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EDITOR

Prospects of Indian Railways' Self-Sufficiency in Equipment

WHILE the Railway Minister Shri Lal Bahadur Shastri has declared that the Indian Railways had advanced very considerably towards the achievement of the goal of self-sufficiency in Rolling Stock yet much has to be done to make India independent of Foreign Imports.

One Committee has already investigated and reported on spare capacity for manufacture both in Government and Private Industry.

Another two Committees are at present engaged in carrying out further investigations. One in the expansion of Railway Workshop Capacity to undertake more work and the other under the Chairmanship of Mr. Kotak, the Chairman of the Stores Purchase Committee to advise Government on the more intensive utilisation of indigenous capacity for the manufacture of railway equipment particularly for the manufacture of special type of wagons, narrow gauge locomotives and other stock and fittings which are still being imported.

The terms of reference of this latter Committee which include the self-sufficiency in indigenous production cover specifically :—

(a) Locating of Capacity in India for the manufacture of railway equipment and rolling stock which are at present imported, and

(b) Suggesting ways and means of expanding the existing plants and/or setting up of new industries in India for producing items of railway equipment which cannot at present be manufactured with existing resources.

It would appear from the steps now being taken that the Railway Ministry is in earnest to encourage local established industries and such other new ones that are of anxious to enter into the field of indigenous manufacture on behalf of Railways.

The Railway Minister has further stated " It would be in the fitness of things that new factories in the private sector should come up and I can assure them that they will get the needed encouragement from us ".

Mr. Kotak realises the importance of his task too as he has said that " the economic development of the country would throw the maximum strain on the country's railways and the fact that the Railways are planning to increase transportation capacity by 50% during the Second Five Year Plan period indicates their increased requirements ".

There are still many problems that confront both the Government and the private industry which must be resolved before any progress can be expected and among them the one that looms the largest is the shortage of Steel.

That the problem of Steel so vital to the development of railways requires early solution is realised by all concerned both on railways and in private industry and Government will have to undertake imports of all types of Steel in larger quantities during the next 3 years until, our proposed Steel plants go into production if any railway equipment is to materialise at all.

Two other problems which require tackling immediately if there is to be no time lag in the production of railway equipment are :—

(a) A large enough pool of trained artisan staff to be drawn upon both in the private and public sector and

(b) A high standard of quality production.

The first requires the establishment of many more artisan training schools and schools for Supervisors, Foremen and Managers. For this purpose Government and the Private Industry should jointly find the funds in 50–50 proportion if necessary.

Government should collect information of all its retired employees who though they may no longer be able to do strenuous work would be eminently, fitted if sufficient inducement is offered to them, to train the younger generation of budding artisans. Further a few schools where the Supervisors and Foreman could receive intensive training by means of refresher courses in modern workshop methods, labour relations and labour control will be required in the principal cities of the country like Delhi, Calcutta, Bombay and Madras.

Part time courses in all the ramifications of Management should be offered to those in Government or Private Industry who are holding or aspiring to hold higher positions in Management. It is only by these steps that we can expect real progress.

With regard to a high standard of quality production, the Indian workman can hold his own in skill against the best of his class anywhere, but he requires guidance, owing to his lack of education. It is, therefore, necessary that the higher supervisors should have sound knowledge of the techniques of production. They should also be imbued with the spirit that only the best in quality is good enough and that shabby work will not pass the inspection stage after manufacture.

The size of the orders to be placed by the Railway or the DGS&D on the trade should be of such a size, even if they total upto the annual consumption of a standard item, that they make manufacture attractive to the producing firm.

It is very necessary that new industries should be founded on right lines which should include among other things Research, because it is only by this means that improvements can be expected in industrial production and quality.

The Railways should also be prepared to give price preference to indigenous articles until such time that they come upto the required standard.

If such co-operation can exist between the Government and the Industrialists then the day will not be far off when India can hope to be self-sufficient in her Railways – the biggest industrial enterprise of the country.

HISTORY OF BRITISH RAILWAYS

BRITAIN was the pioneer of railway development which provided the improved transport essential to industrial and commercial expansion.

Railroads were in use around pits and iron works before the end of the sixteenth century. Trucks were mainly drawn by horses. The first railroad to carry goods for the public was the Surrey Iron Railway built between Wandsworth and Croydon in 1801 to 1803. In 1812, William Hedley, a colliery engineer, following up the work of William Symington, William Murdock, Richard Trevithick and others, showed how locomotives could be used on railroads. About the same time, George Stephenson improved the efficiency of existing models by increasing the draught to the firebox. In 1825 the Stockton to Darlington railway was opened and became the first public railroad on which locomotives were used. The first public line built expressly to use only locomotive haulage was the Liverpool and Manchester railway of 1830. Stephenson's 'Rocket' was the chosen locomotive, as a result of a competition in 1829. From that time, the potentialities of the locomotive railway began to be fully developed.

At first, railway projects were mainly local, promoted by groups of people concerned with the needs of particular areas. Parliamentary sanction had to be sought for each project. The general opinion was that the company would provide the track but would not necessarily act as carriers. Private carriers often ran their vehicles over the companies' lines. But the realization that for reasons of safety and efficiency the company must have all traffic under its own control was endorsed by a Parliamentary Committee in 1839. Railway building was particularly rapid between 1840 and 1875, with a short lull following the collapse of a speculative railway boom in 1846. This period also saw the beginning of a process of amalgamation in order to achieve the economics of concentration and large-scale operation. The State began to intervene. Thus, in 1846 an Act of Parliament prescribed a standard gauge of 4 feet $8\frac{1}{2}$ inches for all new lines except extensions of the Great Western Railway which had a gauge of 7 feet. Not until 1892 was the Great Western gauge completely converted to the standard gauge. In 1850 statutory recognition was given to the Railway Clearing House which began in 1842 and had the function of facilitating through traffic by providing for the adjustment of balances between companies. The Railway and Canal Traffic Act of 1854 laid upon the companies the obligation of providing reasonable facilities, especially for through traffic, and of avoiding undue preference between users. In 1873 jurisdiction under this Act was given to a body of three Railway Commissioners which in 1888 was renamed the Railway and Canal Commission. The Railway and Canal Traffic Act of 1888 drew up a standard freight classification and schedules of maximum freight charges which came into operation in 1893. A company wishing to increase these rates had to justify itself to the Railway and Canal Commission.

During the 1914-18 war the railways were controlled by the Government, acting through a Railway Executive Committee consisting of the general managers of some of the larger companies. This arrangement made clear the advantages of concentration and it was decided that the handing back of the railways to the companies should be accompanied by a comprehensive reorganization. By the Railways Act of 1921, 123 companies were amalgamated into four large groups—the London, Midland and Scottish; London and North Eastern; Great Western; and Southern. A new tribunal, the Railway Rates Tribunal, was established to take over the jurisdiction over charges and questions of undue preference of the Railway and Canal Commission. It was to carry out an annual review of standard rates and fares which were to be adjusted with reference to the principle of maintaining to the companies a standard net revenue equivalent to that of 1913.

In the inter-war years, the railways suffered both from the general industrial depression and from the growing competition of road transport, and the standard net revenue was never earned. Efforts were made to improve services and efficiency. In 1928 powers were obtained from Parliament of own and operate road services. But the railways were at a disadvantage in competing with road hauliers; the latter were not, as were the railways, bound to accept all traffic; their rates were flexible and need not avoid undue preference, and they were not heavily capitalized undertakings. In 1938, the railways put forward 'Square Deal' proposals calling for relief from statutory regulation of charges and for freedom to decide for themselves the rates for merchandise carried. The campaign was interrupted by the outbreak of war in 1939 when the railways again passed under the control of Government, acting, as in the 1914-18 war, through a Railway Executive Committee.

BRITISH RAILWAYS

In 1947 the Transport Act brought the railways of Great Britain into public ownership and created a Rail-

way Executive empowered to operate them on behalf of the British Transport Commission as a single enterprise known as British Railways, with six regional sub-divisions —London-Midland, Western, Eastern, Southern, North Eastern and scottish—corresponding broadly to the former companies.

The Transport Act, 1953, reversed the policy of centralization, and instructed the British Transport commission to prepare a scheme for railway reorganization and decentralization. The scheme was to provide for the abolition of the Railway Executive (if not already abolished) and for the setting up of area administrations which might follow the existing pattern of regions, to which many of the Commission's powers would be delegated. But there would still be central responsibility for some matters including wages and charges.

To increase the competitive power of the railways, the Commission was to have more latitude in fixing railway charges, e. g., only the maximum rates would need to be provided for and published and not concessions made to secure competitive business.

From 1st October 1953 interim arrangements came into effect pending the reorganization envisaged in the Act. The Railway Executive was abolished and the Commission became the employer of all officers and staff of the British Railways. The six regions remained unchanged but wider powers were given to the Chief Regional Officers who became known as Chief Regional Managers.

The Commission's scheme for the reorganization of the railways was published as a White Paper on 13th July 1954 and followed the general principles of the interim arrangements.

The Commission proposed that the existing six regions should be the areas envisaged under the Act. The area authorities should be boards, each consisting of not more than seven persons including a chairman, one or more of the members being a member of the Commission. Members would be drawn in part from outside the industry but would not be representatives of particular interests; they would not be expected to devote the whole of their time to the work of the authorities. The Commission considered that its control in the scheme of organization should be absolute and that it alone should appoint the members of the area authorities. The area authorities would not be incorporated, and the Commission would remain the employers of staff; it would also retain general financial control including the control of charges.

Within the framework of their responsibilities to the Commission, the area authorities would be responsible for the management of the railway system in their areas, but they would leave day-to-day management to their Chief Regional Managers who would continue to maintain close contact with the staff at Commission Headquarters. Functions delegated to the area authorities, which they would exercise in the name of the Commission, would be to promote initiative in improving services and facilities and in effecting economics; to ensure that contact would be made with users to meet their requirements to the fullest extent possible; and to ensure that proper measures would be taken regarding the safety, health and welfare of the Commission's employees.

The scheme was accepted and is being put into operation.

STAFF AND ASSETS

The following figures summarize the numbers of staff employed and vehicles, ships and track owned by British Railways at the end of December 1953.

Staff, total number	593,768
of which: Administrative	76,436
Operative	305,278
Maintenance	197,854
Permanent Way (standard gauge)	
Railroad mileage (incl.—electrified)	19,222
Track mileage (incl.—electrified)	51,607
Locomotives	
Steam	18,584
Electric	65
Diesel	14
Diesel-electric	242
Gas-turbine electric	2
Petrol	2
Narrow-guage [1]	5
Passenger carriages[2]	
Steam	37,197
Electric	4,565

[1] There are about 27 miles of narrow-gauge track open for traffic.

[2] Including rail motor vehicles.

Freight vehicles	1,122,044
Ships	135
Net tonnage of ships	78,436
Road vehicles	
Motors and tractors	5,409
Articulated motive units ..	9,960
Trailers for above	25,823
Horse-drawn vehicles.. ..	5,394

The railway system is, of course, fully signalled and has a complete telephone and telegraphic network. A system whereby trains are automatically warned and controlled if signals are against them has been in operation on the Western Region—formerly the area of the Great Western Railway—since 1905. The general adoption of a suitable system on all main line railways has been studied since nationalization and plans are in hand for its installation.

The largest railway station in the country is Waterloo, the London terminus of the South Western main and suburban lines in the Southern Region. It has 14,901 feet of platform face (i. e. the side of the platform towards lines). The longest single platform face on British Railways is at Manchester; it extends for 2,194 feet through the adjacent Victoria and Exchange Stations.

Major development works include the electrification of the line between Manchester, Sheffield and Wath, which was opened in September 1954.

Motive power is the subject of continuous study. Twelve standard classes of steam locomotive are being introduced, while experiments are being carried out with diesel-electric locomotives on main line work. Diesel-electric traction is already being employed for shunting in marshalling yards, where it is more economic than steam traction, and in multiple unit passenger trains. The testing of the design, construction and operation of steam locomotives is carried out at the Locomotive Testing Station at Rugby, which was opened in October 1948.

Refreshment rooms and restaurant and buffet car services are the responsibility of British Transport Hotels and Catering Services. Staff employed at the end of 1953, numbered 15,374. Refreshment rooms are operated, often by concessionaires, at 409 stations, and in 1953 approximately 10 million meals were served on trains. There are 40 railway hotels. The policy has been to sell hotels not connected with transport.

Accidents on British Railways are rare; the only major accident in 1953, a collision between a steam passenger train and an electric train on the Irk Valley viaduct in Lancashire on 15th August, caused the death of 10 persons.

* Including 10 jointly owned and 5 operated but not owned. British Railways operate services on twelve routes to the Continent including two train-ferry services, Harwich-Zeebrugge and Dover-Dunkirk. Services are also operated across the Irish Sea, and on coastal waters and lakes.

RAPID EXPANSION OF EAST AFRICA'S ECONOMY

The continued rapid expansion of East Africa's economy is reflected in the latest statement by the East African Railways and Harbours Administration in its revenue position. At £ 1,401,502, the approximate railway revenue for December 1954 was almost £ 90,000 more than that for the previous month, and the total revenue for 1954 was approximately £ 15,250,000, showing an increase of more than 20 per cent. on 1953.

There was a substantial improvement in passenger traffic in the second half of the year—an improvement which, it is anticipated, will continue during 1955.

Similarly, by November the harbour revenue for all ports increased by almost £ 100,000 on the same period of the previous year. This was achieved in spite of the fact that considerable expansions had been taking place which meant reduced working space and facilities for the handling of products which would show a more obvious return in terms of revenue.

PRODUCTION IN CHITTARANJAN

Shri P. C. Mukherjee, Member (Engineering), stated that Chittaranjan's original target of production has already been exceeded and the 200th locomotive will roll out in the first week of February. The new target for Chittaranjan is 200 average size locomotives and 100 boilers per annum. When this is achieved, Chittaranjan will turn over in 36 hours a complete new locomotive.

The Integral Coach Factory at Perambur is expected to start production this year and first coaches will start coming out some time in September or October. It will start producing about 20 coaches this year and reach the target of 350 all steel broad gauge coaches by 1960.

Six Cylinder Oil Engine for Malayan Railway Locomotives

By A Special Correspondent

THE power unit in each of the six diesel hydraulic shunting locomotives recently shipped to Malaya from the works of the North British Locomotive Co. Ltd., is a Paxman four-stroke V6 RPH engine, derated to 300 b. h. p. at 1,250 r. p. m. to suit site temperatures up to 94 deg. F., and a humidity of 70%. This unit is of basically standard type, with six 7 in. x 7¾ in. cylinders arranged in V formation, and pressure charged on Buchi exhaust gas principles by a Brown Boven turbo-blower group running up to 28,000 r. p. m. At normal full load and speed the exhaust temperature in the branches is about 900 deg. F., and the air delivery pressure about 5 lb. per sq. in. Dry weight of the engine including pressure-charger is 6333 lb., or 20 lb. per b. h. p. on the n. t. p. rating of 313 b. h. p.

In this particular size, a leading feature of the engine is the short and extremely stiff shaft and frame system which promotes engine reliability and quietness of running and also gives a most compact power group capable of convenient installation in locomotives and, as was shown in the railcars set to work in Bolivia a year ago, in railcars also. This stiffness and rigidity is enhanced by a shaft diameter well over two thirds of the cylinder diameter, a generous proportion in any case, but even more notable in a three throw shaft. This diameter, first used in the 12 cylinder and 16 cylinder engines of the same range, was retained primarily for the standardisation of main and big-end bearings, so that customers using more than one engine size in the R. P. H. range would need only one class of spares; but also it was realised that this shaft diameter would also result in high performance of bearings, shaft and framing. Being a six-cylinder V, this engine also has a supplementary balancing shaft in the crankcase to look after the secondary forces and the result of all these points has been a remarkably smooth running engine.

Some Necessaries of Progressive India

By W. P. Niyogi, G.I. Loco. E., M.I.L.S., A.A.R., A.R.E.A., V.D.I.

INDIA, while marching ahead with the world's progress, needs some important productions for the maintenance of her progress. Some new railway lines are scheduled to be opened during the next five years to run her trade in a better way and many new wagons are to be manufactured to carry her trade. But it should also be remembered that the maintenance of the existing tracks in India is one of the biggest factors for the smooth transport of her productions. For that reason, she needs some special equipments and those have also to be manufactured.

These equipments are mostly composed of some special types of wagons and machineries, and are extensively used for the maintenance of long distance tracks, as in America. They are very useful for quick unloading, distributing and dressing of ballast. Some of these special equipments and their utilities are discussed here in the following paragraphs.

HOPPER - BOTTOM WAGON

Hopper - bottom wagons are generally designed with floors sloping from the ends and sides to one or more hoppers, which discharge the load by gravity through the hopper doors. When used for ballasting work, continuous ballast distribution is effected by moving the train slowly as successive wagons are unloaded. The hopper wagons are useful for unloading between the rails.

" GONDOLA " WAGON

The 'gondola' type general purpose wagons, with drop-bottom doors controlled by a ratched device at the end of the wagon, are also used for unloading ballast. Because of the difficulties in controlling the amount of ballast to be unloaded, this type is superceded by the other hopper types.

SPECIAL BALLAST WAGON

Special ballast wagons of the hopper-bottom type are designed to unload through controlled doors. This hopper-bottom wagon has a body with sloping floor sufficiently steep to discharge the ballast to the side or centre of the track in the quantity required. The operator walks alongside the wagons working the operating handle which controls the flow of the ballast. The controls for flow of the material from the centre hoppers can be operated from either side of the wagon.

The hopper unloading controls on these ballast wagons are of worm and gear type and are manually controlled. Although it is not practical to close the hopper doors after they are once opened, it is possible to tighten them sufficiently to pinch stone ballast or similar coarse material and prevent its further flow. These ballast wagons are specially designed for ballast service; they are also useful for hauling coal, concrete, sugar beets, ores and similar products.

There is also another type of ballast wagon which may be converted from the flat bottom side unloading type to the V bottom centre unloading type. When used for centre unloading, it is equipped with a longitudinal V type hopper which extends the full length of the wagon. The amount of ballast unloaded is controlled by the opening of the V bottom, which is actuated by a ratchet device at the end of the wagon.

AIR - OPERATED SIDE DUMP WAGON

Modern air - operated dump wagons are built of high-tensile, low - alloy steel to combine strength with light weight. They vary from 23′ - 8″ inside length to 41′ - 0″ and from 35 tons to 68 tons in load - carrying capacities.

Practically all dump wagons are of side pivot or down-turning door type. The doors are moved outward and downward, and returned to their normal positions, by means of a simple mechanism synchronised with the movement of the wagon.

Air dump wagons are not suitable for unloading ballast for surface lifting; they are extensively used to unload ballast in bank restoration. The down-turning door acts as a chute or apron to keep the material being unloaded clear of the ballast shoulder section. A spreader should be used to level the material thus unloaded.

PLOUGH EQUIPPED BULLDOZER

Bulldozers equipped with ploughs are used to unload ballast from special ballast wagons of the gondola type

th side doors. This equipment does not remove the llast very close to the floor of the wagon but its rformance is very quick.

..LAST REGULATOR

It is a machine for regulating and ploughing ballast. is operated by one or two men and is provided with turntable for removal of the machine from the track or ermitting it to be turned to operate in the opposite rection. It is powered with a 100 H. P. petrol or esel engine with a 4-speed forward and reverse transission and is equipped with 4-wheel drive. The ballast ings and plough are adjustable to fit any standard allast section.

This machine can be used ahead of the surfacing gang r regulating and distributing the ballast evenly, filling all empty cribs and removing excess ballast from the entre of the track, placing it on the ballast shoulder for istributing and final dressing. The ballast wings are designed that the ballast is at all times pulled back to the track and thus the wastage is minimised. It can e equipped with a broom attachment to clean ballast oroughly from the tops of the ties.

ALLAST DISTRIBUTOR

This machine picks up ballast from the inter-track pace or border by means of a bucket-type conveyor and ads it into a hopper. The ballast is then distributed the cribs and at the ends of the ties through the adjustble openings in the hopper. The hopper itself can be ised or lowered to give the desired depth of ballast.

The machine is also equipped with wings and levelling lades for dressing the ballast. If necessary, excess allast can be loaded in the hopper and carried to a point here needed. A ballast chute, between the conveyor nd hopper, is provided with a screen which separates irt from the ballast.

