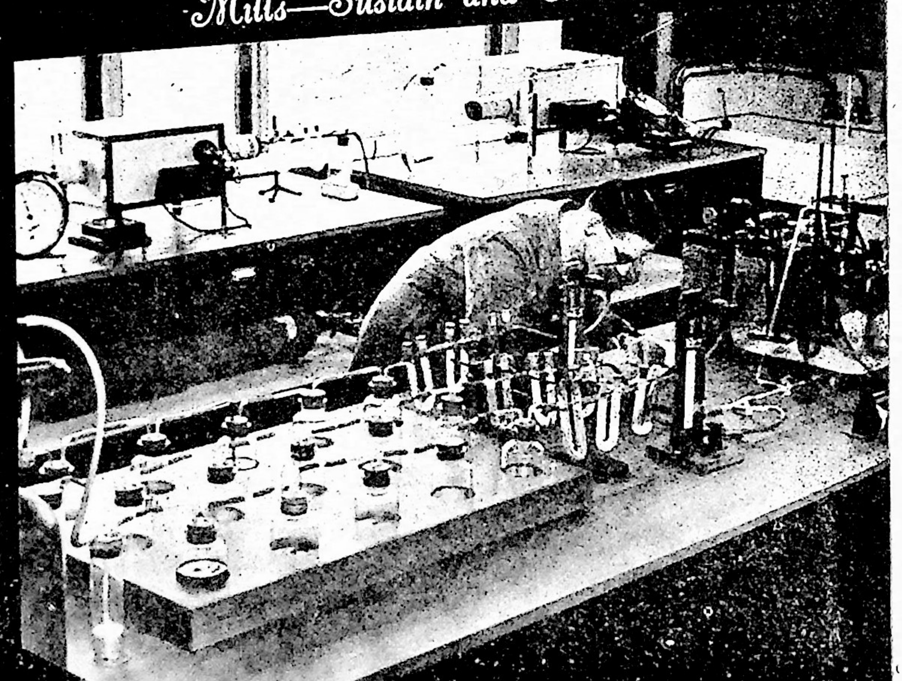

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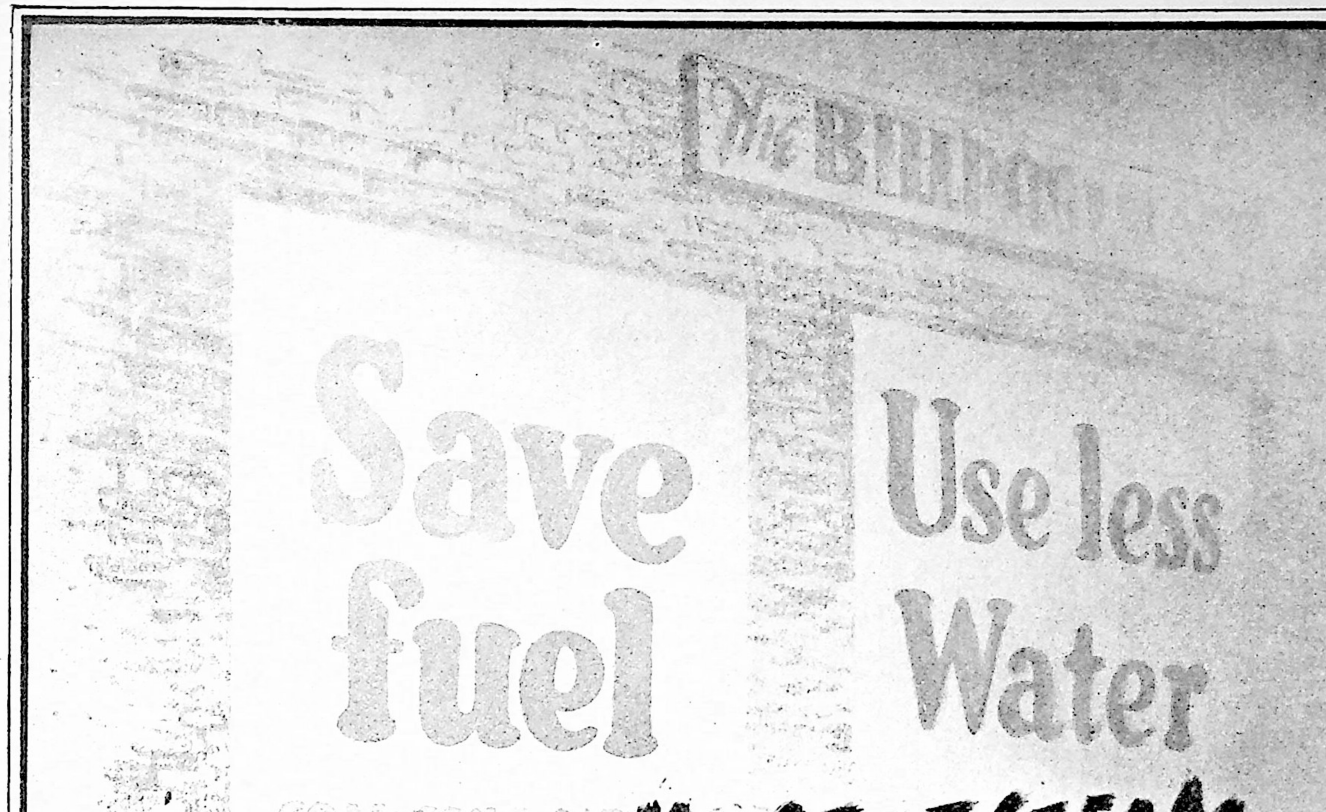

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The fact that goods made of raw materials in short supply owing to war conditions are advertised should not be taken as an indication that they are necessarily available for export.

THE LOCOMOTIVE

MAGAZINE *and* RAILWAY CARRIAGE *and* WAGON REVIEW

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

Volume XLVIII August 15, 1942 No. 600

Locomotive Boiler Balance

IT is often claimed that all engineering solutions are compromises, and in certain ways this is true of the locomotive boiler, the design of which is a compromise between a steam-raising equipment and something that will act as the backbone of the locomotive without overstepping the limits of weight, bulk, and maintenance cost. But, given the limitations in these directions, locomotive boiler design is far more a question of good balance than of compromise.

There is, in any case, a type of balance in that the complete boiler—with draught arrangements—is automatically self-regulating, and more or less adjusts of itself the water evaporation to the steam demand. For a given pressure the amount of steam exhausted through the nozzle is fixed, and a certain amount of combustion gas is drawn through the tubes and flues from the firebox to the smokebox and so cut off the chimney. This process evaporates and superheats a certain amount of water and steam, and the steam is in turn exhausted from the engine. If the speed of the engine and the cut-off are varied, then the back pressure and the evaporation are varied also. By assuming certain back pressure and draught values it is possible to figure the amount of coal burned in the firebox and the amount of heat generated; and by other calculations it is possible to make a fair approximation of the heat absorbed and transmitted, and so evaluate the evaporation of water.

But above all this, if the boiler is to operate with reasonable efficiency over the normal wide range of load, there must be in the constituents a certain balance which must extend right through from the ashpan damper to the top of the chimney. And in endeavouring to get such a balance—if he does attempt it—the designer ought to be quite clear in his own mind as to just what it is he wants to obtain, e.g., the highest possible efficiency over a small, but selected, range of firing; the highest possible evaporation corresponding to working all-out, and with efficiency a rather more secondary consideration; or whether really high efficiency over a small range can be sacrificed in favour of a considerably lower peak efficiency and a more level line of efficiency plotted against firing rate. Yet whether or not the designer realises the desirability of any such basic approach, the boiler cannot have anything like the highest possible efficiency or the highest possible evaporation if there is no balance.

In boilers burning the anthracite types of fuel, adequate grate area is probably the most important of the factors which are under the control of the designer. With the much more common bituminous and semi-bituminous coals, the important factors in the boiler are the firebox volume and the free gas area through the tubes and flues. Yet it is not much use the designer going right up to the limits of weight and bulk to get the maximum possible size of firebox and the biggest possible boiler barrel diameter, if the ashpan damper opening approaches Euclid's definition of a line as length without breadth. There have been cases where a small ashpan air opening increased to proper dimensions has enabled the blast pipe orifice to be increased by ½ in. in diameter, giving a substantial saving in fuel and better efficiency all round. The necessary ashpan openings, and also the air openings in the grate, for any class of coal can be checked reasonably closely if a maximum working firing rate is assumed, as a definite amount of air is always required for the combustion of any given class of fuel. Balance must extend not only to the aggregate area of the grate openings, but also to the size of the individual openings; if they are too big the air current is strong enough to blow particles and pieces of coal off the grate into the high turbulence zone below the end of the brick arch, and the loss through unburnt fuel is increased.

The shape and size of the brick arch also needs consideration in relation to the shape and volume of the firebox, and to the normal working rates and types of fuel. If the grate area and firebox volume can be proportioned to give low firing rates in ordinary service it is possible that a shorter brick arch might increase the evaporation by exposing more of the luminous firebed to the firebox walls, but this must again be balanced against the draught to prevent any increase in the unburnt fuel loss. Efforts to get a big tubeplate and large-diameter barrel in order to provide a large number of tubes and flues must not be nullified by fitting a superheater which blocks up most of the gas area through the tubes. Finally, the firebox crown must not be carried so high that all the good of the greater firebox volume is brought to nought by too restricted a water level and steam space.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—At a general meeting held in the hall of the Institution of Mechanical Engineers, Storeys Gate, London, on July 29, Mr. J. S. Tritton read, on behalf of Dr. L. K. Sillcox, a paper entitled "Power to Pull." The president, Mr. O. V. Bullied, was in the chair.

Indian Locomotive Coal

DURING the course of last year a paper entitled "Low Grade Fuel in Indian Locomotive Practice" was read before the Indian and Eastern Centre of the Institution of Locomotive Engineers by Mr. G. Da Costa. It contained a good deal of information about locomotive coals and locomotive boiler performance as they are found in India, and from it the following extract has been made:—

Indian coals may be graded roughly into three groups X, Y and Z, representing respectively the higher, medium and lower grades mined in the country. The following are typical proximate analyses:—

	Coal X.	Coal Y.	Coal Z.
	p.c.	p.c.	p.c.
(a) Moisture calculated to dry coal...	0.39	0.8	3.25
(b) Volatiles	22.56	24,63	26.09
(c) Fixed Carbon	63.85	55.95	53.01
(d) Sulphur	0.29		0.70
(e) Ash	13.27	18.44	20.20
(f) Gross Cal. Value per lb. of dry coal B.T.U.	13580	12660	11394
(g) Combustible per lb.	86.70	80.60	79.10

Coal burnt in locomotives on railways in England is of a higher grade than any employed in Indian locomotive practice. A typical English coal has an approximate analysis of:—

Moisture	1.12	per cent.
Volatiles	11.72	,, ,,
Ash	3.11	,, ,,
Fixed Carbon	84.05	,, ,,
Cal. value per lb. dry coal	14950	B.T.U.

