

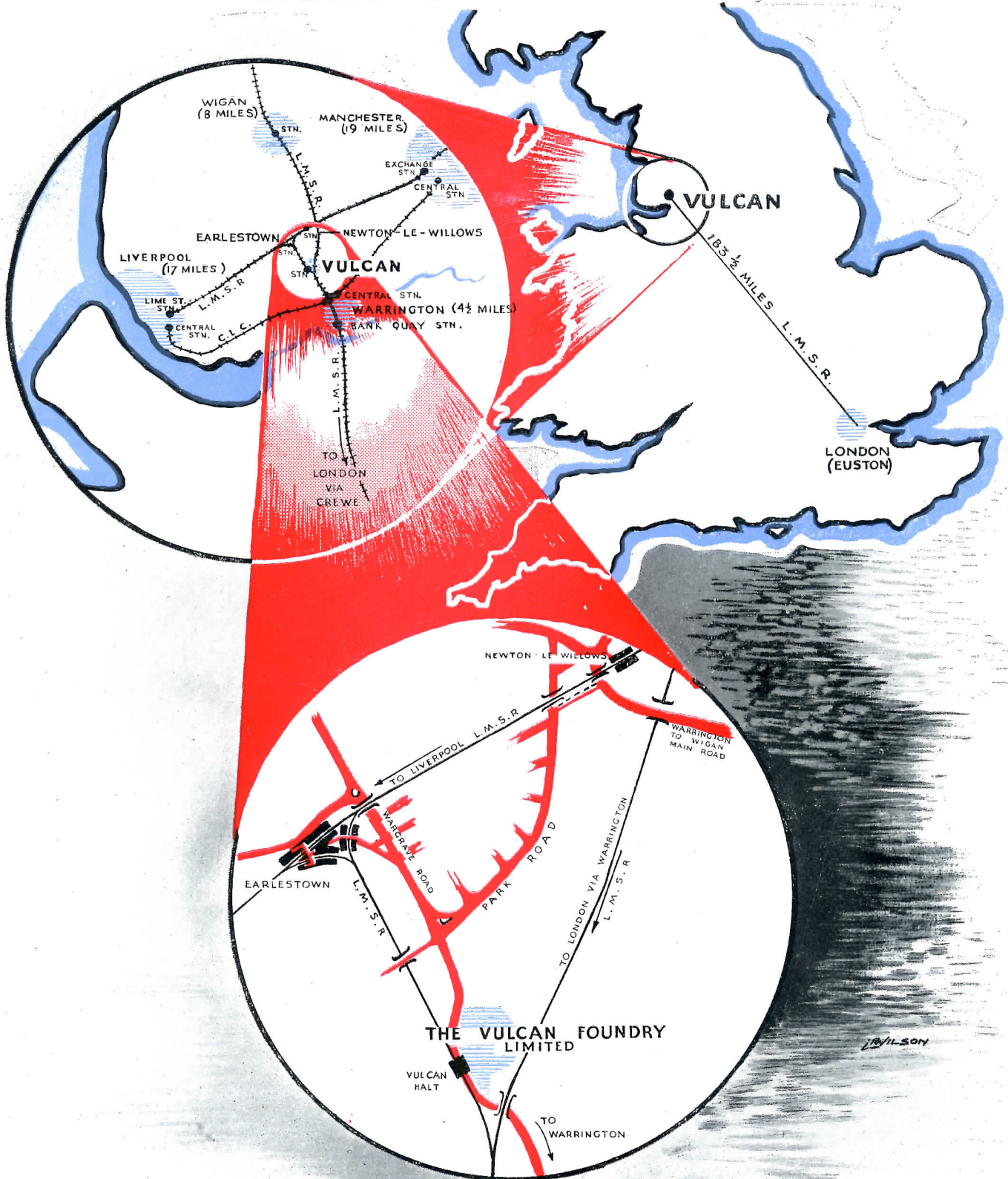
VULCAN DIESEL & ELECTRIC



LOCOMOTIVES



LOCATION OF VULCAN WORKS



VULCAN LOCOMOTIVES



THE VULCAN FOUNDRY LIMITED

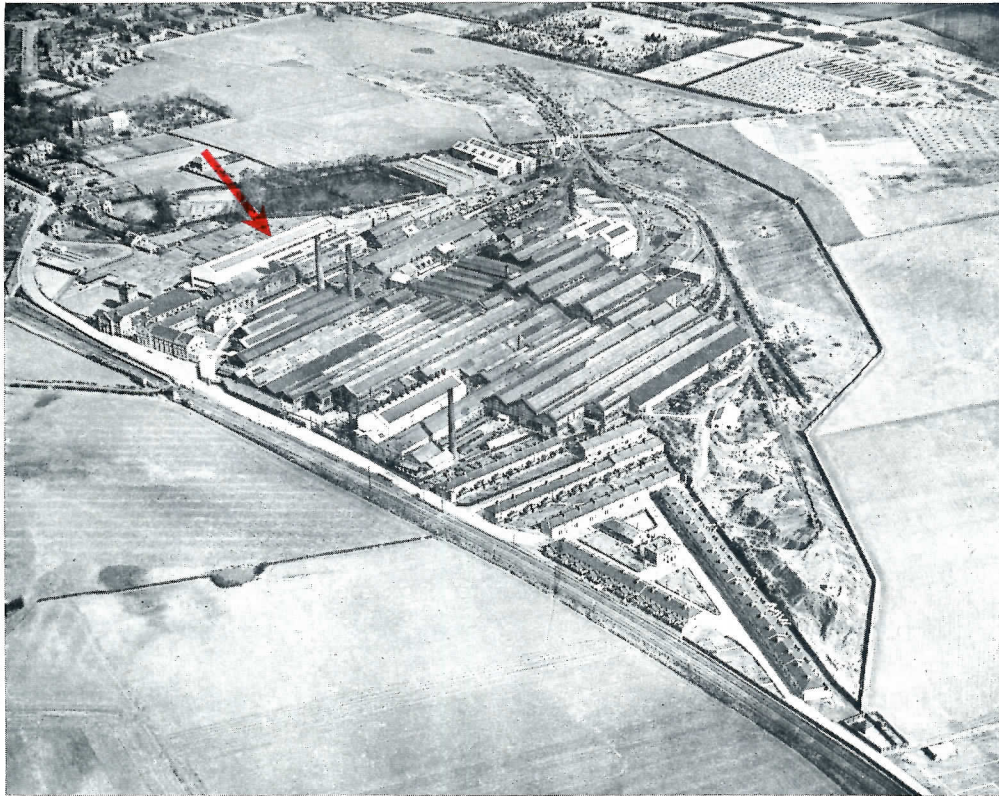
NEWTON-LE-WILLOWS

LANCASHIRE

Telephone : NEWTON-LE-WILLOWS 3244
Telegrams : VULCAN, NEWTON-LE-WILLOWS

LONDON OFFICE : 82 Victoria Street, S.W.1

Telephone : VICTORIA 8778
Telegrams : VULCANLOCO, SOWEST, LONDON



Aerial View of the Works at Newton-le-Willows.
The new Diesel Erecting Shop is indicated with an arrow.

ESTABLISHED IN 1830

DESIGNERS AND BUILDERS OF ALL KINDS OF STEAM, ELECTRIC, DIESEL ELECTRIC,
DIESEL MECHANICAL LOCOMOTIVES, AND DIESEL RAILCOACHES

MANUFACTURERS OF DUPLICATE BOILERS, LOCOMOTIVE SPARES OF ALL
DESCRIPTIONS, OIL BURNING EQUIPMENT, MECHANICAL PARTS FOR ALL TYPES
OF DIESEL, GAS TURBINE, AND ELECTRIC LOCOMOTIVES.

VULCAN LOCOMOTIVES



CONTENTS

	Page
Location of Vulcan Foundry	3
Representation Overseas	5
Enquiries	6
Foreword	7
2,600 H.P. 0-6-6-0 Electric Freight Locomotive, Great Indian Peninsula Rly.	11
275-300 B.H.P. 0-6-0 Diesel Mechanical Locomotive ...	14
250-275 B.H.P. Diesel Mechanical Railcoaches, New Zealand Government Rlys.	19
204 B.H.P. 0-6-0 Diesel Mechanical Locomotive	26
153 B.H.P. 0-4-0 Diesel Mechanical Locomotive	32
1,600 H.P. Diesel Electric Locomotive, Egyptian State Rlys.	35



REPRESENTATION OVERSEAS

ARGENTINA, URUGUAY & PARAGUAY

Percy Grant y Cia.,
Reconquista 314,
Buenos Aires.

AUSTRALIA AND TASMANIA

The Steel Coy. of Australia (Pty.) Ltd.,
Sussex Street,
Coburg N.14,
Melbourne,
Victoria.

BRAZIL

Parson & Crosland Ltd.,
River Plate House,
Finsbury Circus,
London, E.C.2,
and
Rua Graça Aranha 416, Rio de Janeiro.
Rua dos Andradas 24, San Paulo.

CHILE

Kenrick y Cia.,
Calle Bandera 162,
Santiago.

EGYPT

W. D. Long, Esq.,
2 Rue Baehler,
Kasr er Nil,
Cairo.

INDIA AND PAKISTAN

Heatly & Gresham Ltd.,
14 Great Peter Street,
London, S.W.1,
and
P.O. Box 190, Calcutta.
P.O. Box 225, Bombay.
P.O. Box 228, Madras.

NEW ZEALAND

G. W. Arnold Ltd.,
A.M.P. Building,
Customhouse Quay,
Wellington, C.I.

PERU

Ronald M. J. Gordon y Cia.,
Edificio Republica,
Paseo Republica 111,
Lima.

PORTUGAL

H. M. F. Hatherly Ltda.,
Rua do Comercio 8,
Lisbon.

SOUTH AFRICA, RHODESIA, PORTUGUESE EAST AND WEST AFRICA AND THE CONGO

Edgar Allen & Co. (S. Africa) Ltd.,
P.O. Box 551,
Garlick House,
Harrison Street,
Johannesburg.

