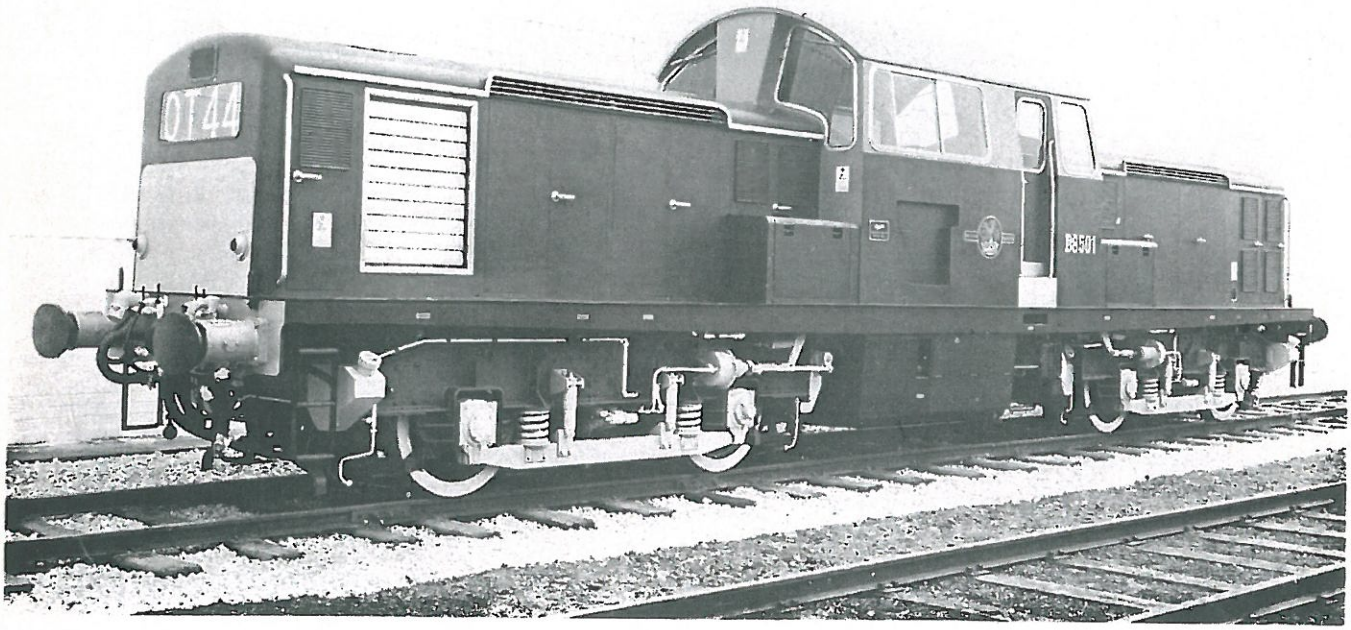
Standard Type 1 Diesel-Electric Locomotive

for

British Transport Commission



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Reprinted from Diesel Railway Traction, November 1962 issue

PUBLICATION NO. 1003

Small General-Purpose Locomotives for B.R.

Centre-cab 900 b.h.p. diesel-electric design incorporating twin horizontal engines for the Scottish Region

Fig. 1—New type 1 locomotive showing the centre cab with a 450 b.h.p. power-unit mounted over each bogie

ADVENT of the new type 1 locomotive marks a number of departures from the rather conventional aspect of British Railways' locomotive designs to date. In the first place a twin power-unit is used, though single engines of suitable output are readily available; secondly, the transmission is electric though all twin-engine installations hitherto, with the exception of the type 5, have incorporated hydraulic drives; finally a horizontal engine has been selected and mounted above underframe level. The reason for selecting a flat twin power-unit is to provide a centre cab arrangement and improve driving visibility and so implement the economics of single-manning for duties where the locomotive is frequently reversed. The existing hood-type locomotives provide a poor out-look for the driver in the forward direction and restricts shunting and pick-up duties. The provision of two engines indicates that the slight increase in maintenance time compared to that for one unit is not sufficient to overrule the operating advantages of the shorter twin bonnets.