A typical sample of selected American bituminous coal returns an approximate analysis of:—

Moisture	1.10	per cent.
Volatiles	19.83	,, ,,
Ash	4.04	,, ,,
Fixed Carbon	75.03	,, ,,
Cal. Value per lb. dry coal	14200	B.T.U.

Most American coals have calorific values between 13,200 B.T.U./lb. and 14,800 B.T.U./lb., but coals are also employed with calorific values as low as 11,600 B.T.U/lb., with a carbon content of only 36 per cent. As a rule, however, the ash content does not exceed 13 per cent.

The maximum quantity of steam required by a locomotive per hour is determined by the following factors:—

(a) Train and loco. resistance under the heaviest service conditions of load, gradient, and speed. From this data it is possible to derive the maximum indicated horsepower the locomotive may be required to develop.

(b) The steam consumption per I.H.P. hr., including the steam required for auxiliaries.

As a result of dynamometer trials, the following formulæ have been evolved for estimating resistance, horse-power and steam consumption for Indian broad gauge trains:—

(1) Resistance R for passenger trains per ton behind drawbar. $R=3.20+0.023\,V+0.00161\,V^2$ lb./ton.

(2) Resistance R_1 for goods trains per ton behind drawbar (average wagon wt. 25 tons).

$R_1=3.14+0.0175\,V+0.00150\,V^2$ lb./ton.

(3) Resistance R^2 for the locomotive varies considerably with the track, but the following formula from Dalby may be used for estimation.

$$R_2=\frac{120\,Wc}{D\times We}+4\left(1-\frac{Wc}{We}\right)+0.05\,nV+0.004\,V_2 \text{ lb./ton.}$$

where We = total wt. of engine in tons.
Wc = wt. in tons on coupled wheels.
D = dia. of coupled wheels in ft.
n = number of axles.
V = speed of train in m.p.h.

The steam consumption per I.H.P. hr. may vary from 15 to 23 lb., depending on the design of the locomotive. An average value of 18 lb./I.H.P. hr., may be adopted for calculation. The consumption per hour, S, in lb., would be:— $S=18\times$ I.H.P.

With these formulæ the maximum demand for any specific conditions may be deduced. For instance, consider an express train hauled by a 125 ton, 6-coupled, 6 ft.-2 in. wheel dia. locomotive with 52 tons on the coupled wheels —load behind tender 440 tons. If this train is expected to run at (a) 60 m.p.h. on the level (b) 30 m.p.h. on a 1/150 up gradient, the estimated steam consumption would be:—

(a) 25,920 lb./hr. (1440 I.H.P.)
(b) 18,900 lb./hr. (1050 I.H.P.)

Similarly consider a goods engine (135 tons, 68 tons on coupled wheels, 8-wheel coupled, wheel dia. 4ft.-6 in.) required to haul a load of 1,450 tons up a gradient of 1/200 at 20 m.p.h. The steam demand would be:

(c) 25,380 lb./hr. (1410 I.H.P.)

These examples are representative of actual conditions on an important main line section of the Great Indian Peninsula Railway, and indicate the maximum steam demands on the boiler.

An analysis of gradients, loads and time schedules of steam operated sections of the G.I.P. Railway show that they do not require a steam demand exceeding 27,000 lb./hr. As far as this railway is concerned, the scope of the employment of a low grade fuel is defined by the ability of that fuel to generate 27,000 lb. of steam per hour economically within the limits set by boiler capacity.

The economical firing limit is generally put at 120 lb./sq. ft. gr./hr. The figure, however, is quite arbitrary and should depend on a large number of factors the most important of which are (a) cost of coal (b) grade of coal (c) section on which

the locomotive functions (d) type of locomotive (e) economic possibilities of introducing locomotives with larger boilers—briefly, the total cost of production and use of steam. If in spite of a reduced efficiency of production, economical factors make it worth while to burn coal at a rate of 200 lb./sq. ft. gr./hr., then this maximum rate of combustion may be adopted. On the other hand, if mechanical stoking is not adopted, the maximum rate of combustion is limited by the maximum rate at which coal can be hand fired.

Experiments in India have shown that for short periods (15 min.) a fireman can maintain a firing rate above 6,000 lb./hr., but over long periods (1 hour 30 minutes) the rate drops to 5,200 lb./hr. It is this figure which sets a practical limit to the amount of steam that can be generated from a given grade of coal. For instance, consider a boiler with a grate area of 32 sq. ft. fired with each of the Indian coals X, Y, Z, at 5,200 lb./hr. The rate of burning per sq. ft. of gr. per hour would be 162.5 lb. and the boiler efficiency would be about 55 per cent. As the calorific values of the coals are respectively 13,580 B.T.U./lb., 12,660 B.T.U./lb., and 11,394 B.T.U./lb., and it requires 13,000 B.T.U. to convert 1 lb. of water 85°F. into steam at 180 lb./sq.in./gauge 650°F. it is possible to determine the maximum steam production obtainable by hand firing each of the three grades of coal. The values are 32,590, 30,380 and 27,350 lb. of steam per hour respectively. It has been stated earlier, the maximum steam demand in a locomotive on the Great Indian Peninsula Railway does not exceed 27,000 lb./hr. There is, therefore, no doubt that the low grade of coal Z can meet this maximum demand on a grate no larger than 32 sq. ft.

On Indian locomotives the single orifice blast pipe with single petticoat draught device is almost exclusively employed. Under heavy working back pressures are quite large. For instance, with a B.E.S.A. 2-8-0 burning Coal Z at 200 lb./sq. ft. gr./hr. the smoke box vacuum has to reach 10 to 11 inches of water, giving a cylinder back pressure of 12 to 14 lb. per sq. inch.

At late cut-offs, the back pressure is augmented by the blow-over effect and frequently rises to 18 or 20 lb./sq. inch.

The B.E.S.A. 4-6-0 locomotive requires under capacity operation 7 to 9 in. of water as smoke-box vacuum with coal X, and the cylinder back pressure is about 8 lb./sq. inch.

The back pressures obtaining on B.E.S.A. 4-6-0 and 2-8-0 locomotives cannot be regarded as small and there would appear to be an urgent need to *incorporate a more efficient draught apparatus* than the single blast orifice of Indian locomotives.

The volume of the firebox should be particularly large with Indian low grade fuels owing to their high percentage of volatiles. It is not, however, practical with the lower grade Indian coals to legislate for average combustion rates as low as 50 lb./sq. ft. gr./hr. and generally it will not be found worth while to insist on average ratios of combustion less than 90 lb./sq. ft. gr./hr. with coals Y and Z. The maximum area of grate (for hand-firing) that can be conveniently accommodated between the frames is 36 sq. ft.

With regard to the percentage air space to grate area, there exists a school of thought which favours a reduction of this ratio and experiments have been made in America with a percentage air space as low as 12 per cent. Tests in India with air space varying from 23 to 36 per cent. of the grate area do not suggest that the smaller air spaces are more economical, though it has been found that the round hole table grate is slightly more efficient than the finger type rocking grate. This difference in favour of the round hole grate is attributed to a smaller loss of unburnt fuel into the ashpan through the openings of the grate. It is believed in consequence that a grate with (a) a high percentage of air space to grate area (b) a large number of well-distributed air openings, each of which is small, would give the most satisfactory results.

OBITUARY.

We regret to record the death, at the age of 73, of Mr. Fred V. Russell, C.B.E., who was, previous to the grouping, Superintendent of Operation on the Great Eastern Railway.

Mr. Russell started as an apprentice to Mr. Holden at Stratford in 1886. He entered the drawing office in 1893 and eventually became chief locomotive designer.

Shortly before his death Mr. Russell wrote, in connection with our article on James Holden: "In my opinion, there was not much of modern democracy about Jimmy Holden. He was about the last railway officer to recognise the Trade Unions, and he only did that when he had to. As for the delegated designing of the "Decapod," Holden was a long time before he could trust a man. But when once he had satisfied himself as to a man's worth he left that man alone to his job and did not keep irritating him and messing him about. When the electric experts thought they would have a shot at running electric railways into the territory served by the G.E.R., Holden and our legal adviser got together and decided that if Holden could produce a steam locomotive that could with a full-sized suburban train attain a speed of thirty miles an hour in thirty seconds after starting we could probably put the kibosh on their scheme. Holden sent for me and asked if this could be done. I said that I must make calculations, with the result that I told Holden it could be done, but that the engine would be much heavier than anything that we had built until then, and that the permanent way engineer might kick. Holden said 'Go ahead!' and I designed every part of the engine myself. All the reciprocating weights, even the eccentric gear, were balanced."

Mr. Russell also designed the "Claud Hamilton" class, following a brief expression of Mr. Holden's requirements, and the design was worked out while the latter was taking a cure (he was weak-chested) in Egypt.

After the L.N.E.R. was formed Mr. Russell devoted his time to special research work. He retired in 1933.

ENGINE HOURS ON BRITISH RAILWAYS.—The number of engine hours for passenger services has been reduced by one sixth, and the number of engine hours in traffic for goods trains (apart from shunting) has increased by one half, compared with 1939.

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* 104)

X. *ENGINE FAILURES.*

Various summaries may be completed from these data. One, indicating the relative vulnerability of components for each class of engine, may be presented in the manner indicated by Fig. 108, the actual grouping of the details into which the engine as a whole is subdivided is governed by the conditions obtaining on the railway concerned. Other summaries may be arranged to illustrate the incidence of failures with reference to their nature and to compare the relative standards of maintenance attained by each district. In connection with the latter matter it is beneficial to issue lists at regular intervals in which the districts are arranged in order of merit according to the average mileage run per failure. The mileages per failure and placings, either for the preceding period or the corresponding period of the previous year, should also be recorded on the list for the purpose of comparison. It is generally found that the mileage run per failure increases with more intensive use of engines.

The subject of engine failures is one which demands incessant attention, at headquarters, district offices and depots, in order that each succeeding period of time may shew an increased mileage run per failure. The perfect state, in which all engines run from one heavy repair to the next with complete immunity from failure, is unattainable; for one reason, the human element enters into the matter. On this account the constant efforts made for the nearer approach of the actual state of affairs to the ideal are a source of great interest and potential satisfaction to the staff concerned; new systems must be initiated and existing methods modified in order to eliminate as far as possible the effects of the imperfect human element. Whilst the investigation of the individual failure may bring to light a weakness or deficiency in some direction, a universal improvecan only be achieved by taking a broader view; this is assisted by analysing, and making the necessary deduction from, summaries of the general position, such as have been here described.

The general causes of failures are wear: flawed, fatigued or unsuitable material: unsatisfactory design: mismanagement by enginemen and unsatisfactory workmanship, either in the works or in the shed. Failures due to wear may indicate the necessity for more frequent periodical examinations; alternatively, an increased modulus of section or the use of material having greater strength may be required. The need for the latter remedies may also be demonstrated by cases of fatigued material. Failures due to flaws may be reduced by the institution of greater stringency as regards the specifications for, and inspection of, materials. Alternatively alterations in shops methods during manufacture may be indicated; tolerances may be too close, or heat treatment faulty. Design may be unsatisfactory in that the specified material is not appropriate to the function of the detail concerned: again, as with cases of failure by wear, an increased modulus of section may be required: joints may call for greater rigidity: sections may require to be made more flexible: changes of section may be violent: maintenance of details is in some cases difficult owing to inaccessibility; detailed treatment of this subject is beyond the scope of the present work.* Mismanagement by enginemen may be traced to a faulty system of training; on the other hand it may indicate that the intelligence of the individual is below the average, or that his mind reacts either unsatisfactorily or too slowly to an emergency. Investigations of cases of poor workmanship may lead to similar conclusions. The system of training or subsequent specialised instruction may be inefficient: the equipment provided for the job may be inadequate or otherwise unsuitable; again, shortcomings of individuals are the primary causes of some failures.