TURKEY

A. B. Tubini & Partners Co.,
48-50 Unyon Han,
Galata,
Istanbul.



ENQUIRIES

ENQUIRIES

When making enquiries for new Locomotives kindly include the following details :-

Gauge.

Horsepower required.

Service (Passenger, Freight or Shunting).

Maximum Weight of Train.

Maximum Speed required.

Details of Loading Gauge.

Ruling Gradient and length.

Are gradients compensated for curvature ?

Minimum Curvature (Main Line).

Minimum Curvature (Sidings).

Longest Run without a stop.

Maximum Axle Load.

Brake System.

Drawgear System.

Maximum Height above sea level.

Maximum and minimum shade temperature.

DEMANDES DE RENSEIGNEMENTS

En demander renseignements au sujet de Locomotives nouvelles renvoyez s'il vous plait les suivants détails :-

Voie.

Puissance de moteur demandée.

Service (Voyageurs, Marchandises, ou Manoeuvres).

Poids maximum de Train.

Vitesse maximum demandée.

Détails de Gabarit de Chargement.

Rampe maximum avec longueur.

Si les rampes sont compensées en courbe.

Courbe minimum (Ligne Principale).

Courbe minimum (Voies de Garage).

Plus long trajet sans arrêt.

Charge maximum par Essieu.

Système de Freinage.

Système d'Attelage.

Hauteur maximum sur niveau de mer.

Températures maximum et minimum à l'abri.

SOLICITUDES DE INFORMACION

Al pedir informacion sobre Locomotoras nuevas sirvase adjuntar los siguientes pormenores :-

Trocha.

Poder de motor requerido.

Servicio (Pasajeros, Carga, o Maniobras).

Peso maximo de Tren.

Velocidad maxima necesaria.

Detalles del Perfil.

Pendiente maximo y su largo.

Si los pendientes son compensados para curvas.

Curva minima (Via Principal).

Curva minima (Desvios).

Recorrido mas largo sin parar.

Peso maximo por Eje.

Sistema de Frenos.

Sistema de Enganches.

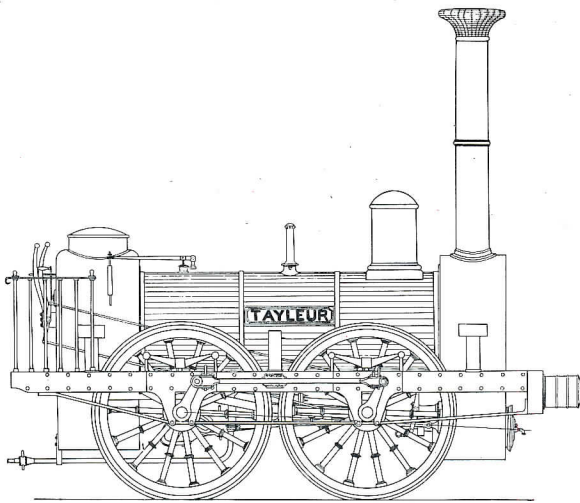
Altura maxima sobre nivel del mar.

Temperatura maxima y minima a la sombra.



FOREWORD

THE Vulcan Foundry was founded in 1830 by Robert Stephenson in collaboration with Charles Tayleur, a Liverpool Engineer. Robert Stephenson was already managing a Locomotive Works in Newcastle-upon-Tyne, but finding it difficult to transport Locomotives from his Newcastle factory to Lancashire for use on the Liverpool and Manchester Railway, he decided to go into partnership with Charles Tayleur with a view to building engines on the spot.



The "Tayleur."

The first Locomotive to be built at Vulcan was produced for the North Union Railway and was named "Tayleur," and this was followed shortly afterwards by three more for the Warrington and Newton Railway opened in 1831.

The Vulcan Foundry was soon building Locomotives for the new railways which were springing up all over Great Britain; the Firm was also very early in the Export Market, and between 1835 and 1839 they were

already sending Engines to the European Continent.

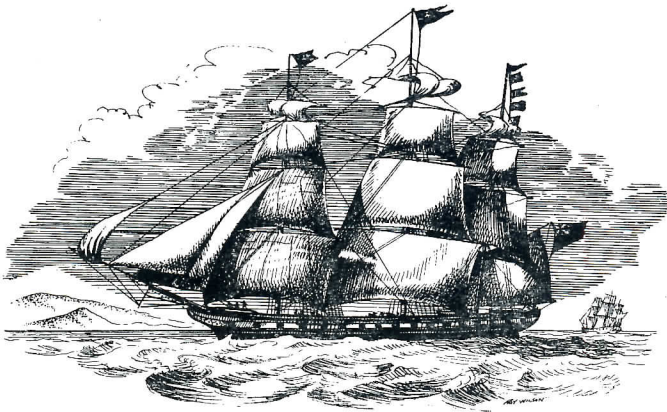
In 1847, a subsidiary firm, by name the Bank Quay Foundry, was taken over. This foundry had been operating in Warrington since 1834 and it was here that the materials for such enterprises as the Conway Bridge and the Britannia Bridge across the Menai Straits were prepared. The first iron seagoing vessel, "Tayleur," was also built at Bank Quay Foundry in 1853.



Building the Conway Bridge.



Locomotive building proceeded apace and many famous Locomotive Engineers were concerned with the Vulcan Foundry, including William Kirtley, H. Dubs, and Sir Daniel Gooch.



The first Iron Sea-going Vessel "Tayleur."

The first Locomotives to run in India and Japan were built at Vulcan in 1852 and 1871 respectively, and from then onwards Vulcan Locomotives became known throughout the world for the excellence of the materials used and the accuracy and precision of their workmanship.

During the 1914-18 War a great deal of Armament Work was undertaken and for some years prior to the recent World War and up to 1943, the Works were engaged on the production of Tanks and other munitions for the War Department, together with Torpedoes and Gun Mechanisms, &c., for the Admiralty.

A large amount of the design work for the Matilda Tank was entrusted to the Firm and subsequently no less than 620 were built at the Works, whilst 2,280 more were manufactured by other Companies with Vulcan jigs and gauges and under their guidance. These fought in France, North Africa, Russia and S.E.A.C.

With the entry of Diesel Traction into the Railway field the Vulcan Foundry



Erecting "Matilda" Tanks during the War.



immediately recognised the necessity of being able to supply their customers with this alternative form of Motive Power, and as a result in 1933 the Firm entered into an agreement with A/S Frichs of Aarhus, Denmark for the development of Diesel vehicles.

As a start a prototype 0-6-0 shunting Locomotive was designed, and completed in 1935, and subsequently 10 Rail Coaches were built for New Zealand. All these vehicles were provided with Frichs type power units manufactured at the Vulcan Works, and they are described in detail later in this brochure.

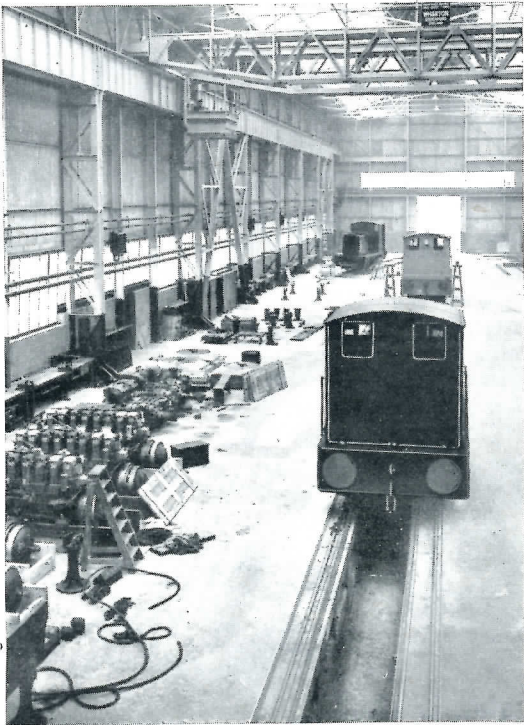
With the enemy occupation of Denmark the agreement with A/S Frichs was interrupted, and a new agreement was made with Messrs. The Drewry Car Co. Ltd. for the manufacture of Diesel Mechanical Locomotives of under 250 B.H.P. Many Locomotives of 153 B.H.P. were built for the Ministries of Supply and Works during the War for industrial and shunting purposes, and so popular has this unit become for this type of work that it can now be supplied in four different gauges. In addition, a more powerful version with a 204 B.H.P. Engine is now available, and this also is being built in a variety of gauges for service in three different continents. These Locomotives are provided with the well-known Gardner Diesel Engine and the Self-Changing Gear Co.'s transmission.

Apart from these smaller shunting Locomotives the Firm is also equipped to build the largest Electric and Diesel Electric Locomotives, or alternatively to manufacture the Mechanical parts.

Due to the exigencies of post-war production it is not at present possible to manufacture Diesel Engine Units at the Works at Newton-le-Willows, but Diesel Motors and Electrical Equipment of the latest design by approved manufacturers are provided to suit customers' requirements.

At the time of writing this brochure orders are in hand for the Mechanical Parts for six 1,600 H.P. Diesel Electric Locomotives for the Egyptian State Railways, and fifteen 3,000 volt D.C. Electric Locomotives for the San Paulo Railway of Brazil.

In order to meet the heavy present-day demand for this type of Motive Power a large new Diesel Locomotive Erecting Shop has been completed. This shop is 325 ft. in length by 67 ft. wide and is 41 ft. high to eaves. It is provided with two 50-ton overhead travelling cranes each with a 5-ton auxiliary hoist.

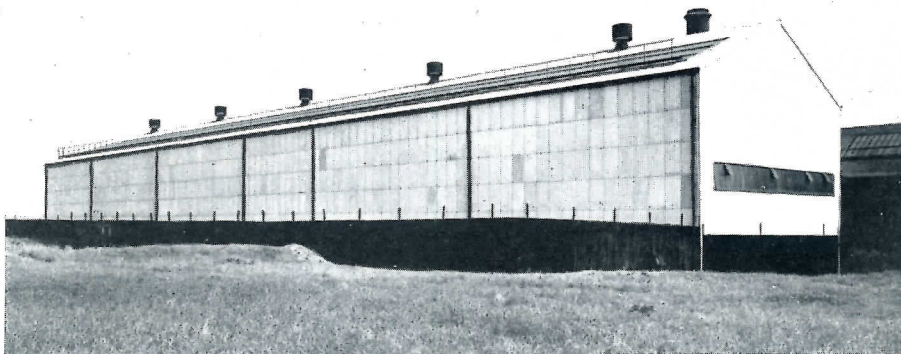


Interior of new Diesel Erecting Shop
a few days after its completion.

