3,000-V. BO-BO ELECTRIC LOCOMOTIVE FOR POLAND

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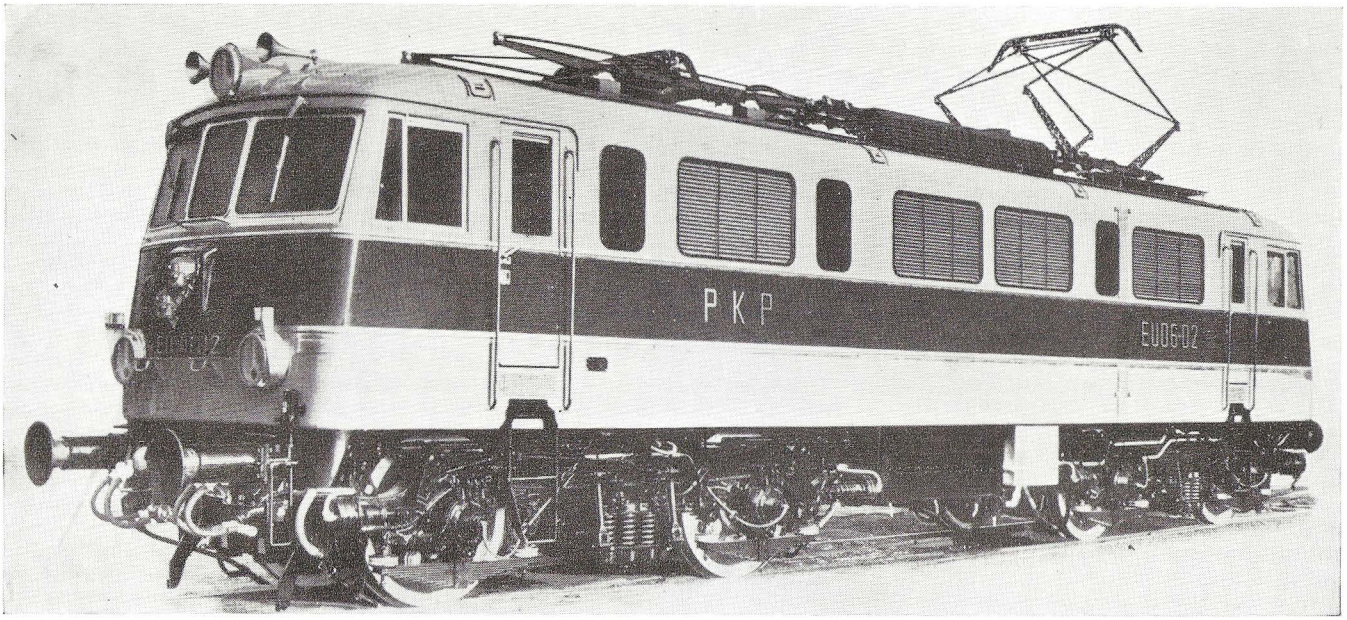


3,000-h.p. electric locomotive for Polish State Railways

3,000-V. BO-BO ELECTRIC LOCOMOTIVE for Poland

Contract for English manufacturers' joint product includes Polish manufacturing licence

TECHNICAL details have now been released of the 3,000-V d.c. Bo-Bo electric locomotives in course of construction for the Polish State Railways at the Vulcan Foundry, Newton-le-Willows, Lancashire. The current order is for 20 locomotives, seven of which have been delivered. Control equipment and auxiliary machines are being supplied by Associated Electrical Industries Limited. Traction motors and mechanical parts are being supplied by The English Electric Co. Ltd., which is building the locomotives. These two companies, together with British Insulated Callender's Construction Co. Ltd., form the contractors' committee for the electrification of Polish State Railways.