Some Common Causes of Specific Failures.

Hot Boxes. Insufficient or unsuitable oil supply, e.g., excessive lowering of viscosity with rise of atmospheric temperature.

Dirty or unsuitable trimmings.

Pads dirty, and/or glazed, or not up to journal, owing to weak or broken pad springs.

Sand, grit or ash on journal.

Water in oil reservoir or keep; original sources are rain, tender or side tank leaking, carelessness during washing out, overflow from injector, joints in water pipes leaking, or condensate from blows at joints in steam pipes.

Blockage or fracture of oil pipes.

Slack joint in oil pipe.

Oil pipe from framing not registering with intake in box.

Keep broken, lost or rubbing on journal.

Inserted brass broken or loose.

Unsatisfactory fitting of brass to journal: not properly bedded down on crown and tight at sides, brass bearing hard on radius (where collars are used), box tight in horns, oilways cut into radii, oilways cut in whitemetal and not in brass.

Bearing springs weak or broken, spring pins broken or weight distribution faulty owing to other causes.

* Readers may be referred to "Steam Locomotive Design: Data and Formulæ," by the same author (Locomotive Publishing Co., Ltd.).

.... RAILWAY

LOCOMOTIVE DEPARTMENT.

NUMBER OF ENGINE FAILURES DURING THE .... ENDED .... 19..

CLASSIFIED ACCORDING TO THE DETAILS CONCERNED.

CLASS OF ENGINE		A	B	C	D	E	F	TOTALS.	REMARKS.
TOTAL NUMBER ALLOCATED									
ENGINE WHEELS AND FRAMES.	Axleboxes, Driving								
	.. Coupled								
	.. Bogie								
	.. Pony & Radial								
	Axles								
	Tyres								
	Springs								
	Spring Gear								
	Draw Gear								
	Unclassified								
CYLINDER, MOTION, ETC.	Cylinders								
	Cylinder Covers								
	Drain Cocks & Relief Valves								
	Piston Heads & Rods								
	Crossheads								
	Slide Bars								
	Connecting Rods								
	Big Ends								
	Small Ends								
	Valves								
	Glands								
	Eccentrics & Straps								
	Eccentric Rods								
	Motion								
	Lubricators, Hydrostatic								
	.. Mechanical								
	Reversing Gear								
	Sanding Gear								
	Unclassified								
BOILER.	Tubes								
	Stays								
	Superheaters								
	Injectors								
	Other Mountings								
	Joints								
	Pipes								
	Unclassified								
ENGINE BRAKES	Continuous								
	Steam								
	Brake Rigging								
TENDER.	Axleboxes								
	Axles								
	Tyres								
	Springs								
	Brakes								
	Brake Rigging								
	Tanks								
	Water Scoops								
TOTALS									
MILEAGE RUN PER CLASS IN PERIOD									
MILEAGE RUN PER FAILURE									

FIG. 108.

Opposite axleboxes out of alignment, e.g., wedges unequally adjusted.

Whitemetal defective.

Failure of mechanical lubricator, e.g., pump not working, pipe union slacked back, check valve defective, lubricator loose on bracket or feed incorrectly set.

Reservoir in crown of box inaccessible for replenishment and examination, owing to engine riding low in frames.

Engine overworked.

Engine prematurely rostered on arduous turn subsequent to re-fitting of box.

Effect of previous derailment.

Steel boxes with inserted brasses are more prone to distortion, and therefore more liable to heat, than solid " brass " axleboxes. The disposition of oilways is also a deciding factor; care must be taken, when designing, in locating them in the case of coupled boxes, and they should be eliminated as far as possible for carrying boxes, for which bottom feed lubrication is emphatically preferable.

Hot big ends. (It will be realised that many of the causes of heating in boxes apply also to big ends and other bearings.)

Plug trimmings too tight.

Plug or wire trimmings too short, causing oil to be delivered between strap and brasses.

Abrasive foreign matter on journal.

Cotter slacking back owing to loose or broken studs.

Brasses loose in strap or broken.

Crank pin worn oval.

Insufficient lateral play allowed.

Small ends out of alignment.

With inside big ends, dowels working out of built up crank axle webs.

Excessively short connecting rods.

Excessive compression of engine when notched up.

Excessive rigidity of engine as a vehicle.

Fractured or distorted big end straps. Brasses loose.

Water trapped in cylinders, e.g., priming.

Bolts not properly fitted.

Fractured or shouldered big end bolts. Cotters not properly fitted.

Brasses loose.

Overheated slide bars. Lubrication interrupted by glands blowing.

Sand or grit on bars.

Slide bar bolts loose.

Damaged piston rod or sheared crosshead cotter. Obstruction in cylinder.

Water trapped in cylinder, e.g., priming.

Piston rod insufficiently lubricated, especially when engine is coasting.

Slide blocks seized.

Fractured piston head. Too tightly fitted on rod.

Water trapped in cylinder, e.g., priming.

Portions of valve or piston rings, or other obstruction in cylinder.

Piston glands blowing. Insufficient compression on packing spring.

Rod dropping owing to wear.

Rod either bent, worn taper or not truly circular.

Packing not properly bedded to rod.

Cylinder pressure relief valves blowing or sticking. Grit on seating.

Spring made up with carbon, etc.

Cracked inside cylinders. Worn thin on top by action of smokebox ash.

Valves seizing. Rocking shaft bent or loose.

Fracture of mechanical lubricator (as with hot boxes).

Excessive lubrication, causing deposit of carbon under rings.

Defective reversing gear. Trigger fractured (fatigue hardened).

Reversing rod jammed when engine negotiating curve.

Oil leaking from cataract cylinder (power reverse).

Excessive valve friction.

Valve spindle seized or too tight.

Eccentric straps seized or fractured. Valve motion or strap itself insufficiently lubricated, in some cases due to main bearing surface being arranged on the minor, as opposed to the major diameter of the sheave.

Strap bolts not cottered, or otherwise improperly secured.

Abrasive foreign matter on bearing surface.

Excessive carbonisation of valve.

Hornblock wedges dropping. Vibration.

Wedge bolts not securely locked.

Fractured laminated bearing springs. Thick back plates.

Fastenings of unsatisfactory design.

Absence of indiarubber auxiliaries.

Insufficient flexibility of engine.

Bent or fractured coupling rods. Excessive slipping.

Uneven distribution of sand.

Material fatigued or unsuitable.

Insufficient flexibility in the case of multi-coupled engines.

Rod collars not properly secured.

Defective sanding gear. Supply of sand exhausted.

Pipe not set to rail or not discharging directly under wheel.

Sand blown off rail by wind.

Steam pipes burst, e.g., by frost.

Pebbles in valve or trap.

Wet sand in box, valve or trap (water may be thrown up from the wheels, enter through sand box bolt holes, or through the box lid if the latter is too shallow or not tight; sanding steam valves may blow through and condense).

Operating gear jammed when overtravelled, and pins come into line with fulcrum in consequence.

Operating rods whipping.

(*To be continued*)

The Locomotives of the Caledonian Railway

By JAS. F. McEWAN.

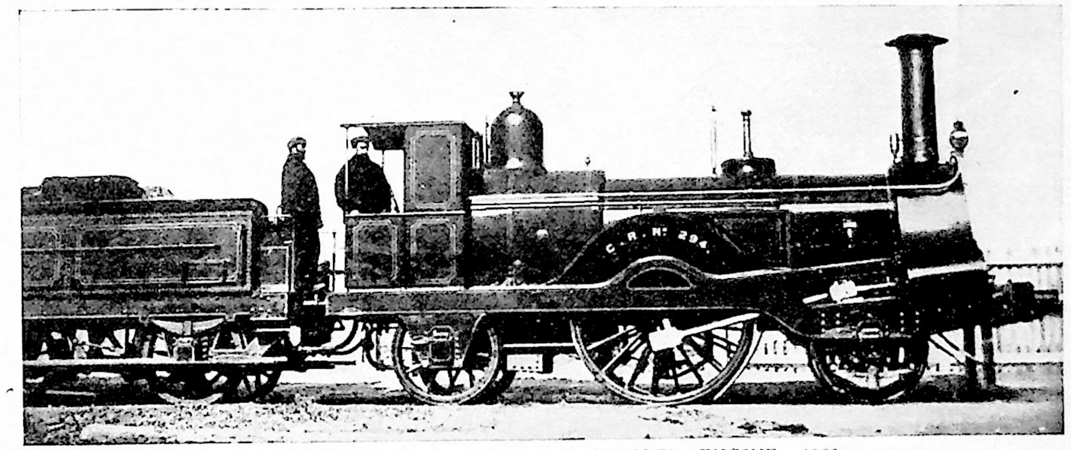
(*Continued from page* 10)

After the lapse of eight years the S.C. recommenced the contruction of locomotives at Perth. These were 2-2-2 type passenger engines and were designed by Allan for light passenger duties and goods work on the branches which were being worked by the S.C.R., and to use up the spare boilers made for the rebuilding of the six original singles but which were found to be unsuitable for rebuilding in an improved form. These engines did not actually have the complete new barrel and firebox made for the rebuilding as the steel fireboxes from the six new boilers were put into six engines of the No. 7 class which had been rebuilt. The class designed to make use of the spare barrels was augmented until ten engines were in the class. The new fireboxes had the trough in the crown plate of the firebox and a transverse midfeather with the result that the firebox was divided into two parts. The grate of the " fore " part was sixteen inches long and the " after " part 3 ft. 4 in. long, and in consequence two ash pans were fitted. The distance between the top and bottom midfeathers was 12 inches, and it is therefore concluded that the firemen of the S.C.R. were a steady lot and had an aim in firing which was second to none. It is hardly likely that Allan intended the front portion for combustion only.

The leading dimensions were:—cylinders 16 in. diam. by 20 in. stroke, diameter of driving wheels 6 ft. 1 in.; of carrying wheels 3 ft. $7\frac{3}{4}$ in., wheelbase 6 ft. 9 in. plus 7 ft. 3 in., total 14 feet. The overhang at the leading end was 4 ft. $5\frac{1}{2}$ in. and at the trailing end, 3 ft. $10\frac{1}{2}$ in. The frames were 22 ft. 4 in. long. The boiler barrel was 9 ft. $6\frac{3}{4}$ in. long and 3 ft. 9 in. diam. The distance between the tubeplates was 9 ft. $11\frac{7}{16}$ in. and there were 207 tubes of $1\frac{3}{4}$ in. diam. giving a heating surface of 919.56 sq. ft. The firebox and midfeather had a heating surface of 95.2 sq. ft., which gave a total heating surface of 1,014.76 sq. ft. The grate area was 16.06 sq. ft., and working pressure 125 lbs. Boiler centre line 5 ft. $10\frac{5}{8}$ in. The midfeathers were removed about 1872 by Mr. Conner, although it was admitted by McIntosh in later years that these engines were excellent steamers on account of the midfeather. The tenders ran on four wheels and carried 1,383 gallons of water and $2\frac{1}{2}$ tons of coal.