Adjoining this new shop are two further bays of the same length and each 40 ft. wide. These were converted during hostilities for War Department purposes, and they have now been adapted for general machining, fitting, assembly of electrical equipment, &c., in connection with Diesel Locomotives.

It will be realised, therefore, that the Vulcan Foundry now have excellent accommodation for Diesel Locomotive manufacture without interfering with Steam Locomotive production.

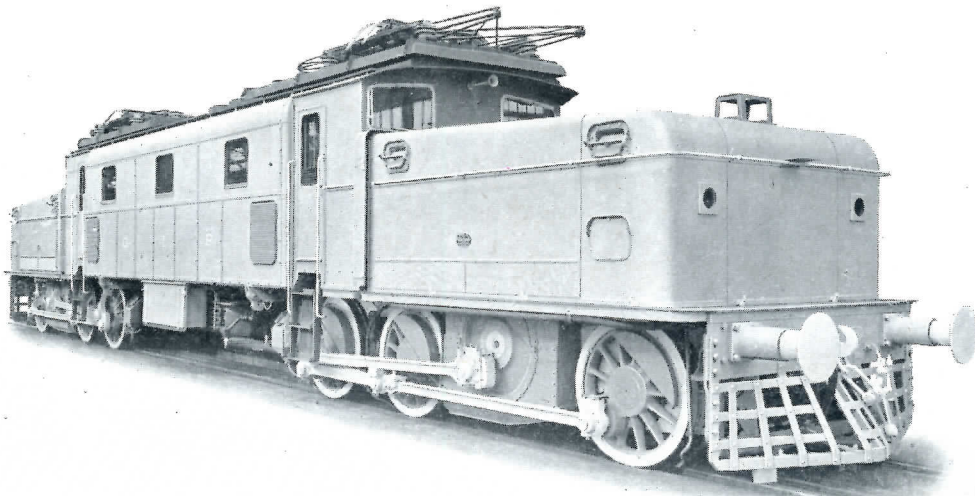
The following pages describe the Electric and Diesel Locomotives and Rail Coaches constructed in recent years.



Exterior of new Diesel Erecting Shop.



**2,600 H.P. 0-6-6-0 ELECTRIC FREIGHT LOCOMOTIVE,
GREAT INDIAN PENINSULA RAILWAY.**
(Built in conjunction with Metropolitan-Vickers Electrical Co. Ltd.)
5 ft. 6 in. Gauge.



2,600 H.P. 0-6-6-0 Electric Freight Locomotive, G.I.P. Railway.

IN 1928 the Vulcan Foundry built the Mechanical Parts for 31 heavy Electric Freight Locomotives on order with Messrs. Metropolitan-Vickers Electrical Co. Ltd., for



Freight Train operation on one of the "Ghat" sections, G.I.P. Railway.

the Great Indian Peninsula Railway. These Locomotives were required for the very steeply graded "Ghat" sections of the G.I.P. main lines running out of Bombay, which are encountered between Kalyan and Igatpuri and Kalyan and Poona. These sections were at that time in course of being electrified on the 1,500 volt D.C. overhead system because the difficulties of operating them with Steam Locomotives had greatly increased due to the heavier traffic. The first



of these lines has 32 miles (51.5 Kms.) of continuous up grade steeper than 1 in 100, including 6 miles (9.65 kms.) of 1 in 37, whilst the latter has 15 miles (24.1 kms.) of 1 in 37 to 1 in 40.



Hauling a heavy Freight Train near Bombay, G.I.P. Railway.

In consequence a powerful locomotive was required and an 0-6-6-0 design of articulated construction carried on two six wheeled trucks, was adopted. Although the total length over buffers is 66 ft. 1 in. (20,141 mm.) the wheelbase of each truck is only 15 ft. 1 in. (4,596 mm.), thus enabling the sharpest curves to be easily negotiated.

Each of the trucks is driven by two 650 h.p. motors connected to the running wheels through a jackshaft with connecting and coupling rods; the total h.p. which can be developed is therefore 2,600. The continuous rating Tractive Effort is 40,000 lbs. (18,144 Kgs.) at 20.5 m.p.h.; for an hourly rating at 18 m.p.h. it is 56,000 lbs. (25,481 Kgs.), and the maximum T.E. (at 25% coefficient) is 67,200 lbs. (30,482 Kgs.). The maximum permitted speed is 45 m.p.h. (72.5 k.p.h.).

The total weight of 123 tons is divided into 72.25 tons for the Mechanical Parts and 50.75 tons for the Electrical Equipment.



On each truck two motors, bolted together, are mounted above the frame between the two outer axles. Each pair of motors drives a common jackshaft by means of flexible gears with helical teeth ; crankpins on the jackshaft gear wheels transmit the power to the wheels through the rods. By raising the jackshaft axis above that of the driving wheels, the rods are located in one plane, thus reducing the bending moment on the crankpins.

The central body containing the driving cabs and control gear, is built upon one main longitudinal girder connecting the two motor units by means of large spherical pivots at the ends and supplemented by the necessary side members. These pivots are supported in housings on the bogie frames and through these housings the tractive effort is transmitted.

Four spring-loaded side bearers are fitted under the ends of the main cross stays of the underframes, bearing in sockets on the inner ends of the bogie frames, to give the necessary freedom between body and trucks when running.

Two reciprocating compressors driven by 1,500 volt motors provide air for operating the air brake on the Locomotive whilst two exhausters create the vacuum for the brakes of the train. The air brake on the Locomotive is operated automatically when the driver applies the vacuum brake valve. A foot pedal controls the compressed air sanding and an air operated hand valve raises and lowers the pantographs. All the necessary controls and meters are duplicated in each driving cab.

A résumé of the leading particulars of these Locomotives is as follows :—

Gauge : 5 ft. 6 in. (1,676 mm.).

Motors : 4 ; each 650 h.p.

Capacity : 2,600 h.p.

Current : 1,500 volt D.C.

Tractive Effort : (Continuous)

40,000 lbs. (18,144 Kgs.) at 20.5 m.p.h.

Tractive Effort : (Hourly rating)

56,000 lbs. (25,481 Kgs.) at 18 m.p.h.

Tractive Effort : (Maximum)

67,200 lbs. (30,482 Kgs.).

Diam. of Wheels : 4 ft. 0 in. (1,219 mm.).

Truck Wheelbase : 15 ft. 1 in. (4,596 mm.).

Total Wheelbase : 54 ft. 11 in. (16,738 mm.).

Length over Buffers : 66 ft. 1 in. (20,141 mm.).

Maximum Axle Load : 20½ tons.

Weight of Mech. Parts : 72¼ tons.

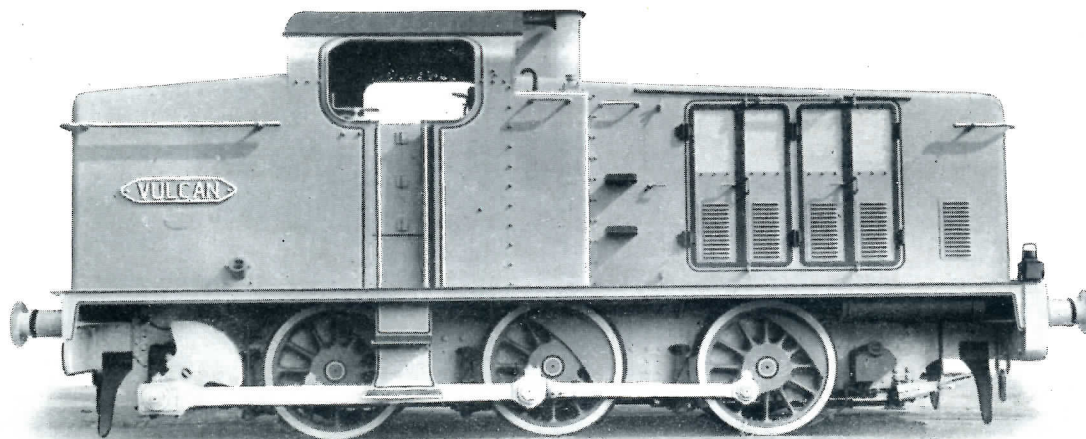
Weight of Elec. Parts : 50¾ tons.

Total Weight : 123 tons.

Minimum Negotiable Curve : 500 ft. (152 Ms.).



275-300 B.H.P. DIESEL MECHANICAL 0-6-0 LOCOMOTIVE.
4 ft. 8½ in. Gauge.



275-300 B.H.P. Diesel Mechanical 0-6-0 Locomotive.

Engine : 6 Cylinder 275/300 B.H.P. Vulcan Frichs 4 stroke.

R.P.M. : 775 maximum.

Cylinders : 8.5 ins. (215 mm.) bore x 11 in. (280 mm.) stroke.

Starting : Compressed Air at 440 lbs. per sq. in. (30.9 Kg. Cm²).

Maximum Tractive Effort : 20,300 lbs. (9,208 Kgs.).

Fluid Coupling : Vulcan Sinclair Ring Valve Type.

Gearbox : Wilson Pre-Selective Self-Changing, 4 speeds, pneumatically controlled.

Reversing : Bevel and Spur Drive to Jackshaft.

Diam. of Wheels : 4 ft. 0 in. (1,219 mm.).

Wheelbase : 12 ft. 0 in. (3,657 mm.).

Length over Buffers : 29 ft. 7¾ in. (9,036 mm.).

Maximum Width : 8 ft. 0 in. (2,438 mm.).

Maximum Height above Rail : 12 ft. 11 in. (3,936 mm.).

Brake : Compressed Air and Hand.

Fuel Tank Capacity : 320 gallons (1,454 litres).

Lubricating Oil Capacity : 50 gallons (227 litres).