Manufacturing licence

A licence has been granted for the manufacture of this type of locomotive in Poland and certain features are incorporated in the design to suit Polish manufacturing industry requirements. The electrical rating of all machines is required to conform to Class "B" temperature limits, irrespective as to whether Class "H" or Class "B" insulation is used. Welded fabrications are extensively employed instead of steel castings, and particular attention has been given to the suitability of equipment for the severe climatic conditions in Poland. Ambient temperatures range from minus 22 deg. F. to 104 deg. F. and special air filtering has been required to prevent the entry of fine-powdered snow.

Leading particulars are as follows:—

Track gauge	4 ft. 8½ in.
Loading gauge	U.I.C.
Wheel arrangement	Bo-Bo
Line voltage	3,000-V. d.c.
Weight in service order	79½ tons
Maximum service speed	78 m.p.h.
Tractive effort—one hour ...	32,634 lb.
Tractive effort—continuous ...	30,870 lb.
Length over buffers	52 ft. 0 in.
Width over body sides	9 ft. 6 in.
Roof height	12 ft. 9 in.
Bogie pivot centres	28 ft. 0 in.
Bogie wheelbase	10 ft. 0 in.
Wheel dia.	4 ft. 1 in.
Minimum curve negotiable ...	395 ft.

The main starting resistances are force-ventilated from two blowers mounted below each unit. Each is situated in the middle of the locomotive, one on either side of the central corridor. Other main items of equipment mounted down the sides of the central corridor are the two motor generator sets, two compressors, the high-speed circuit breaker and the two h.t. equipment cupboards. All normal electrical equipment access covers are fully interlocked to prevent personnel entering while the equipment is energised.

The mechanical parts have been designed to ensure a high strength: weight ratio. Aluminium alloys have been used for air reservoirs, floor-tread plate, interior cab panelling, battery boxes, and bulk heads, and fibre glass has been used for cable ducts, locomotive doors, driver's desk, controller, and inductive shunt covers.

Low temperature operation

Special care has been taken with the locomotive design because of the low temperatures prevailing in Poland during the winter months. The driver's window and that of his assistant are of "Therglass" electrically-heated glass and 3 kW. electric cab heaters are provided in each cab. The cab roof and sides and the roof of the equipment are thermally insulated with a fibreglass mat, the body sides and battery box with "Onazote."

The frame and body are designed and fabricated as a unit stress-bearing structure with all members and panels in "Cor-Ten" steel. The underframe is of shallow cellular construction with closely spaced light-gauge longitudinal and transverse members interlocked with each other. This base structure is plated top and bottom to form a closed cell with

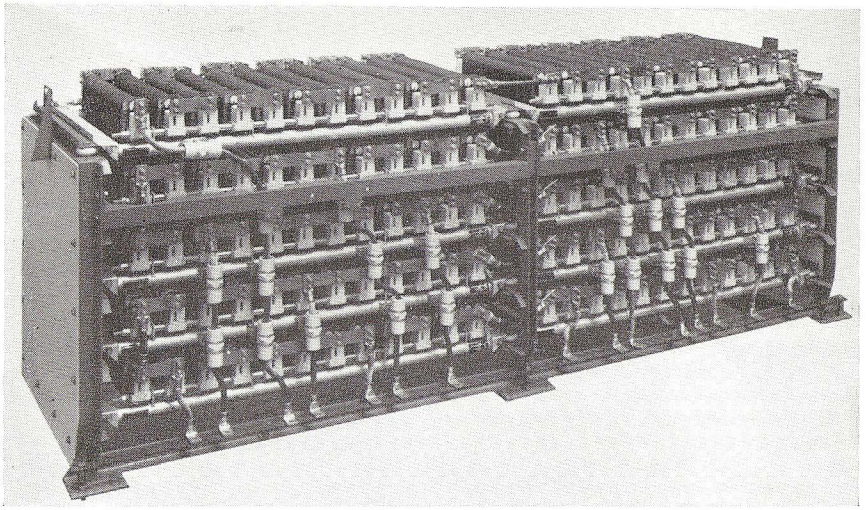
high vertical, longitudinal and torsional rigidity. The interior is metal-sprayed during later constructional stages to counteract corrosion. The bodyside-frames are of girder design, with vertical pillars of rectangular tubes and with a cantrail of compound closed section.