No.	C.R. No.	Date	Reno. to "A" list	Withdrawn
—	294	1866	—	1882
—	295	,,	—	1883
83 (a)	296	11/1865	—	1883
84 (b)	297	10/1865	1883	1892
82	298	6/1865	1883	1888
81	299	3/1865	1883	1888
4	306	3/1864	—	1882
5	307	9/1864	1883	1884
16	308	11/1864	1883	1884
18	309	5/1865	1886	1888

Notes (a) and (b) see undernoted text.



C.R. No. 294. ALLAN'S 2-2-2 PASSENGER ENGINE, 1866.

The engines which became C.R. Nos. 296 and 297 were laid down as S.C. Nos. 83 and 84 respectively. In the building of this class some odd spare parts from the withdrawn locomotives of classes No. 1 and 7 were used. In August, 1868, No. 307 was provided with a new tender of the six-wheeled pattern and soon after No. 308 was similarly fitted. In the latter case the old tender was transferred to No. 499, an ex-Scottish North Eastern engine whose page in the accounts was debited with the new tender for 308. These singles finished their days around Perth, two working regularly on the Dundee and Arbroath Joint line, and No. 297 employed on the Perth to Forfar stock train until withdrawn. A direct acting steam brake was fitted to one of the engines of this class in 1864.

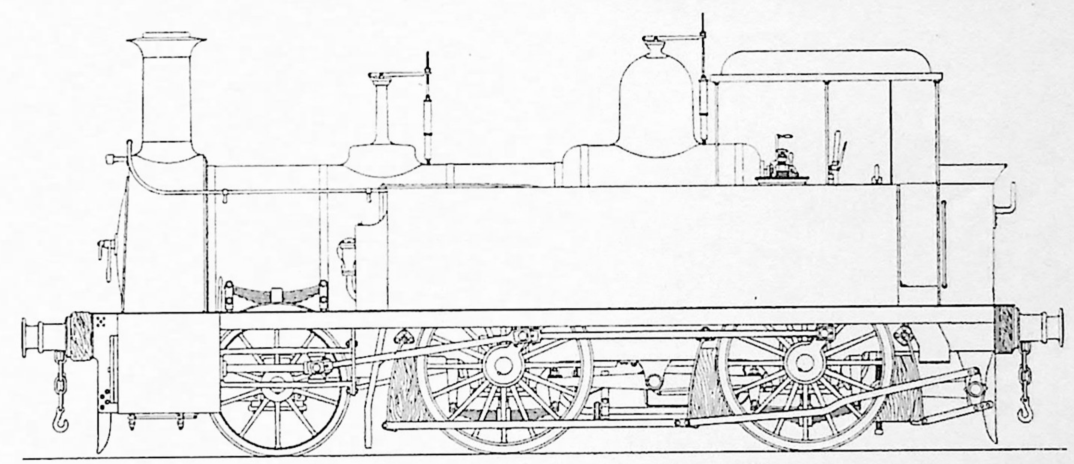
Although the locomotive history of the Scottish Central is now completed and includes locomotives actually laid down after the amalgamation it seems suitable at this point to refer to some of Allan's duties and work when at Perth.

The Scottish Central introduced gas lighting to trains in Scotland and the first train fitted to Allan's design and system left Perth for Edinburgh at 10.45 a.m. on December 8th, 1862, and returned from Edinburgh at 4 p.m. that day. It was one of the usual block trains carrying first and second class passengers only, and the gas was carried in a tank in one of the vans. Subsequently the Glasgow " set " was so fitted. As already referred to Allan had the repair of all the Aberdeen Railway engines during the period of the " pooling " arrangements and quite a number of the locomotives were heavily overhauled at Perth. There also existed from about 1855 until March, 1866, a tri-partite arrangement for the pooling of traffic and stock between the S.C., Edinburgh and Glasgow and Caledonian Railways. Only certain routes were affected and under this arrangement one of the Caledonian Railway's carriages which had broken down at Perth in October, 1859, was overhauled and two new hammered axles provided. Round about the period from 1855 to 1857 several engines from the Edinburgh, Perth and Dundee Railway, appear to have been sent to Perth for overhaul instead of being done at the E.P. and D's own shops at Burntisland. The attempt to repair No. 9 appears to have baffled Allan for ultimately it is recorded after several parts had supplied that " No. 9 was loaded into wagons and sent to Burntisland." No. 1 was similarly dealt with. The locomotives from the Dundee, Perth and Aberdeen Junction Railway were also repaired at Perth probably dating from the time when Brittain took up his post as "superintendent" at Dundee. Allan also fitted two engines experimentally with a water type pressure gauge in 1861 but unfortunately no record of the actual engines fitted is extant although it is known that the idea was none too successful, being susceptible to the shortcomings of the drivers and firemen. The six Neilson engines delivered in 1863 were fitted with a coiled copper pipe of elliptical section between the engine and tender for the feed water. Steel tyres were used on the S.C. in January, 1859, when No. 54 was fitted, although it was not until 1862 that these first appeared on the C.R. At the same time No. 19 was fitted with old rolled tyres on the driving wheels. It has been said, but with what authority it is not known, that Allan submitted a set of names for his engines to the directors in 1854 but the idea was turned down as it was thought to be out of the general harmony of the policy of the S.C. In January, 1865, No. 8 was given new driving tyres with patent fastenings and No. 32 was similarly fitted in the following month. In the following May the fastenings were first used on the small carrying wheel tyres. Unfortunately the method of effecting repairs prior to the arrival of Allan are unknown but after his arrival it became common practice when an engine required slight repairs and another of the same class was in the works and likely to be in for some time, that the required part was removed from the greater " crock " and used to get the other engine out as speedily as possible. In January, 1854, No. 15 came in with a broken rear axle and was sent out two days later with the corresponding axle and wheels from No. 18. In the same month No. 13 was hauling the 4.55 p.m. down train and became a casualty through the top of the under clack breaking off and falling inside the pump which was smashed.

During the " pool " period S.C. No. 12 was sent to Stirling as No. 50 (an Aberdeen Railway engine) had one of the leading tyres so bad that it was impossible to run the engine to Perth for overhaul and Stirling begged the loan of a spare pair of 3 ft. 6 in. wheels so that No. 50 could go to the shops. The engine was apparently lying at Greenhill. The depot promised the return of No. 12 after the return of their own engine. Several of the S.C. section engines were shedded on the Aberdeen section of the line. No. 35 was about the same time booked in by its driver as " having the leading springs on the one side higher than on the other, slide blocks out of line, pistons requiring examination, damper handle spring too weak, etc., and buffers lost." No. 11 turned up to be squared as the tyres on one side were wearing excessively. No. 46 was booked by its driver, John Knox, who despite his great Scottish name did not ascend to the same level as his earlier historical namesake, for when reporting states " weigh bar shaft broke, both feed pipes broke, one buffer head broke, one buffer lost, ashpan bent and other damage *which may have been caused by the accident* with running into the wagon at Stirling station." Mr. Davidson who was foreman at Arbroath stated that the tender tyres of No. 31 were in bad order and new ones were needed. Either a new tender or new wheels and axles for in their present state the engine could not go out as working tender first was considered too risky. In the same period an interesting note appears concerning No. 35, viz.:—" on taking off the right-hand cylinder cover five pieces of boiler plate were discovered inside the cylinder, the largest being $4\frac{1}{2}$ in. by $2\frac{1}{2}$ in. and $\frac{3}{8}$ in. thick and are supposed to have been wilfully put into the port when the cylinder was waiting for a new cover." Nos. 28 and 39 suffered from the same trouble, the rear axle would not clear the bolts under the footplate. Stirling again had more trouble, No. 52 (Aberdeen) had broken its leading springs and just " sat down." The engine had apparently been loaned in place of No. 40 and Mr. Bone writes, " let me have No. 40 back as soon as possible for this one is no use at all." To please Bone, the leading springs from No. 40 were sent to Stirling so that No. 52 could go into traffic. No. 24 at this time was driven by H. Ogilvie, referred to in the part of the history dealing with the Conner 2-4-0 engine of "class 92," and he is always booking engines for repair. If it was not loose wheels, it was axle trouble or shaky motion.

James Winterbottom, who will be remembered long from the fact that he took a pet monkey around on the engines with him, had a bad mishap in February, 1854. The driving axle broke at the left-hand bearing and both the connecting rods were bent. The stay behind the cylinders broke and the tender appears to have been badly shaken and knocked about. The damage was reported, and is concluded by asking " that the chimney be turned the other way round." Aberdeen depot announces that a pair of wheels from the tender of No. 15 were borrowed to bring No. 17 home for repair. Cheeseboro who handled No. 14 asked that new pins, new brasses, etc., be fitted and also that a " bit be cut off the valves," and that the regulator be examined " as the gland nuts wont fit the holes." Lake, who was driver of No. 21 intimates that " the wheels on the driving axles are slack and that the engine slips badly," also that the " trailing wheel tyres have side play." So far as the tender was concerned, " the tank leaks on to the journals, and the hand rail is slack and the water leaks at the bolts, the angle iron round the tank is broke, and the wheels want seeing too as the tyres are broken." These incidents cover a period of only three months and are quite apart from the many bookings of loose motion, bolts or screws, journal boxes requiring re-lining and the various repairs to springs and axles too large for the running depots to handle are cited as an example of what the locomotive superintendents of all railways had to put up with.

Ere leaving the history of the S.C. it will not be out of place to refer to a design which Allan had prepared for a small 2-4-0 type side tank engine, presumably for shunting duties. This was single framed with outside cylinders. The boiler had raised firebox casing. The dimensions were to have been as follows:—Cylinders $14\frac{1}{2}$ in. by 22 in. Leading wheels 3 ft. $7\frac{3}{4}$ in. and driving wheels 4 ft. 7 in. diameter, and axle centres 6 ft. plus 7 ft. 11 in., total wheelbase 13 ft. 11 in. Frame length 23 ft. $8\frac{1}{4}$ in. Boiler barrel 3 ft. $6\frac{3}{4}$ in. diameter by 9 ft. 4 in. long made of three rings butted together with butt straps at the joints. 191 tubes $1\frac{3}{4}$ in. diameter and 9 ft. $8\frac{1}{2}$ in. between the tubeplates giving a heating surface of 850.3 sq. ft. The firebox had two midfeathers, one across the grate. There were consequently two grates, fore and aft arrangement, but two ashpans only were to be provided. There were to be two firedoors fitted, one slightly higher than the other but alongside it. The reason for this arrangement appears to have been based on the lack of " elbow room " for the firing of the engine. The cab could only be entered from the left-hand side and the back cab sheet after forming an entry passage curved towards the backplate and crossed the the footplate floor to meet the tank on the right-hand side leaving a space of 3 ft. 6 in. between the back plate and the back of the bunker which the lower part of the cab sheet had formed. The tanks had a capacity of 300 gallons and the bunker carried about 18 cubic feet. The regulator handle worked in an " OG " quadrant, and as it rotated it withdrew a plug regulator lying in a horizontal steam pipe supplied by steam from the dome through a vertical collector pipe. An improved type of self-acting steam injector was to have been fitted, in lieu of the Giffard pattern then being used. The coupled axle springs were to have a compensated lever attachment. The valve rod was cranked over the leading axle. An interesting feature with the links supporting the firebox crown bridge bars was that half were riveted to the roof of the outer firebox and the remainder were to be inserted through holes cut in the plating of the outer firebox. The cylinder exhaust pipes were covered by false sheeting until they entered the smokebox and then passing above the top row of tubes turned into the chimney with the mouth about six inches below the base of it. It will be recollected that the Highland Railway in the '70's built three generally similar locomotives.