Enquiries to leading British builders invited designs for single- and double-engine power units; and the selection of a design submitted by Clayton followed that company's earlier work for B.R., for it designed and built the mechanical parts and erected the type 1 locomotives ordered from Associated Electrical Industries Ltd. In this earlier Clayton design the Paxman 12-YL engine was used, and a total of 44 have been delivered. They are used principally on the Great Eastern Lines of the Eastern Region. All 88 Bo-Bo locomotives of the present order are scheduled for allocation to the Scottish Region.

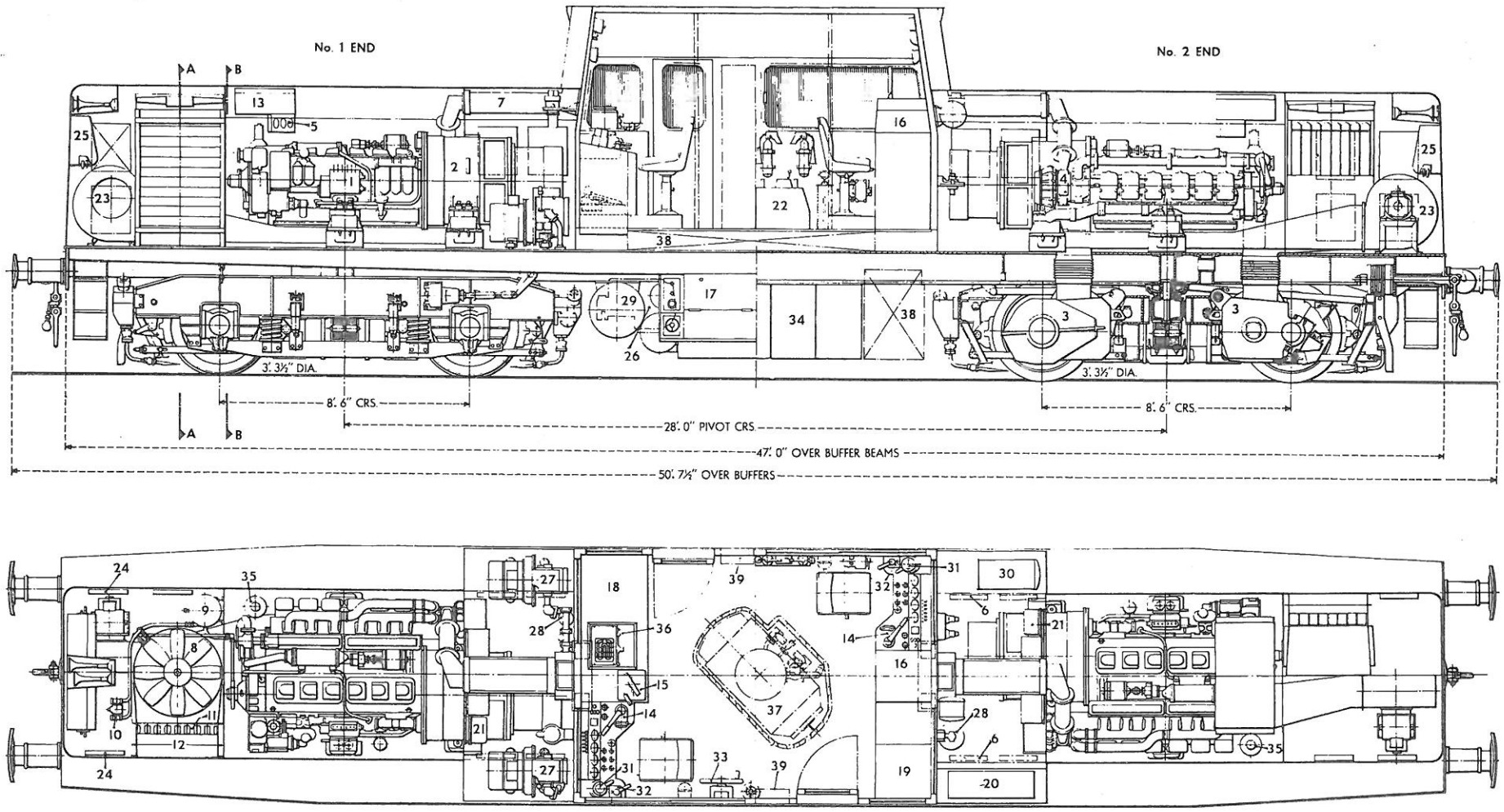
The design provides for the installation of a train-heating boiler in the driving cab, but this is not required for those at present on order for the Scottish Region. Such provision would suit these locomotives to passenger-train running and empty stock station pilot work in winter. As far as type 1 locomotives are concerned this class of work has had to be restricted to the summer period, and has included week-end passenger excursion services from the London area. It would seem the handling of electrically-heated stock for empty-train station working could be easily accommodated. Heating could be supplied by one generator set, as the new locomotives are arranged to power the four traction motors by either prime mover. British Railways have, however, restricted electric heating to the Southern Region under present conditions and there would appear to be a likelihood of this for policy continuing for some time to come.