The machine is operated by one man through a bank of hydraulic control valves located in an enclosed cab. It is powered by a petrol or diesel engine driving three hydraulic pumps. The machine is mounted on flanged wheels driven through a chain drive and transmission by a hydraulic motor. The travel speed of the machine is 24 miles per hour. It is equipped with hydraulic brakes and a sanding device. Hydraulic jacks and transverse flanged wheels are also provided for removing the machine from the track.

SPREADER - DITCHER

This is a heavy, rugged, on-track machine designed for a multitude of maintenance assignments including ballasting. With its versatile front plough and adjustable ballast section blades, the machine can plough and flange ballast from between the rails to either or both sides of the track as desired, at the same time shaping existing ballast or dressing freshly applied ballast on the shoulders. The spreader-ditchers are also used extensively to cut foul ballast away from the ends of ties. With the combined spreader-ditcher and bank sloper wings, the subgrade can be levelled, fills dressed, and drainage ditches cleaned. The machine may also be used to carry excess material from cuts, widening and contouring them in one operation.

The spreader-ditcher is generally pneumatically controlled by one operator. The machine has a total spread with both wings of 40 ft. or more, with a vertical range from one foot above to 3 feet below the top of the rail.

ACKNOWLEDGEMENT

It is acknowledged that some datas have been taken from the Bulletin of American Railway Engineering Association, Chicago, to complete this article.

PRESS PARTY TOURS RAILWAY CENTRES

A 14-member Press Party consisting mainly of representatives of leading Indian newspapers and News agencies started from Delhi on January 10, 1955 on a -weeks tour of the country to visit places of interest all over the Indian Railways. Their itinerary included visits to Moghalsarai, Chittaranjan, Howrah, Khargpur, Vizagapatam, Dhanushkhodi, Trichinopoly, Bangalore, Bombay and Baroda.

Whilst on the Central Railway the press party saw the passenger amenities provided at the remodelled station of Gulbarga on the Sholapur Division. In Bombay they saw the models of Dadar station old and new and later inspected the remodelled station to see at first hand the progress effected. They visited the electro-pneumatically controlled Signal 'A' Cabin at Victoria Terminus and saw the handling of peak hour traffic at the Suburban station. They also visited the Matunga Carriage & Wagon Workshop where they saw the furnishing of Schlieren coach shells and the building of Air-conditioned coaches. They press party was generally impressed with the fine work done by the Railways since Independence.

British Locomotives for World's Railways

OVER 400 EXPORTED TO INDIA IN FIVE YEARS

SINCE the war, Britain's locomotive industry has exported to all parts of the world locomotives and component parts to the value of no less than £ 100,000,000, says an article in a special trade and transport issue of the *British Trade Journal and Export World*, just published.

Today Britain can offer deliveries of locomotives as speedily as any other country. During the last five years the industry has exported no fewer than 405 locomotives to India, 468 to Africa, 395 to Australia, and 356 to other parts of the world. These were all main-line locos, some of the largest ever to leave Britain.

There have also been numerous orders for Diesel locomotives; these include 30 for Brazil, 25 for Ceylon, 94 for Ireland, and 75 for the Netherlands. Electric locomotives have also been produced in increasing numbers, and these include very large main-line locomotives for South Africa, Spain and Brazil. In 1953, no less than 93 per cent. of the total production of the industry went overseas.

The article recalls that one of the largest contracts ever placed for railway equipment was awarded last year to a British firm (Metropolitan-Vickers). The Central Railway of Brazil ordered 200 complete railway coaches, to be built and equipped in Britain, and 100 sets of electrical equipment to fit into coaches being built in Brazil. The contract, financed in part by an International Bank loan of $ 12,500,000 was worth about £ 7,000,000.

U. K. MASTER PLAN

Referring to the new 15-year plan to re-equip and reorganize Britain's State-owned railways, the article observes that oversea buyers interested in this field will watch with interest implementation of various aspects of what has been called the master plan for British Railways. The £ 1,200 million programme, which will include extensive schemes for electrification, more Diesel locomotives, re-planning of stations, and improvement of rolling stock and the permanent way, may, by the time it is completed, set new standards of modern railway practice which will serve as a model for the world.

The potentialities of gas turbine and atomic power for propulsion are not being overlooked.

The technique of White-Metalling Carriage & Wagon Bearings

By A. C. Bhattacharya, A.M.I. Prod. (E).

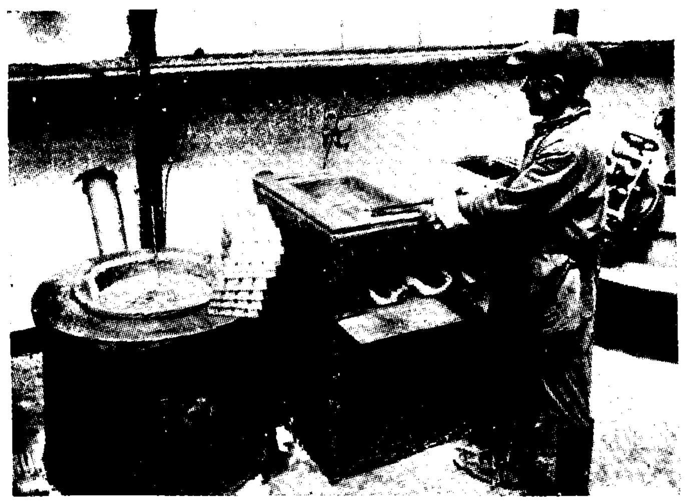
THE adage " For want of a nail the wheel comes of " may be old but is still perfectly true and is equally applicable in case of Railway Rolling Stock when for want of a correctly lined bearing very many of them have had to be taken off the active movement list or a complete train suffered detention on account of bearing troubles.

The bearings of Carriages and Wagons are very important parts as upon their form and treatment the well-being of the stock, the tractive force required to propel a train, and the comfort of the passengers, greatly depend.

The efficiency of the bearings not only depends on the correct chemical composition of the bearing metal but also on its accurate crystal structure. When correctly produced, the chief characteristics present in a metal are :-

(i) Lowest possible co-efficient of friction with the maximum degree of durability, and

(ii) Sufficiently malleable to adopt itself to the bearing pressure and permitting the same to adjust itself readily to any irregularity in the distribution of load, so that the vehicle can take its own bearing on the journey.

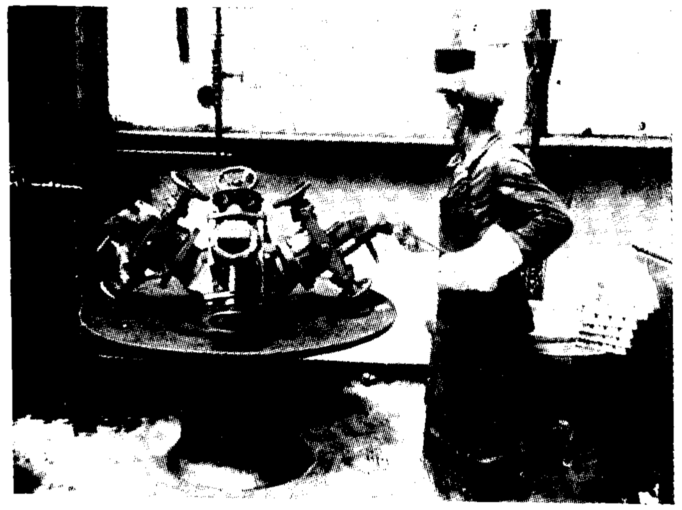


A bearing being tinned in the tinning bath.

BEARING METALS

The bearing metal or the white antifriction metal as it is generally called is an alloy of Lead, Tin, Antimony and Copper or Tin, Antimony and Copper according as it is a Lead Base or Tin Base Alloy.

The Lead Base alloy which is used in our country for Carriage and Wagon bearings consists mainly of three ingredients, Lead in predominance with a comparatively small percentages of Tin and Antimony and sometimes Copper and the standard mixture comforming to Indian Railways Standard Practice consists of :- Tin 4.5 to



The white metalling jig (which illustrates that four bearings can be poured at the same time)

5.5%, Antimony 14 to 16%, Copper 0.75 to 1.25% and Lead the remainder. Although the Lead Base alloy is cheaper than Tin Base Alloy and is employed in Carriage and Wagon bearings because of the stresses and strain in them being considerably less than those in Locomotive bearings, it however requires more careful temperature control because the Tin-Antimony crystals which give a bearing metal its hardness, have less buoyancy in a Tin-base alloy and therefore tend to segregate less than in a Lead-base alloy, though the presence of Copper in sufficient proportion to form Copper-Antimony crystals in the Lead-base alloy counteracts this tendency to some extent.

The essential features of a good bearing are :-

(i) The white metal must wet the brass and stick to it in perfect metallic union.

(ii) The ingredients should be mixed in correct proportions and evenly distributed.

(iii) Correctness of the physical structure of the hard crystal is maintained throughout the melting and pouring operation.

For this reason, it is of great importance that the correct methods are employed when lining bearings with white metal to avoid future troubles and from what the writer has seen, the procedure described hereafter has been found satisfactory and may be adopted with advantage.

For keeping the mixture uniform and in order to avoid the more fluid portion of the alloy alone passing into the bearing leaving behind the hard Tin-Antimony and Copper-Tin Crystals in the ladle or pot, it is essential to keep the temperature of the metal while melting above the melting point of the principal ingredient and stir it gently. On the other hand overheating must be avoided as it will tend to impair the crystal structure of the metal in the following ways :-

1. Formation of oxides of Tin and Antimony. Overheating accelerates the separation of these two metals which as they rise to the surface become exposed to the action of atmosphere and having a greater affinity for oxygen, readily form into oxides.

2. Reduction in Tin-Antimony content.

LAYOUT OF THE PLANT

When dealing with large quantities of bearings in flow production the layout is as follows :-

One pot for running out of old metal at 500° – 550° C.

An electrically heated degreaser for cleaning the greasy bearing shell.

A muffle furnace for preheating bearing shells at 200° – 250° C.

Second pot for tinning at 300° C.

Third pot to contain the lining metal at 360° – 400° C.

PROCESS

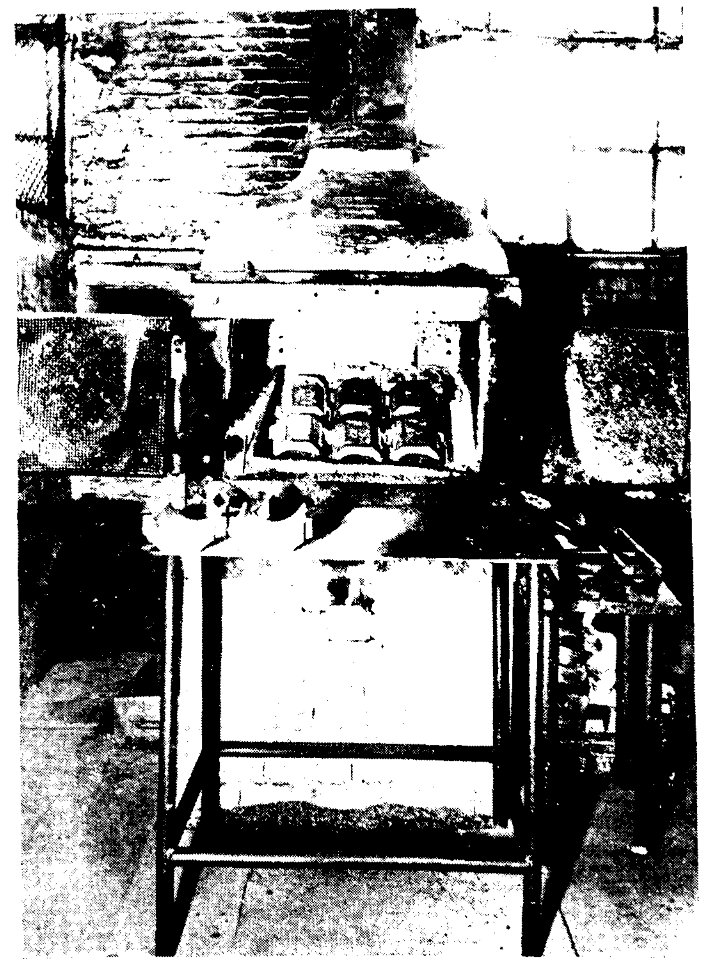
The work of lining the old bearings is done in the following sequence of operation.

1. *Demetalling :-* The old bearings are demetalled at a temperature of about 500° C to get rid of the last traces of old white metal. The time required is approximately 8-10 minutes.

2. *Cleaning of bearings :-* It is essential that the bearing shell should be cleaned and made free from all dirt and grease before tinning to ensure proper adhesion of the white metal lining. Lack of adhesion between lining and shell subjects the lining to excessive stress and, by failing to conduct away the heat generated by friction, may give rise to excessive temperature with resultant distortion and cracking of white metal under working conditions.

The cleaning is done by means of pneumatic wire brush and by granding which take approximately 5 minutes per shell. If the shell is found to be greasy, it is taken on to degreaser and kept immersed in caustic Soda bath (15% solution) for approximately 30 minutes at a temperature of 100° C.

The shell is then washed thoroughly in running water for half hour or so and the water is allowed to drain off for another 30 minutes. The shell is thereafter tested



Pre-heating oven.

for any crack by suspending it in the air and striking the same with a hammer. A good shell gives a clear ring.

3. *Preheating* :- The shell is then preheated within a range of 200 to 250 C in the muffle furnace, care being taken to see that the temperature does not exceed 300 C as otherwise the surface of the shell will be oxidised so as to interfere with subsequent white-metalling. It is sometimes advisable to cover the surface which has to be tinned with liquid flux before preheating to cut down oxidation.

4. *Fluxing* :- Liquid flux which is prepared by adding 2½ lbs. of zinc to 1 gallon of commercial Hydrochloric acid is then applied by means of hand brush to the surface to be tinned. The sides and back are blanked off by using a white wash and black lead mixture to prevent them from tinning. Time taken is generally about 5 minutes for the complete operation.

5. *Timing* :- A satisfactory method of tinning a shell is to immerse the fluxed bearing surface for 5 to 10 minutes in a molten tinning bath containing pure tin for relining with a Tin-base alloy and an alloy of 50% tin and 50% lead for relining with a lead-base alloy and kept at a temperature of 280 - 300 C. A lower tinning temperature gives a non-uniform streaky appearance and at higher temperatures, tin gets oxidised giving yellow stains resulting in poor adhesion. Every care is taken to ensure that surface to be lined is tinned uniformly all over and to do the same the tinned surface is re-fluxed followed by wire brushing and again dipped in the tin bath. The process is repeated at least 3-4 times and until the best tin coating is obtained. After tinning all traces of flux are removed by wiping with cotton waste. A bristle brush may also be suitable specially where there is danger of fluff in the cotton waste adhering to the surface of the shell. It much depends whether the shell is smoothly

A general view of the layout in a white metalling shop.

machined in the bore or not. Immediately after tinning and as quickly as possible the shell is white metalled so that pouring of white metal may be done before the tinning has solidified.

It is desirable to cover the tinning bath with a layer of zinc chloride flux to prevent dressing.

6. *Metalling* :- For metalling the shell is secured in suitable jigs. The mandrel is heated to a temperature of about 120° - 150° C so that it may be hot enough to check premature freezing and cool enough to give a slight chill to the white metal surface, the object being to allow formation of beta (Sn - Sb) crystals in a matrix of tin-lead-antimony eutectic.

However, care has to be taken that the lining solidifies from the shell towards the mandrel and therefore the shell is cooled by spraying with water. This ensures a strong bond between the lining and the shell.

Sufficient well distributed beta crystals (to carry the load) are essential together with a relatively plastic component so that the bearing may conform to the journal rather than vice-versa. If the white metal cools very fast, the formation of essential beta crystals will be arrested and the alloy will lose its antifriction properties.

Since lead base white metal is not so fool-proof from a casting point of view as are the tin base alloys, the metal having a marked tendency to form shrinkage contractions just below the pouring gate, a relatively large pouring gate (about 2 Sq. inch) is provided so as to give a " Head " of at least 2 Cu. inches of metal to feed the contracting mass.

The white metal is then poured from the third pot, kept at a temperature of 360 - 400 C and covered with charcoal dust to prevent oxide getting into the bearing, in a steady stream without splashing and puddled with clean iron wire so as to release entrapped air.

The following points are to be carefully noted while pouring metal into the bearing.

(i) To prevent blow holes the metal should be poured with the mouth of the ladle close to the top of the shell and every attention should be paid to see the mandrel or surface to be lined is free from water, oil or flux.

(ii) The pouring should be at one point only, preferably in mid-position, slowly at first to release air entrapped at the bottom of the bearing.

(iii) White-metalling of each bearing should be done by one pour; therefore the ladle should be sufficiently large to take adequate white metal required for one bearing.

(iv) The method of vertical pouring should be adopted in preference to horizontal pouring as in that case the dross, gases, etc., if any in the metal will rise to the top and escape.

(v) The whole process of tinning and pouring should be carried out uninterruptedly and as quickly as possible.

After pouring each bearing, the mandrel should be swabbed with a rag moistened with clay wash. This will leave a thin layer of fine clay dust on the mandrel surface, which in turn will assist in producing smooth bearings free from blow holes and other surface defects. As it is important to keep the shell and mandrel within the correct temperature it may be necessary after each pour to cool the mandrel by dipping it in clay wash. However, the mandrel should never be damp when the bearing metal is being poured.

7. *Testing* :- When the bearing has finally cooled down it is taken off and suspended in the air and struck with a hammer for a clear ring to test proper adhesion of white metal.

For new shells the production line is entered from item 2 and is proceeded with as described thereafter.

The process described in the foregoing paras has given satisfactory results and though apparently the subject looks like too simple to deserve any careful attention, the importance of adopting correct method cannot be over-emphasized due to its having a direct influence on bearing efficiency.

Acknowledgments: The author acknowledges his indebtedness to the Eyre Smelting Co., Ltd. and to Heatly & Gresham Ltd. for supplying the photographs for re-production along with this article.

Brush Bagnall Diesel Electric Locomotives

GENERAL DESCRIPTION

THE locomotive is of the type designated A1A—A1A, the superstructure being mounted on two bogies, each bogie having three axles of which the two outer axles are motored whilst the centre axle is for carrying purposes only.

The locomotive superstructure has a driving cab at each end mounted behind a short, streamlined, nose end compartment. The power unit with its auxiliary equipment and control gear is mounted in the main body of locomotive. A partition separates the engine from the generator and control equipment, and unobstructed walk-ways are provided on both sides of the power unit.

Both driving cabs are fitted with a driver's position and controls on the left-hand side of the cab with an assistant driver's position on the right-hand side of the cab. All instruments essential to the driver are mounted on a panel in front of the driver and his assistant. Unobstructed vision for both men is provided by large driving windows, fitted with pneumatically operated windscreen wipers. A powerful headlamp is fitted into the nose at each end of the locomotive.

Immediately behind No. 1 cab is the main radiator ducting carrying the radiator fan motor and runner. Air is drawn through the radiator panels, which are mounted vertically on either side of the locomotive, and after passing through the twin branches of the ducting is ejected upwards through a grille in the roof.

Access to the main body of the locomotive is provided by doors in the cab bulkheads. At No. 1 end, the centre walk-way through the radiator ducting branches on either side of the diesel engine; the generous loading gauge of the Ceylon Railways allowing sufficient space between engine and locomotive sides for the withdrawal of the engine pistons and connecting rods from the sides of the crankcase.

Doors are provided in the partition separating the engine and generator compartments and the walk-ways

continue on either side of the main and auxiliary generators, exhausters, compressor and control equipment cubicle. Doors in No. 2 cab bulkhead give access into No. 2 driving cab.

The nose and compartments in front of each driving cab contain a traction motor blower, electrically driven, which supplies filtered air to the two traction motors in the bogie beneath. Access to the nose compartment is by removable panels inside the cab and by hinged louvre panels on the outside of the locomotive nose.

All auxiliaries are electrically driven with the exception of the engine cooling water circulating pump, which is belt driven from the free end of the crankshaft, and the engine lubricating oil pumps, which are gear driven from the crankshaft. Power for the auxiliary machines is taken from the auxiliary generator, which is mounted on an extension of the main generator shaft.

The main fuel tank and batteries are slung beneath the locomotive between the bogies. A separate fuel service tank is mounted in the roof of the locomotive.