S.C.R. ALLAN'S PROPOSED 2-4-0 SIDE TANK.

(To be continued.)

Majorca and Its Railway System

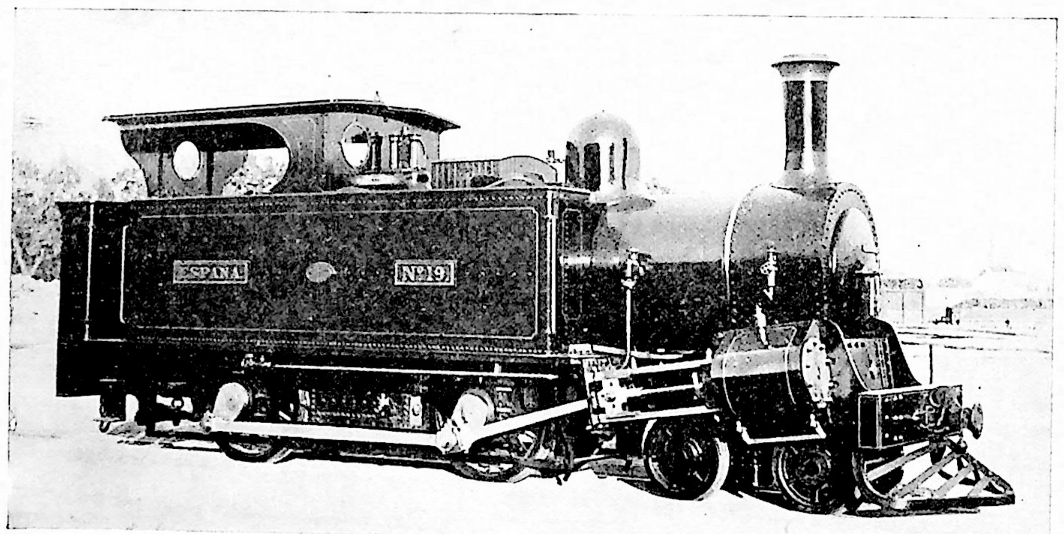
From Notes by the late MAJOR S. A. FORBES.

PROBABLY one of the least known railway systems in Europe is that of the island of Majorca, or, as it is known in Spanish, Mallorca. Majorca derives its name from the fact that it is the largest of the Balaeric Islands, and it is the only one to possess a system of public railways. Both the Majorcan railways, namely the Majorca Railways and the Soller Railway, begin at the capital, Palma. The former is the principal system of the island and comprises several lines branching out to different parts of the island.

Roughly north eastwards a line runs from Palma to La Puebla through Santa Maria and Epalme. At the time of the outbreak of the recent Spanish War, the extension of this was projected to the port of Alcudia on the bay of that name. Three other lines run south-eastwards, forming a sort of grid-iron across the flatter parts of the island. Of these, the longest branches off from Epalme, running to San Miguel and Arta. The line Palma-Epalme-Arta really forms the island's trunk line, and is 58½ miles long. From Epalme to La Puebla is a distance of 8 miles. From Santa Maria (9¼ miles from Palma) a 27-mile branch runs down to Felanitx, forming the middle bar of the gridiron. The southernmost branch bears off within the environs of Palma itself and runs to Lluchmayor and Santany (38½ miles). Finally; there is a short branch to the docks at Palma, which runs down through a tunnel under the city.

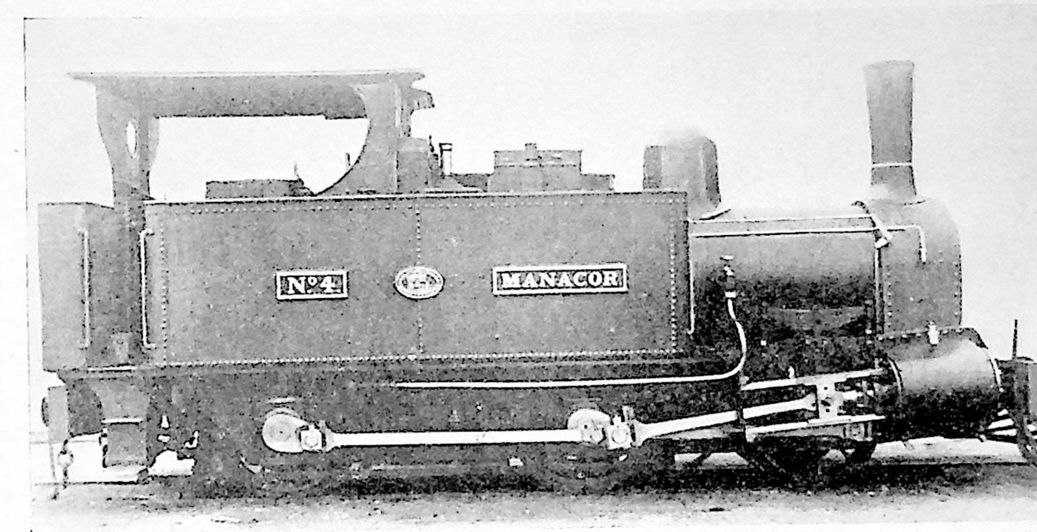
The Majorca Railways Company was formed in 1872 and the first section opened in 1875 from Palma to Inca (18 miles) on what is now the main line. Considerable and picturesque religious ceremonies attended its inauguration. Most recent is the southern line, which reached Lluchmayor (18½ miles) in 1916 and was completed to Santany in the following year. The main line, however, did not finally reach Arta until 1921, a section of 18¾ miles having been opened from Manacor in that year. The gauge of the Majorca Railways is 3 ft. and most of the system is laid with 60 lb. flat-bottom rails. The line is double between Palma and Inca, where trains run on the right-hand track. The ruling gradient is 1 in 67.

There is still a peculiarly British-Colonial aspect about the Majorca Railways, by reason of the interesting old Nasmyth Wilson engines with which the system started operations. Coaching stock includes some good modern vehicles, carrying first and second class accommodation. From the opening of the M.R. up to 1911, the standard Majorcan passenger engine was a 4-4-0 tank with outside cylinders. The engines varied somewhat in size and detail, according to their age, but all had outside frames and a very pretty, perky appearance. The illustration of No. 19 *España*, shows the class at its best, with a capped chimney and the dome on the second ring. Original practice was to place the dome on the front ring. Two of the class, bearing the numbers 22 and 23, were built by Talceres & Company in the island and are the only " native " Balaeric locomotives.



MAJORCA RAILWAYS. 4-4-0 TANK. No. 19, "ESPANA."

In 1876 a small 0-6-0 type, also built by Nasmyth Wilson, appeared in the island. Two engines, Nos. 4 and 5, were built. In 1889 another shunting engine appeared, No. 6, from Nasmyth Wilson, and was used for the Docks branch. This is no longer in service. Previously, in 1887, half a dozen 4-6-0 locomotives were built by Nasmyth Wilson for the heaviest trains and all these, as far as is known, are still in existence today. Recent locomotives of the Majorca Railways are of German or Spanish design and construction. They consist of three classes; two of

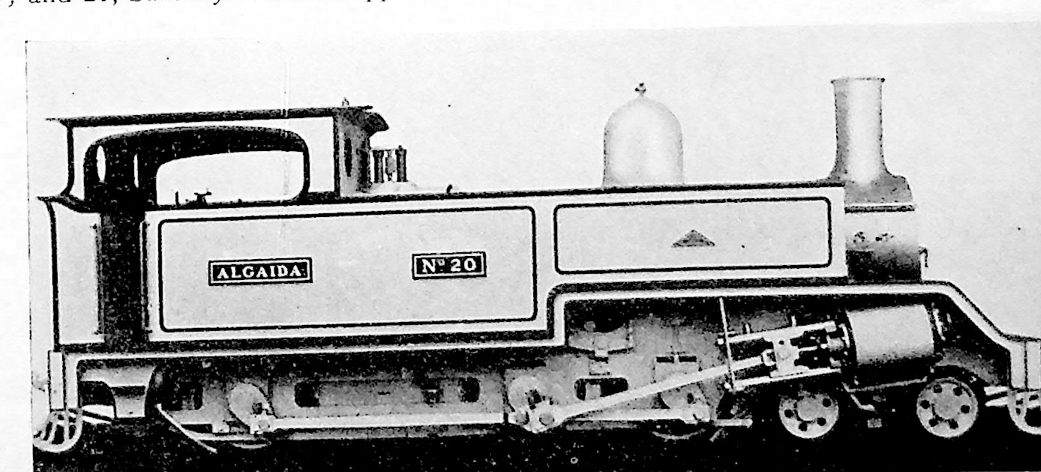


MAJORCA RAILWAYS. 0-6-0 TANK. No. 4 "MANACOR."