Power-Equipment Layout

The locomotive is symmetrically arranged about the transverse centre line with two quick-running light-weight Paxman/G.E.C. power units fore and aft of the centre cab. The principal dimensions of the locomotive are given in Table I. Each of the

TABLE I—LEADING PARTICULARS OF THE TYPE 1 CLAYTON LOCOMOTIVE

Wheel arrangement	Bo-Bo
Weight in running order	68 tons
Tractive effort (maximum)	40,000 lb.
Tractive effort (continuous)	18,000 lb. at 13 m.p.h.
Wheelbase (total)	36 ft. 6 in.
Wheel diameter	3 ft. 3½ in.
Bogie wheel centres	8 ft. 6 in.
Bogie pivot centres	28 ft.
Width overall	8 ft. 9⅛ in.
Height overall	12 ft. 8 in.
Length overall	50 ft. 7½ in.
Length over buffer beams	47 ft.
Minimum curve	230 ft.
Maximum permissible speed	60 m.p.h.
Minimum hump radius	660 ft.
Fuel tank capacity	500 gal.
Cooling water (per power unit)	Radiator—8·5 gal. Header tank and system 36 gal. Engine—5 gal. Total—49·5 gal.
Diesel engines (2)	Paxman type 6ZHXL pressure-charged and developing 450 h.p. at 1,500 r.p.m.
Main generator (2)	G.E.C. self ventilated type, continuous rating 157 h.p. 397 V. 350 A. at 480 r.p.m.
Traction motor gear-ratio	15 to 66
Blower motor (2)	G.E.C. continuous rating 7·9 h.p. 110 v. 67 A.
Lighting circuit	110 V.
Radiator fan	Serck-Behr hydrostatic drive. Fan 2 ft. 9 13/16 in. dia.
Exhauster (2)	Northey type 125 RE.FM. electric motor driven. Capacity 128 A. at 1,850 r.p.m.



1—Diesel engine
2—Main and auxiliary generators
3—Traction motor
4—Turbo-charger
5—Engine instrument panel
6—Engine and generator air filters
7—Engine exhaust
8—Radiator fan
9—Hydrostatic drive oil tank
10—Hydrostatic drive controller
11—Radiator elements
12—Radiator shutters
13—Radiator header tank
14—Master controller
15—Selector switch
16—Voltage regulator
17—Battery box
18—Main control cubicle
19—Auxiliary control cubicle
20—Weak field resistance
21—Load regulator
22—Battery isolator
23—Traction motor blower
24—Blower air filters
25—Route indicator
26—Air compressor
27—Exhauster
28—Brake equipment
29—Air reservoirs
30—Control reservoir
31—Vacuum brake valve
32—Air brake valve
33—Handbrake
34—Fuel tank
35—Fire extinguisher cylinder
36—Breakfast cooker