Due to the bad weather conditions encountered in Ceylon, which include tropical rain and heavily corrosive salt atmosphere, special care has been taken to make all ventilating and air inlet louvres water-proof and anti-corrosive materials have been used throughout the construction of the locomotive.

DIESEL ENGINE

The locomotive is powered by a Mirrlee, Bickerton and Day, Vee-type 12 cylinder, turbo-charged four-stoke oil engine, with a rating of 1,254 B. H. P. at 850 r. p. m. under normal temperature and altitude conditions.

Under site conditions in Ceylon, the engine develops 1,000 H. P. at 850 r. p. m.

The bedplate is of welded construction, andc arries the crankshaft bearings. The cylinder housing and upper part of the crankcase are also of fabricated construction and the complete crankcase assembly is solidly bolted to the bedplate. The cylinders themselves are of the "wet" type.

The crankshaft is of solid forged steel and is supported by main bearings of steel, white metal lined. The pistons are of light alloy fitted with compression and scraper rings. The piston pins are of the floating type. The connecting rods are of steel "H" section and carry marine type large end bearings consisting of steel-backed white metal shells.

The twin camshafts are mounted in the cylinder housing and are driven by spur gears from the flywheel end of the crankshaft. They are located on the outer sides of the two banks of cylinders, and operate the valve and fuel pumps through roller ended push rods and tappets.

The engine is force-lubricated from gear type lubricating oil pumps, and a shutdown device is incorporated which automatically stops the engine when the oil pressure falls below a certain point, or when the engine speed exceeds a certain limit.

The engine cooling water is circulated by a water pump, belt-driven from the forward end of the crankshaft.

The engine and generator, which are bolted together to form a single unit, are mounted on three pedestals carrying Silentbloc bushes, thus eliminating any possible distortion of the locomotive underframe being transmitted to the diesel engine.

ENGINE AUXILIARIES

The engine is started by motoring the main generator from starting batteries slung beneath the underframe. Starting connections cannot be made until sufficient oil pressure has been built up in the diesel engine by an electrically driven priming pump.

Fuel oil is delivered to the engine fuel rail under pressure by an electrically driven fuel transfer pump. In the event of failure of this pump, fuel is supplied from a service tank under gravity feed. A semi-rotary fuel transfer pump is provided for filling the service tank from the main fuel tank.

Suitable radiators are supplied for the diesel engine oil and water cooling circuits.

The radiator fan which draws air through the radiators and expels it through the roof, is driven by an electric motor fed from the auxiliary generator.

ELECTRICAL EQUIPMENT

The main generator is directly coupled to the diesel engine and provides power to the four traction motors, which are axle hung on the outer axles of the two bogies. The motors may be connected in series-parallel, full-parallel or arranged so that an initial connection in series-parallel is re-grouped automatically to full-parallel.

Control of the locomotive is effected by varying the excitation of the main generator and the speed of the diesel engine. Current for the field excitation of the

main generator, auxiliary machines, battery charging and operation of the control equipment is supplied from the auxiliary generator which is overhung from the main generator.

The main control cubicle is mounted in the generator compartment and is provided with doors giving full access to all equipment mounted in the cubicle. The cubicle is dust-proof, and special care has been given to the design of the control equipment to make it suitable for the arduous conditions of railway working.

The locomotives are arranged for multiple unit operation by which means two locomotives are coupled electrically as well as mechanically and operated together by a driver in the leading locomotive.

A single handle on the Master Controller enables the driver to select Engine Starting, Forward and Reverse positions and all running notches.

Lead acid batteries of 192 ampere-hour capacity are provided for starting the main power unit and for supplying the necessary auxiliary power when the diesel engine is not running.

The driving axles are fitted with tubes for the axle suspension of the traction motors, the nose of each traction motor being suspended by a flexible link from the centre transom.

The traction motors are fitted with roller bearings for both the armature and suspension bearings. The drive from the motors to the axles is taken through single reduction gearing; a pinion on the armature shaft meshing with a resilient gear wheel on the road axle.

BRAKE EQUIPMENT

The locomotive is fitted with twin Westinghouse reciprocating exhausters, electrically driven, to provide vaccum for the train brakes. The locomotive itself is braked by compressed air brakes, four brake cylinders being fitted to each bogie and operating clasp brakes on all wheels. A Westinghouse compressor provides compressed air for the locomotive brakes, and also for the control and other auxiliary equipment.

The driver's brake controls consist of a vacuum brake valve which operates the train brakes and automatically operates the locomotive brakes through a proportional valve. This valve ensures that the locomotive air braking is applied in direct proportion to the vacuum braking on the train. A separate brake valve is supplied which gives independent braking on the locomotive when required.

A hand brake for the locomotive is also provided in each driving cab.

CONSTRUCTIONAL DETAILS

Underframe

The underframe is constructed of four main rolled steel "I" sections, which are reduced in depth over the bogies by means of flame cutting and welding along the neutral axis, in order to provide clearance for the bogies between underframe and rail head.

The two outer main members terminate at the bogie centre cross members, to which they are welded, but the inner main longitudinals continue and are welded integral with the fabricated drag box.

Cross members, which are riveted to the main longitudinals at various points along the underframe, carry channel section sole-bars and an unbroken deck of steel plate covers the underframe skeleton.

SUPERSTRUCTURE

The superstructure is constructed in sections comprising the two cab ends, two sides, and three roof sections.

All the superstructure is constructed of 14 gauge steel sheet welded to frameworks of angle and top hat section.

Entrance doors to the locomotive are provided on each side of both driving cabs. Top hatches in the roof section permit easy access to the cylinder heads of the diesel engine, and the roof itself is easily removable for major overhauls or complete removal of the power unit.

Port-hole type windows are provided in the sides of the engine and generator compartments, and full drop windows are provided in the cab doors and side windows.

BOGIES

The bogies are constructed from box type side frames of welded construction joined by a heavy fabricated steel centre transom, and by two channel members as headstocks.

The weight of the locomotive is carried on the centre bolsters of the bogies. Each bolster rests on eight nests of coil springs carried on two spring planks, one on each side of the centre carrier axle of each bogie. The spring planks in turn are suspended by swing links from the bogie side frames.

The leaf springs for the axles are carried internally in the hollow side frames, suitable openings being provided for inspection and withdrawal, whilst the coil springs are situated below the bogie frames.

Roller bearing axle boxes are fitted in manganese steel horn guides, which are replaceable.

Electro-pneumatic sanding gear, operated from a foot pedal in the driving cabs, is provided for the outer axles of each bogie.

LOCOMOTIVE DETAILS

Locomotive Weight	87 tons
Track Gauge	5′ 6″
Maximum Height	13′ 3½″
Maximum Width	10′ 3⅞″
Length over Buffers	50′ 9″
Bogie Wheel Base	10′ 6″
Bogie Centres	27′ 0″
Minimum Curve Negotiable	5 chains
Clearance from Gearcase to Rail Head	4½″
Capacity of Fuel Tank—main	775 gallons
—service	75 gallons
Wheel diameter—motored	3′ 7″
—carrier	3′ 0″

LOCOMOTIVE PERFORMANCE

Maximum speed	55 m.p.h.
Starting Tractive Effort (26% Adhesion)	33,700 lbs.
Tractive Effort (1 hour rating)	30,000 lbs. at 9.2 m.p.h.
Tractive Effort (continuous)	24,600 lbs. at 11.7 m.p.h.
Estimated Range with Full Fuel Tanks	750 miles

DIESEL ENGINE DETAILS

Maker	Mirrlees, Bickerton & Day
Type	JS12VT
Output at Sea level and normal temperature and Humidity conditions	1,254 H.P. at 850 r.p.m.
Developed continuous Power at Site	1,000 H.P. at 850 r.p.m.
Bore	9¾"
Stroke	[illegible]
Number of Cylinders	12
Superchargers	Two, Napier type TS200/1
Exhaust Temperature (Cylinder outlet full load)	750 F./850 F.
Lubricating oil pressure	30 lbs./sq. inch

ELECTRICAL EQUIPMENT DETAILS

Main Generator	Brush Electrical Engineering Co. Ltd.
Continuous Rating	850 r.p.m. 652 kW. 630 V. 1,035A.
	850 r.p.m. 652 kW. 750 V. 870A.
Auxiliary Generator	Brush Electrical Engineering Co. Ltd.
Continuous Rating	850 r.p.m. 35 kW., 110 V. 318A.
Traction Motors	Brush Electrical Engineering Co. Ltd.
Number per Locomotive	4
Continuous Rating	196 H.P. 315 V. 517.5A.
1 Hour Rating	225 H.P. 315 V. 610A.
Gear Ratio	82 : 16
Radiator Fan Motor	Brush Electrical Engineering Co. Ltd.
Continuous Rating	110V. 3.1 H.P./12.6 H.P.
	32/115A. 600/960 r.p.m.
Traction Motor Blower Motors	Brush Electrical Engineering Co. Ltd.
Continuous Rating	110 V. 5 H. P. 1980 r.p.m.
Exhauster Motors	Brush Electrical Engineering Co. Ltd.
Continuous Rating	110 V. 3/6.05 H.P. 29/55A.
	600 1,115 r.p.m.
Compressor Motor	Westinghouse Brake & Signal Co. Ltd.

AUXILIARY EQUIPMENT DETAILS

Compressor	Westinghouse Brake & Signal Co. Ltd.
Working Pressure	85/100 lbs./sq. inch
Exhausters	Westinghouse Brake & Signal Co. Ltd.
Type	4-cylinder reciprocating (4V 110)
Normal Speed	600 r.p.m.
" Release " speed	1,115 r.p.m.
Batteries	D.P. Battery Co. Ltd.
Number of Cells	48
Capacity	192 amp.-hours @ 5-hour rate
Traction Motor Blower	Sturtevant
Output	2,940 cu. ft. per min.
	2,170 r.p.m.
Radiators	Serck Radiators Limited
Axle Box Bearings	The Skefko Ball Bearing Co. Ltd

PORTABLE ELECTRIC TOOLS

By F. W. Hughes, M.A.S.E.E. ★

THE practice of 'bringing the tool to the job' has rapidly increased the usage of portable electric tools in industry. Moreover as such tools have been developed for industrial applications, they have also been applied by garages as well as in small workshops by the home craftsman. This article, therefore, offers advice in the selection and use of such tools not only to the industrial but also to the domestic user.

There are a number of factors that should be considered in determining the best model of portable electric tool for a specific job. Before purchasing a tool, it should be examined in regard to its weight, spindle speed, suitability of shape, safety features and ease of maintenance. A tool may be favoured because of its light-weight, yet it may not have a motor powerful enough for the job in hand, since tool weight and motor horsepower are generally roughly proportional. At the same time, it is slow and uneconomical to use a heavy tool when a light tool can do the job equally well.

The spindle speed of a protable tool is usually established to suit its application. If the speed is too high in relation to horsepower, the tool may stall in operation. But a tool of the same horsepower with a lower speed has more torque and is less apt to stall. For proper application to the job, it is considered by the present writer that the relationship should be such that the speed under load can drop off to between two-thirds and one-half of the no-load speed.

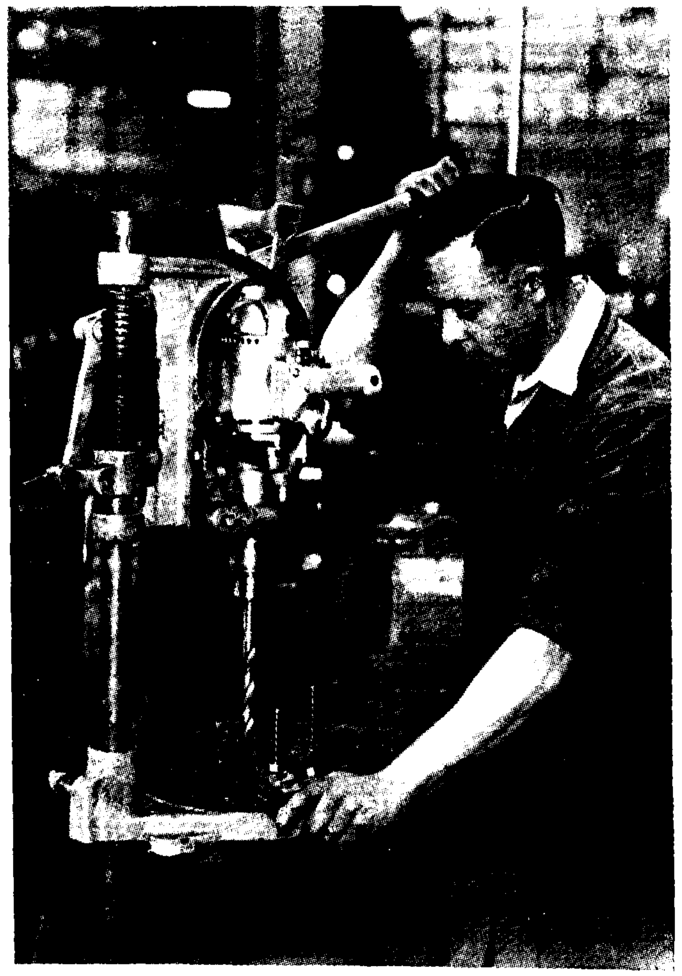
A large tool with a low speed will, of course, have ample torque to drive a small cutter, but at a rate that is too slow to give a satisfactory output. Thus, there are the two extreme conditions, firstly, a speed too high for a motor that is not strong enough, so that the tool stalls and, secondly, a motor strong enough but too slow, so that time is wasted.

Proper cutting speeds must also be considered in determining spindle speed. If spindle speed is excessive and the motor of the tool strong enough to sustain the speed under lead, the cutter will burn. A tool with a lower spindle speed and possibly a less powerful motor is indicated for this situation.

No-load spindle speeds recommended for various sizes of portable electric drills are indicated in Table I. The speeds given are for drilling mild steel. For soft materials, such as aluminium, these speeds can be practically doubled. For harder or tougher materials, such as stainless steel or Monel metal, these speeds should be about one-half of those given.

TYPE OF HANDLE

The smaller portable electric tools, such as drills and screwdriver generally have a pistol-grip-type handle.



It is better to use a tool that is powered to do a job easily than an undersized tool that might be overloaded.

This permits the tool to be held securely and comfortably with one hand. For medium-sized tools, where there is more over-hung weight, a closed end handle is

★ Sales Research Engineer, Black & Decker Ltd., Harmondsworth, Middlesex, England.

better. An auxiliary side handle on low-speed high-torque models lets the operator use both hands to resist any tendency of the tool body to turn. On the larger drills and screwdrivers, side handles or pipe handles (usually located opposite the switch handle) are essential to give the operator good control over the tool.

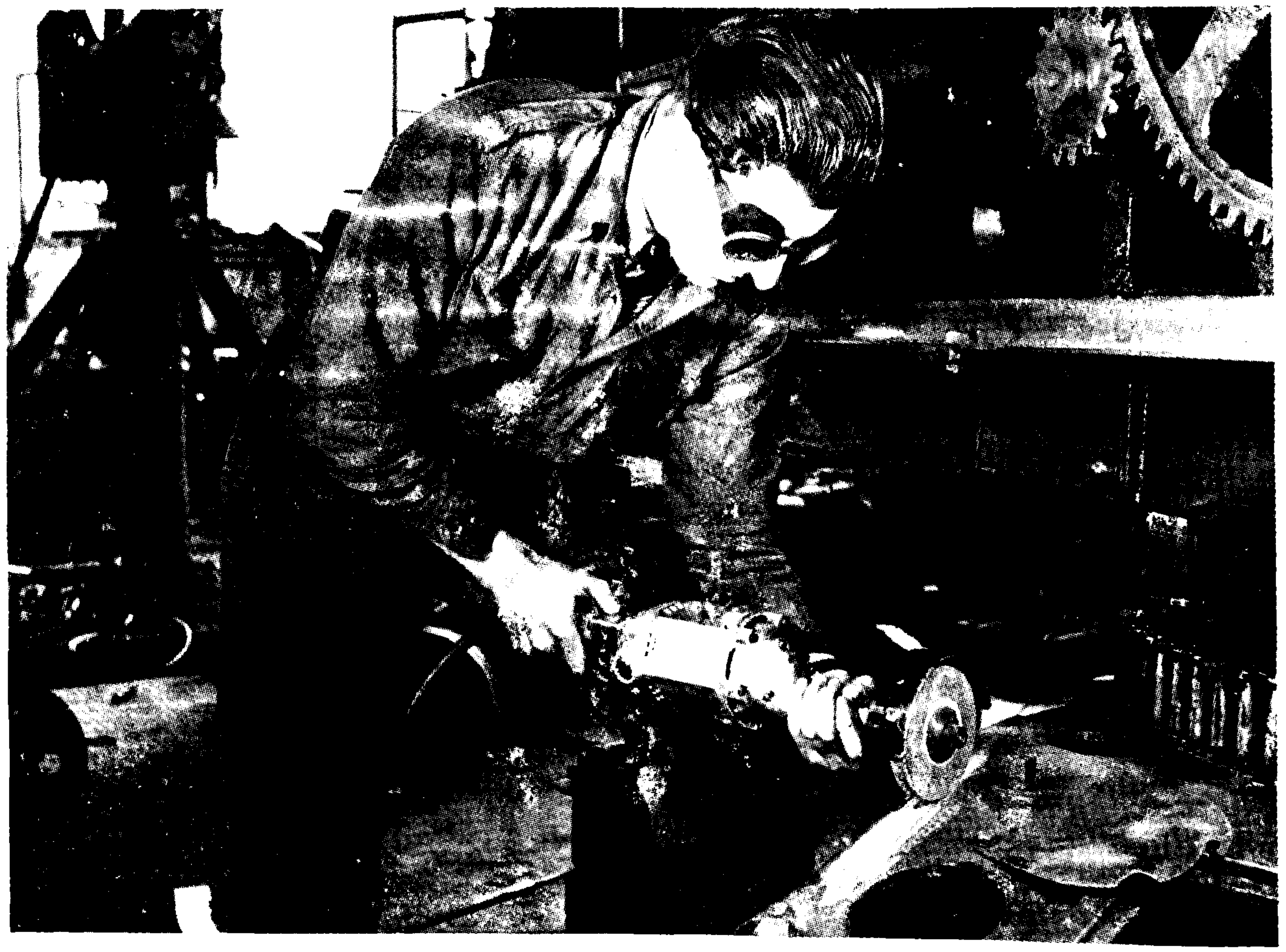
Closed handles afford the best control for portable saws. For grinders and right angle sanders, straight end handles are preferred. The sanders preferably have an auxiliary side handle at the spindle end.

ELECTRIC CABLE

Every tool should have a suitable motor switch, conveniently located. This switch is generally of the instant-release type. On tools like drills, screwdrivers and tappers, the switch can have a pin for locking it in the 'on' position. But on tools with cutting blades, like saws, there should be no arrangement for locking the switch 'on' so as to product the operator. Still other tools, like grinders and sanders, are equipped with plunger or toggle switches. It is important that all switches be located and protected so as to avoid accidental operation.

Even if the tool is designed for light service, it should have a substantial cable of sufficient size to carry the full load current to the motor. Where an extension cable is needed, this should be substantial enough to carry the current without too much loss in line voltage. Lighting flex should *never* be used for electric tools.

In Table II are shown wire sizes for various ampere capacities and wire lengths for 220 volt tools. These figures actually represent the wire section necessary and this cross sectional area may be made up of the requisite number of wires of any smaller diameter. Data are based on a current equivalent to 150 per cent of the full load with a loss in voltage of not over 5 volts. For 115 volt tools, the wire size indicated for twice the cable length



Safety instructions should always be heeded. In the grinding operation illustrated there is a suitable guard over the wheel and the operator wears goggles.

required should be used. The words under the size represent the recommended insulation.

The motors of portable electric tools are normally designed to operate satisfactorily with a variation in their nominal voltage of up to 6 per cent. Any greater variation has a pronounced effect on the motor performance. A 10 per cent drop in voltage reduces the power of the motor about 20 per cent and the speed of the operation at full load falls off considerably.

The necessity for using the proper rating of cable is obvious. On the other hand, with an increase in voltage, motor speed increases as well, with the possibility that the motor will overheat if operated over an extended period.

EARTHING

All British electric tools to-day are supplied with a three-core cable. The third wire, having green-coloured insulation, is for earthing. One end of the earth wire is connected to the tool housing and the other end should be connected to a good earth contact, such as a water pipe, conduit or copper rod driven into the earth. Earthing is particularly important when tools are being used in a damp area or inside of a tank, or on metal structures that are themselves earthed. The earthing connection should always be made *before* the current supply connection is made.