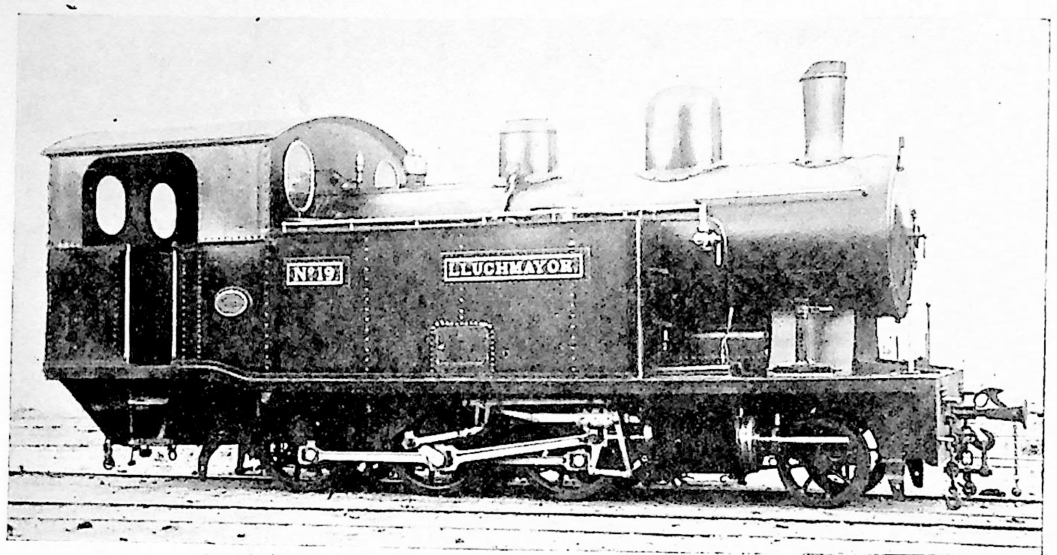
the 2-6-0 type built respectively by La Maquinista Terrestre y Maritima in 1917 and by Krupp of Essen in 1930, and one of the 2-6-2 type built by Babcock and Wilcox (Bilbao). The Krupp and the Babcock and Wilcox engines are fitted with Schmidt superheaters, Wagner top-feed, Knorr feedwater heaters and pumps, Clayton vacuum brakes, Friedmann lubrication to the bearings and Detroit lubricators for the cylinders. They are fitted with electric lighting on Henschel and Son's system. All the Majorca Railways locomotives are painted green and are well kept. The following are the names and numbers. Type 4-4-0: Nos. 1, *Mallorca*; 2, *Palma*; 3, *Inca*; 16, *Porreras*; 17, *Montuiri*; 18, *Petra*; 19, *España*; 22, *Alfonso XIII*; 24, *Coll*; 25, *San Miguel*; 26, *San Lorenzo*; 27, *Arta* and 28, *San Servera*. Type 0-6-0 : Nos. 4, *Manacor* and 5, *Felanitx*. Type 4-6-0: Nos. 10, *Santa Eugenia*; 12, *San Juan*; 13, *Lloseta*; 14, *Marratxi*; 15, *Alaro* and 20 *Algaida*. Type 2-6-0 (Spanish-built): Nos. 19, *Lluchmayor*; and 21, *Santany*. The Krupp 2-6-0's are numbered 30-35 and the Babcock and Wilcox 2-6-2's 50-55.

There is an odd engine in the shape of an 0-4-0 contractor's type tank engine built by the Madrid branch of Orrenstein and Koppel in 1921. It succeeded the old Nasmyth Wilson 0-4-0 tank locomotive No. 6 as dock shunter at Palma and although built in Spain is typical of the practice found on the small German *Bimmelbahn*. The latter name, by the way is derived from *bimmeln* (jingling) of the bell mounted on the locomotives of steam tramways or other lines which wander through frequented public places.

Majorca's remaining railway, the Soller Railway, connecting the beautiful resort of that name in the mountainous district of the north coast with Palma, is nowadays more akin to a mountain tramway, resembling certain lines in the Alps and Pyrenees than to the usual type of local railway as found in such other Mediterranean islands as Corsica, Cyprus, and formerly, Malta. It is 17½ miles long and steeply graded, reaching a summit



MAJORCA RAILWAYS. 4-6-0 TANK. No. 20, "ALGAIDA."



MAJORCA RAILWAYS. 2-6-0 TANK. No. 19, "LLUCHMAYOR."

level of 1,060 ft. above sea-level at a distance of 12½ miles from Palma. Soller terminus is 134 ft. above sea-level, entailing an almost staircase drop on the most northerly section of the line.

It was built in 1891 and the contractor's locomotive, a Brush steam tramway locomotive with an all-over cab, remained on the line throughout its existence as a steam railway, though the standard steam locomotive of the Soller line was a rather more robust 2-6-0 type suited to the heavy gradients. Today motive power is provided by four 500 h.p. double-bogie electric motor coaches, with pantographs mounted at each end of the roofs. There are ten trailer cars and various goods wagons. A short and steep electric tramway, owned by the Soller Railway, connects the latter's terminus with the port of Soller. On the railway, direct current is supplied to the contact line at 1,200 volts, while on the tramway a pressure of 500 volts is used.

L.M.S. (Caledonian Section).—Kelvinside Station on the Glasgow Underground line has been closed for traffic.

Crane Loco. with Magnetic Lift

ANDREW BARCLAY SONS AND CO., LTD.

A NEW type of crane locomotive has recently been completed and tested at the Kilmarnock works of Messrs. Andrew Barclay, Sons, and Co., Ltd.

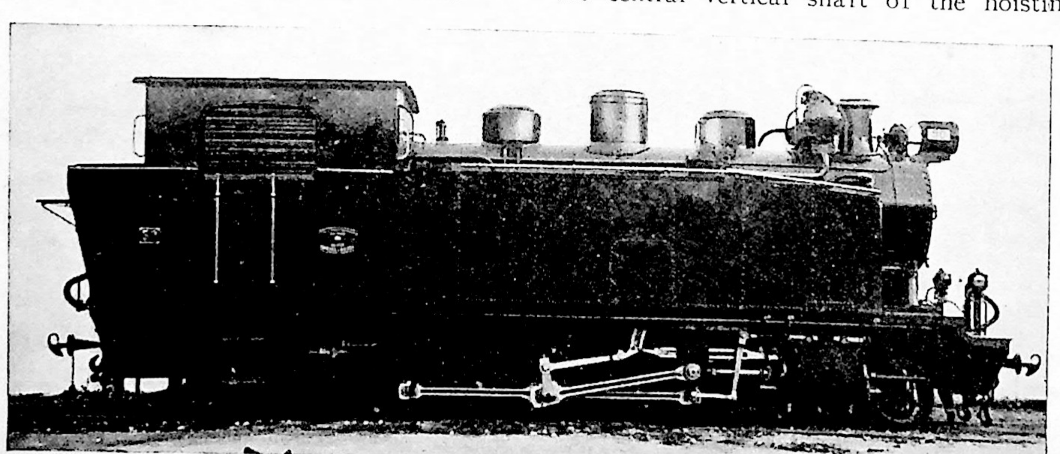
In operation it eliminates the necessity for slinging, filling of skips, and bundling, and this means a considerable saving in time and labour, as the loading, lifting, transporting and dropping the load can be carried out by the driver alone. Time may also be saved in the handling of scrap, pig iron and small parts by dropping them from the magnet without lowering it at the point of delivery. This type of crane is of great advantage in works or shipyards where quantities of steel plate and angles, etc., are being constantly handled.

The problem of how to carry the current from the generator set to the magnet at the end of the revolving jib was successfully solved by making the central vertical shaft of the hoisting gear hollow and passing a conduit tube through it to carry the cable. The conduit tube revolves with the jib, while the shaft is free to revolve around it as required in the process of hoisting and lowering. At the bottom end of the conduit tube is a disc of insulating material carrying two slip rings connected to each of the cables for energising the magnet. These slip rings are supplied with current by brushes connected to the generating set.

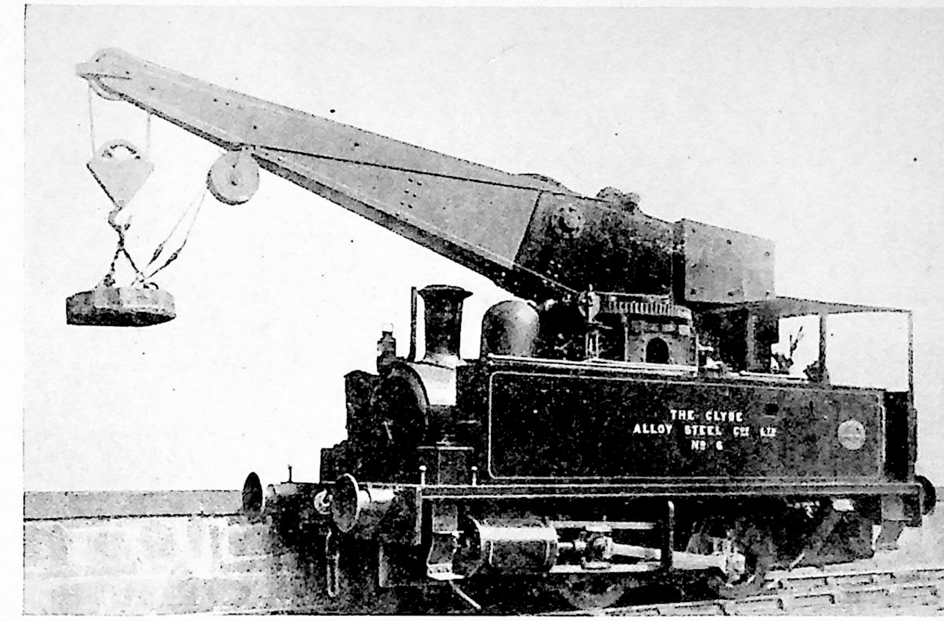
For connecting the magnet to the cable of the jib two single core extra flexible cables are used which are wound on to and unwound from a spring operated cable drum of the usual construction.

The current for operating the magnet is supplied by a turbo-generator set mounted on one of the side tanks of the locomotive.

The locomotive is of Barclay's standard 5-ton type, but the addition of the lifting magnet which, with its appliances, weighs 18 cwt., reduces the lifting capacity of the locomotive to 4 tons 2 cwt. at 16 ft. radius. If it were desired to lift 5 tons this could be done by temporarily discarding the magnet or, alternatively, the length of the jib could be reduced to 13′-6″, in which case 5 tons could be lifted with the magnet or a greater load without the magnet. The locomotive cylinders are 14″ diameter x 22″ stroke, giving a tractive effort of 14,200 lb. at 85% boiler pressure, so that it is an effective shunting engine. The weight in working order is 42 tons 14 cwt.



MAJORCA RAILWAYS. 2-6-2 TANK, No. 50.



BARCLAY 5-TON CRANE LOCOMOTIVE, WITH MAGNETIC LIFT.

L.N.E.R.—The story of how L.N.E.R. men during the air raid on York of April 29 made efforts to restore services to normal was recently revealed by Mr. C. M. Jenkin Jones, Divisional General Manager of the Company's North Eastern area.

"So far as York station was concerned," he said, "the first bomb to cause damage fell shortly after the 10.15 p.m. express from King's Cross to Edinburgh had arrived, and the passengers had been warned to leave the train at once to take cover. Some of the passengers appeared to be more concerned about their luggage than their lives and did not alight when they were advised to do so!

"Then another bomb fell, this time near the Parcels Office, and simultaneously a large shower of incendiaries hit the station buildings, the roof, the track and the 10.15 p.m. express. The buildings and the roof were ignited and burning debris fell upon the express, which also caught fire. Our staff brought hoses into play at once, supplementing them with the smaller fire-fighting appliances.