OPTIONAL EQUIPMENT

37—Train heating boiler
38—Boiler water tanks
39—Water filling duct

Fig. 2—Layout of equipment of type 1 Bo-Bo 900 b.h.p. diesel-electric locomotive

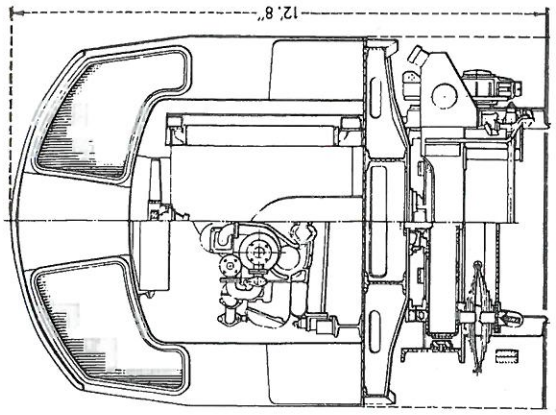


Fig. 3—Cross section of type 1 locomotive

two power-units incorporates the Paxman turbo-charged six-cylinder diesel engine Type 6ZHXL rated at 450 b.h.p. at 1,500 r.p.m. This is a lightweight four cycle direct-injection horizontal engine primarily designed for underfloor installation in diesel railcars and trials in daily railcar service commenced in 1956 with two production units on the London Midland Region. These service trials showed good reliability and extended over a period of 17 months. Cast-aluminium is used for the six-cylinder monobloc, the cylinders of which are 7-in. bore and 7¾ in. stroke. Piston speed is 1,937 ft. per min. and the b.m.e.p. 132·5 lb. sq. in. The four-valve heads are cast in light alloy and have replaceable valve seats. The main and big-end bearings are of the prefinish steel shell copper-lead type with the bearing surface lead-tin plated.

The engine auxiliary drives are at the free end of the engine and are taken through a torsionally flexible coupling. Engine speed is controlled by an Ardleigh type 303 pneumatic control governor. An independent electrically-driven pump is fitted for priming the lubricating system before starting. Each power group is mounted on four B.T.R. low frequency resilient mountings and has its own radiator and cooling equipment with a single radiator panel mounted in the body side. Each cooling group is of the Serck-Behr type in which the fan is driven hydrostatically and its speed regulated under thermostatic control. Under similar thermostatic control shutters outside the radiator elements are opened and closed pneumatically. Air is drawn in over the radiator blocks through the sides and expelled upwards. Combustion air for the diesel engine is drawn from the generator compartment through oil-wetted filter panels mounted in the bonnet side doors. The exhaust passes through stainless steel flexible bellows and mild steel ducting and is expelled through bifurcated outlets attached to the outer cab bulkheads. One fuel tank is provided to supply both engines, but separate fuel lines are installed. Each line has an Auto-Klean fuel strainer and a non-return valve. By this means, in the event of fuel-line blockage, one engine will always be available. The fuel tank is fitted with a self-sealing pressure filler, a mechanical fuel gauge and 1½-in. drain valve. These are duplicated on each side of the locomotive. An additional feature is that of an automatic shut-off valve to prevent over filling and spillage on to the track. With only 50 gal. or so in the tank, the low level switch lights up a fault lamp in the cab. A 20-gal. radiator header tank is fitted; it has a sight glass to indicate the water level and a low level switch which shuts down the engine if loss of coolant occurs.

Main and Auxiliary Generators

The main generator is a self ventilated G.E.C. type W.T.800 single bearing machine and has a continuous rating of 274 kW. The generator shell is flange-mounted to the engine crankcase. The frame is fabricated from rolled steel plates with the main poles secured to it by bolts which engage with steel clamping bars in the pole pieces. Field coils are former-wound with high conductivity copper, using class " F " insulation. Chafing of the coils is prevented by fitting steel springs between them. The armature conductors are to class " B " insulation and are formed from rectangular copper strip. A semi-rotating type brush gear assembly is fitted to facilitate maintenance. The auxiliary generator, type WT.763, has a continuous rating of 35kW, and is flange-mounted on the end of the main generator. The armature is mounted on an extension of the main generator shaft. Voltage is maintained constant at all engine speeds by a carbon-pile automatic voltage regulator. Ventilation of both the main and auxiliary generators is by a fan mounted at the driving end of the armature shaft. Air is drawn in at the rear end and discharged at the front.

Traction Motors

The four force-ventilated series wound traction motors, are G.E.C. type WT 421 and have a continuous rating of 157 h.p. at 480 r.p.m. These motors are axle-hung on whitemetal sleeve bearings and drive through 15/66 reduction gearing. Heavy duty class " H " insulation is used for all windings. To