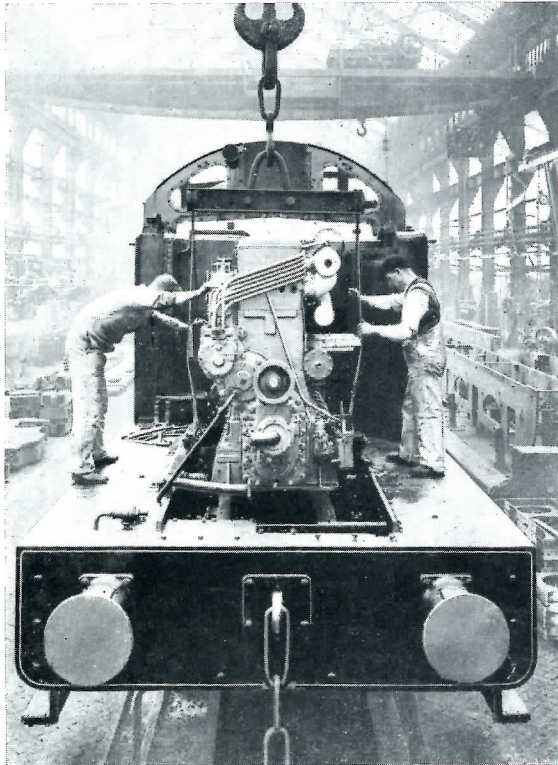
Adhesion Ratio : 5.24.

Maximum Axle Load : 17.25 tons.

Weight in Working Order : 47.5 tons.

THE six coupled Locomotive illustrated herewith was the first Diesel Locomotive to be built by the Vulcan Foundry, the design work being commenced in 1932. It is suitable for shunting work in marshalling yards and can also be utilised on Local Goods Train workings. The frames and mechanical parts are very robust and follow closely on standard steam practice, one of the main frame stays forming the bedplate for the Diesel Engine.

DIESEL ENGINE : Power is provided by a Diesel Engine of the Vulcan Frichs six cylinder, four stroke, solid injection 6215 CL type, developing a continuous output of 275 B.H.P. at 775 r.p.m. and capable of a short time rating of 300 B.H.P.



Lifting the Engine into the Frames.

The cylinder block is a steel casting with cast iron liners, held rigidly at the top and free to expand at the bottom. The crankshaft is carried on seven bearings having white metal linings on steel bushes and the big ends have white metal linings on bronze bushes.

The engine is safeguarded against overspeed when running downhill by a centrifugal governor which can release the pressure of the air engaging the transmission clutches, at the same time applying the Locomotive brakes. It is also protected against damage from a failure in the lubricating oil supply, since the governor controlling the fuel delivery is servo-assisted by the lubricating oil pressure, and the fuel by-pass valves remain open if this pressure falls too low.

Starting is effected by compressed air at 440 lbs. 30.9 Kg. Cm²) provided by an auxiliary petrol-driven compressor.

The engine is cooled by a radiator and fan, arranged at the side of the Locomotive. No special cooling arrangements are necessary for the lubricating oil as the whole of the oil (50 gallons) is in circulation.

TRANSMISSION : The mechanical transmission consists of a Vulcan Sinclair ring valve fluid coupling, a 4 speed Wilson pre-selective self-changing epicyclic gearbox, a reverse box with double reduction gear, and a jackshaft with driving and coupling rods.

The ring valve coupling forms a fluid transmission between the engine and the gearbox and allows the drive to be taken up smoothly, at the same time minimising shocks.

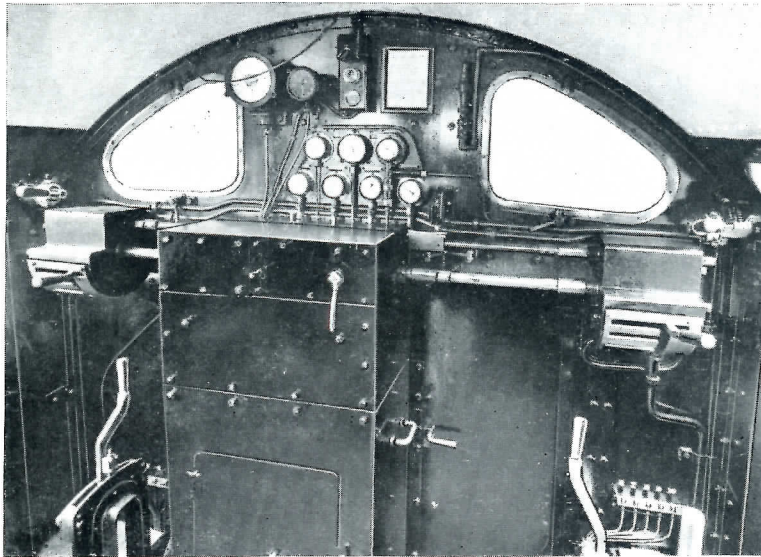
The Wilson gearbox gives speeds of 4.57, 11.4, 21.2 and 32.6 m.p.h. (7.3, 18.3, 34.1 and 52.5 k.p.h.) with the engine running at 775 r.p.m. The band tightening struts in the gearbox and the gearbox clutches are all air operated and there is a larger air piston for raising the bus bar.



The reverse gearbox consists of a totally enclosed bevel reverse and final reduction gear unit provided with nickel-chrome case-hardened steel spiral bevel and spur gears.

The final drive to the connecting and coupling rods is by a solid forged jackshaft with cranks at each end, supported on roller bearings of heavy design.

Flexible couplings are provided between the units of the transmission to allow for any flexing of the Locomotive frames.



View of Interior of Cab and Controls.

CONTROLS : The driving controls are ingenious and simple. Apart from the brake valve and reversing lever, there is only one main control handle and this is duplicated on either side of the cab. This handle regulates the engine speed, pre-selects the gears, puts the gears into operation and also actuates the ring valve of the fluid coupling. With the exception of the engine throttle, the movements are all servo-operated by means of compressed air. The main control handle can be moved downwards, and in four definite positions it can also be moved sideways in slots provided in the guide plate.

Side movement controls the engine speed whilst up and down movement performs the remaining operations automatically, a complete cycle taking place between each horizontal slot. A checking device is provided which prevents the lever being moved straight down through the various gear positions, it being necessary to move the lever horizontally, i.e. accelerate the engine at each successive gear step before it is possible to pass on to the next higher gear. It is, however, possible to return straight from top to bottom or to any intermediate gear as desired.



In changing from one gear to the next higher ratio, the operations, which are all carried out by means of the one lever in the correct sequence, are as follows :

- (1) The engine is reduced to idling speed.
- (2) The ring valve of the hydraulic coupling is closed.
- (3) The next gear ratio is pre-selected.
- (4) The next gear is engaged.
- (5) The engine is then accelerated in the new gear ratio.
- (6) The ring valve is opened.

AUXILIARIES AND ACCESSORIES : In addition to the separate petrol-driven compressor for starting, an engine-driven compressor provides air at 110 lbs. (7.73 Kgs. Cm²) for operation of the Wilson Gearbox. By means of a reducing valve lowering the pressure to 60 lbs. (4.22 Kgs. Cm²), the air brake, ring valve, horn, and sanding gear also obtain their pressure from this line.

A hand brake is provided and the driver's cab is equipped with all the necessary instruments and gauges including a speed indicator and mileage recorder.

THE LOCOMOTIVE IN OPERATION : When early trials had been completed at the Vulcan Foundry it was arranged that the Locomotive should be taken over by the L.M.S. Railway for service tests. It accordingly commenced work at Warrington in January, 1937, and was subsequently transferred to Bolton and Crewe, carrying out shunting operations and trips over a period of 18 months in the marshalling yards at these centres.



Shunting with a train of forty loaded wagons at Warrington, L.M.S. Railway.



At Crewe the Locomotive successfully handled work of a similar nature to that performed by the L.M.S., 350 H.P. Diesel Electric Locomotives and the average fuel and lubricating oil consumptions were stated by the Railway Company to be as follows :—

Fuel : 1.35 gals. per mile (3.8 litres/km.) ;
2.45 gals. per hour (11 litres/hour).

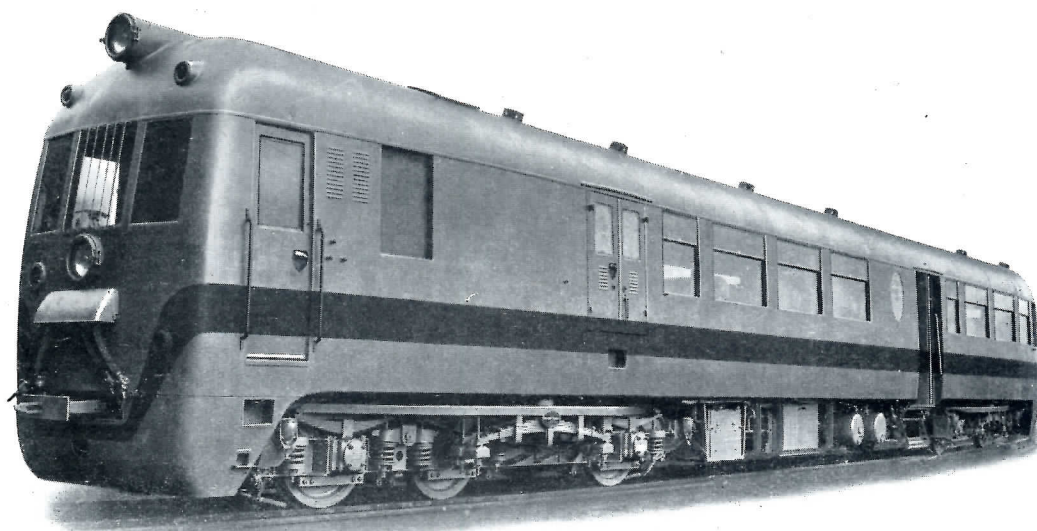
Lub. Oil : 0.112 pints per mile (0.063 litres/km.) ;
0.32 pints per hour (0.18 litres/hour).

During the War the Locomotive was taken over by the Ministry of Supply and utilised for hauling traffic on the Melbourne Military Railway and also for the instruction of Military drivers in the operation of Diesel Locomotives at No. 2 Railway Training Centre R.E. Derby. It has recently been working on behalf of U.N.R.R.A. at Trieste.