Some wiring systems are supplied with three-pole earthed socket, in which case the cable can be equipped with a three-pole plug. The prong to which the earth wire is connected is longer than the two other prongs, so that an earth is automatically made before the current can flow through the power wires.

CARING FOR THE TOOL

With few exceptions, the gears in portable electric tools are grease lubricated. The lubricant will remain in the gearbox for quite a long time. When it becomes necessary to replace it, all the old grease should be removed and the box thoroughly cleaned. A grade of grease recommended by the manufacturer of the tools should be used. Care should be taken not to fill the gearbox more than one-half to two-thirds of its capacity.

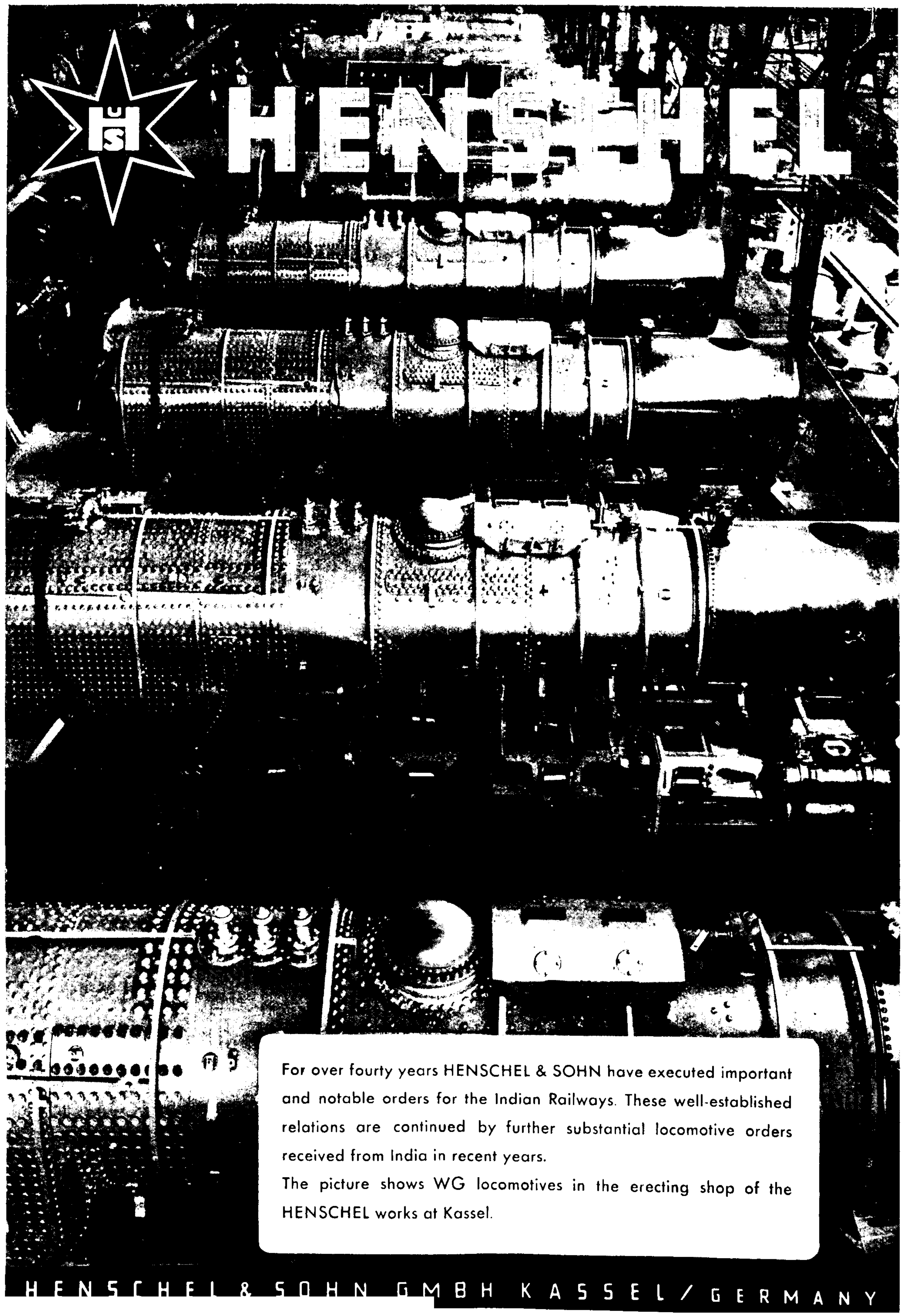
Ball bearings in tools so equipped are usually permanently sealed. They should never be put in cleaning fluid, as this removes the grease, which cannot then be replenished. If the tool has sleeve bearings, they are usually self-lubricating. Other sleeve bearings can be oiled through a ball valve on the tool.

For production work, portable tools can frequently be mounted on a bench stand in order to minimise operator fatigue.

TABLE I

No-load spindle speeds for portable electric drills

Drill Capacity in inches	No-load spindle speed, r.p.m.
$\frac{1}{4}$	1,700 to 2,500
$\frac{3}{8}$	600 to 900
$\frac{1}{2}$	400 to 650
$\frac{5}{8}$	350 to 550
$\frac{3}{4}$	300 to 450
$\frac{7}{8}$	250 to 375
1	225 to 350


HENSCHEL
HS
For over fourty years HENSCHEL & SOHN have executed important and notable orders for the Indian Railways. These well-established relations are continued by further substantial locomotive orders received from India in recent years.
The picture shows WG locomotives in the erecting shop of the HENSCHEL works at Kassel.
HENSCHEL & SOHN GMBH KASSEL / GERMANY

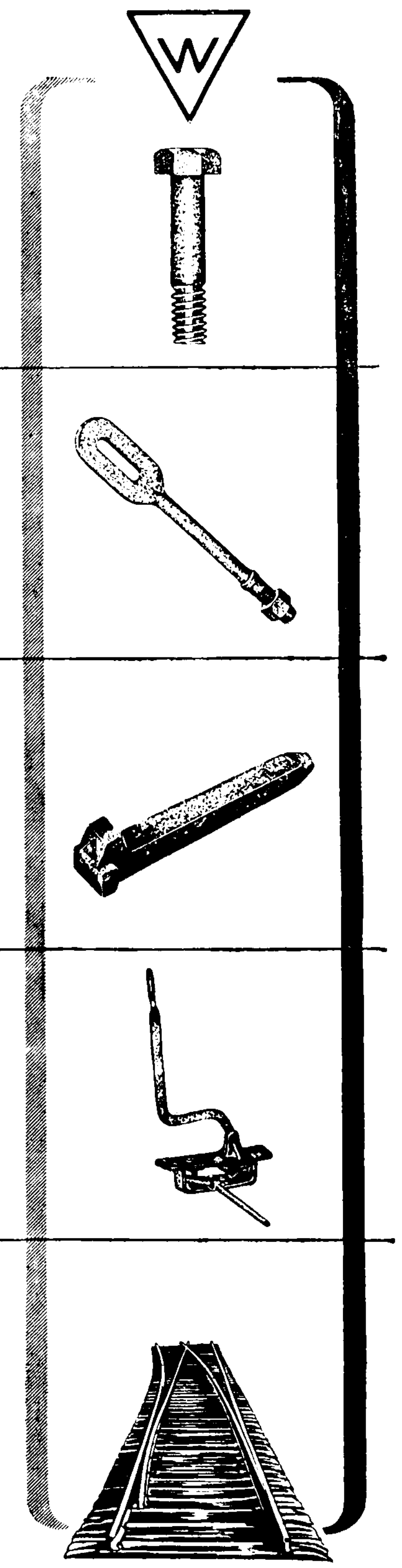

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TABLE II

Size of extension cable for portable electric tools
(Based on current equivalent to 150%, full load of tool and a voltage drop of approximately 5 volts)

Name Plate Rating of Tool in Amps	0 to 2.0	2.1 to 3.4	3.5 to 5.0	5.1 to 7.0	7.1 to 10.0
Distance in Feet	Wire Sizes (S.W.G.)				
25	20 3 core thin	20 standard	18 standard	18 standard	16 standard
50	20 3 core thin	20 standard	18 standard	18 standard	16 standard
75	20 standard	18 standard	18 standard	18 standard	16 standard
100	20 standard	18 standard	18 standard	16 standard	16 standard
200	18 standard	18 standard	16 standard	16 standard	— standard
300	18 standard	16 standard	16 standard	—	—

Note : If voltage is already low at the source, have voltage increased to standard, or use a much larger cable than listed in order to prevent any further loss in voltage

Brushes are readily removed for inspection. If worn to less than about ¼ in. length, they should be replaced; otherwise the motor will are badly and damage the commutator. If the commutator shows roughness, it can be smoothed with fine sandpaper. A smooth, dark brush track on the commutator is normal.

The switch should operate freely. There should be no likelihood of it sticking in the 'on' position with the possibility of causing an accident The cable connections with the switch and plug should be tight. If the cable is worn it should be replaced with another of the same size.

SPECIAL FEATURES OF TOOLS

Portable electric screwdrivers usually contain a clutch that disengages the drive when the screw (or nut) has been tightened sufficiently. There are three general type of these tool. In one type, there is a positive clutch, enabling the operator to control the release of the driving torque by the pressure he applies. This screwdriver is ideal for driving for wood screws, where torque increases constantly and varies widely. It is not recommended for use in metal assemblies, unless by experienced operators, since the sudden increase in torque when the screw is tightened can cause damage and injury.

In the second type, the clutch of the screwdriver is adjustable. Here the release of the driving torque is not controlled by the pressure applied by the operator but by a change in tension of a spring against which a jaw of the clutch operates. Once the value of torque is set, it remains fairly constant until the jaws of the clutch wear appreciably. This type of clutch is preferred to a positive clutch for driving machine screws and fasteners in metal assembly work.

The third type of screwdriver, the impact wrench, employs a driving torque releasing mechanism that is not controlled by the pressure applied to the tool or by spring tension. Its construction is such that there is practically no torque reaction transmitted to the operator. Tool size must be carefully chosen to suit the work, because the impact can create stress beyond the elastic limit of the fastening device.

Portable electric grinders have an elongated gear housing which can be grasped by the operator's hand. The grinding wheel is mounted directly on the end of the spindle. If the tool is inadvertently dropped or hit against an object so as to damage and possibly crack the wheel, there is the danger of having the wheel fly apart. Before using a wheel, it should be examined for cracks by being sounded with a solid piece of wood, such as a hammer handle.

A maximum surface speed of 6,000 ft. per minute should be observed for the general run of vitrified wheels. Special bonded wheels can run at a higher speed and require separate consideration. A quick way to check the

surface speed (in ft./min.) is to multiply one-fourth of the wheel diameter in inches by the speed of the spindle in revolutions per minute. For protection, the operator should always wear goggles and a suitable guard over the grinding wheel is mandatory.

Electric saws are usually equipped with a lower guard that recesses into the upper guard as the tool enters the cut and springs back over the exposed portion of the blade after the tool completes the cut. If the lower guard ever sticks and fails to spring back, the saw should be disconnected from the power source before any attempt is made to rectify the condition.

Unless portable electric tools are fitted with explosion-proof motors, they should never be used where there are inflammable dusts or vapours, because of the arcing between the brush and the commutator. Tools subjected to an excessive amount of moisture should be disassembled, cleaned and baked dry. Otherwise the motor is likely to be earthed, thus endangering the operator.

Table III shows some of the most common causes of portable tool failure together with suggested means of correction.

TABLE III

Possible causes of trouble in portable electric tools

Fault	Check for	Remedy
New tool, motor does not operate	Brush stuck in holder, not making contact with commutator	Remove burr from brush holder
	Poor contact at the socket	Replace plug
	Broken conductor in cable	Cut off broken end or install new cable
Tool has been in service, but motor does not operate. Takes no current	Worn out brushes	Replace brushes, preferably by those recommended by tool manufacturer
	Switch not making contact	Replace complete switch mechanism
	Open circuit in field coil	Rewind or replace field coil
	Two or more open coils in armature	Rewind or replace armature
Motor hums and takes heavy current, but does not operate	Short circuit in field coil	Rewind or replace field coil
Motor operates abnormally. Slow, jerky excessive sparking at commutator, runs hot	Short circuit in armature. Charred insulation may give location of short circuit. Solder may be thrown from connections to commutator bars effected	Rewind or replace armature. *Note :* An accumulation of dirt with carbon and metallic particles between commutator bars can cause a short circuit
Motor operates at excessive speed, gives poor operating performance	Partial short circuit in field coil	Rewind or replace field coil
Ring of fire visible around the commutator	Open circuit in armature	Rewind or replace armature
Motor overheats, solder thrown from connections to commutator bars	Overload voltage too low	Use heavier extension cable
	Dull cutter, requiring heavy pressure	Sharpen cutter
	Motor ventilation poor	Clean vent holes of motor housing
Operator gets shock	Earthing wire not connected	Connect earth wire
	Carbon and metallic dust on brush holder insulation	Clean brush holder insulation

SURVEY FOR TWO NEW LINES IN BOMBAY STATE

The Railway Board has sanctioned a traffic survey to be carried out by the Western Railway Administration for Metre Gauge lines between Bhaili and Bhadran and Sojitra and Dholka, ex-Baroda State territory.

Work on the construction of the Bhaili-Bhadran and Sojitra-Dholka projects was started in 1949 as a famine relief measure. After the merger of the Baroda State Railway with the ex-B. B. & C. I. Railway, further construction work was stopped in October, 1949, due to the then prevailing financial position.

The Railway Board has now decided to have the traffic prospects of these projects re-examined with a view to arriving at a final decision in regard to the construction of these lines.

* * *

NEW 44-MILE RAIL LINE TO BE CONSTRUCTED—ALTERNATIVE ROUTE BETWEEN KANDLA AND DELHI

The Railway Board has sanctioned the construction of a new 44-mile Metre Gauge Railway line from Bhiladi to Raniwara, on the Western Railway. When completed the new line would connect the Kandla-Deesa line with Raniwara and join the Metre Gauge system in Jodhpur with the Metre Gauge system in Saurashtra and Kutch. It will also provide an alternative main line connection between Kandla and Delhi as well as other important points on the Metre Gauge system. The new route will provide a shorter connection between Kandla Port and a large portion of its hinterland in Rajasthan, Pepsu and Punjab.

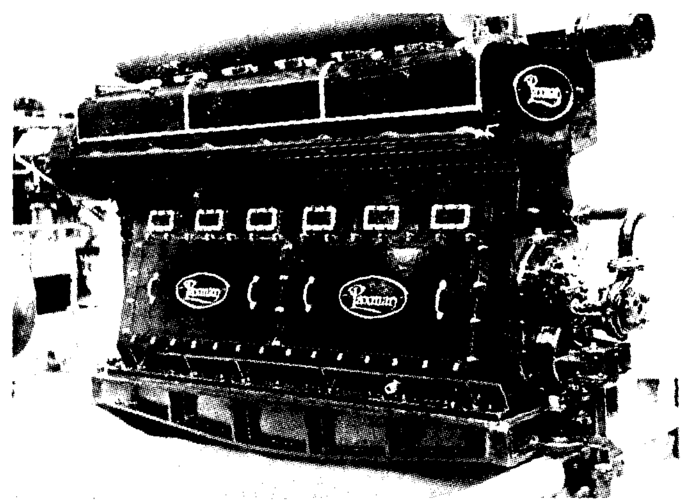
The Bhiladi-Raniwara link will reduce the pressure on the line between Palanpur and Marwar Junction, and the Railways will be able to better handle and carry the large volume of traffic expected to develop at Kandla Port for carriage to and from the hinterland.

25 Years of Railway Oil Engine Building

By A Special Correspondent

IT is now just a quarter of a century ago since Davey, Paxman & Co. Ltd. began to build its first railway diesel engine, and 24 years since that engine was put to work. With the exception of the war years, when immensely increased production facilities were devoted to marine and a few stationary applications, building for rail traction has been continuous since 1934, first with small engines for shunters and later with larger types for line service.

The first engine itself, however, was not so small. Indeed, for the time - 1929-31 - it was in the medium class. It was a notable engine installed in a notable locomotive. Yet one must record that the combination did comparatively little work. The engine was notable in being of the Stevens all-welded steel frame type. The locomotive was notable in being the first diesel locomotive to be built by a British railway.



The first Paxman railway oil engine—Year 1931 400 h.p. at 750 r.p.m. All-welded steel frame.

This was L.M.S.R. No. 1831. The frame, wheels and chassis were those of an old Johnson 3F 0-6-0T steam locomotive; on them were mounted the Paxman 400 b.h.p. six-cylinder oil engine and a Haslam & Newton hydraulic transmission. This transmission was of the hydrostatic type with high fluid pressures and temperatures which led to troubles. These might have been overcome by more persistent effort; but the time then was barely ripe for railway diesel locomotives in England, and nothing more was done until the four Hunslet and two Hudswell Clarke diesel-mechanical locomotives were set to work on the same railway in 1933-34.

The engine, of the Paxman VXS class, is worth more notice, not only because it was the first of its type, but also because its constructional principles were developed and used extensively in later years in U-class submarines, being then known as the Paxman X range. The post-war development was the RPL series, with 9 in. by 12 in. cylinders and a top speed of 750 r.p.m., and with outputs up to 1,420 b.h.p.

At that time (1929-30) welding as applied to diesel engines was in its infancy. The Stevens welded frame sought to gain strength and lightness; but its leading feature was a close mechanical interlocking of the various constituents before they were welded up, so taking all the firing stresses through the material away from the welds. Top and bottom deck plates and the side members were all interlocked together in this fashion with each other and with the main transversals which carried the main shaft bearings.

This first engine had six 9 in. by 12 in. cylinders and was set to give 412 b.h.p. output at 750 r.p.m. It was about 30 per cent lighter in specific weight than the Paxman cast iron engine of the same period. Similar construction was used in the second Paxman railway oil engine, the 6VZS, though this was a smaller model of 198 b.h.p. top output from six $6\frac{1}{2}$ in. by 10 in. cylinders at 900 r.p.m. It was installed in the fourth Hunslet shunter for the London, Midland & Scottish Railway in 1934, the well-known L.M.S.R. No. 7054. Unlike its predecessor it has had a long record of successful service on the L.M.S.R. and at Government depots. It is still in being; and at the moment both locomotive and engine are undergoing heavy overhaul at the Hunslet Engine Works preparatory to taking up fresh service after a working life of 20 years.

From that time on until the beginning of the war Paxman railway deliveries were of two main types: first the RQ and RQT engines of 11 b.h.p. per cylinder at 1,000 r.p.m., mainly installed in small locomotives for export; and, secondly, the RW and RWT engines of 150 to 200 b.h.p., mainly for industrial locomotives in this country.

It was with the small RQ engines that the Ricardo combustion chamber was introduced into Paxman practice, and it has remained ever since in all models for railway work until the recent introduction of the powerful YL series, for it was, and is, considered that its combustion qualities over a wide range of load and speed, and over a wide range of engine conditions, coupled with low exhaust temperatures, are worth retaining for many traction installations.

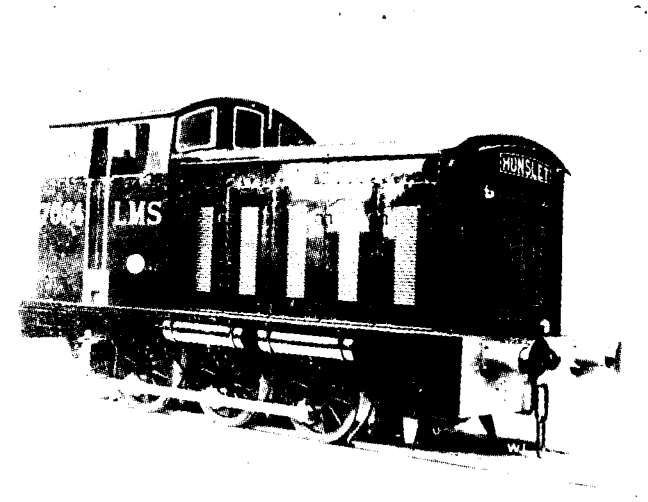
The RQ is a simple conventional cast iron frame engine of 2, 3, 4, 5, 6 and 8 eight cylinders. It has been much used by a number of locomotive builders such as Hunslet, Hudswell Clarke, Barclay and Baguley; and especially by Hibberd, who, for example, supplied nearly 30 locomotives powered by the RQ to the West African goldfields. In a post-war flameproofed version it has been installed as standard by the North British Locomotive Co. Ltd. in the 100 h.p. North British Miner underground mines locomotives for the N.C.B., for Rhodesia and Australia.