Power from the 3,000-V. d.c. overhead-supply system is taken by one or both of the two single-pan air-operated pantographs. It is then fed by a high-speed circuit-breaker to the main power circuits.

The four traction motors are connected permanently in pairs in series, with series parallel combinations between pairs. Bridge transition is used.

There are 28 notches in series, with a further 15 in parallel; in addition, six field-weakening notches are available for both the series and parallel connections.

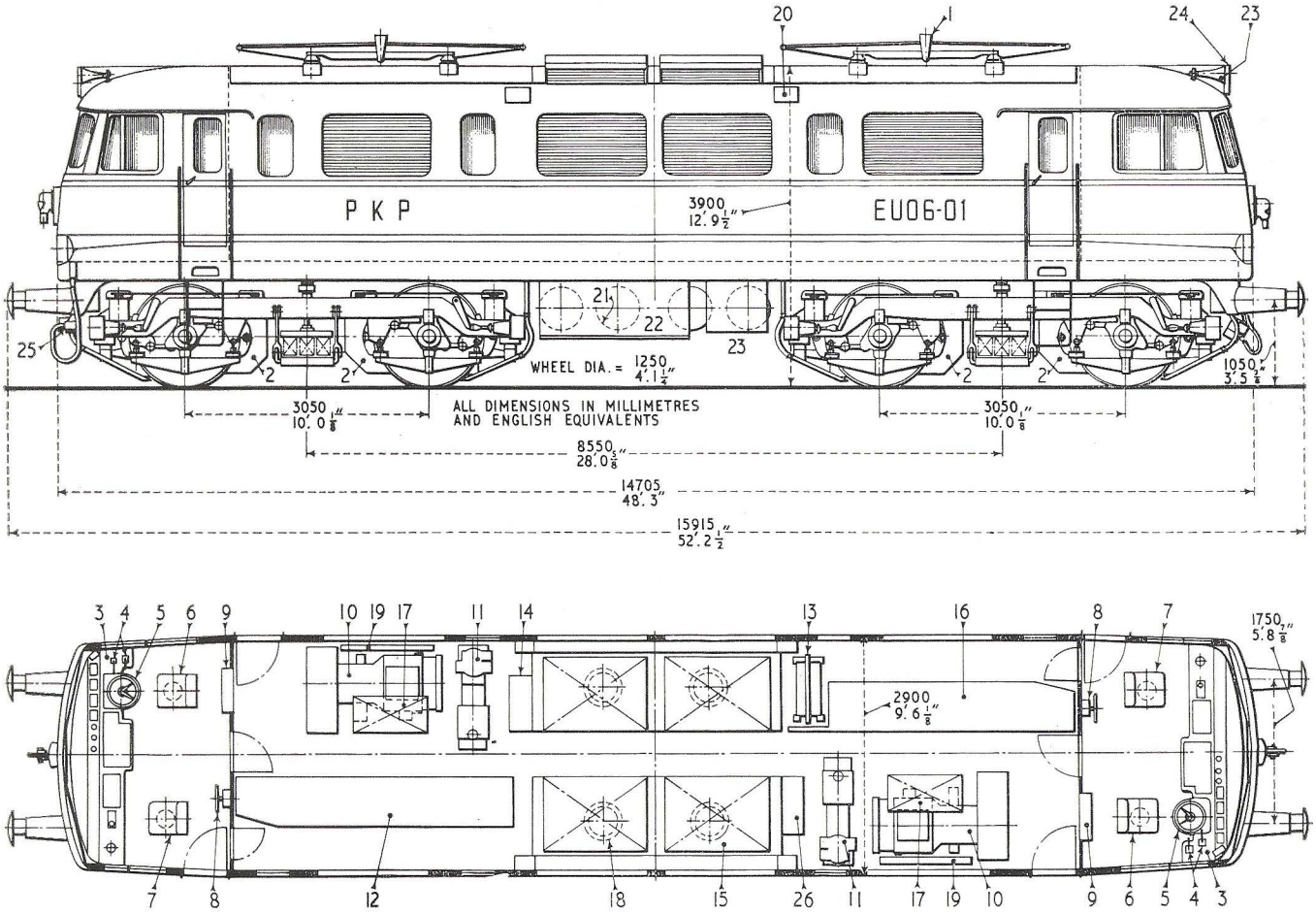
The bulk of the high-tension control gear is mounted on one of the two frames which form part of the two high-tension compartments, the doors of which are interlocked with the pantograph air supply to prevent access until the pantograph has been lowered and the h.t. circuits earthed. These compartments house the electro-magnetically-operated high-speed circuit breaker and the reverser and resistance, line switch, and field-weakening contactors, which are electro-pneumatically-operated.