**250-275 B.H.P. DIESEL MECHANICAL RAIL COACHES.
NEW ZEALAND GOVERNMENT RAILWAYS.**

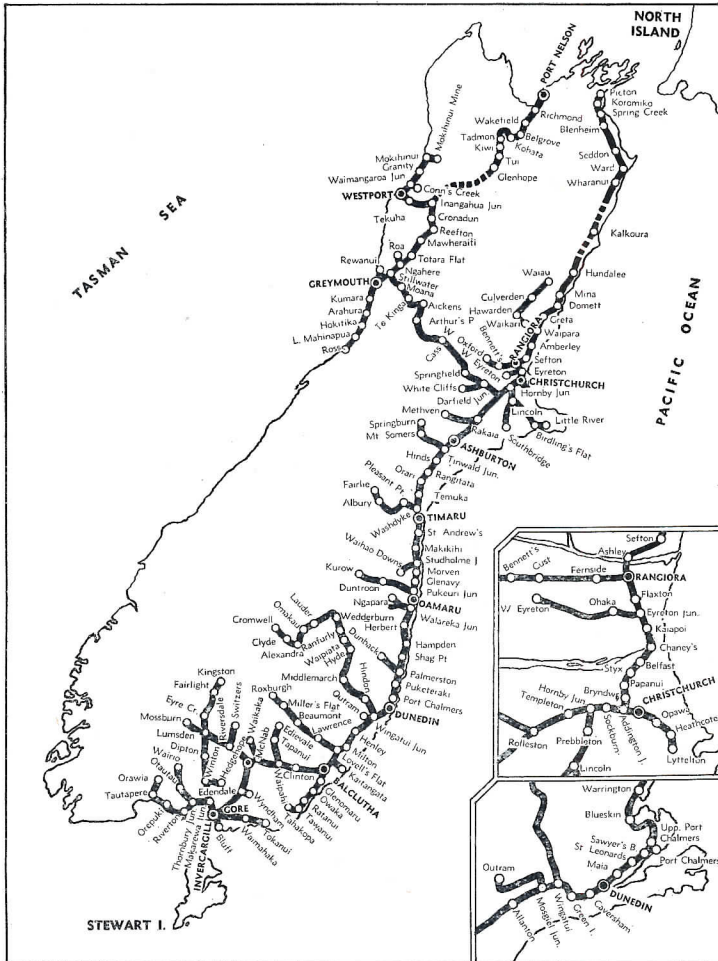
3 ft. 6 in. Gauge.



250-275 B.H.P. Diesel Mechanical Rail Coach, New Zealand Government Railways.

TEN Diesel Mechanical Rail Coaches of 250-275 B.H.P. with bodies supplied by English Electric Co., and with a seating capacity for 52 passengers, were designed and built by the Vulcan Foundry, and nine of these were put into service between 1940 and 1942 on the New Zealand Government Railways, whose gauge is 3 ft. 6 in. (1067 mm.). The tenth car was lost due to enemy action in transit.

Although maximum speeds of 76 m.p.h. (122 k.p.h.) have been attained by these Coaches when on trial, speeds for Railcars are normally limited to 55 m.p.h. (88.5 k.p.h.) in New Zealand. All the Coaches are employed in the South Island on the Christchurch-Timaru, and Christchurch-Greymouth-Hokitika-Westport routes, and in actual fact the fastest start to stop run in the Dominion is performed in daily service by these vehicles between Rakaia and Ashburton, a distance of 16.7 miles (26.9 Kms.), which is covered in 21 minutes at an average speed of 47.7 m.p.h. (76.8 k.p.h.).



Railway Map of S. Island, New Zealand.



Coach No. R.M. 52 at Ross Station, New Zealand Government Railways.

On the Christchurch-Greymouth route the Southern Alps mountains have to be negotiated and the line rises to a height of 2,400 ft. (731 Ms.) at the entrance to the Otira Tunnel, in which there is a six mile (9.6 kms.) gradient of 1 in 33. The Railcars ascend this gradient at 20 m.p.h. (32 k.p.h.).

The following is a brief description of these cars :—

LEADING DIMENSIONS :

Diesel Engine : "Vulcan-Frichs"
6185 C.A. 4-stroke. 250-275
B.H.P. at 1,000 R.P.M.

Transmission : Hydraulic Coupling,
"Vulcan - Sinclair" Traction
type.

Gearbox : Wilson Epicyclic with
five ratios and reverse.

Speeds : 14, 20, 35, 51 and 75
m.p.h. (22.5, 32.2, 56.3, 82.1
and 120.7 k.p.h.) at maximum
engine r.p.m.

Diam. of Wheels : 2 ft. 9 in.
(838 mm.).

Total Wheelbase : 53 ft. 6 in.
(16,306 mm.).

Overall Length : 66 ft. 3 in.
(20,193 mm.).

Seating Capacity : 52 passen-
gers.

Baggage : 1 ton.

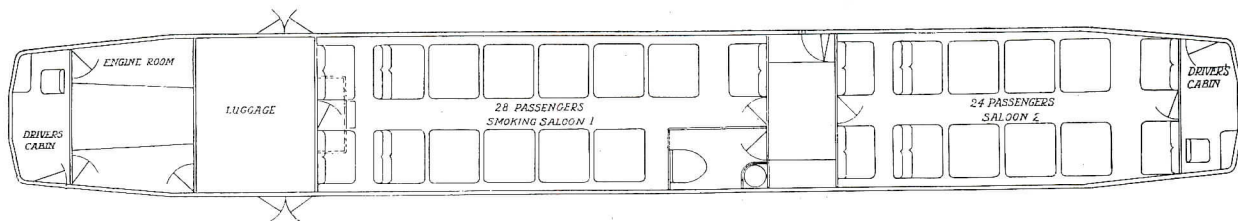
Fuel : 140 gallons (636 litres).

Maximum Axle Load : 8.5
tons.

Weight fully laden : 40.5 tons.



THE VEHICLE : Body and underframe are an integral welded structure, the roof being built separately. The solebars are each a single member running the full length of the car and form the underframe, which carries the fuel and water tanks, batteries, and air receivers. To this underframe is secured an auxiliary subframe, referred to later.



Plan of Seating Arrangement.

Side and roof panelling is in 18 s.w.g. steel, spot-welded to the framing. The exterior finish is devoid of mouldings. Seats are provided for 52 passengers in two compartments separated by an entrance vestibule. Folding steps are available for use where there are no platforms, and these are interlocked with air-operated jack-knife type doors. A baggage compartment is placed next to the engine-room.

Body weight is transferred to the two bogies by side-bearers and laminated springs. These bogies are of welded steel construction, and the carrying bogie has two axles with a wheelbase of 10 ft. (3,047 mm.).



Interior of one of the Saloons.

Three axles are used in the power bogie, which has a wheelbase of 12 ft. (3,657 mm.), but the centre one is fixed and has flangeless wheels revolving on S.K.F. spherical roller bearings; the other axles are fitted with the normal type of S.K.F. roller bearing axleboxes.

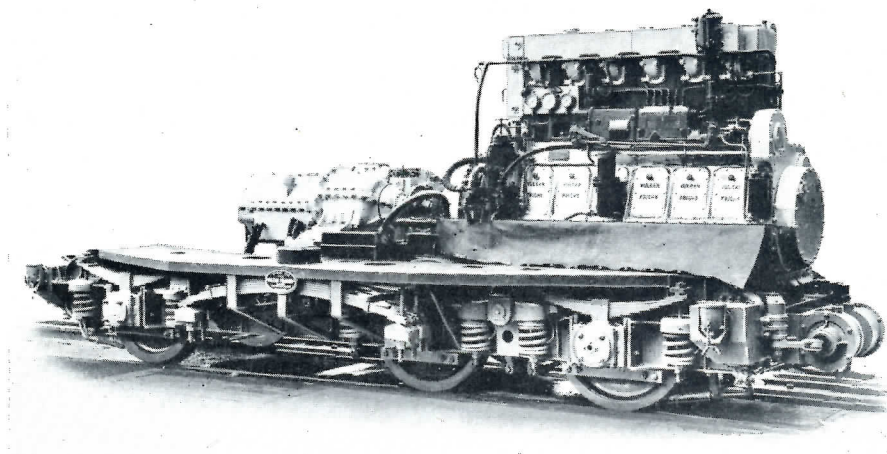
ENGINE : When these Rail Coaches were built, the Vulcan Foundry were manufacturing Diesel Engines in association with Messrs. Frichs of Aarhus, Denmark, and the Vulcan-Frichs 6185 CA

4-stroke power units provided were all built at Newton-le-Willows. This engine, supported on three anti-vibration rubber mountings, has six cylinders of $7\frac{9}{32}$ in. (185 mm.) bore and $10\frac{1}{4}$ in. (260 mm.) stroke and has a normal rating of 250 B.H.P. at 1,000 r.p.m. or a maximum of 275 B.H.P. for one hour at the same speed.



Seven bearings in the crankcase carry the solid-forged crankshaft, on the forward end of which is a friction type vibration damper as well as the distribution drive. The camshaft is in the crankcase, with push-rod and rocker operation for the valves.

Big-end bearings consist of white-metal lined bronze shells and the small-end bearings are fully floating with aluminium end pads for the gudgeon pins. Pistons are aluminium alloy, working in "wet" cast-iron liners pressed into the cylinder block. The cylinder heads are six detachable castings.



Engine in position on one of the Power Bogies.

Lubricating oil is circulated by a gear type pump. A cooler, which may be by-passed if desired, is mounted at the inner end of the power bogie. In addition to oil pressure warning lamps in the driving cabins, there is an automatic safety shut down device which is operated by the lubricating oil pressure in the governor. If the pressure falls appreciably, the governor shuts off the fuel and stops the engine.

This governor is of the centrifugal type, mounted in tandem with the C.A.V. fuel injection pump. It acts upon the fuel pump rack rod and controls deliveries at full load and idling position only ; normal working load fuel quantities are set solely by the air operated piston under the driver's control. To obtain overload power, the driver's engine speed control lever is moved beyond the full load position. This actuates an electrical solenoid which raises the wedge limiting the travel of the extended rack rod of the fuel pump. In this way the normal fuel delivery can be exceeded so long as the driver-controlled wedge is kept in the raised position.