In general design and details the RW engine was very similar to the RQ, but had $5\frac{1}{2}$ in. by 7 in. cylinders giving a normal traction output of 20 b.h.p. per cylinder at 1,000 r.p.m. Both RQ and RW types had special traction mountings in the form of bearers, and both were equally suited to mechanical or electric transmission.

At the time war broke out, another class of engine was being constructed for locomotives. This was the RZ type, in which a Ricardo head was combined with cast iron frame construction and a cylinder size of 6.7/8 in. by 10 in. One of these, a six-cylinder unit with an output of 277 b.h.p. at 1,000 r.p.m., was installed in the Hunslet eight-wheeler for local freight and heavy port shunting duties on the standard-gauge Trinidad Government Railways in 1940, and is still at work there with the original engine and principal components.

Before this, however, the company had taken initial steps along an altogether different line. With the growth of diesel traction in the 1930s, especially of powerful railcars and railcar-trains, Edward Paxman became convinced that a lightweight quick-running engine was essential; and, as he viewed it, the top power of such a range would need to be up to the four-figure mark. Such an engine lined up also with his views on a high-speed marine engine for light fast craft. Therefore what came to be known in the Paxman list as the VRB range was designed, and prototypes and a few commercial models were built before the outbreak of war.

This series comprised 8-, 12-, and 16-cylinder V engines of almost phenomenal characteristics for their time. Paxman's idea was to built 'em light and then



The Second Paxman-engined diesel locomotive, 193 h.p. Built in 1934, this locomotive is still at work after 21 years of service.

increase the scantlings if experience showed that more strength and rigidity were wanted, though he was already fully aware of the desirability of a most rigid frame, and introduced into these engines a feature found in Paxman practice to this day, viz. a crankcase with exceptional lateral rigidity at the crankshaft centre line. Another feature retained to the present time was the 7 in. by $7\frac{3}{4}$ in. cylinder size in combination with a Ricardo head. The original intention was to build naturally-aspirated engines up to 1,000 b.h.p. maximum output, and then, when these had been thoroughly proved in service, to cater for any increased power by the incorporation of the Buchi form of exhaust-gas pressure-charging.

Top speed of these engines was 1,750 r.p.m., and at that rate the output per cylinder was $62\frac{1}{2}$ b.h.p. and the output per litre 12.8 b.h.p. The piston speed was then 2,260 ft. per min. and the b.m.p. 95 lb. per sq. in. On test, b.m.p.s. of 131 lb. per sq. in. at 1,000 r.p.m. and 126 lb. at 1,500 r.p.m. were attained; and at 1,000 r.p.m. the specific fuel consumption was below 0.4 lb. per b.h.p. hr. for all brake mean pressures between 60 and 107 lb. per sq. in. In cast iron construction a dry weight of about 9,000 lb. for the 16-cylinder engine gave a specific weight of just 9 lb. per b.h.p.; but models with Hiduminium light-alloy framing and heads of the same material were available, with a weight of $5\frac{3}{4}$ lb. per b.h.p.; and an even more special light-alloy model of 5 lb. per b.h.p. was 'on the stocks '.

Such was the position at the beginning of the war. The years 1939-45 are not directly part of the railway story. They are a saga in themselves, and the tale of the design and enormous production of the tank landing craft engines - the 12TPM in Paxman classification -

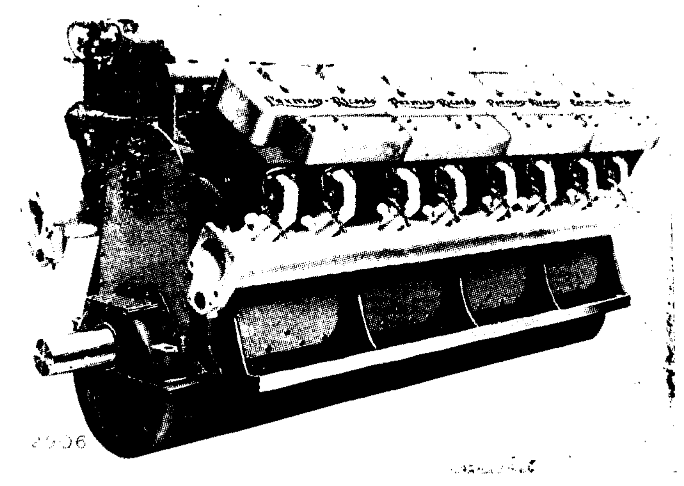
has been graphically told by P.N. Everett. The traction history may be taken up again with the adaptation of the TPM engine to railway work, and the making of it into medium-weight medium-speed engine of exceptional reliability for use in either railcars or locomotives, and known as the RPH.

The TPM had been designed quickly, and it had been designed originally for the confined space of a tank - at first in conjunction with electric transmission, and then modified for hydraulic drive. This project was not actually carried out, but for reasons of quick production the design features resulting from the extremely limited space in tanks were retained when the engine was selected for tank landing craft. Further, use had to be made of materials then readily available; and the engine had to be suited to quick production methods which involved much decentralisation of manufacture and sub-assembly preparation. In fact, there were never less than 250 works in harness together producing parts.

Though the 12VRB high-speed engine of 1938-39 was taken as the design base, the output characteristics were brought down and the scantlings increased, for it was realised that reliability in critical situations involving bad operating conditions was essential. As built, the speed of the resulting 12-cylinder 500 b.h.p. engine was limited to 1,375 r.p.m., the piston speed to 1,770 ft. per min., the b.m.p. to 81 lb. per sq. in., and the dry weight to 14 lb. per b.h.p. More than 4,000 of these engines were constructed, the intensive experience with which proved a splendid background for the evolution of today's Paxman RPH railway oil engines.

Production was the first principal post-war problem. The greatest possible works output had to be maintained coincident with a change-over from war-time to peace-time labour and materials conditions. Thus it was not until 1950 that the RPH-I engine began to appear; and appropriately the first two went to British Railways—one, a 16RPHXL pressure-charged unit set to 827 b.h.p. to the London Midland Region for the mixed-traffic Bo-Bo locomotive No. 10800, and the second, a 12-cylinder naturally-aspirated engine, to the Southern Region for the 500 b.h.p. shunting and freight transfer locomotive no. 11000 with S.S.S. gearbox.

The changes made to the RPH-I engine compared with the TPM were the major ones needed for traction work, but this new engine was considered only as a first stage, to last over the period of transition covering the works tooling up for increased production, and the introduction of a quality-control department responsible directly to the managing director.

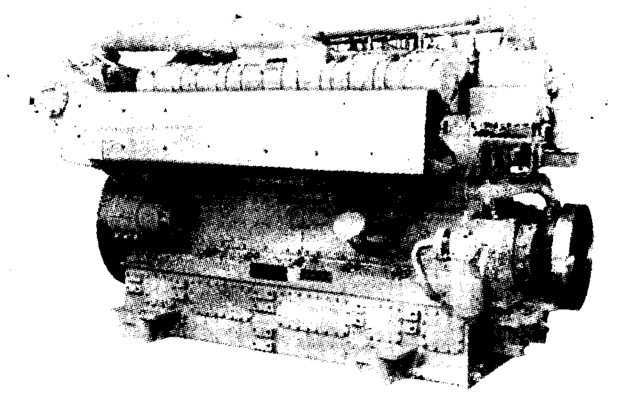


Paxman light-weight high-power engine of the year 1938 1,000 h. p. at 1,750 r. p. m.

The second stage, with every detail and all characteristics and mountings intended specifically for traction work, was not completed until the beginning of 1953 with the introduction of the RPH-II range. The suffixes X and L attached to the classification mean 'pressure-charged' and 'locomotive' respectively. For a short time, solely to provide customers with engines of their needed output at a time when production had to be concentrated, a six-cylinder engine of 250/300 b. h. p. was supplied using the 12-cylinder V crankcase and mounting only one bank of cylinders, the top deck of the other bank being blanked off and used to carry auxiliaries.

The RPH-I range, however, has operated with success in several remarkable applications with electric, mechanical and hydraulic transmissions; such as the Norwegian 'Snoggtog', or 'Lightning Trains', running between Oslo and Bergen; the Hunslet locomotive of 500 b. h. p. which achieved such outstanding performances on British Railways (see Inst. of Locomotive Engineers, paper No. 522) before being shipped to the Paita-Piura Railway in Peru; at 13,000 ft. altitude in railcars of the Bolivian National Railways; and in a large number of steelworks locomotives in Great Britain, in which field the RPH is probably the most widely applied of all British oil engines. Two of the pressure-charged 'sixteens' set to 800 b. h. p. each also replaced old Sulzer engines in one of the well-known mobile power-houses operating the Buenos Aires suburban traffic of the General Roca Railway of the Argentine National system.

The present RPH-II range now comprises 4- 6-, 8- and 12-cylinder naturally-aspirated engines with traction outputs of 167, 250, 333 and 500 b. h. p. respectively; and 12-cylinder and 16-cylinder pressure-charged



Paxman 12 RPHX-II pressure-charged engine of 625 h.p., built in 1955 for the diesel-hydraulic locomotives being supplied to the Kanla-Deesa line of the Indian State Railways.

engines with outputs of 625 and 833 b. h. p. respectively at 1,250 r. p. m. The rating itself is the top output as limited by the travel of the fuel injection pump rack, for Paxman believes the true railway rating of an oil engine is simply the maximum the driver can get out of it.

The general design is so well known that only a couple of points concerned with the RPH-II need of points concerned with the RPH-II need emphasis. First, the series is designed to cover a power range of 160 to over 800 b.h.p.—or 160 to 1,600 b.h.p. per locomotive—with duplicate and interchangeable wearing and renewable parts, and all essential details the same, except for such constituents as the crankshaft and crankcase which must vary with the number of cylinders, and the pistons and camshafts of pressure-charged engines which must, of course, be slightly different from those of normal engines. Secondly there is the great transverse strength of the crankcase and main bearings, which has been supplemented by a shaft with a diameter 71½ per cent that of the cylinder bore and a pin diameter 66 per cent. of the bore, this giving a very stiff shaft system. This combination of stiff shaft and great lateral rigidity of the frame has been recognised as one of the prime requisites in enabling a railway oil engine to run big mileages between general overhauls.

All the RPH-II engines are of the V type, and, again, this means an inherently stiff shaft and frame system with the short 4-cylinder and 6-cylinder models, with their special counterbalance shafts to eliminate the effects of the secondary forces; and it also means that these two engines—up to 313 b.h.p. when pressure-charged—are short enough for transverse mounting in railcars.

Installations of the Mark II engine are found in Western Australia, New South Wales, Mauritius, where the locomotives concerned work over 1 in 27 grades, Tasmania and in England. In new South Wales two of the 12-cylinder 500 b.h.p. engines are fitted in each of 10 freight-transfer locomotives of 1,000 b.h.p. which operate between the big marshalling yards and traffic concentration points in the whole Sydney area, with loads up to 900 tons. When opened up for an inspection after 1,600 hr. and 8,175 miles of heavy haulage, the pistons of the first one were found in perfect condition; all rings were quite free and there was no carbon build up whatever. Big-end, main and gudgeon pin bearings also were in splendid condition, with no defects. These RPH-II engines have been used as standard by the North British Locomotive Co. Ltd. in its standard shunting and mixed-traffic diesel locomotives up to 833 b.h.p.; and by the Yorkshire Engine Co. Ltd. in its standard 275 and 400 b.h.p. diesel-electric shunting locomotives.

Apart from the old original 400 b.h.p. engine for the L.M.S.R., Paxman 'began small' and gradually built up the power output; but in all models the keynote of design was to attain great reliability with the merely nominal and often indifferent maintenance which is all that can be given in many installations. That is why the speeds and characteristics of the light-weight prototypes which showed such great promise in 1938–39 have not been offered in the post-war market. But the gamut of Paxman experience in welded frames, high-speed light-weight, medium-speed medium-weight, and reliability and dependability under appalling working conditions have now been concentrated in the new YL engine, which in output begins where the RPH leaves off, and which at the beginning was designed specially as a traction job.

In a remarkable degree it combines great strength and simplicity with moderate weight, low fuel consumption, accessibility within the confines of a railway loading gauge, and modern constructional technique. The prototype of this range was completed in 1950, and was run for over 4,000 hr. before the traction production model, with various detail modifications suggested by the prototype's performance, was put on the market. This 12-cylinder prototype was set to 1,500 b.h.p. and was coupled to a B.T.H. traction generator of 850 volts on the continuous rating and with 2,200 amp. as the maximum current.

Paxman-engined diesel locomotive on suburban passenger train.

All YL engines are of V formation, and at the moment 8–, 12–, and 16-cylinder models are made, all of them in both naturally-aspirated and pressure-charged forms. The output range is thus in six steps from 750/800 b.h.p. (the railway output of the naturally-aspirated 'eight') to 2,000 b.h.p. (the pressure-charged 'sixteen', all at a speed of 1,000 r.p.m. and with an overall width at cylinder head level of 5 ft. 10 in.

For the first time in 20 years a Paxman railway engine has appeared without a Ricardo combustion chamber, direct injection and four valves per head being used here; and for the first time a Paxman engine for line service has been built to cylinder dimensions different from 7 in. by $7\frac{3}{4}$ in., the bore and stroke of the YL being $9\frac{3}{4}$ in. by $10\frac{1}{2}$ in. This stroke-to-bore ratio of 1.08 to 1 helps to promote robust construction, and provides maximum strength in conjunction with the moderate piston speed of 1,750 ft. per min. at maximum revs. The cylinder banks are at an angle of 45 deg. to each other, contrasted with the 60 deg. in the RPH series. Dry weight varies from 22 lb. per b.h.p. in the normal 8YL to $17\frac{1}{2}$ lb. in the pressure-charged 16YLX.

An increasing number of enquiries for engines of the general RPH type but of higher specific output and lower specific weight led recently to the introduction of the YH range, in which Paxman's considerable experience of light-alloy cast and welded construction has been combined with four-valve heads and direct injection, the 7 in. by $7\frac{3}{4}$ in. cylinder size and 1,250 r.p.m. rotational speed of the RPH engine being retained. With these engines — all of the V type — the power range is extended up to 1,000 b.h.p. and the unit weight, at 11 to 18 lb. per b.h.p., is 25 to 40 per cent lighter than that of the RPH range, which extends from 18 to 25 lb.

Finally, in order to meet growing demands for underfloor engines for railcars, a horizontal engine has been developed; but because of the considerable experience

(Continued on page 39)

New Powerful Beyer-Garratt Locomotives for 3'-6" Gauge

RHODESIA RAILWAYS 20th CLASS

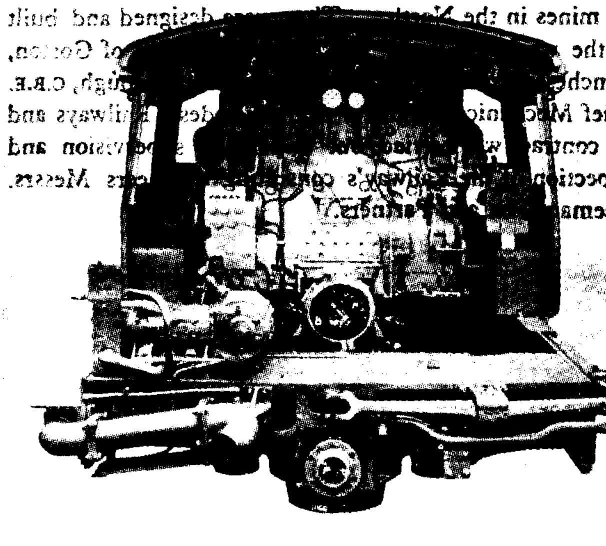
DURING the last few years the Rhodesia Railways have had to cope with a phenomenal increase in traffic. The first 96 miles of line of 3' 6" gauge were laid in 1894 and progressively through the years a network of extensions has enabled the country to be opened up. The development and increasing demands for copper and chrome coupled with the movement of coal supplies, consequent upon the industrial development of the country, have necessitated long hauls combined with heavy loads, thus making the railway a vital link in the country's economy. All these factors, to which is added the need for speedy and concentrated means of transport to the neighbouring territories in order to reach the sea, have placed a great strain on the system.

The first locomotives had a total weight of less than 20 tons in full working order and were purchased for under £2000. As the years passed, locomotives became bigger and more powerful until in 1925 it was realised that the maximum power had been obtained with the ordinary type of locomotive on the 60 lb. rail and the bridges and other restrictions of the line. In consequence, a number of Beyer-Garratt locomotives were introduced thus enabling greater power to be obtained without an appreciable increase in axleload.

Since that date 204 Beyer-Garratt locomotives of various classes have been purchased by this railway, growing in power and application.

In 1953 thirty Beyer-Garratt locomotives were supplied with a 2–8–2+2–8–2 wheel arrangement and a tractive effort at 85% Boiler Pressure of 55,270 lb. on an axleload of $14\frac{1}{2}$ tons, these were then followed by a further eighteen Class 14A Beyer-Garratts of the 2–6–2+2–6–2 type which have a Tractive effort of 39,170 lb. on a $13\frac{1}{2}$ ton axleload, these locomotives being suitable for branch line operation.

For some years it was realised by the Rhodesia Railways authorities that an increase in traffic would require greater capacity and this could only be obtained by raising the axleload. This meant re-laying with heavier rail and generally strengthening the track. As a result of this policy, re-laying with heavier track has been [illegible] from the Wankie coalfield in the South and copper from the mines in the North [illegible] designed and built at the [illegible] of Gorton, Manchester [illegible] C.B.E., Chief Mechanical [illegible] Railways and the contract [illegible] supervision and inspection [illegible] Railway's consulting engineers Messrs. Freeman [illegible] Partners.



Cab Arrangement.

(Continued from page 38)

with 7 in. by $7\frac{3}{4}$ in. cylinders and the production machinery installed at Colchester to deal with the substantial deliveries, it was decided not to develop small-power quick-running engines of this type, but to combine RPH and YH design and have a relatively powerful model. The first of the new series, the ZH, is a six-cylinder aluminium alloy frame single-bank engine with a normal output of 250 b.h.p. at 1,250 r.p.m. and top values of 300 b.h.p. at 1,500 r.p.m., and further single-bank and twin-bank are being considered.

Though this concludes the record of the basic models, Paxman's latest development opens up certain new fields for the diesel locomotive as a traffic machine. That is the Hi-Dyne, or, as it is more often called, the constant h.p., engine. This received its first practical application in 1954 in the Hudswell Clarke locomotive 'Enterprise', which has operated with notable success in heavy industrial and steelworks shunting. The pressure-charged RPH-II and YH ranges are those to which this principle is being applied by Paxman and constant h.p. is given over a speed range of 1.8 to 2.0:1, and in conjunction with a suitable mechanical transmission provides a stepless drive, and a speed-tractive effort curve of hyperbolic shape as given by electric transmission.

proceeding steadily so that now there is a sufficient proportion of strengthened track with 80 lb. rail to merit the introduction of still heavier Beyer-Garratt locomotives on a greatly increased axleload. These locomotives are described below and represent a still further step forward in the use of modern economical steam power. In accordance with modern trends and consequent upon the large grate area, they are provided with mechanical stokers, the first to be introduced on this railway.

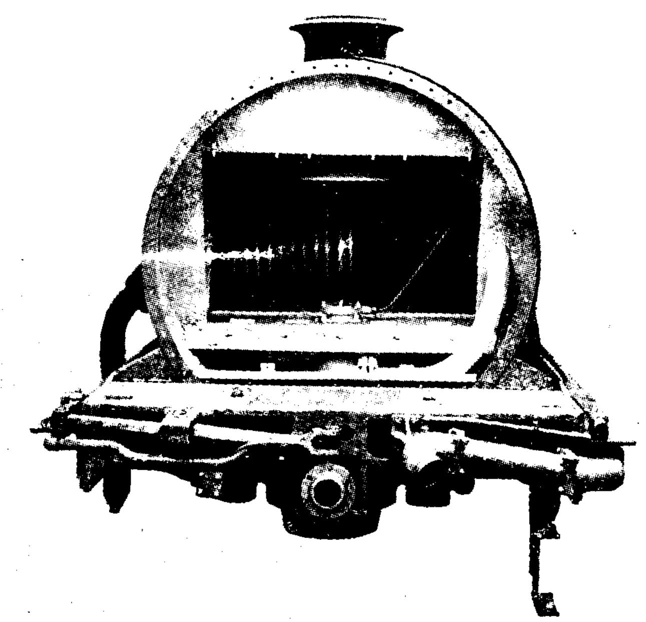
These new locomotives which are the largest on the railway, weigh 225 tons in working order when fully loaded with fourteen tons of coal and 8,000 gallons of water. The locomotives can negotiate a 275′ 0″ radius curve.