Main resistance frame with A.E.I. type R.P. resistors

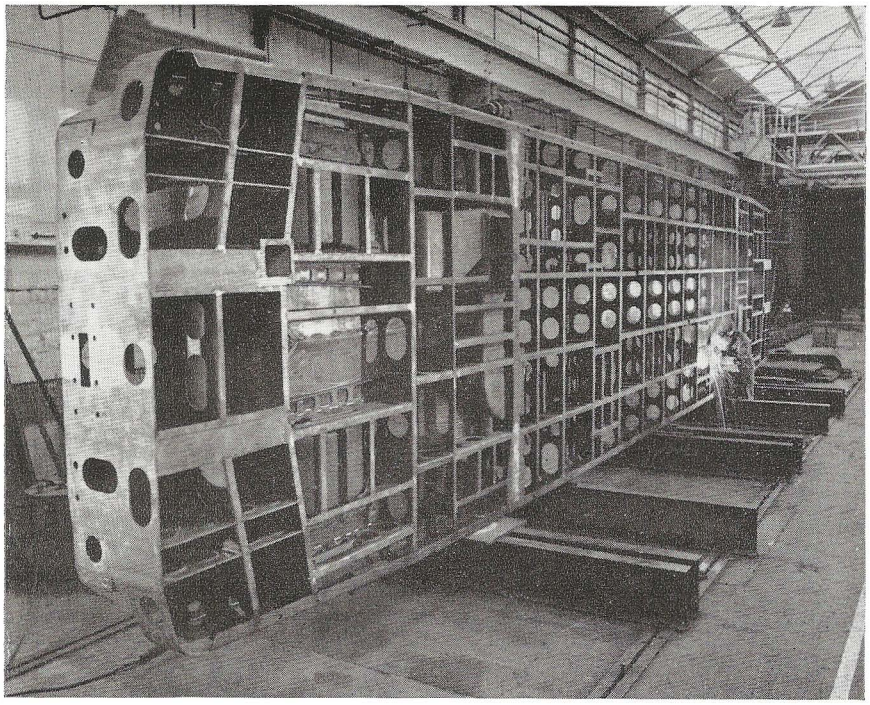
The low-tension control gear, including all compressor and battery-charging contactors, relays, and so on, together with voltage regulators, is located either in one or other of the two locomotive cabs or in one of the two low-tension cubicles. Driving-cab equipment comprises controller, driving instruments, and switches.