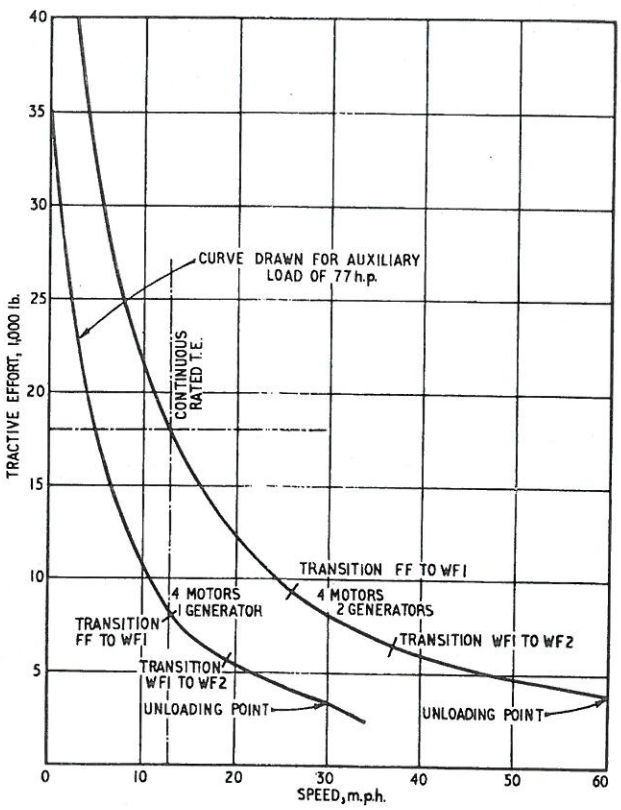


Fig. 4—Tractive effort curves, showing single- and twin-engine performance

Fig. 5—View from driving cab showing excellent visibility and freedom of movement for the driver

eliminate vibration the armatures are produced with a high degree of dynamic balance. Each pair of motors are force-ventilated by a motor-driven blower of 7·9 h.p. running at 2,465 r.p.m.

The traction motors are arranged permanently in parallel with two weak field steps. Transition from full to weak field is initiated automatically in steps at any engine-load setting without increasing engine speed. Backward transition from weak field to full field is in one step only. When operating four motors from one engine the motors are arranged in series pairs. Either pair and either engine may be isolated by the selector switch. Wheel slip is detached by a relay between two motors which causes the load regulator to run back into the full resistance position, the tractive effort is thus automatically reduced.

Superstructure

The superstructure is divided into three main sections: no. 1 equipment casing, cab, and no. 2 equipment casing. Each equipment casing is divided into three compartments; the radiator section, the engine compartment, and the generator compartment. The radiator section is a sealed compartment and it houses the radiators, fan, fan ducting and traction-motor blowers. Air for the traction-motor blowers is drawn through oil-wetted filter panels in the radiator compartment side doors and blown through steel ducting and flexible moulded rubber bellows into the traction motors. The generator compartment is sealed from the engine room. This is to prevent recirculation of warm air and the ingress of oil mist and dirt into the compartment. The generator cooling air is discharged into the engine compartment, thereby pressurising it, and the engine-room air flow then passes to atmosphere through the louvres fitted in the compartment roof.

A three-way pneuphonic horn is mounted in the nose compartment. This enables the driver to sound high and low notes on his front facing horn and a high note on the rear facing horn. A four-digit route indicator is fitted at each end of the locomotive, and to the control handles are accessible through the radiator compartment.

Driving Cab

Two identical diagonally-opposite driving positions are provided. The cab is built of steel sections and plate and lined with fibreglass panels and hardboard. The space between the interior and exterior panels is filled with heat and sound absorbing material. Large armour plate glass windows occupy most of the front and rear cab walls above bonnet level, and equally large sliding side windows are provided adjacent to the driver. A section of the cab roof is removable so that the control cubicles, train-heating boiler (when fitted) and the like can be installed or removed. The main power control cubicle is at no. 1 end of the cab and the auxiliary control cubicle at no. 2 end. Access doors are provided across the full width of the cubicle front panels. These give full access to the ancillary cubicle from the cab and wide access to that in the main cubicle. The other equipment in the main power cubicle is reached through the adjacent generator compartment.

Underframe

The underframe is designed to support fully the equipment above and below footplate level and to withstand without permanent deformation an end buffing load of 200 tons. The frame is of all-welded steel construction. The main longitudinals are