Fifteen of these locomotives are now going into service and will be stationed in Northern Rhodesia where they will work between Kafue and Broken Hill, hauling coal from the Wankie coalfield in the South and copper from the mines in the North. They were designed and built at the works of Beyer Peacock & Co. Ltd., of Gorton, Manchester to the requirements of Mr. F.E.Hough, C.B.E. Chief Mechanical Engineer of the Rhodesia Railways and the contract was carried out under the supervision and inspection of the Railway's consulting engineers Messrs. Freeman, Fox and Partners.

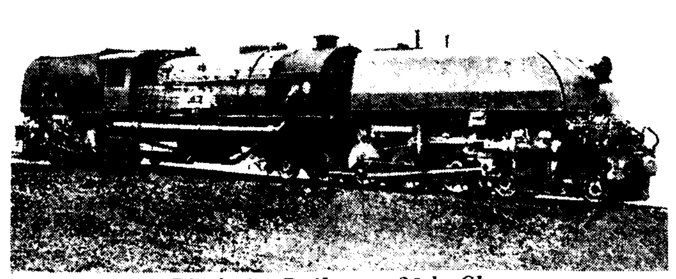
THE BOILER UNIT

The boiler which is of all-steel construction has a grate area of 63.1 sq. ft. with a total heating surface of 3,772 sq. ft.; the outside diameter of the boiler being 7′ 3″. The inner firebox is of all-welded construction and is made from Colville's "Double Crown" branch steel plates and fitted with four arch tubes and a normal type of brick arch. The firebox is round topped and is fitted with flexible water space stays in the breaking zones at the sides and back of the box. The front three rows of roof stays are flexible, whilst plate stays are used at the top of the outer firebox back plate and the smokebox tube plate, cross stays are fitted in the firebox shell. Brown Bayley's "Longstrand" steel water strays are employed for ten boilers, and the remainder have Steel Peech and Tozers "Non-alloy" stays. All stays are rivetted over on the fire side. The large tubes are $5\frac{1}{4}$″ outside diameter, and the small tubes are 2″ diameter, both being made from "Aquacidox" brand of corrosion resisting steel, the ends being expanded, welded and beaded at the firebox tubeplate for eight engines, whilst in the remainder the tubes have not been beaded.

A "Waugh" firegrate is fitted which can be manually rocked in four sections, provision being made for dumping. The big capacity ash-pan possible in this type of



View of Smokebox.



Rhodesia Railways 20th Class.

locomotive, is of self emptying hopper type with a drench and a door on either side; a fixed air space is provided between the pan and the foundation ring.

The superheater consists of fifty double return elements of $1\frac{1}{2}$″ outside diameter and the header incorporates a multiple valve regulator, all being supplied by the Superheater Co.

The smokebox is of the self cleaning type with a diaphragm spark arrestor and the blast pipe is fitted with four Goodfellow tips.

The boiler is well provided with washout plugs, which are easily accessible, as is always possible with the Beyer-Garratt design and two Everlasting blowdown valves are located at the bottom of the throat plate. Three 3″ Ross "pop" valves are mounted and two steam turrets are positioned outside the cab. The boiler is fed by two Gresham & Craven No. 13 RHW live steam injectors mounted on the fireman's side feeding through a top feed clackbox and operated by quick-acting steam valves mounted on the side of the firebox in front of the cab.

THE STOKER

With a grate area of this size a mechanical stoker is essential and these powerful engines are therefore fitted with a Standard stoker of the H. T. type. These well proved stokers of world wide application are now manufactured in Britain. In this particular application the 5″×5″ reversable stoker engine is mounted on the boiler unit frame. The drive to the rear of the conveyor trough is by means of a propeller shaft and universal joints. The unit has been designed for easy servicing. The stoker controls are conveniently mounted in front of the fireman together with a neat arrangement of the necessary pressure gauges for the jets and engine.

FRAME UNITS

The two engine units have bar frames, machined from $4\frac{1}{2}$″ thick rolled steel slabs and are rigidly stayed with cast steel cross-stretchers and dragbox. The Beyer Peacock patent self-adjusting pivots are of the oil-bath type. The bottom pivot centre integrally cast with the cross-stretcher forms a strong box-stay between the frames. These new pivots have not only improved the riding of the Beyer-Garratts but by avoiding the dependence on manual adjustment have greatly reduced maintenance. Many designs of Beyer-Garratts have been fitted with these pivots and no attention has been necessary between general repairs.

The boiler unit frame is of steel plate, very strongly stayed and all three units are designed to resist heavy buffing shocks. Alliance No. 1 couplers and Spencer Moulton draft gear are fitted in accordance with the Railway's standards.

The main steam and exhaust pipes are of solid drawn steel and their expansion joints are fitted with Walkers "Supasca" self-lubricating packing. The design of the pipes is such that a minimum of interference to normal maintenance is caused by their location. For small steam pipes crossing from the boiler unit to the engine units, Dorman's "Flextel" joints are used, these have been found to give satisfactory service in previous applications.

CYLINDERS AND MOTION

The four cylinder castings are identical and are made of cast iron, each pair being bolted together on the centre line of the engine, and form a rigid stay. The exhaust ports are designed so that a connection may be made to a condenser vehicle if so required. Cast iron liners are pressed in to both the cylinders and valve chests, the latter being 11" bore. The pistons have extended skirts at the bottom and are fitted with narrow rings. Paxton Mitchell Metallic packing is used, together with " Wota " N. C. type bye-pass valves. The cylinder drain cocks are mechanically operated from a small steam servo motor at the front of the cylinders. The cast steel crosshead is of the " Laird " type, which has been found to give satisfactory results, in spite of the dusty conditions.

The connecting rod big ends and the coupling rods have fixed nickel-chrome cast iron bushes with bronze floating bushes. Bronze bushes are used for the valve motion which has 6¾" travel. The return crank is fitted with a S.K.F. self-aligning roller bearing. Reversing is by means of a standard Hadfield Precision power reverser mounted alongside the boiler. Many of these reversers have been supplied for all types of locomotives as they have been proved to give positive locking and easy finger tip control for the selection of accurate cut-offs. The motion is so arranged that when the locomotive is running chimney first, the die blocks are at the bottom of the reversing link on both front and hind units.

WHEELS AND BOGIES

Full flanged tyres are used throughout and they are secured by Gibson retaining rings. The coupled axle-boxes are of the solid bronze type arranged for oil lubrication from the mechanical lubricators.

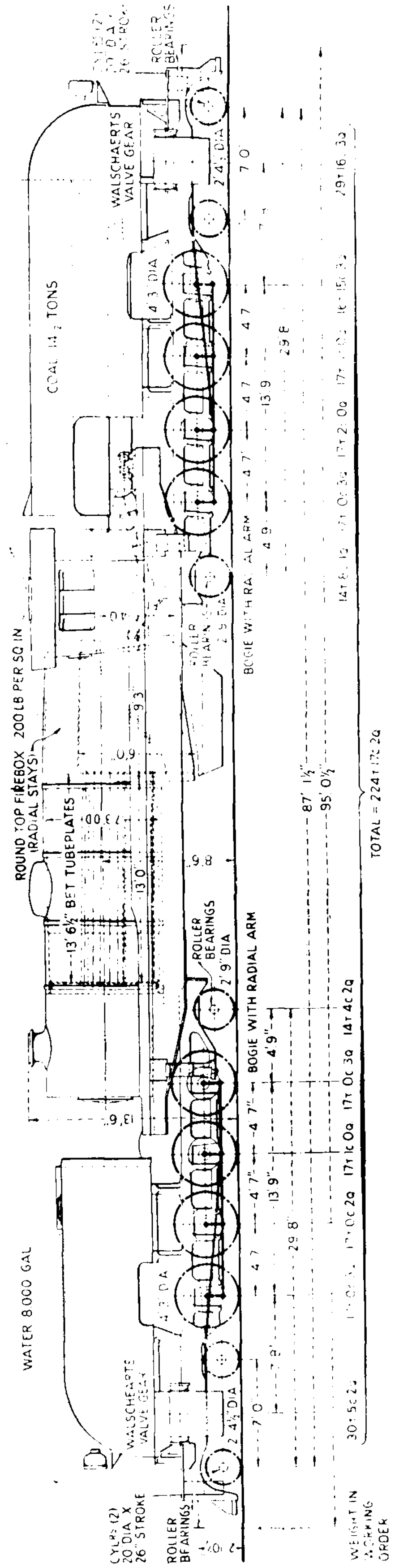
The outer bogies have one piece cast steel frames, with manganese liners for the axlebox guides, and Timken Cannon type roller bearing axle boxes. Side control is by laminated springs in conjunction with two pin swing links.

The inner trucks are of the radial arm type and have " Timken " separate roller bearing axle boxes mounted in cast steel housings. The spring weight is applied through sliding shoes operating in oil wells located on top of the axlebox housing. The side control is by helical springs.

The coupled wheel springs and the inner truck on each side of the engine units are compensated throughout and a three-point suspension is thereby obtained with the four wheeled bogie.

LUBRICATION, BRAKE AND SAND GEAR

" Ajax " hard grease lubrication is used for the connecting and coupling rods, and soft grease for motion,



springs and brakegear. Mechanical lubrication is arranged for the cylinders, coupled axleboxes, pivot centres and ball joints by means of two Wakefield " 7Z " lubricators on ... unit. Davies & Metcalfe " FSA " lubricators are fitted on one engine.

The vacuum brake equipment includes a Gresham & Craven " SSJ " ejector type " G " and graduable MK (IV) steam brake valve. The latter controls the steam cylinder, fitted to the rear unit, which also is hand braked, whilst the train and front unit are vacuum braked. Lambert wet sanding is arranged for chimney first running only.

TANKS AND BUNKERS

In order to obviate stressing of the tanks due to the racking caused by the slight flexing of the engine units, the Beyer Peacock patent method of tank fastening has been used, consisting of locating shoes in combination with spring-loaded holding down bolts. The tanks and bunker are of riveted construction and the bottom of the bunker is fitted with sliding plates to control the flow of coal to the conveyor screw.

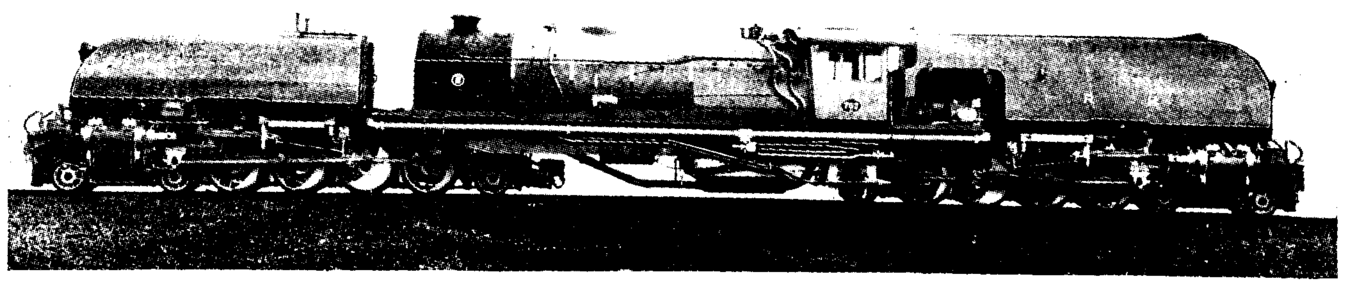
CAB AND MOUNTINGS

The cab is spacious and airy with Dunlopillo seats for the driver and fireman. Glass screens are fitted behind the seats to give full protection when running bunker first. All the controls in the cab come easily to hand and a Smith-Stone's speedometer is mounted clearly in front of the driver. Two water gauges supplied by Davies and Metcalfe are fitted, Sellars type of drifting valves are fitted. The regulator control is of the inverted notched-sector type, working fore and aft.

The cab has electric lighting and a Stone 14" Tonum E Headlight is fitted at each end of the locomotive, the current being supplied by one of their 500w type TGI turbo-generators.

The locomotives were shipped from the Mersey to Beira where they were unloaded and sent to Umtali in Southern Rhodesia for final erection and painting in the railway's colours of black with red buffer beams before going into service.

Cylinders (4) dia. by stroke	20 in. by 26 in.
Coupled Wheels dia.	4 ft. 3 in.
Bogie Wheels dia. outer	2 ft. 4½ in.
Truck Wheels dia. inner	2 ft. 9 in.
Axleload	17 tons.
Length Over Buffers	95 ft. 0½ in.
Total Weight (in working order)	225 tons.
Boiler Pressure	200 lb./sq. in.



Rhodesia Railways 20th Class.

Heating Surface :		Grate Area	63.1 sq. ft.
Tubes	2,791 sq. ft.	Tractive Effort at 75% B. P.	61,180 lb.
Firebox (incl. arch tubes)	233 sq. ft.	,, ,, 85% B. P.	69,330 lb.
Total Evaporative	3,024 sq. ft.	Coal Capacity	14 tons.
Superheater (inside)	748 sq. ft.	Water Capacity	8,000 gal.
Total	3,772 sq. ft.		

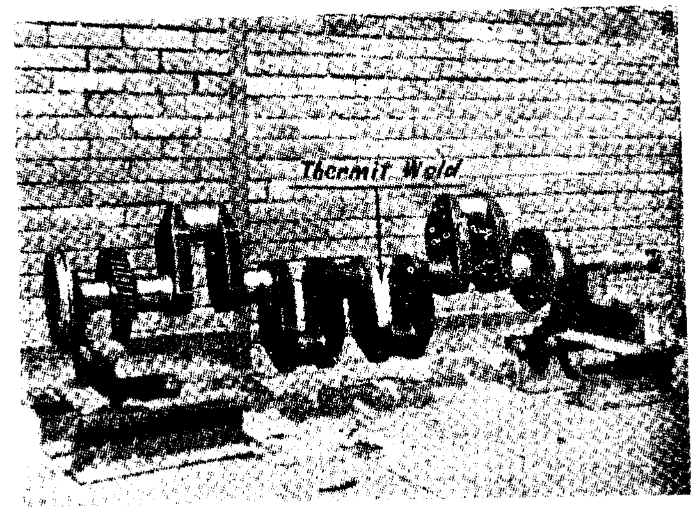
Thermit Welding of Rail Joints & Broken Steel Parts

By Gokul Das Nagory

LOWER MAINTENANCE AND REPLACEMENT COSTS

THE discovery of Thermit Reaction by Dr. Hans Goldschmidt of Essen (Germany) just before 1900 revolutionised the production of certain heavy metals from their oxides. A few years later, it was realised that Thermit reaction which depends on the chemical phenomenon of great affinity of Oxygen for aluminium can be used for chemical welding. When Thermit basically a mixture of finely divided aluminium with iron oxide in suitable proportions is ignited, chemical reaction takes place, the oxygen in the iron oxide units with the aluminium forming a light aluminium slag and setting the iron free. The heavy iron concentrates in the lower part while the lighter thermit slag ($Al_2.O_3$) corrundum — swims on the top. The chemical reaction is expressed by the formula.

$$2Al + Fe_2O_3 = 2\ Fe + Al_2O_3 + 18{,}150 \text{ calories of heat.}$$



A Temperature of about 5000°F is developed by this reaction and a supply of molten steel at a tremendous super-heat is thus provided for welding. If this high temperature molten steel is poured into a mould surrounding the parts to be welded, it has sufficient heat to fuse the sections so that the thermit steel and the parent steel amalgamate to form a homogeneous Mass or a perfect fusion weld.

A wide range of steels of different physical and mechanical properties are produced by thermit method and intensive researches have made available steel of 45/50 Tons per square inch tensile strength by this process. The fatigue strength compares favourably with the fatigue strength of the medium carbon steels and the brinell hardness and mechanical wearing properties can be adjusted to suit any particular purpose.

SIMPLE EQUIPMENT

The modern Thermit Chemical Welding has revolutionised the welding of rail joints and repair welding of broken steel parts such as crank shafts, steel housings, ship frames, gears, pinions and other big machine parts. Worked by a very simply equipment which is easy to handle this process is easy to work and has caught the fancy of engineers in all modern countries of the world, to economise maintenance and replacement costs and to assure smooth running of trains and industries.

Since the beginning of the era of Rail transport, the Railway engineers have advocated use of longer and longer lengths of rails to minimise fishplated joints which are the weakest points in the track and which are the cause of early deterioration and consequent replacement of track. The ideal track has always been considered to be without any fishplated joint. However, the maximum length of the rail which can be used in the track has been restricted by:—

(a) Limitation of the steel mills for rolling long lengths of rails.

(b) Difficulties in transporting long rails.

(c) Limit of the maximum safe gap allowable between two rails which restricts maximum rail length to be used depending on variation of temperature.

(d) The quality of the track.

There has always been a limit beyond which rails could not be rolled in the Rolling Mills. Of course, this limit is going up from year to year and today the maximum length rolled in India is 42′ and in Continental countries about 60′. The transport of big rails is also a problem and the maximum length that can be easily transported is at present 100′.

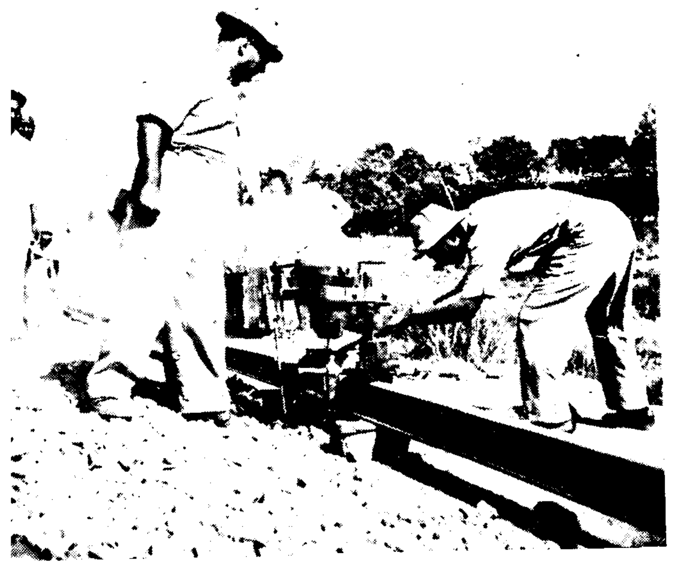
At one time it was thought that rails of lengths bigger than 30′ or 40′ would not be used as the rails expand and contract with temperature. There is a limit to the maximum gap that can remain between the two rails and this limits the maximum length of the rail which can be used in the track. Experiments in recent years have proved that with the improvement of ballasting, sleepers and rail fastening, the fractional resistance to the expansion and contraction of rails in general has increased and this has so improved the permanent way that the forces of expansion and contraction are arrested by the strength of the permanent way track. The expansion and contraction of rails is greatly reduced from the end of the rails towards their middle. Beyond a certain length of rail on a good permanent way it is only the ends which are able to expand while the middle remains motionless. It has been observed on the Continental Railways that if the permanent way is sound and if ten rails of 40′ are welded together and put in the track, then only the end 40′ rails expand and contract while the other 8 rails in the middle are not affected. It was therefore observed that it is not necessary to provide any extra gap for bigger rails. Rails have been welded to lengths of 1 Kilometer and more by Thermit process and they have given good results in the track with permissible gap.

The track having been so improved that it can bear the long rails it is natural that the engineers like to use only long rails. Short rails with joint gaps to allow expansion and contraction create conditions which lead to the early and premature destruction of the track. The fishplated rail joints may be the best and new, yet

the impacts caused by the Rolling Stock running over the joint gaps will bend the ends of the rails downwards, will loosen fishplates and bolts, will affect the position of the sleepers and loosen ballast. These impacts will also deteriorate the rolling stock badly and cause discomfort to the traveller and damage to the goods transported.