The auxiliary machines comprise two



1. Pantograph
2. Traction motor
3. Driver's desk
4. Brake valves
5. Controller
6. Driver's seat
7. Assistant's seat
8. Handbrake
9. Control connection box
10. M.G. set and blower
11. Air compressor
12. No. 1 frame—control gear
13. High-speed circuit breaker
14. Air equipment frame No. 1
15. Resistances
16. No. 2 frame—control gear
17. L.T. cupboard
18. Resistance blower
19. Air filters
20. Sand filler
21. Air reservoir
22. Battery
23. Horn
24. Headlamp
25. Train heating coupler
26. Air equipment frame No. 2

Side elevation and plan view of 3,000-*h.p. electric locomotive for Polish State Railways*



Main frame showing lightweight cellular construction

motor-generator blower sets, which ventilate the main traction motor, two main and one pantograph air compressor, and four motor-driven fans ventilating the main resistances.

Air for the traction-motor blowers is taken from the machinery compartment and is delivered at a rate of 3,500 cu. ft. per min. to each traction motor.

For the main resistors, air is drawn in through louvres in the locomotive side and expelled through cowls in the locomotive roof. Each of the four axial-flow resistance ventilator fans delivers 10,000 cu. ft. per min. of cooling air during normal acceleration of the locomotive.

From the pantographs, the current is fed by a high-speed circuit breaker to the line switches. The main resistances are of the Associated Electrical Industries Limited type R.P., and are force-ventilated.

Four resistance ventilating motors are connected in parallel across a portion of the main resistance, thus ensuring that the ventilation is proportional to the traction current. Field weakening is provided by means of divert resistances and inductive shunts.

Auxiliary circuits

Two motor generator/blower sets each supply air to two of the four traction motors and also provide a proportion of the low-tension load. Each set supplies electrical power for one compressor and for one half of the electric cab heating, as well as for a hotplate, located in each cab.

The two main compressors are both Westinghouse type 2 E.C. 72 A. vertical, two-cylinder, two-stage, air-cooled machines driven by A.E.I. type AY. 26 motors, with a maximum working pressure of 118 lb. per sq. in.

Battery-charging, control, and lighting can be supplied from either generator, a changeover switch being provided. Train heating is taken direct from the high-tension supply. The control of the relays and contactors is arranged from the driver's cab.

When compressed air is not available on the locomotive the pantograph can be raised by using a small battery-driven compressor feeding directly into the pantograph air system. The Nife 72-cell alkaline battery has a capacity of 55 amp. hr.

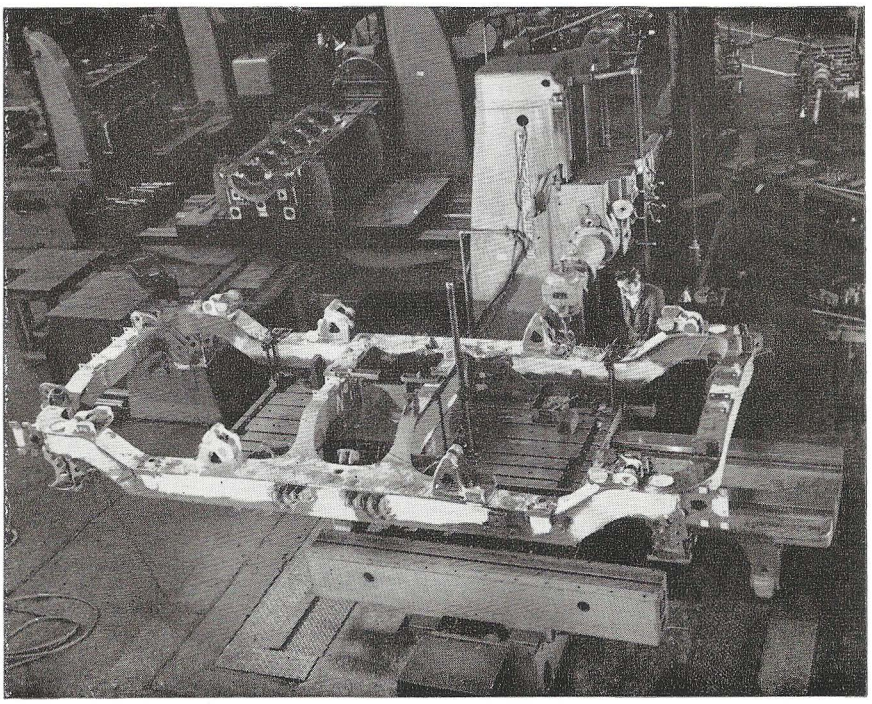
The high-speed circuit breaker is normally controlled from the driver's cab, but in the event of neither low-tension supply nor compressed air being available, it is possible to close it mechanically by hand.