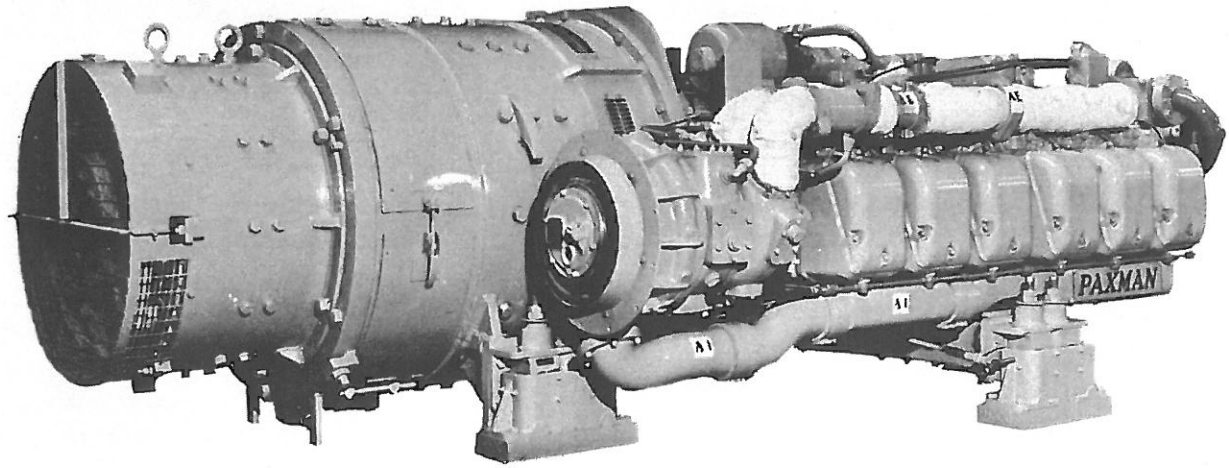


Fig. 6—Paxman-G.E.C. 450 b.h.p. traction unit showing the 6-cylinder 6ZHXL engine with Napier turbo-charger

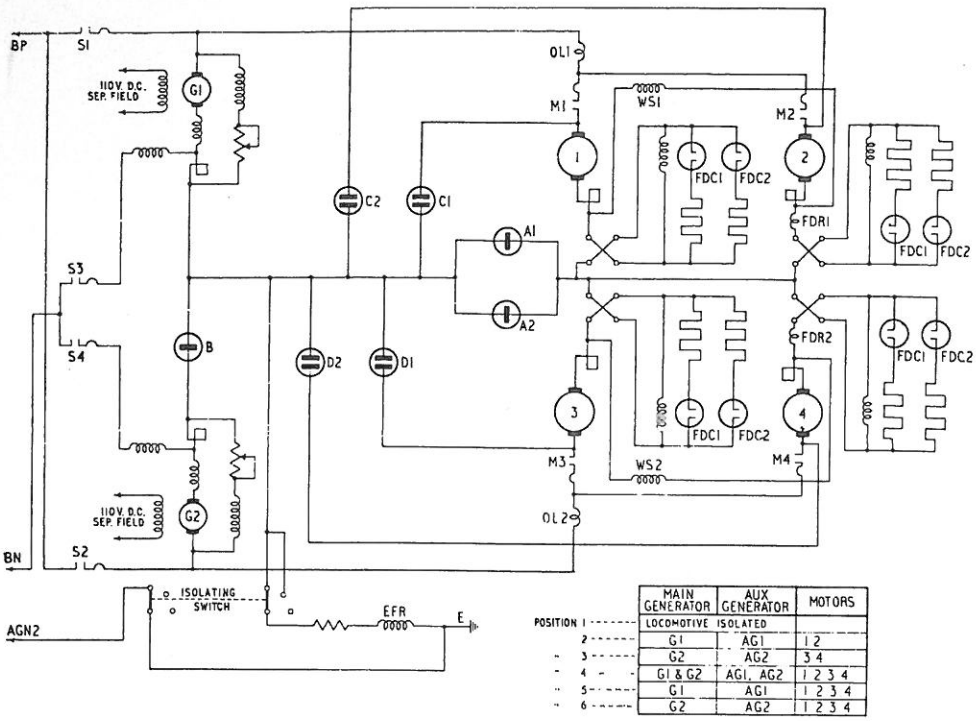


Fig. 7—Wiring diagram of twin-power unit 900 b.h.p. type 1 locomotive

deep-section beams extending the full length of the locomotive and braced with cross stretchers of plate and channel. The solebars are fish-bellied for appearance only, as they contribute little to the overall strength of the underframe. The underframe top is completely covered with continuously welded deckplate which prevents oil penetrating through into the motors, cables, etc. Any spilt oil or oil leakage is drained into large trays under the engines and sumps built into the underframe.