ADVANTAGES OF THERMIT METHOD

However the long rails could not be used due to the limitations of the mills to roll big lengths and the transport difficulties involved. Naturally if some welding method could be evolved for welding the rails in the track these difficulties could be solved. Thermit method gave the answer.



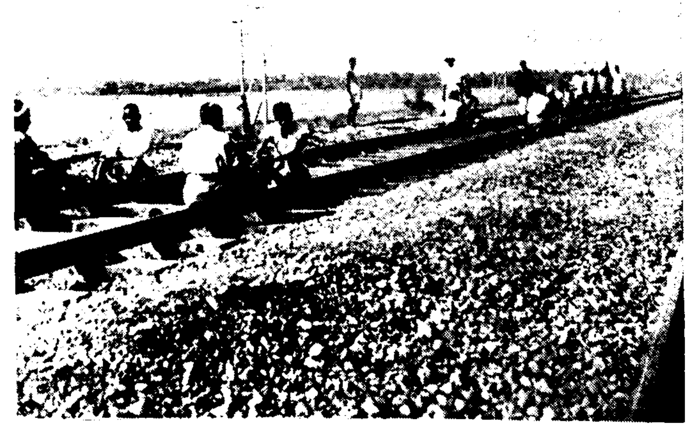
There are only two methods by which the rails can be welded safely:

(1) Flash Butt and (2) Thermit.

The Flush Butt method has a disadvantage; it requires heavy appliances and enormous amount of electrical energy and in this process one rail has to be moved to and fro during the welding process. The welding operation is therefore executed in stationary welding works specially established for this purpose. Mobile or portable flash Butt welding plants capable of welding the rail joints at the site of the track have so far failed to be introduced. In contrast to this Thermit Welding Process requires only an exceedingly small amount of materials and implements. Thermit welding

materials and equipments are made in India and cost of such an equipment is hardly 1% of the cost of same capacity Flash Butt welding equipment. One weld is completed within 25/30 minutes by Thermit process depending on profile. It can be applied in rail yards or in other suitable places and with adequate organisation the output is highly satisfactory. It is therefore that all railways should advocate the thermit welding of rail joints.

Thermit welding affords a number of advantages to the Railways:—



(1) Saving in track sleepers due to even spacing of sleepers throughout the welded track.

(2) Longer life of rails due to elimination of end batter.

(3) Decreased wear and tear to rolling stock.

(4) Labour saving in laying rails due to increased life of rails.

(5) Better conductivity in track circuits.

(6) Elimination of joint bonds for signalling.

(7) Smoother riding track providing greater comforts to passengers and greater safety for the materials to be transported.

(8) Huge saving in maintenance and replacements costs particularly in consumption of steel which can be used for other important purposes.

All railways in the world where welding of rail joints is being done on a big scale have reported sizeable savings in maintenance and replacements costs. The following figures of savings made by German Railways on Thermit Welded Tracks are interesting:

		Saving between 1945 to 1951	Average
1.	Saving on Thermit welded track by sparing maintenance in track and switches.	15,00,000 day Work (one day work-8 hrs. of man work)	700 men per day.
2.	Saving by sparing switches & rails.	13,00,000 day Work	600 men per day.
3.	Saving by sparing steel for rails and Fishplates.	1,07,000 Tons of steel.	15,000 Tons steel per year and 22,500 tons coal per year.
4.	Saving by sparing transport of steel	110 Goods Trains.	16 Goods Trains per year.

With this background and to be of some service to the Indian Railways, The India Thermit Corporation Ltd., and its parent institution started Thermit welding in India from indigenous materials. So far over 45,000 joints have been welded, the maximum length being 419′ against 39′ to 42′ ordinary rail length. The welding has been done for Main Line Tracks between Bombay and Baroda and Phulera and Ahmedabad on Western Railway, between Gaya and Dehri-on-Sone, and Howrah and Kharagpur on Eastern Railway, and between Allahabad and Mirzapur and Delhi and Ferozepur on Northern Railway. Thermit welding has also been adopted by Calcutta Tramways and Martin's Light Railway. The first Thermit joints welded in India by local materials have given over 5 years of service and all concerned are satisfied with the work.

It is important to note that welding does not involve any extra cost as the saving of extra sleeper provided for fishplated joint, together with the saving of fishplates and bolts practically off-sets the initial cost of welding.

Indian Railways have been so far hesitant to allow normal sleeper spacing below the Thermit Welded Joints, but this is universal practice on the Continent. Closer spacing at the Fishplated Joint is provided because at the Fishplated Joint the continuity of the rail is broken and in its place we have a pair of Fishplates. The strength of the Standard Fishplate in Bending is about 30% that of the Solid Rail. At this point, therefore, the rail is quite incapable of effecting longitudinal distribution of the load. The load, therefore, is carried on a few sleepers near the joint. By putting two joint sleepers closer together and slightly reducing the space between the 1st and 2nd sleepers—it is tried to compensate for this. The nett result is that while the stiffness of Fishplated Joint is reduced by about 70% in comparison to rail — the number of sleepers affording support in the vicinity of joint is increased some 25 or 35% i. e. the rail is weakened about 70% and the sleepers are locally strengthened about 30%. The Thermit Joint however has the same Bending Strength as the Rail and as such no closer spacing is required below it. There is however another factor, which the Railway Engineers have to consider and that is the possibility of accident due to the chance failure of some welded joint. Even though, so far no accident has been reported from anywhere due to such failure, it is safer to proceed cautiously in the beginning. Plans have, therefore, been submitted to Railway Board, and it is expected that they would be approved by Railway Engineers. On the basis of these plans — there is saving of sufficient sleepers on welded track which together with the saving of cost of Fishplates and Bolts and the cost of drilling holes, which are not necessary when welding rails, off sets the cost of welding.

SAVINGS

The application of thermit welding to repairing broken shafts, rollers and other steel parts has been developed considerably on the Continent and America. In India our firm has welded several crank shafts and gears which

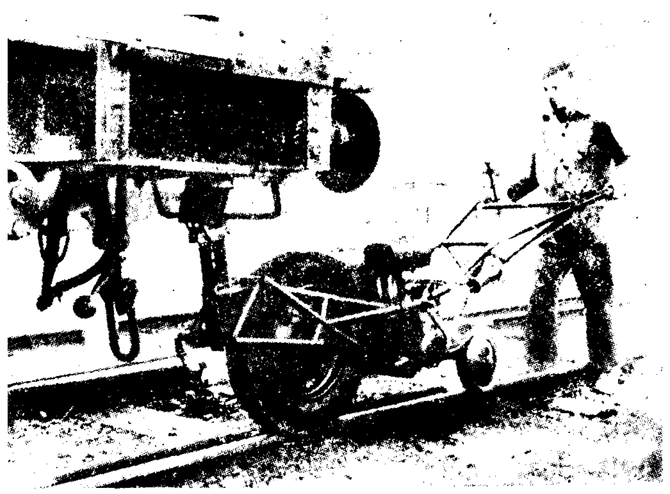
(Continued on page 50)

LOCOPULSOR SHUNTING MACHINE

By A Special Correspondent on the staff of E. G. Steele & Co. Ltd.

ALL Industrial firms possessing their own Sidings have at one time or another been faced with the problem of how to move and shunt the wagons on these Sidings into position for loading and unloading.

If the Sidings are very extensive or very small the problem generally solves itself, for if the length of the Sidings is great it will probably be necessary to employ



a Locomotive, either steam or diesel, whereas if the Sidings are very small, probably the Railway Company will be able to place the wagons in position once per day.

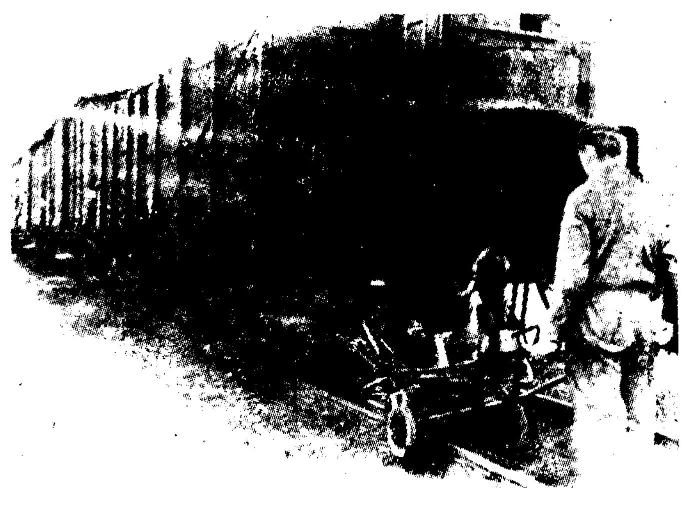
With the intermediate size of Siding installation, however, the problem is by no means simple, and many Engineers will feel that whereas the extent of their Railway sidings does not justify the heavy costs, both in maintenance and capital expenditure, of a full sized Locomotive; neither is it satisfactory to work the Sidings without some suitable mechanical means of shunting the wagons from one siding to another.

Accordingly, over the years a number of methods of shunting wagons without using Locomotives have been adapted, and these vary from the simple device of using a horse full scale installation of electric capstans, etc.

One of the most recent developments in connection with shunting problems has been the design of the Locopulsor Shunting. Machine, which has been specially constructed to meet the needs of Industrial Engineers who wish a compact and simple, yet powerful method of shunting Railway Wagons in their own Sidings.

The photographs gives a good general idea of the layout of the machine and the method of use. Briefly the details of the machine are as follows.

The Locopulsor has a driving wheel fitted with a pneumatic tyres. This tyre is grooved and corrugated to afford the maximum adhesion to the rail, and this wheel is driven through a gear box and a special speed reducing device. There are auxiliary wheels for transporting the machine from one place to another, but in actual shunting operations these are not used and the machine is operated by running the driving wheel on the rail.



(*Continued from page 49*)

are working satisfactorily. The Thermit welded part is as good as new while the cost is roughly only 25% of the new. This work has been started in India only recently in Kanpur and Calcutta and it is expected that when the Indian Industries start to take full advantage of this process there can be a saving of 10 Million rupees a year to them in Replacement Costs in addition to their minimising losses due to stoppage of work on account of difficulties to replace immediately the broken parts. The saving of foreign exchange will also be considerable as most of the two and more throw crank shafts which are at present being imported to replace broken shafts need not be imported—the broken ones can be easily and economically welded by Thermit Process.

The power unit is a 600 c.c. J.A.P. petrol engine.

The general principle of the machine is rather ingenious as it utilises the forward torque of the driving wheel to give a forward and upward thrust through a pushing jack which sits below the headstock of the wagon, thereby employing the weight of the wagon to given adhesion to the rail and not depending on the weight of the machine itself to give the necessary frictional adhesion. This frictional force would be small as the machine weighs only 3.1/2 cwts. for easy handling.

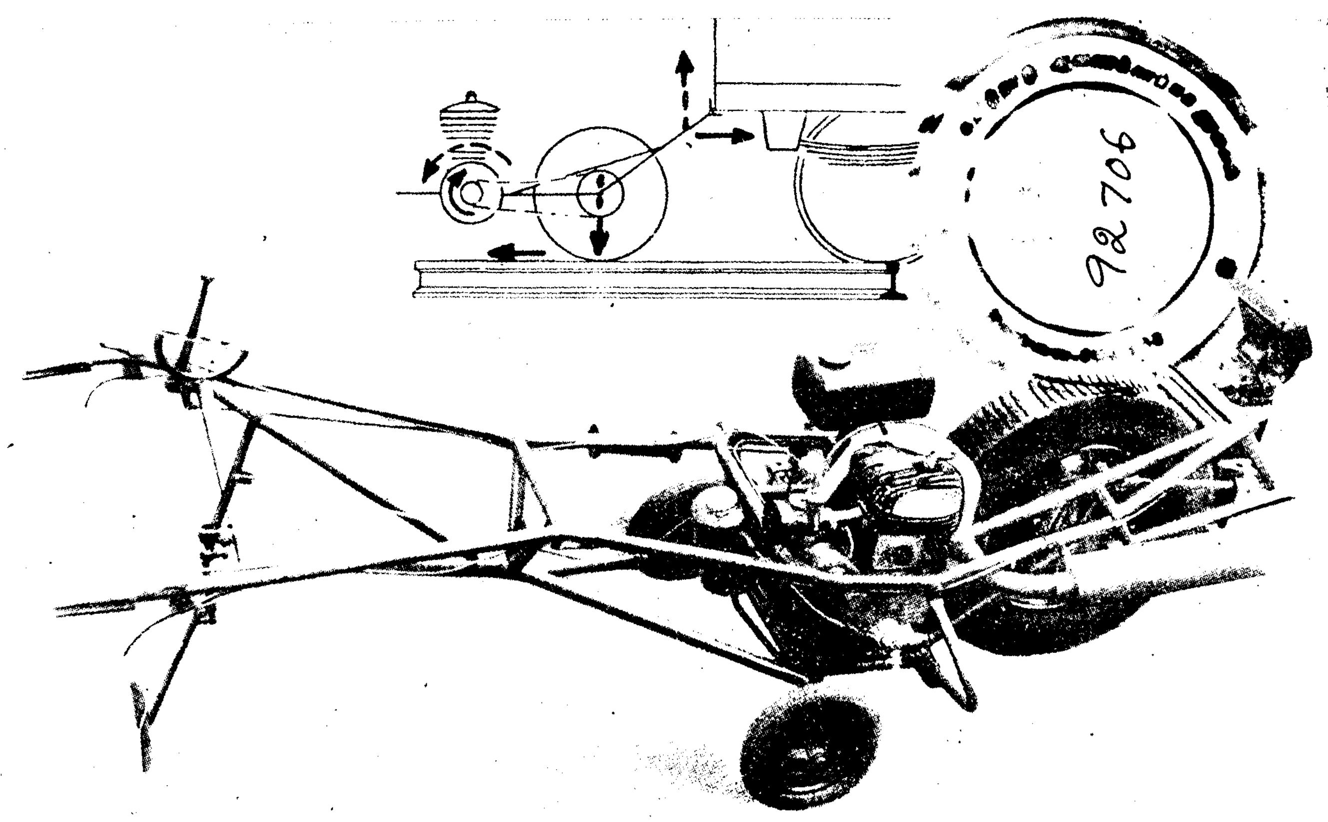
The chassis of the machine is welded throughout from high tensile tubular steel, and specially annealed steel castings are employed in the pushing jack. The whole design of the machine incorporates lightness and strength and wherever possible high tensile aluminium alloy is used in any part where the necessary strength can be obtained in this metal.

The operation of the machine is very simple as the Operator sits the machine on the rail a yard or so from the wagon and raises the pushing jack to the requisite height by means of a hand lever. He then places the jack under the headstock of the wagon and after that it is merely necessary to engage first gear, let in the clutch and simply guide the machine gently on the rail. There is no difficulty in negotiating points or crossings.

Several features of the design are ingenious. There is for example, a preselective gear box. This enable the Operator to have at all times the free use of at least one hand on the handlebars. Once a particular gear has been engaged the gear selector quadrant can be moved to any other position. No change will result until the clutch is let out and in when the desired gear position will then be automatically selected.

In the speed reducing unit there is an ingenious yet simply maintained arrangement of epicyclic gearing; also the clutch is heavily reinforced for heavy starting duties and the gear box has a wide range of ratios which allow for heavy starting and also for high speeds when the shunting is well under way, or when taking the machine from one part of the works to another.

It might be thought that with such an apparently lightly built machine that it would not stand up to heavy duty over a period of years, but the opposite is found, in fact, to be the case. There have been some machines operating in the south of England for almost ten years and the maintenance of them has been exceedingly low. In fact, the bulk of the attention which they require

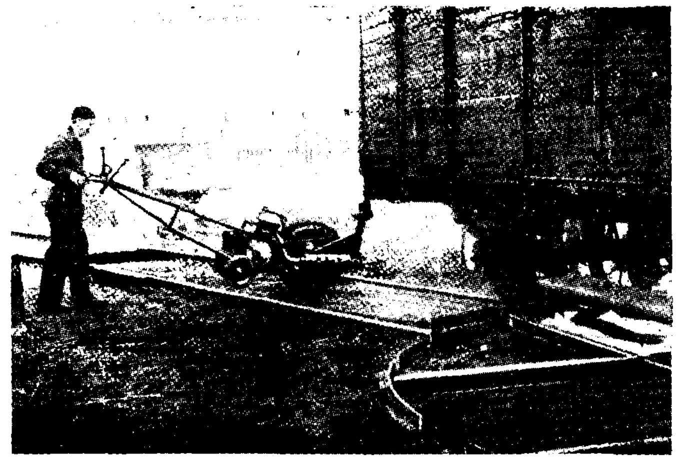


is the renewal of worn control cables from time to time. The specially designed pneumatic tyre is also very resistant to wear and with normal attention the tyre should last for two or three years without renewal.

It is, of course, important in designing a machine of this nature to consider the number of wagons which will be shunted, and it has been found in practice that loads of up to 150 tons or more can be shunted with ease on a well laid level track, with, of course, correspondingly smaller loads on inclines. The writer has seen the Locopulsor Shunting Machine shunt over 200 tons, although this probably would not be recommended for every day use, but does demonstrate the fact that 150 tons is well within the working capacity of the machine.

Accessories which can be supplied are a sanding gear which can supply a trickle of sand to the rail if the rails are likely to be wet or greasy. Also a special low head can be supplied for use with very low wagons, for example, those of the type used in quarries, etc. If inflammable material is used in the works the machine can be completely flameproofed.

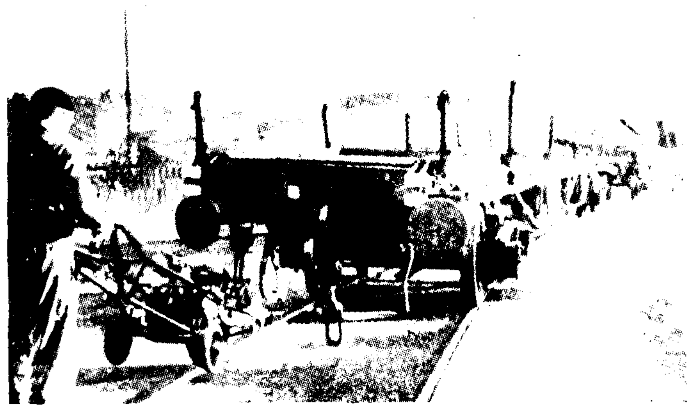
The safety aspect of the design of the machine has been well considered, in particular the question of a



runaway down an incline which might carry the machine away out of control, has been successfully dealt with. First of all there is an immediate release apparatus to the pushing jack which allows it to drop from contact with the wagon headstock immediately on the pull of a hand lever. There is, in addition, a free wheel device on the machine which would operate in the unlikely event of the release mechanism failing.

Over a thousand of these machines are now in use throughout the world and it has been found that the machine stands up to heavy use with very little wear and maintenance being required.

One of the facts which might not be considered at first, is that even large works which use Locomotives, often have parts of the works where it is not economical to employ an additional locomotive. Or again, it might be that on weekend working it is not an economical



method of working to keep a Locomotive under steam, apart altogether from the question of a day requiring to be set aside for boiler cleaning etc. For these reasons a number of very large firms, employing several locomotives, have found that the Locopulsor is extremely useful as an auxiliary, or as a standby in the event of a break down, especially in view of the fact that the capital cost of the Locopulsor is only a very small fraction of that of a Locomotive, and the maintenance and running costs are correspondingly very small.

The following table may be of interest in considering the question of operating costs. The figures are based on the assumption of an eight hour shift with a running time of five hours per shift for the machine.

	Fuel	Lubricating Oil	Wages	Total
Locopulsor	8/-d.	1/-d.	24/-d.	33/-d.
Steam Locomotive	49/-d.	1/-d.	61/-d.	111/-d.

The marked difference of the operating costs is obvious and the fuel costs of the Locopulsor is based on its petrol consumption of 3/8 gallon of petrol per hour. The comparison between the Locopulsor and the steam Locomotive becomes even more pronounced when annual standing charges are compared. On the following table the following assumptions have been made.

"Depreciation" has been calculated on the life of the machine over the period shown with the machine or Locomotive thereafter assuming a nil scrap value.

"Interest" on the purchase cost has been taken at 4%.

"Maintenance" accounts for the general care of the machine together with recommended oil changes and servicing.