FUEL, HEATING AND COOLING SYSTEMS : Fuel is carried in two underframe tanks of sufficient capacity for 800 miles (1,288 kms.) travel ; an air pressure of 6 lb. per sq. in. (0.42 Kgs./Cm²) delivers the oil through duplex filters to the ball-cock controlled service tank in the roof of the engine room. A cloth cartridge filter is placed between this service tank and the fuel feed pump, driven off the injection pump shaft, whilst a third C.A.V. filter is arranged between the supply pump and the injection pump.

On each side of the car is a filler for the main water tank, which supplies the cooling and heating systems, and a semi-rotary pump is installed for effecting this replenishment if an external pressure supply is not available. V-section belts from the hydraulic coupling drive the centrifugal pump on the engine bedplate, which serves the cooling system.

Two Coventry radiators are placed under the car facing outwards, so as to be unaffected by the direction of travel, and air passage through the elements is controlled by fans. Pivoted vanes can be set to scoop in the air in either direction, and baffles in the radiator headers direct the flow, which is horizontal.

These radiators are carried by an auxiliary subframe, suspended from the main underframe. Power for the various drives is taken from an auxiliary shaft which has Hardy-Spicer joints and is driven from the gearbox in the power bogie.

The auxiliary shaft also serves a Stone's 24-volt ventilated dynamo and a Westinghouse twin 26 cu. ft. min. (0.73 M³/min) compressor mounted on the sub-frame.

As the cars work in a dusty atmosphere special care was taken with the positioning of the air inlets, engine combustion air passing through a filter mounted in the top of the baggage compartment.

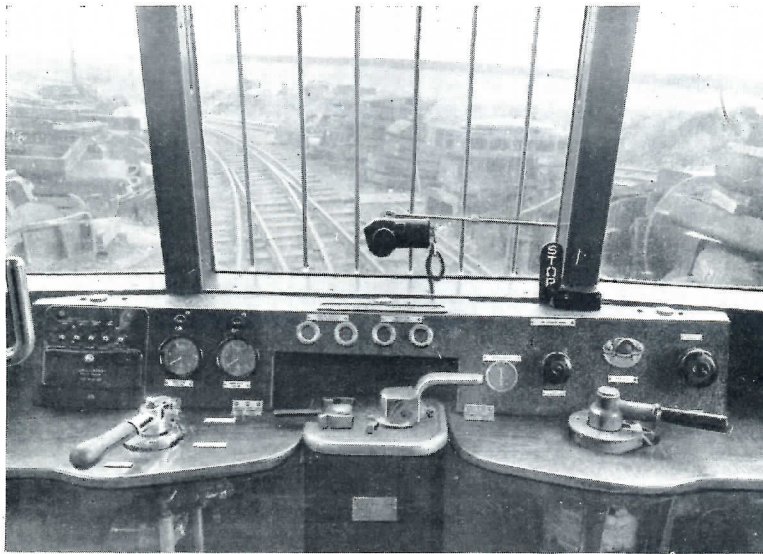
Heating of the cars is affected by Clayton-Dewandre units, employing engine cooling water, some being placed under the seats and one in each driving compartment. The hot air streams are directed by fans, and a thermostat controls the temperature of the water delivered to the heater. An air thermostat in each saloon cuts out the heaters if a predetermined temperature is exceeded. In hot weather the water is shut off and the fans in the heaters are used for air circulation.

TRANSMISSION : Behind the engine is a Vulcan-Sinclair traction type hydraulic coupling, which transfers the drive to a Wilson five-speed pre-selective epicyclic gearbox of the self-adjusting type. It is threepoint mounted in the bogie subframe. Between the hydraulic coupling and the gearbox is a Standage flexible coupling to deal with relative movement between the engine and gearbox.

The reverse mechanism is incorporated with the Wilson set. Layrub jointed shafts connect the gearbox and the spiral-bevel final drive boxes on the first and third axles of the power bogie. At 1,000 engine r.p.m. and allowing for coupling slip, the rail speeds are 14, 20, 35, 51 and 75 m.p.h. (22.5, 32.2, 56.3, 82.1 and 120.7 k.p.h.).



CONTROLS AND ACCESSORIES : The disposition of the controls as arranged for multiple unit operation, is shown in the illustration below, the engine speed control being pneumatic. In the case of the gearbox and reverse box, electro-pneumatic valves on the box casings operated by a controller in each cab admit air to the various cylinders. Thus, simple electrical circuits obviate lengthy flexible air hoses.



View of one of the Driver's Cabins.

A self-lapping valve controls Westinghouse straight air brakes and the control layout includes an automatic emergency feature. Should there be a loss of air from the emergency pipe, due to a breakaway, emergency application, or release of the "deadman's" pedal, the brakes on the coach are applied, bringing the engine to idling speed and putting the gearbox into neutral. Air for braking is derived from the compressor previously mentioned, and it also serves the gearbox controls, water and fuel raising systems, door operation and engine control.

All electrical circuits for the controls may be isolated by a removable key on the gearbox master controller, and this can be inserted or withdrawn only in the "off" position. It makes one or other driving desk "dead" and free from interference. When the master key has been inserted the engine can be started and air pressure built up.

The gear lever has a mechanical interlock, so that it cannot be moved to the first-gear position unless the direction lever is in forward or reverse.

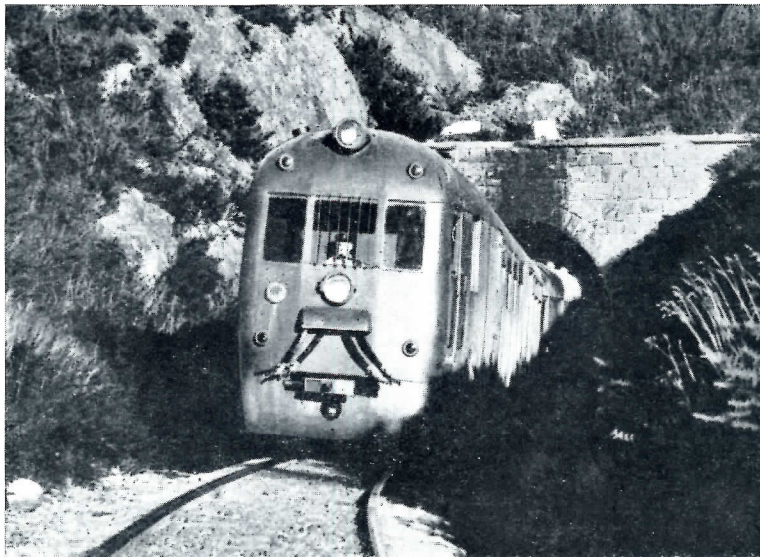
Starting is by a C.A.V. motor. Each car has a control for setting in motion the motor of an attached car if running in pairs, and in each engine room is a local starting point, primarily for the convenience of maintenance men.



When working in pairs the engine and transmission of either vehicle can be cut out by disconnection of a multi-point plug in the engine room which disconnects the control from these units.

The dynamo charges an Exide 24-volt battery, the charge and voltage of which are controlled by a Stone's carbon-pile regulator in the engine room control cabinet.

OPERATING DETAILS : These nine railcars have given consistently good service on the arduous routes on which they are employed and up to March 14th, 1947, they had completed 1,952,409 miles (3,143,350 Kms.) running, an average of 216,935 miles (349,250 Kms.) each.



Passing through the Southern Alp Mountains,
New Zealand Government Railways.

Some details of their performance during 1946 have been kindly supplied by the New Zealand Government Railways, and are as follows :—

Cost of Maintenance (Wages and Material).....	8.64d./mile (5.4d./km.).
Cost of Fuel	2.05d./mile (1.28d./km.).
Cost of Running and Cleaning Stores	0.74d./mile (0.46d./km.).
Total Cost of Operating.....	30.96d./mile (19.35d./km.).
Percentage of Available Working Days in Traffic...	83.21.
Fuel Consumption : Miles per gallon	6.35 (2.25 kms./litre).
Gallons per mile	0.157 (0.44 litres/km.).

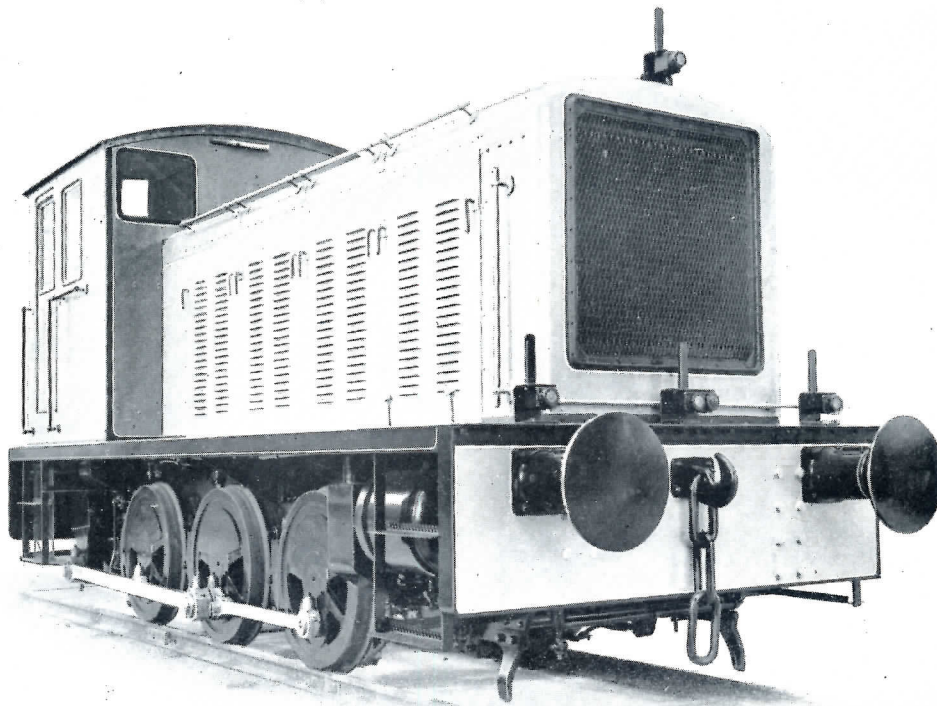
N.B.—The balance of 19.53d./mile of the 30.96 comprises Drivers', Guards' and Cleaners' Wages, Depreciation and Interest.