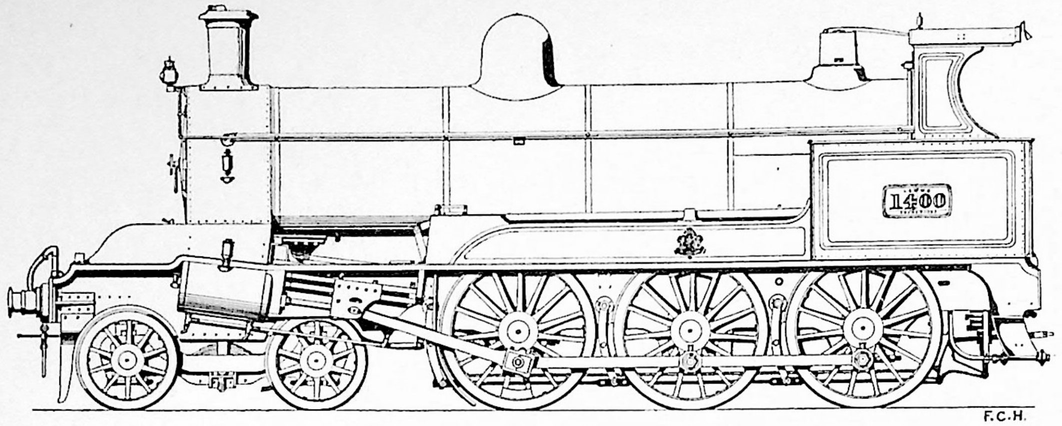
"With the aid of a soldier and shunters Wharton and Lee, the Assistant Station Master divided the 10.15 p.m. express and thereby saved 14 of the 20 coaches.

A bomb hit one of the engine sheds containing more than 20 locomotives but fortunately only three of them sustained serious damage.

"As soon as the raid was over our first thought was to get going with the restoration of services and facilities," continued Mr. Jenkin Jones. "Thanks to smart work on the part of the staff, and a number of voluntary helpers, who whilst the buildings were blazing, dragged out heavy desks, ticket racks and other furniture across the road to the moat beneath the city walls, we had established a temporary booking office in the tea room within a few hours of the raid. The money in the booking office tills, by the way, was saved by two of our firewatchers, who carried it to safety in our hotel in a Wellington boot, 'borrowed' from the Passenger Agent.

"The damaged No. 1 Refreshment Room was brought into use as a temporary parcels and left luggage office on the day of the raid, and the loud-speaker installation was in operation on the following day. During the first week of May we had the booking office and two of the refreshment rooms in service again, and the tea room thus released became a temporary parcels office. The remarkable speed of the erection of temporary station buildings reflects great credit on Mr. Love, the L.N.E.R. Works Superintendent, and his staff.

"Valuable aid in clearing away the debris was given by the military, and the world-famous rapidity with which British railway engineers repair air-raid damage was aptly demonstrated at York. Some damage to running lines was inevitable, but I am proud to say that our Engineer's Department had all affected running lines available for traffic by the early evening of April 30, and actually the majority of them were in use on the evening following the raid."



L.N.W.R. 4-6-0 MIXED TRAFFIC ENGINE. No. 1400.

L.N.W. Compounds

THE MIXED TRAFFIC ENGINES

By F. C. HAMBLETON.

THE last design that F. W. Webb was to prepare for the L.N.W.Ry. was a four-cylindered compound with six-coupled driving- wheels 5 ft. 3 in. in diameter. No. 1400, the first of the class, appeared in February, 1903, and from then onwards 29 more were built, the last one, No. 2059 being finished in March, 1905, by Mr. George Whale, who had taken the position of C. M. E. in succession to F. W. Webb some two years earlier—on June 6, 1903, to be precise. They were thus, with the exception of the first one, built entirely under the supervision of the new chief. However, there was no alteration to the general features common to the L:N:W.Ry. but a new note was struck by the inclusion of a continuous splasher over the driving wheels, and a capuchon chimney—two features which were to become familiar later on in the new Whale "Experiment" class. The details of the whole of the cylinders, boilers and axleboxes were the same as the 8-coupled "B" class mineral engines, except that the centre line of the boilers was raised to 8 ft. 3 in., and that the leading wheels, which were arranged in a radial truck as employed on the "Alfred the Great" class were somewhat smaller, viz., 3 ft. $1\frac{1}{2}$ in. No. 1400 ran some very satisfactory trials over various sections of the line, and these engines were engaged at first on fast mixed traffic and goods trains on the Northern division. About 1906 they began to be transferred to the London area, being employed on the faster goods services. For example, No. 610 regularly took the 9 p.m. goods ex Camden to Walsall, being stationed, along with No. 511, 695, 1113, 1352, 1379, 1414 and 1729 at Walsall shed.

Considering that their appearance coincided with the abolition of the compound system on the L.N.W., these engines had a fairly long life; No. 2059, the last built, and the last to go, being scrapped as late as September, 1920. They also passed their somewhat uneventful career without being rebuilt in any way. Their Crewe Works numbers were: 4365, built 1903; 4376-4384, in 1903; 4420-4429, in 1904; 4430-4439, in 1905.

The principal dimensions were as follows:—

Cyls.—Two H.P. 15 in. by 24 in.
Two L.P. $20\frac{1}{2}$ in. by 24 in.
Rigid Wheelbase, 11 ft. 6 in.
Total Wheelbase, 24 ft. 6 in.
Boiler, 4ft. $6\frac{3}{8}$ in. by 15 ft. 6 in.
Firebox, length outside, 6 ft. 10 in.
Heating surface: Tubes, 1,630 sq. ft..
Firebox, 123 sq. ft.
Grate area, $20\frac{1}{2}$ sq. ft. Pressure 200 lbs.
Weight in working order 60 tons.
Tender, Coal, 5 tons.
Water, 2,500 gallons.
Total weight of engine and tender in W.O.,
91 tons, 12 cwt.

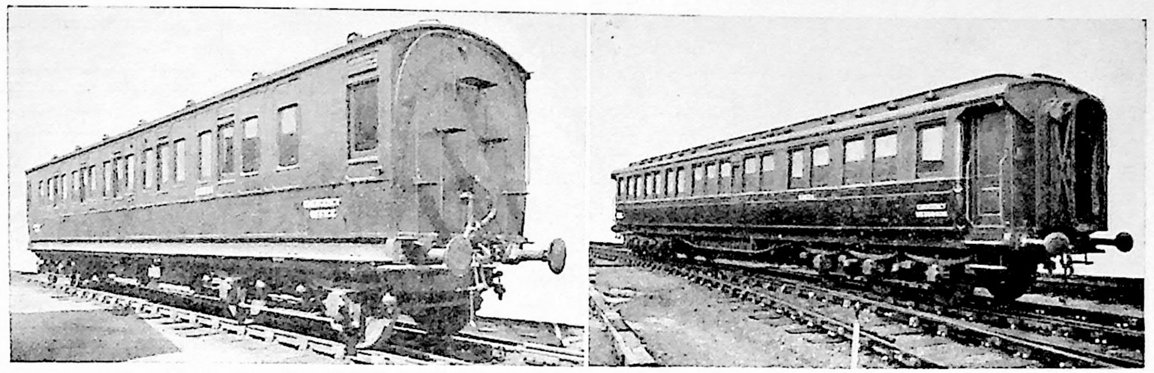
L.M.S.R.—Non-stop runs of 100 miles and more are still made every day, even after almost three years of wartime operating, and to the L.M.S. goes the distinction of what are probably the world's longest daily non-stop runs worked by either steam or diesel locomotives, as well as the British record for the number of daily runs of over 100 miles. The total is 53 and is increased to 61 on Fridays. These runs are made mainly over the West Coast Route between London (Euston)—Crewe—Carlisle and Glasgow.

The claim to the world's long-distance non-stop record is made on behalf of two trains which run non-stop over the $243\frac{1}{4}$ miles between Crewe and Glasgow in both the up and down directions. They are the 9.15 p.m. express from Euston to Glasgow and the 9.30 p.m. express from Glasgow to Euston. The record for periodical non-stop runs performed at regular intervals is almost certainly held by the L.M.S. also, as once a week a relief train is run 300 miles without stop from Euston to Carlisle.

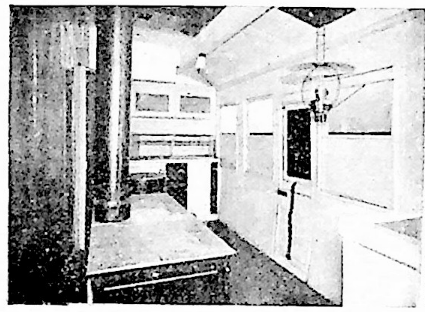
Other noteworthy daily runs are the $229\frac{3}{4}$ miles from Crewe to Motherwell by the 7.20 p. m. from Euston to Perth (this also exceeds the present known overseas record); the 183 miles from Stockport to Euston by the 2.5 p.m. from Manchester and the 177 miles from Euston to Wilmslow by the 5.30 p.m. from Euston to Manchester.

The 7.20 p.m. and 9.15 p.m. trains from Euston add lustre to their accomplishments of runs exceeding 200 miles by beginning their journeys with non-stop runs from Euston to Crewe (158 miles), where they halt to change engines, the latter then creating the world's distance record by running on to Glasgow without stop whilst the 7.20 p.m. goes on to Motherwell.

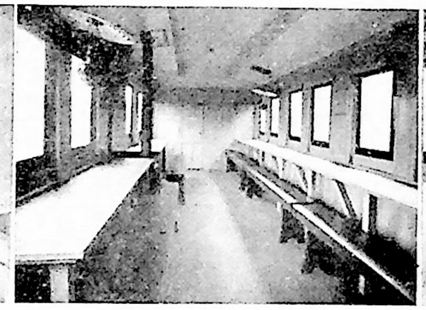
The 9.10 p.m. from Glasgow to Euston also makes a journey of outstanding interest, as it makes three runs each of over 100 miles.



L.M.S. EMERGENCY OFFICE AND MESSROOM.



KITCHEN.



RESTAURANT.

OFFICE

MOBILE OFFICES AND MESSROOMS.—A number of carriages have been converted by the L.M.S. Railway for use as emergency offices and messrooms should existing accommodation be made unfit for use by aerial attack. These mobile offices and messrooms are completely self-contained; they can be attached to any train and rushed to any particular place or district at a moment's notice. With their aid the task of directing the movement of war supplies can go on uninterrupted, even if offices are totally destroyed.

Accommodation is provided for 16 in the offices. The whole of the partitions have been removed and a long desk, supported by nests of drawers, fitted down one side of the vehicle, leaving ample passage way through the car on the other side. The desk tops are covered with linoleum to facilitate cleaning.

The mobile messrooms have a kitchen compartment equipped with a coal-fired double oven stove of large capacity and a boiler for the supply of hot water. A provision cupboard, cutting-up table and sink are also provided. The messroom, which is partitioned off from the kitchen compartment, is equipped with tables and forms along both sides, leaving a clear gangway in the centre of the car. Accommodation is provided for an average of 40 persons.

L.M.S.R. MOBILE SALVAGE EXHIBITION.—A mobile Salvage Exhibition is making a 10,000 miles' tour of the L.M.S. system. The object of the exhibition is to stimulate the salvage effort amongst the 230,000 staff of the L.M.S. Railway. It will be halted at passenger stations and the public will be admitted.

The thirty-four year old railway coach itself forms part of the exhibition. Damaged in the "Blitz," it was scheduled for breaking-up, but was "salvaged" to house the exhibition. All the materials used in the exhibition are, in fact, salvaged materials. The walls are lined with damaged balloon fabric loaned by the Air Ministry, which has been salvaged from damaged balloons. The cast-iron letters forming the slogans displayed in the coach, were originally used as station names, but were removed by Government order in 1940. The ashtray at the entrance is made from an old biscuit tin.