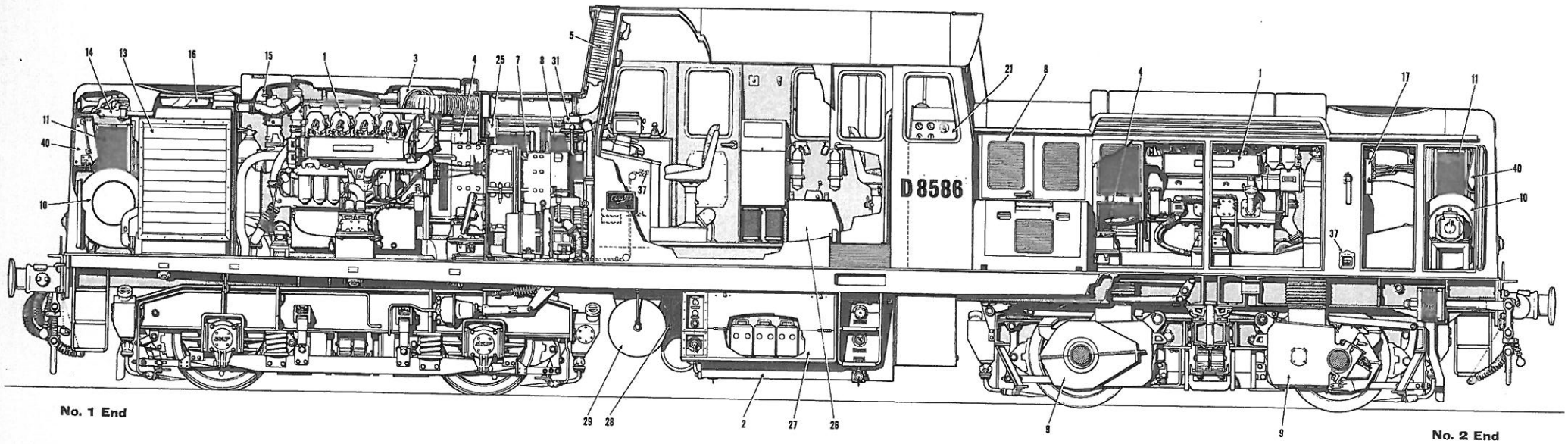
Jacking and lifting brackets are built into the underframe slightly forward of the bogie centre pivots and the whole of the locomotive, including bogies, can be lifted from these points. A large proportion of the brake piping is mounted in the underframe together with the carriage-heating train pipe. This is provided to permit the locomotive to work in multiple with others fitted with steam heating. Provision is made on the underframe for attaching a standard British Railways snow plough. In these locomotives the connections for multiple-unit working are fitted to the buffer beam and are arranged for up to three locomotives to be controlled from the leading cab. They are arranged to multiple with all " blue-star " locomotives, but any formation of train is limited to 60 m.p.h.

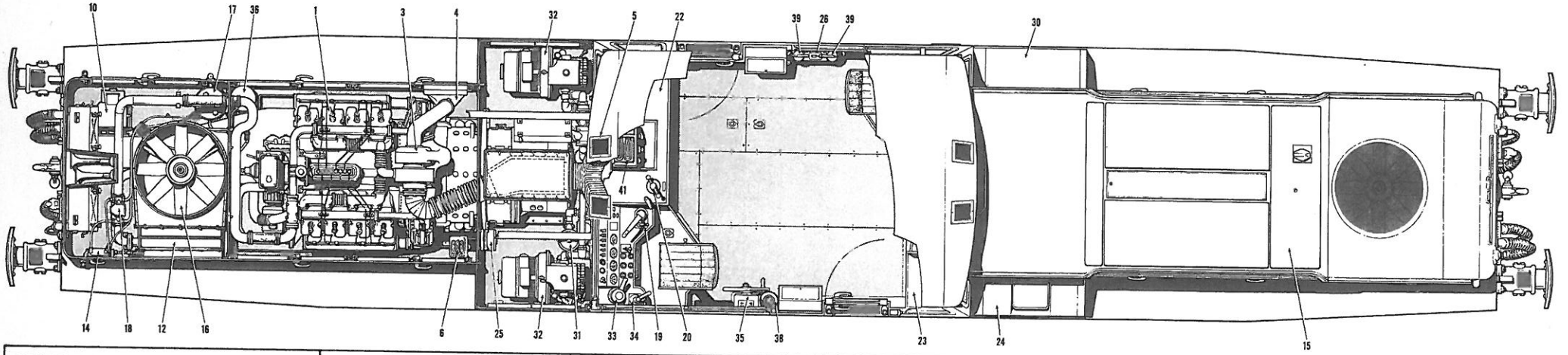
The 77-amp. hr. lead-acid batteries are located beneath the underframe. For convenience of mounting these are arranged in two parts one either side of the locomotive with hinged doors fitted to the battery containers. A battery-charging socket is provided in an end pocket of each battery container together with external lighting socket and the shed lighting change-over switch. Emergency start terminals are fitted to enable the engine to be motored by electrical supply from another locomotive. The main battery isolating switch is in the cab and to enable the driver on leaving the locomotive to isolate the battery this switch is connected by linkage to an external handle at footplate level.