204 B.H.P. DREWRY DIESEL MECHANICAL 0-6-0 LOCOMOTIVE.

(Built in conjunction with the Drewry Car Company Ltd.).

Various Gauges.



204 B.H.P. Drewry Diesel Mechanical 0-6-0 Locomotive.

IN view of the outstanding success achieved by the 153 B.H.P. 0-4-0 units built in conjunction with the Drewry Car Co. Ltd., and described on page 32, it was decided that a somewhat larger and more powerful Locomotive should be designed on similar lines, but incorporating an 0-6-0 wheel arrangement and a 204 h.p. engine.



This Locomotive can now be supplied for gauges of 1 metre (1,000 mm.), 3 ft. 6 in. (1,067 mm.), 4 ft. 8½ in. (1,435 mm.) and 5 ft. 6 in. (1,676 mm.), the first two categories having outside frames and the latter two inside frames. They are of robust design with the vehicle based on Steam Locomotive practice with axleboxes of cast steel and gunmetal or phosphor bronze inserts.

At the time of going to press orders are in hand as follows :—

METRE GAUGE (1,000 mm.) :—

TANGANYIKA : Tanganyika Railway 3 Locomotives

3 ft. 6 in. GAUGE (1,067 mm.) :—

ALGERIA : Colomb Béchar Coal Mines... .. 2 ..
 TASMANIA : Tasmanian Government Railways 4 ..
 NEW ZEALAND : Ohai Railway Board... .. 1 ..
 New Zealand Government Railways 4 ..
 Wakatane Paper Mills 1 ..
 SOUTH AFRICA : Whites S.A. Portland Cement Co. ... 1 ..

4 ft. 8½ in. GAUGE :—

GREAT BRITAIN : L.N.E. Railway 1 ..
 Northern Aluminium Co. 2 ..
 ALGERIA : Colomb Béchar Coal Mines... .. 2 ..

5 ft. 6 in. GAUGE (1,676 mm.) :—

PORTUGAL : Portuguese State Railways 6 ..



DIMENSIONS : The principal dimensions of these Locomotives, subject to any minor modifications which may be necessary for specific orders, are as follows :—

<u>Gauge</u>	<u>METRE</u>	<u>3 ft. 6 in.</u>	<u>4 ft. 8½ in.</u>	<u>5 ft. 6 in.</u>
Wheel Diam.		3 ft. 3 in. (991 mm.)		
Wheelbase		9 ft. 0 in. (2743 mm.)		
Overall Length	27 ft. 6 in. (8381 mm.)	27 ft. 6 in. (8381 mm.)	25 ft. 9 in. (7848 mm.)	25 ft. 9 in. (7848 mm.)
Length over Buffer Beams	22 ft. 6 in. (6857 mm.)	22 ft. 6 in. (6857 mm.)	22 ft. 6½ in. (6870 mm.)	22 ft. 6½ in. (6870 mm.)
Overall Width	8 ft. 0 in. (2438 mm.)	8 ft. 6 in. (2590 mm.)	8 ft. 6 in. (2590 mm.)	8 ft. 6 in. (2590 mm.)
Height above Rail	11 ft. 3 in. (3429 mm.)	11 ft. 6 in. (3505 mm.)	12 ft. 2 in. (3708 mm.)	12 ft. 2 in. (3708 mm.)
Fuel Capacity		150 gallons (681 Litres)		
Max. Axle Load	9 tons app.	9 tons app.	10 tons app.	11 tons app.
Weight in Work'g Order	26½ tons app.	26½ tons app.	28 tons app.	30½ tons app.
Max. T.E. under normal conditions :—				
Final Drive 8.47 : 1			14680 lbs. (6659 Kgs.)	
Final Drive 9.83 : 1			16900 lbs. (7666 Kgs.)	

ENGINE : The Engine is of the cold starting, airless injection 8L3 type constructed by Messrs. Norris, Henty & Gardner Ltd., of Patricroft, Manchester, and has 8 cylinders in line, 5½ in. (140 mm.) bore by 7¾ in. (197 mm.) stroke. This engine has a swept volume of 24.1 litres, an idling speed of 330 r.p.m., and develops a B.H.P. of 204 at the maximum governed speed of 1,200 r.p.m.

The cylinders are in pairs with renewable liners and each cylinder head is separate and detachable, with one inlet and one exhaust valve actuated by push rods and enclosed rockers.

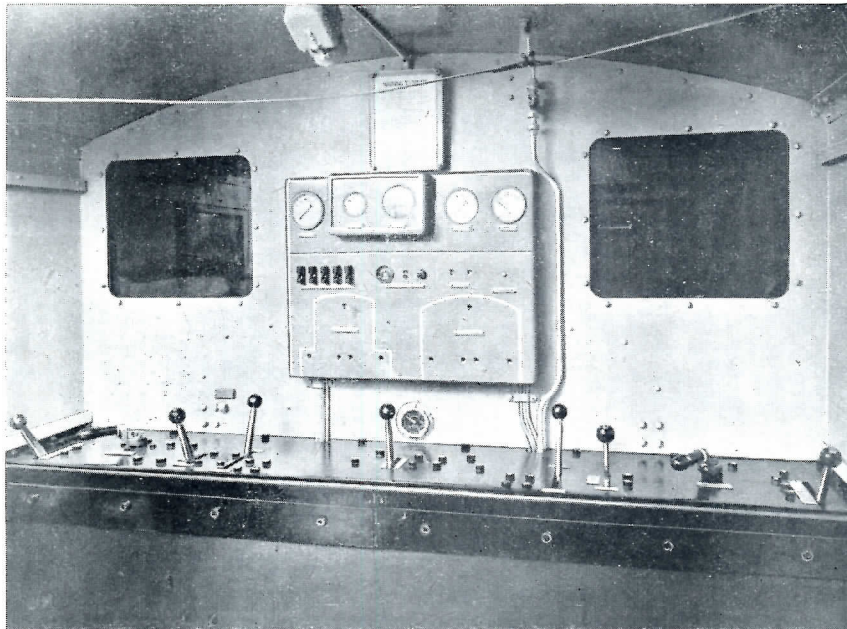
A Gardner C.A.V. fuel pump controlled by a variable speed Governor is employed for fuel injection, the sprayers being of the multi-hole type.

Lubrication is forced throughout to all engine bearings including connecting rod small ends, and special double interconnected oil pumps are fitted for circulating the oil through the external oil radiator.

Starting is by means of two C.A.V. 24 Volt axial type electric starters engaging with a toothed ring on the engine fly wheel; no heater plugs or other external adjuncts are required.



CONTROLS : The main controls in the driver's cab consist of the engine speed control, change speed control, reversing handle and driver's brake valve, all these being duplicated on either side. The change speed and reversing controls are interlocked to prevent operation of the reversing handle until the change speed has been put in the neutral position. Engine starter and stop buttons, sanding gear, and a screw hand brake are also provided.



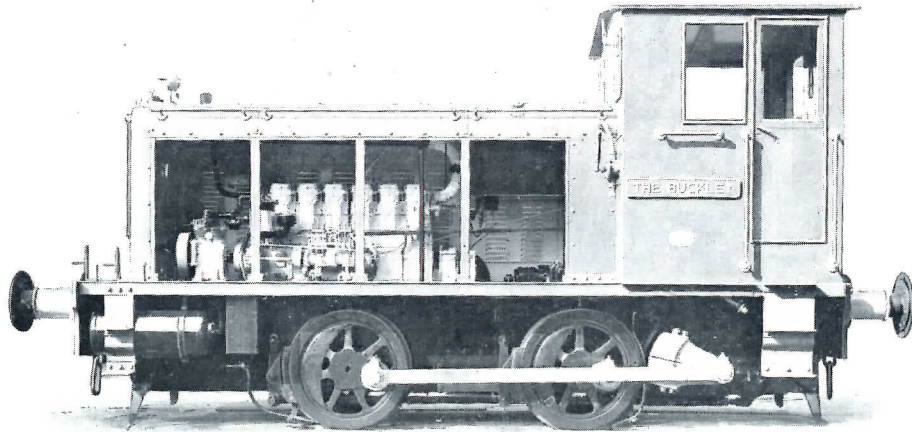
View of Interior of Cab.

ACCESSORIES AND EQUIPMENT : The air service for gear changing, braking and sanding is provided by an engine-driven Westinghouse reciprocating compressor. A Westinghouse straight air brake with self-lapping brake valve affords the braking power, but if the locomotive is required to operate with vacuum-braked stock, an engine-driven exhaustor is also provided together with a vacuum-operated straight air application valve controlling the air brake on the Locomotive itself.

Other fittings worthy of mention are the air-operated whistle, C.A.V. 24 volt engine-driven generator, starter motor, and large capacity lead acid battery. All the necessary instruments and gauges are provided on the control panel, and electric lighting can be fitted according to requirements.



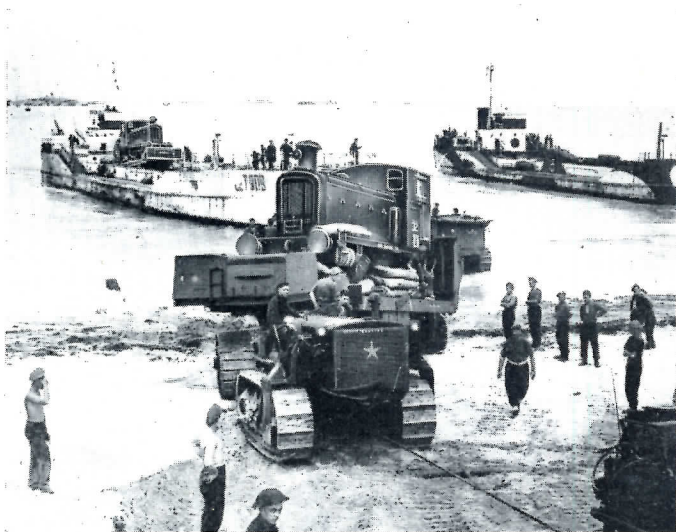
153 B.H.P. DREWRY DIESEL MECHANICAL 0-4-0 LOCOMOTIVE.
 (Built in conjunction with the Drewry Car Co. Ltd.).
Various Gauges.