The theme of the exhibition is "The reason why." From it L.M.S. railwaymen and the public will find the answer to the question, "Why is salvage necessary?" The exhibits have come from all over the system; some of them are shown in ordinary jam jars. Dominating the display are two photographs, one of a bomber and the other of a train-load of tanks. By means of arrows, visitors are shown exactly where their salvage is used in these two vital war machines. They can see how powder obtained from old boots is used for hardening steel, and that ammonia from the same source is used in fertilisers. Exhibits explain how even two-year-old bones are valuable. From bones can be obtained fats (including nitro-glycerine), glues and bone-meal. Other exhibits show how used tracing paper is cleaned and turned into bandages. The coach was prepared at the Wolverton Works of the L.M.S. Railway to the design of their Advertising and Publicity Department.

PHOTOGRAPHING BLUE PRINTS AND DRAWINGS.—In their photographic studio at Derby the L.M.S. have a special apparatus by means of which paper negatives are made from large, complicated and fine-work drawings. The originals can be reduced to negatives of any size, but 12" x 10" has been found the most satisfactory. To reduce an involved drawing 75" x 40" below 12" x 10" is not really practicable, and it is quite out of the question to bring it down to the limits of a 35 mm. film (as is done in the case of micro-photography) because the latter method is not sufficiently accurate to produce the required results.

The L.M.S. adopted their own process in pre-war days as a precaution against fire, but as the danger of destruction is naturally greater during hostilities the work has been extended and negatives of the more important drawings covering L.M.S. standard locomotives are now securely filed away in a strong room.

Examination of a print from a reduced negative of the general arrangement of a 2-6-4T and an enlargement of a small portion of it shows that quite legible reproductions are possible of the most complicated details. During the past twelve months, 2,300 reduced negatives have been made for the various departments of the L.M.S. Railway.

CORRESPONDENCE

Editor, The Locomotive.

PULLMAN CARS.

Dear Sir,—With reference to Canon Fellow's most interesting and valuable article on the early Pullman car trains, I would suggest that the woodcut showing an interior represents a parlour car on an American railroad, and not on the Midland. Its impression of greater loftiness may be due to exaggeration, a not uncommon practice on the part of Victorian artists when depicting Pullman car interiors. The lamps, however, are of a type employed on the first Union Pacific trains of 1869. I think that by 1874 the balanced kerosene lamp, with burner and reservoir separate, was the standard Pullman fixture. The windows also are set in pairs, and not in threes as on the early Midland Pullmans. This view also appears in the later editions of Williams's "Our Iron Roads," and it would seem, from the spacing of the windows and deck-lights, to portray the interior of the 12-wheel Pullman car *Ocean*, a U.S. vehicle, which Williams illustrates on the opposite page. It would be interesting to know whether any photographs still survive showing the interior of a Midland Pullman drawing-room car. Later Pullmans on British railways were much photographed, and in 1908, when the Southern Belle was built in England, a sumptuous booklet, illustrated in colour from a series of paintings by Fortunino Matania was published by the Pullman Car Company. Was anything similar done when the first Midland train started running in 1874?

Yours faithfully,
C. HAMILTON ELLIS.

May 15, 1942.

Editor The Locomotive.

DR. CHURCH'S TANK ENGINE OF 1837.

Dear Sir,—Further to Mr. Dendy Marshall's letter in "The Locomotive" of June, page 115, both the victims of the boiler explosion at Bromsgrove Station (Thomas Schaife and J. Rutherford) were buried side by side in Bromsgrove Churchyard. At the top of their tombstone is cut in high relief the representation of the Norris engine brought from Philadelphia, U.S.A., to compete with Mr. Bury's on the Lickey Bank, and on Schaife's tombstone is the famous epitaph in verse which has made them so well known, viz.:—

" My *Engine* now is cold and still,
No *Water* does my boiler fill," etc.

In 1932, Mr. F. W. Brewer mentioned in an article that in Whickham Churchyard, near Gateshead-on-Tyne, there was another epitaph in similar verse to a driver on the Newcastle and Carlisle Railway, who was killed a year or two previously (due to injuries from the boiler of his engine) and suggested that the author might be the same in both cases. As the writer was in Newcastle at the time he visited the Whickham stone and copied it carefully, sending a copy to Mr. Brewer, and it was certainly very similar.

Re "The Bloomer Engines" of Mr. McConnell. In the "National Encyclopædia" of the '70's (Article " Locomotive") a good cross section plate of a 7' Bloomer of the later design was given, evidently inserted in error for one of "Lady of the Lake," which was an exhibit in the 1862 exhibition. After the death of the late Mr. David Joy photographs were found among his papers of McConnell's later engines, 6'6 and 7', as well as the exhibition 7'6 engine number 373. Apparently no photograph of the latter was known to the late Mr. C. E. Stretton, as he gives a line drawing (from memory) of this engine in his book "On Locomotive Development."

Yours faithfully
J. H. McDOWELL.

July 3, 1942.

FREIGHT STOCK OF THE FUTURE.

Editor, The Locomotive.

Dear Sir,—We have read the Editorial article on page 101 with considerable interest and are in perfect agreement with your remarks in paragraph 4, where you emphasize the saving in labour and material charges in addition to the reduction of rolling resistance of stock equipped with roller bearings. In this connection we may mention that it is the practice of one railway company to lubricate our roller bearing axle-boxes once only every 16 months, and that it finds this to be quite satisfactory. The above applies, however, more particularly to a locomotive tender, so that for freight wagons the intervals will probably have to be somewhat shorter, especially in such cases as coal wagons, where dust and grit are in evidence. Even so the reduced attention over plain bearings is most marked.

Yours faithfully,
THE HOFFMAN MANUFACTURING CO., LTD.

June 30, 1942.

REVIEWS

British Railway Rolling Stock.—H. C. Webster 159 pp. Oblong 8vo. Oxford University Press. 4s. 6d.:

An attractively produced book of oblong format, giving illustrations and a brief non-technical description of a comprehensive range of modern British rolling stock. 25 locomotives, 26 carriages and 24 freight vehicles are dealt with, each one at an opening.

The more spectacular vehicles are treated in detail, but no example is included of an 0-6-0 tender or tank, which outnumber by far any other class of locomotive in this country.

Produced for the non-technical public, one must not be too critical, but it is surely incorrect to say that superheating was "the great discovery of a Sir John *Aspinal* in 1906" and that the Southern Railway tube between Waterloo and City is known as the City & South London Electric.

Of the Southern "Lord Nelson's" the author says that the class has been improved recently by the substitution of a large boiler with combustion chamber. The facts are, of course, that one engine only of the class was so fitted as an experiment, and this was subsequently removed as its retention was not justified.

Squared Ruled Paper Projection. By Sir Charles V. Boys, L.L.D., F.R.S., F.Inst.P. Reprint—8 pp.—from the "Journal of Scientific Instruments," Vol. 19, No. 5, May, 1942:—

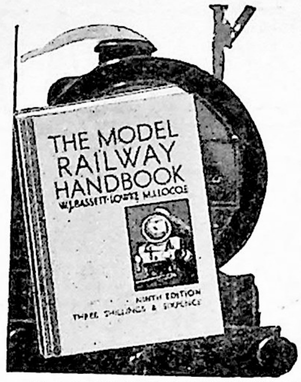
A method is described for making a projection drawing from any point of view in which the drawing is set out directly from the dimensions of the object without the use of intermediate plans and elevations. Seven key figures are given with the necessary numerical factors which give directly the proportions for forty-two points of view. By the use of square ruled paper and these figures, aided by the slide rule, figures may be drawn in which the dimensions are found by means of the rulings on the paper only, so that scales of length are not needed. An example of the use of the method is an illustration of two pentagonal dodecahedrons, one that of Euclid and the other that of a crystal of iron pyrites. The last part of the paper deals with the solution of the spherical triangles on which the method depends.

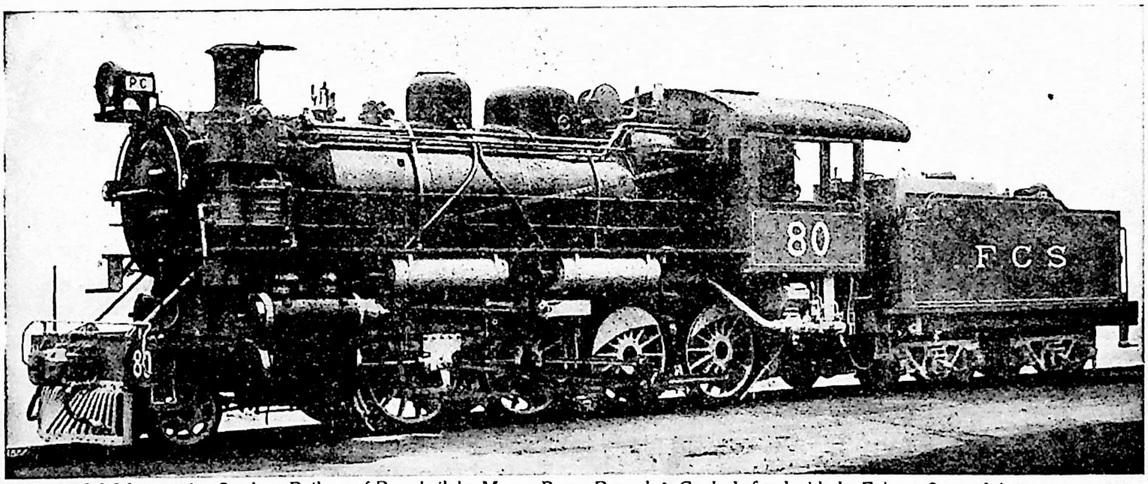
Paper on Diesel Locomotives and Railcars: Their development and suitability, with special reference to their future in Railway Traction in India and Post-War Reconstruction." By P. R. Argawal, B.Sc.(Eng.), A.M.I.E., Assistant Chief Controller of Standardisation, Central Standards Office for Railways, Railway Department Government of India, New Delhi. (Institution of Engineers, India).

A comprehensive review of the progress in Diesel Traction on railways throughout the world, including historical notes. The author refers in length to the various services and the types of vehicles most suited to work them. Maintenance, Repairs, Fuel costs, etc., are dealt with.

E.Q.A. Engineering Questions & Answers. Vol. III. Emmott & Co., Ltd., London and Manchester, 6s.

This third volume, consisting of 176 pages in stiff covers, continues the record in permanent form of selected answers from the Questions and Answers columns of the "Mechanical World." The subject matter is wide, and to aid reference an index has been included as in the first two volumes. The numerous line illustrations are clear and well selected.





2-8-0 Locomotive, Southern Railway of Peru, built by Messrs. Beyer, Peacock & Co. Ltd., fitted with the Exhaust Steam Injector

Printed in Great Britain by Richard Tilling, 106, Great Dover St., London, S.E.1, & published by the Locomotive Publishing Co., Ltd. 88, Horseferry Road, Westminster, S.W.1.