A CO_2 gas system of fire protection is installed with electrical detectors, which automatically give warning of an excessive temperature rise in the engine and generator compartments. At a temperature in excess of 255 deg. F (125 deg. C) the heat detectors ring a fire alarm bell in the cab. The system in no. 1 engine-generator compartment can only be operated by breaking the glass and pulling the handle located at no. 1 end driving position or at the right-hand side of no. 1. end radiator compartment from the trackside. A separate system is similarly arranged at no. 2. end.

The weight of the body and also the traction and braking forces are taken by the conventional dished type centre pivot which has a phosphorbronze liner. This type of centre pivot allows marshalling yard humps to be negotiated reasonably. The bolster is mounted on two double elliptic springs, which are spaced by a channel section spring plank suspended from the bogie frame by swing hangers and knife-edge rockers. Main suspension is by four triple nests of coil springs mounted in spring cups on the forged steel underslung equalising beams. The equalising beam ends fit into stirrups cast integrally with the S.K.F. self-aligning roller-bearing axleboxes. Woodhead-Monroe shock absorbers are fitted between the equalising beams and the bogie frame to damp the recoil of the primary suspension. The axleboxes and horn guides are faced with manganese steel liners.

Westinghouse vacuum-controlled straight air brakes are fitted to the locomotive. Two 10-in. dia. $3\frac{3}{4}$-in. stroke brake cylinders are mounted on each bogie, and one on each side and fitted with combined slack adjusters. These apply clasp brakes to each wheel through fully compensated rigging and provide a braking force of 86·7 per cent. The brake shoes are of B.R. standard pattern and are held in holders by steel keys. Adjustment for block changing and tyre wear is provided on the lower pull-rods by screw and pin and hole adjustment. An anti-slip brake push button control is fitted and the deadman system is electrically operated by footswitch and push button. The handbrake provides a braking percentage of 21.





ENGINE/GENERATOR EQUIPMENT

1 Diesel engine (2)
2 Engine fuel tank
3 Turbocharger (2)
4 Turbocharger air inlet duct
5 Engine exhaust
6 Engine instrument panel
7 Main and auxiliary generators (2)
8 Engine and generator air filters

TRACTION MOTOR EQUIPMENT

9 Traction motor (4)
10 Traction motor blower (2)
11 Blower air filters

COOLING EQUIPMENT

12 8-element radiator (2)
13 Radiator shutters
14 Shutter ram
15 Radiator header tank
16 Radiator fan
17 Hydrostatic drive oil tank
18 Hydrostatic drive controller

ELECTRICAL EQUIPMENT

19 Master controller (2)
20 Selector switch
21 Voltage regulator
22 Main control cubicle
23 Auxiliary control cubicle
24 Weak field resistance housing
25 Load regulator (2)
26 Battery isolator
27 Battery box (2)

BRAKING AND AIR EQUIPMENT

28 Air compressor
29 Air reservoirs
30 Control reservoir housing
31 Brake equipment
32 Exhauster (2)
33 Vacuum brake valve
34 Air brake valve
35 Handbrake

FIRE EXTINGUISHING EQUIPMENT

36 Fire extinguishing cylinder (2)
37 Fire extinguisher pull handles (4)
38 Hand fire extinguishers (2)
39 Portable fire extinguishers (2)

MISCELLANEOUS EQUIPMENT

40 Route indicator
41 Breakfast cooker

CLAYTON 900h.p. STANDARD TYPE 1 LOCOMOTIVE fitted with ROLLS-ROYCE engines

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