153 B.H.P. Drewry Diesel Mechanical 0-4-0 Locomotive.

THE 153 B.H.P. 0-4-0 Locomotive illustrated above is the predecessor of the 204 B.H.P., 0-6-0 type described on page 26 and is extremely similar in conception and design. It is very popular for industrial duties and yard shunting work.

Thirty-four of these Locomotives have been built at Newton-le-Willows to standard 4 ft. 8½ in. gauge for :—



Landing 153 B.H.P. 0-4-0 Locomotives in Normandy shortly after D-Day.

Ministry of Supply	25
Ministry of Works	7
Liverpool Gas Co.	1
Vulcan Foundry Ltd.	1

and at the time of going to press a further 9 are in hand for :—

Liverpool Gas Co.	1
Barking Jetty Co. Ltd.	1
New Zealand Government Rlys.	5
Wm. Cory & Son	2

The 5 for New Zealand are for 3 ft. 6 in. (1,067 mm.) gauge.



Those supplied to the Ministries of Supply and Works were all employed in Government Factories, Ordnance Yards and Transportation Stores Depots during hostilities, this being the type of work for which they are admirably suited.

DIMENSIONS : The following are the principal dimensions :—

Wheel Diameter : 3 ft. 3 in. (991 mm.).	Height above Rail : 11 ft. 7 $\frac{3}{4}$ in. (3,550 mm.).
Wheelbase : 6 ft. 3 in. (1,905 mm.).	Fuel Capacity : 100 gallons (454 litres).
Overall Length : 23 ft. 9 in. (7,239 mm.).	Adhesion Ratio : 4.74.
Length over Buffer Beams : 20 ft. 0 $\frac{1}{2}$ in. (6,108 mm.).	Maximum Axle Load : 11.5 tons.
Overall Width : 8 ft. 0 $\frac{1}{2}$ in. (2,451 mm.).	Weight in Working Order : 22.75 tons.

ENGINE : Power is furnished by a Gardner 6.L.3 Engine developing a maximum of 153 B.H.P. at 1,200 r.p.m., and having 6 cylinders 5 $\frac{1}{2}$ in. (140 mm.) bore x 7 $\frac{3}{4}$ in. (197 mm.) stroke giving a swept volume of 18.1 litres. The arrangements for starting, cooling and lubrication are all of the same pattern as those used in the 204 H.P. Locomotives.

TRANSMISSION : Here also a Vulcan-Sinclair rigid traction type fluid coupling is used to transmit the power, together with a Wilson-Drewry Epicyclic gearbox, reverse and reduction gears, jackshaft and driving and coupling rods, all similar to those previously described. In this case, however, the gearbox has only 4 ratios, and at the maximum of 1,200 r.p.m. the following speeds and tractive efforts are obtained :—

<u>Gear</u>	<u>Speed</u>	<u>Tractive Effort</u>
1st	4 m.p.h. (6.43 k.p.h.)	10,750 lbs. (4,867 Kgs.)
2nd	7 m.p.h. (11.26 k.p.h.)	6,150 lbs. (2,790 Kgs.)
3rd	11 m.p.h. (17.7 k.p.h.)	3,900 lbs. (1,769 Kgs.)
4th	16 $\frac{1}{4}$ m.p.h. (26.1 k.p.h.)	2,650 lbs. (1,202 Kgs.)

CONTROLS AND ACCESSORIES : Air brake, accelerator, change speed, reverse and sanding controls are all duplicated on either side of the driver's cab. The Westinghouse straight air brake with self-lapping brake valve, obtains air pressure from a twin cylinder compressor, and sanders and whistle are also air operated.

OPERATING DETAILS : The Locomotive "Matilda" in service at the Vulcan Foundry's own Works at Newton-le-Willows started its duties on June 7th, 1943, and was not withdrawn from service for a major mechanical overhaul until September 1st, 1947, and during these 4 $\frac{1}{4}$ years' service has proved so reliable and economical as to become absolutely indispensable.



Our customers also report most favourably and one of them gives us the following servicing data :—



Series of 153 H.P. Locomotives
for M.O.S. under erection.

Total Hours Worked between April 20th, 1945,
and January 24th, 1946 :—

(7.3 hours per day excluding Sundays)
1,741 hours.

Fuel Oil Used :—

1,260 galls. (5,720 litres).

Average Fuel Consumption :—

0.72 galls./hr. (3.27 litres/hr.).

Lubricating Oil Used :—

28 gallons (127 litres).

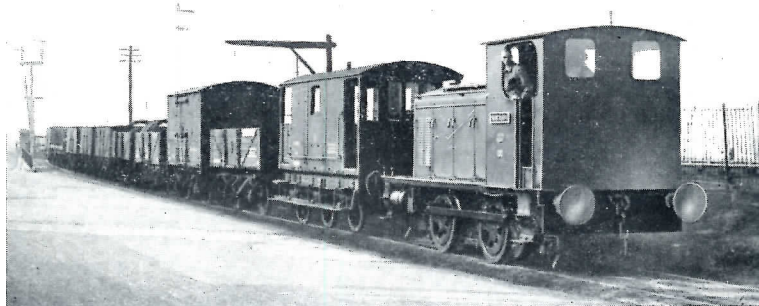
Average Lubricating Oil Consumption :—

0.128 pints/hr. (.072 litres/hr.).

Man Hours per week spent on Routine
Servicing :—

8 hours.

These figures correspond closely with the experience obtained with the "Matilda" which at the Vulcan Works regularly hauls 200 tons up a gradient of 1 in 90 on a curve of 300 ft. (91 ms.) radius.



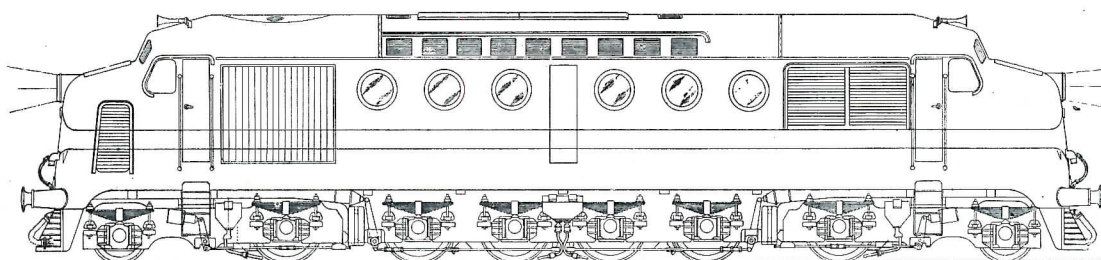
Operating a Shunt at Vulcan.



1,600 B.H.P. DIESEL ELECTRIC LOCOMOTIVES. EGYPTIAN STATE RAILWAYS.

(Under construction in conjunction with Messrs. English Electric Co. Ltd.).

4 ft. 8½ in. Gauge.



Outline diagram of 1,600 B.H.P. Diesel Electric Locomotive, E.S.R.

Under construction at the Vulcan Foundry at the time of going to press are the Mechanical Parts for six 1,600 B.H.P. Diesel Electric Locomotives forming part of an order for 12 Locomotives received by Messrs. English Electric Co. Ltd., for the Egyptian State Railways. The other 6 units are being constructed throughout by English Electric Co. Ltd. with whom the Vulcan Foundry have collaborated in the mechanical design.

English Electric Co. Ltd. are supplying the complete power transmissions for all the Locomotives, the leading particulars of which are as follows :—

Locomotive Type : 1-Ao-Do-Ao-1 (4-8-4 with inner axles of each bogie motored.

Diesel Engine : E.E. Co. 16 SVT 16-Cylinder Supercharged, 10 in. (254 mm.) bore, 12 in. (305 mm.) stroke, 1,600 h.p. at 750 r.p.m.

Transmission : Electric.

Traction Motors : 6.

Tractive Effort (continuous) : 15,600 lbs. at 29 m.p.h. (7,076 kgs. at 47 k.p.h.).

Tractive Effort (Hourly Rating) : 18,000 lbs. at 25 m.p.h. (8,165 kgs. at 40 k.p.h.).

Tractive Effort (max.) : 35,000 lbs. (15,875 kgs.).

Wheel Diam. (Motored) : 3 ft. 9 in. (1,143 mm.).

Wheel Diam. (Carrying) : 3 ft. 0 in. (914 mm.).

Rigid Wheelbase : 16 ft. 0 in. (4,877 mm.).

Fuel Capacity : 760 gallons (3,453 litres).

Maximum Axle Load : 17 tons.

Adhesive Weight : 100 tons.

Weight in Working Order : 124 tons (approx.).

Maximum Service Speed : 75 m.p.h. (121 k.p.h.).



From the illustration showing the outline of the Locomotive, it will be seen that a rigid frame design has been adopted in which all four axles are motored by means of axlehung, single reduction, force-ventilated traction motors. In addition a traction motor also drives the inner axle on each of the two 4-axle bogies. The adoption of this form of wheel arrangement was in some measure dictated by the permitted axle-loading.

A driving cab is provided at each end behind the partially streamlined nose which houses certain items of auxiliary equipment.

The body space between the driving cabs is occupied by the main engine and generator set, cooling equipment and control apparatus.

Special precautions have been taken to ensure an adequate supply of clean air being available for the engine and electrical equipment and to prevent the ingress of dust and other impurities in the Locomotive body.

Power operated air braking will be provided on all driving wheels of the Locomotive, which also carries exhausters for brake operation of vacuum fitted stock. Roller bearings are fitted to all wheels.

The Locomotives are being arranged for multiple unit operation.

We are indebted to the following for a number of the photographs reproduced :—

Metropolitan Vickers Electrical Co. Ltd., Manchester.
G. W. Arnold & Co. Ltd., Wellington, New Zealand.
The Drewry Car Co. Ltd., London.