"Replacements" allows for tyres and engine wear.

	Locopulsor	Steam Locomotive
Life	10 years	50 years
Capital cost	£475	£10,500
Depreciation	£35	£69
Interest at 4%	18	420
Maintenance	78	715
Replacements	20	-
Total Annual charges	£151	£1204

The above figures are from a calculation given by J. G. Lee, Esq., in "The Engineer", April 30th, 1954, in the comparison of various methods of wagon shunting.

It will be seen, therefore, that the Locopulsor has an annual running cost of less than 1/8 that of a Locomotive and yet for many purposes the services of a Locopulsor are sufficient to replace those of a Locomotive.

The conclusion is obvious that many Industrial Firms which are at present shunting by steam Locomotives could effect a very large saving by employing one or more of the Locopulsor Shunting Machines.

The Locopulsor is manufactured in Great Britain by E. G. Steele & Co. Ltd., 93 West George Street, Glasgow and already a few of these machines are in operation in India, but there is undoubtedly scope for the increased use of this machine in many works where the shunting of Railway Wagons is a heavy cost in the Annual Budget, and one, of course, which is tending to become heavier each year with the increased cost of coal and labour.

How Britain Supplies the World's Railways

By a Technical Correspondent

Britain was the first country to develop the locomotive and British engineers pioneered railway development in most parts of the world. By virtue of its wide oversea interests, spread over a long period, Britain's locomotive industry has evolved over the years into an engineering and production group which can meet the most diverse conditions required abroad. —Editor.

WHATEVER the railways of the world want in the way of locomotives — steam, diesel or electric — Britain can supply the best their money can buy. Since the war Britain's locomotive manufacturing industry has exported locomotives and component parts to the value of no less than £ 100 million.

Today Britain can offer deliveries of locomotives as speedily as any foreign competitor. During the last five years, the industry has exported no fewer than 405 locomotives to India, 468 to Africa, 395 to Australia and 356 to other parts. These were all main line steam locos, including some of the largest ever exported.

Diesel locomotive orders have also been high. These orders include 30 for Brazil, 25 for Ceylon, 94 for Ireland and 75 for the Netherlands together with a much larger total of industrial steam locomotives.

Electric locomotives have also been produced in increasing numbers, and these include very large main line locomotives for South Africa, Spain and Brazil. In 1953 no less than 92 per cent of the total production of the industry went overseas.

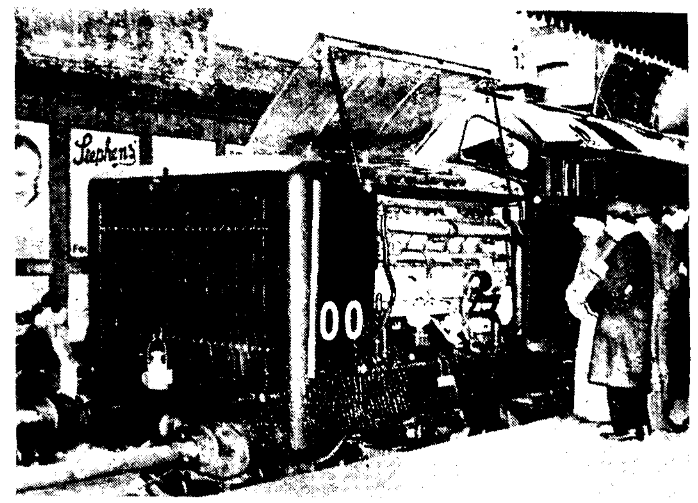
LONG EXPERIENCE

The U. K. industry by virtue of its wide oversea interests has evolved naturally over the years into an engineering and production group which can meet the most diverse conditions required abroad. The limitations of load gauge, axle-loading, gradients, and climatic conditions impose a considerable degree of restraint on standardisation of design. The industry has long experience of "design for the job" and does not attempt to force a standard product on oversea customers which may or may not meet their needs.

For example, diesel locomotives are produced today to meet almost every possible requirement. The range of diesel-mechanical-and-hydraulic types, formerly limited to a ceiling of 275-300 h. p., has now been extended (through the development of advanced forms of transmission by British firms) to include production models of 625 h. p.; designs exist for higher ratings, and an experimental 2,000 h. p. unit developed in conjunction with British Railways is in trial service. Diesel-electric locomotives up to 2,000 h. p. have been built in Britain, and more powerful models are under development.

DIESEL ELECTRIC

The production of locomotives other than steam is one of the most interesting post-war developments. Among the largest manufacturers of diesel electric locomotives in Britain are the English Electric Co., Ltd., Marconi House, Strand, London, W. C. 2., who have also had long experience in this field. They produced their first locomotive of this kind in 1928. This organisation are unique in one respect in that they manufacture on one site complete locomotives. Engines, electrical equipment and mechanical parts are all produced at the



The most powerful diesel-mechanical locomotive yet built for use on British Railways, No. 10,100, is a 2,000 H. P. unit capable of a maximum speed of 78 m.p.h., and having a relatively light axle-load enabling it to be used over a wide range of main line routes. It is of the 4-8-4 wheel arrangement and is powered by four 13-cylinder diesel engines of each of 500 H. P.

Preston factory, although, as occasion demands, some mechanical parts are bought out. Locomotives manufactured today range from 350 to 2,000 h. p. (higher powers are under development) and include a standard 350/400 h. p. shunter. This latter has been produced since 1933.

At the end of 1953, the firm's output of complete locomotives and diesel-electric locomotive equipment, without mechanical parts, had increased by 800 per cent, in terms of horsepower. Locomotives scheduled for completion in 1955 will bring the percentage increase to 1,200.

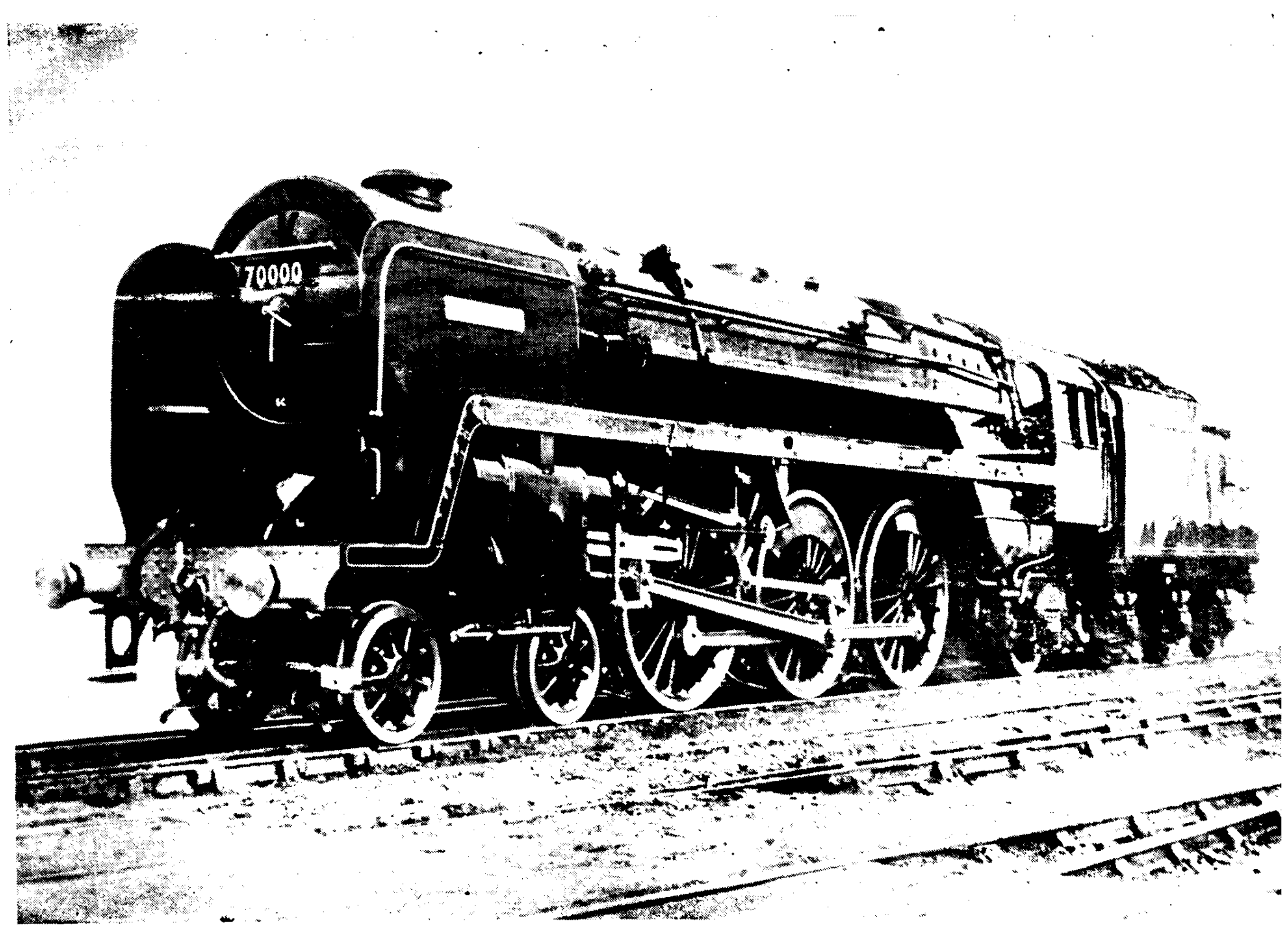
Important recent oversea orders secured by the firm include a contract to supply thirteen 1,000 h. p. diesel electric locomotives for passenger and freight service on the metre gauge system of the Rede Ferroviara do Nordeste, of Brazil. The diesel electric power equipments are being built by the English Electric Co., and the mechanical parts by the Vulcan Foundry.

Twenty-five 2,400 h. p., 1,500 v., d. c. mixed traffic locomotives of the "Co-Co" type are also being built by English Electric for service on the Gippsland main line of the Victorian Government Railways. They are equipped with rheostatic electric braking.

LARGE OVERSEAS ORDERS

The only company in the U. K. which manufacture diesel hydraulic locomotives, the North British Locomotive Co., Ltd., Glasgow, have been making them since 1950 and sales of these both for home and export have continued to expand steadily. One oversea order recently completed was for two 0-6-0 diesel-hydraulic locomotives built for the Mauritius Government Railways. These have successfully completed trials, and will operate on a steeply inclined 32 miles route between Port Louis Central Station, Curepipe and Makebourg. Recent reports indicate that North British and Metropolitan-Cammell Carriage and Wagon Co., will respectively receive orders from the U. S. Foreign Operations Administration to supply 25 locomotives and 2,000 wagons for India.

Formed in 1949 by Metropolitan-Vickers Electrical Co., Ltd., and Beyer, Peacock and Co., Ltd., for the manufacture of electric, diesel-electric and gas-turbo-electric locomotives, Metropolitan-Vickers-Beyer, Peacock, Ltd., Stockton-on-Tees, Durham have completed a number of 1,010 h.p. electric locomotives for Brazil; and 1,105 h.p. diesel-electrical locomotives are in course of construction for the Western Australian Government Railways.



"BRITANNIA" one of the 12 new standard locomotives.

At the same time, one of the largest contracts for electric railway equipment ever placed was awarded last year to Metropolitan-Vickers Electrical Co., Ltd., Trafford Park, Manchester. The Central Railway of Brazil ordered 200 complete railway coaches to be built in Britain and equipped and a hundred sets of electrical equipment for fitting to coaches built in Brazil.

HAULED ROYAL TRAIN

When the Queen and the Duke of Edinburgh visited Ceylon during their Royal Tour last year, diesel electric locomotives supplied by the Brush Bagnall Traction Ltd., Loughborough hauled the Royal train. These were supplied to the Ceylon Government Railway under a contract for 25 locomotives obtained by The Brush Electrical Engineering Co., Ltd. Each of the locomotives weighs some 87 tons in full working order.

The history of this contract underlines the way in which group organisation is of value in completing a project of this kind, utilising the facilities of various companies within the group. While Brush Bagnall Ltd., were responsible for the design and erection of the locomotives, the electrical equipment was manufactured by Brush Electrical Engineering Co., Ltd., the diesel engines by Mirrlees, Bickerton and Day Ltd., and the mechanical parts by W.G. Bagnall, Ltd. The locomotives are capable of a maximum speed of 55 m.p.h. which is the track limit in Ceylon at the present time.

Another important firm in this field is the Birmingham Railway Carriage and Wagon Works Ltd., Smethwick, which has been engaged in the production of 14 diesel electric locomotives, each of 955 h.p. for the Australian Commonwealth Railways for the use in the Alice Springs, Adelaide, and Port Augusta areas. Ten of these have

A general view of a locomotive erecting shop.

been shipped and the remainder are being delivered early this year. Five similar vehicles were dispatched to Sierra Leone at the end of the year. The company are also building twelve 960 h.p. locomotives for the Irish Railways in conjunction with Sulzer Brothers (London) Ltd., 31 Bedford Square, London, W.C. 1.

For the New Zealand Railways the company are also building 35 twin car articulated diesel mechanical trains in association with the Drewry Car Co., Ltd., who are responsible for the engines. The first of these was shipped in December. The Nigerian Railways have ordered 44 cars of various types, while three elaborate Pullman cars are being made for the Antofagastan and Bolivian Railways.

Two recent important contracts worth about £ 800,000 for 797 24-ton railway wagons have been placed by the British Transport Commission. These are of hopper ballast type. The Metropolitan-Cammell Carriage and Wagon Co., is supplying 398 of them, and Charles Roberts and Co. the other 399.

BRITISH RAILWAYS

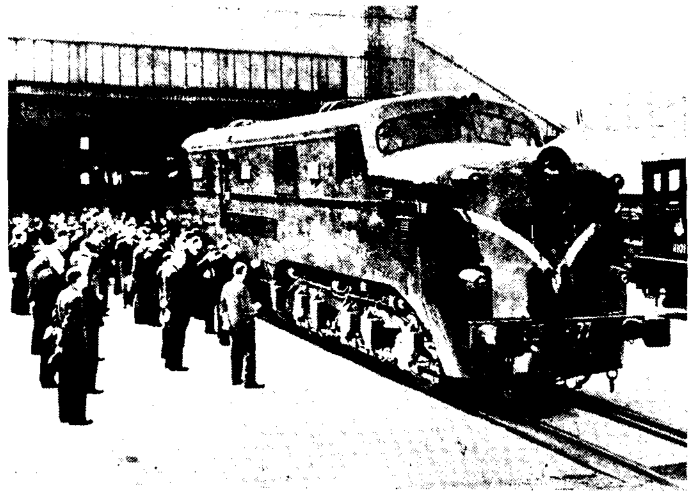
Apart from the direct sale of British locomotives of various types, railway coaches, freight cars and components of all kinds, the British export industry has an important interest in the major scheme to modernise, re-equip and reorganise Britain's State-owned railways at an estimated cost over the next 15 years of about £ 1,200 million.

Today British railways are the busiest in the world, run 40,000 passenger and goods trains daily and carry, on average, 2,702,000 passengers daily and nearly 1,000,000 tons of freight every 24-hours. By comparison, they carry more than twice as many passengers as U.S. railroads. More mileage is travelled by railway passengers in the U.K. than in any other country in Europe. Britain has more railways per square mile than any other country in the world except Belgium. During 1952, British railways carried nearly 285 million tons of freight. This included 15½ million tons of iron ore, over 21 million tons of iron and steel and scrap, over three million tons of grain and of bricks, and nearly three million tons of manure and timber.

Every day, too, British railways are operating 429 express freight trains — 138 more than before the war between such centres as London, Birmingham, Bristol, Glasgow, Newcastle-upon-Tyne, Manchester, Liverpool, Exeter, Plymouth and Cardiff.

STANDARDISATION

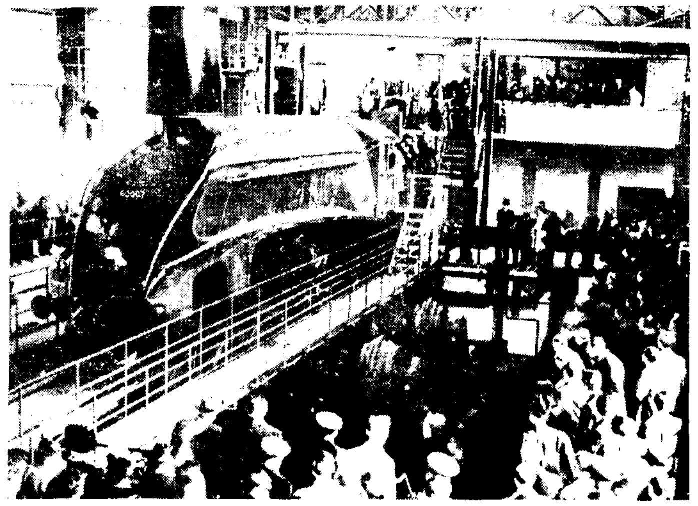
The number of different types of wagons has been reduced from 480 to 90, yielding big economies in construction repairs and stocks of spares. Among new design is the 24½ tons all-steel mineral wagon. Within



Photograph shows the new locomotive at the Vulcan Foundry being inspected by various visitors.

the total of a million wagons in use are varieties designed to suit all kinds of traffics. They range from eight-tonners to a giant 56-wheel vehicle capable of carrying loads up to 150 tons.

Open and covered containers are used for a wide variety of traffics, and there are ventilated and insulated containers for meat, fish and fruit. Special types are also available for bicycles, building materials, cement, chemicals, furniture and grain in bulk. Extended use is being made of highly insulated containers for the conveyance of commodities requiring very low temperature transport, such as quick frozen foods and ice cream.



The special feature of this British Locomotive testing station built at a cost of £200,000 is a roller bench on which engine can be driven up to 230 m. p. h. stationary. A locomotive on the test-bed running at speed during a demonstration

Container services are operated between Britain and the Continent.

Major works costing many millions of pounds are already in progress. Among the main schemes is electrification, improved signalling schemes, reconstruction work at Parkeston Quay, Harwich, improved handling equipment at Clyde Coast piers, reconstruction of inner berth at Mallaig, and schemes to improve freight working in many places. These latter include modernised goods terminal facilities at Liverpool (Hukisson).

RESEARCH

Considerable research, based on Derby, is also being undertaken, and 10 laboratories are maintained throughout the country where research is conducted on a wide variety of both technical and non-technical problems.

Stationary plants are also maintained for testing locomotives up to the highest speeds. These are situated at Swindon and Rugby. A mobile testing train, electrically controlled and the only one of its kind in the world, is also used to obtain data under actual running conditions. This comprises a dynamometer car and three braking units each absorbing 1,500 h.p. Both methods are used to assess the relationship between fuel consumption, power output and speed.

The possibilities and potentialities of new kinds of motive power like the gas turbine and atomic power, are not being overlooked. Already two gas turbine locomotives have been introduced experimentally. One, built in Britain, of 3,000 h.p., is the most powerful passenger locomotive in the U.K. It is now undergoing tests. The impact of atomic energy on railway operation in the future is still not clear. With the development of increasing electrification of railway services in the U.K., coupled with the generation, in time to come, of vast quantities of cheep electricity by atomic means, it may well be that British railways will be the first to benefit in this way. And there is, of course, the prospect of actual atomic units to draw the load. Whatever happens, British railways are looking ahead and the time may not be too for distant when British passengers will be able to travel by Atom Express.

SECUNDERABAD DIVISIONAL RAILWAY USERS' CONSULTATIVE COMMITTEE MEETS

The 9th meeting of the Secunderabad Divisional Railway Users' Consultative Committee was held on 11th March, 1955 at Secunderabad and was presided over by the Divisional Transportation Superintendent.

The question of opening Babupeth Station on the Chanda-Balharshah Section for goods traffic was discussed and the members were informed that the matter was being examined. The proposals regarding accepting indents for wagons to be registered without specifying particular commodities and of sending copies of the restriction notices to Merchants' Associations were discussed. These proposals are being examined further. The suggestion to set apart a small quota of berths for passengers from Secunderabad and Hyderabad in the third class sleeper coach on the North-bound Grand Trunk Express train was accepted.

The statement showing the number of passengers found travelling without tickets and persons killed while travelling on footboards of trains for the quarter ended 31st December, 1954, the progress of amenity works, the report on inspections of Refreshment Rooms and Tea Stalls, financial results and claims statistics were noted to be satisfactory.

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