As mentioned earlier, electro-pneumatic control is employed and a 110-V. supply, regulated by means of A.E.I. vibrating-carbon regulators, is taken from the generators of the two motor-generator sets.

Air-operated units

Each line breaker, main contactor, motor combination switch, and reverser is operated by air, giving a positive and decisive action; the admission of air being controlled by an electro-pneumatic valve. The accelerating handwheel of the master controller operates a series of cam-operated contacts and the wheel can be moved quickly to the final position required. The acceleration is then purely automatic, a current-limit relay governing the speed at which the resistance contactors are closed. The chosen rate of acceleration can be altered by the driver. Field weakening is selected by a separate handle on the master controller. A third control on the master-controller face plate is the removable reverse key, by means of which the controller reverse shaft can be turned. The reverser is electro-pneumatically remotely controlled from this position.

Wheel slip is indicated by a light on the driver's desk. An anti-slip device, by which the driver can apply a partial brake application should wheel slip occur, enables the locomotive to start



Machining lightweight fabricated bogie at the Vulcan Foundry

View of driving cab

heavy trains on steep gradients or under conditions where rail adhesion is reduced to a very low value.

Deadman control consists of two hand and one foot operated switches.

The bogies are designed to ensure the maximum strength:weight ratio and for low maintenance. A low centre pivot is used to minimise weight transfer effects, the pivot is of the conical rubber-bush type with no wearing parts. Good riding of the locomotive is assured by the use of long-range spring gear, swing-motion bolsters, and noise and vibration insulation to the superstructure of the bogies and further assisted by the use of rubber at the centre pivots, side-bearers, and traction links.

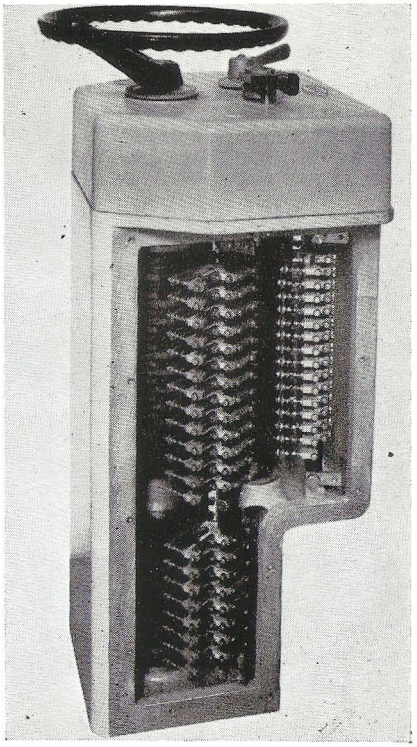
The bogie frames are of one-piece fabricated construction made from steel and are of box section to ensure high bending and torsional stiffness.

To reduce unsprung weight to a minimum, the traction motors are mounted, with their gears and quill shafts, on four point rubber mountings. The drive to the road wheels is by Alsthom-type link drive, which allows relative movement between the quill drive and the road wheels.

A proportion of the vertical load from the superstructure is transmitted through sidebearers incorporating coil springs. Periodic movements of the swing bolsters are restrained by transverse hydraulic dampers. These swing bolsters are fitted with transverse anchor links between bolster beam and swing beam. The centre of the bolster supports most of the superstructure weight on the conical-rubber centre pivot, and the ends of the bolster are in turn suspended on three nests of coil springs at each side. The spring support beam is suspended from the bogie side frames by inclined swing links.

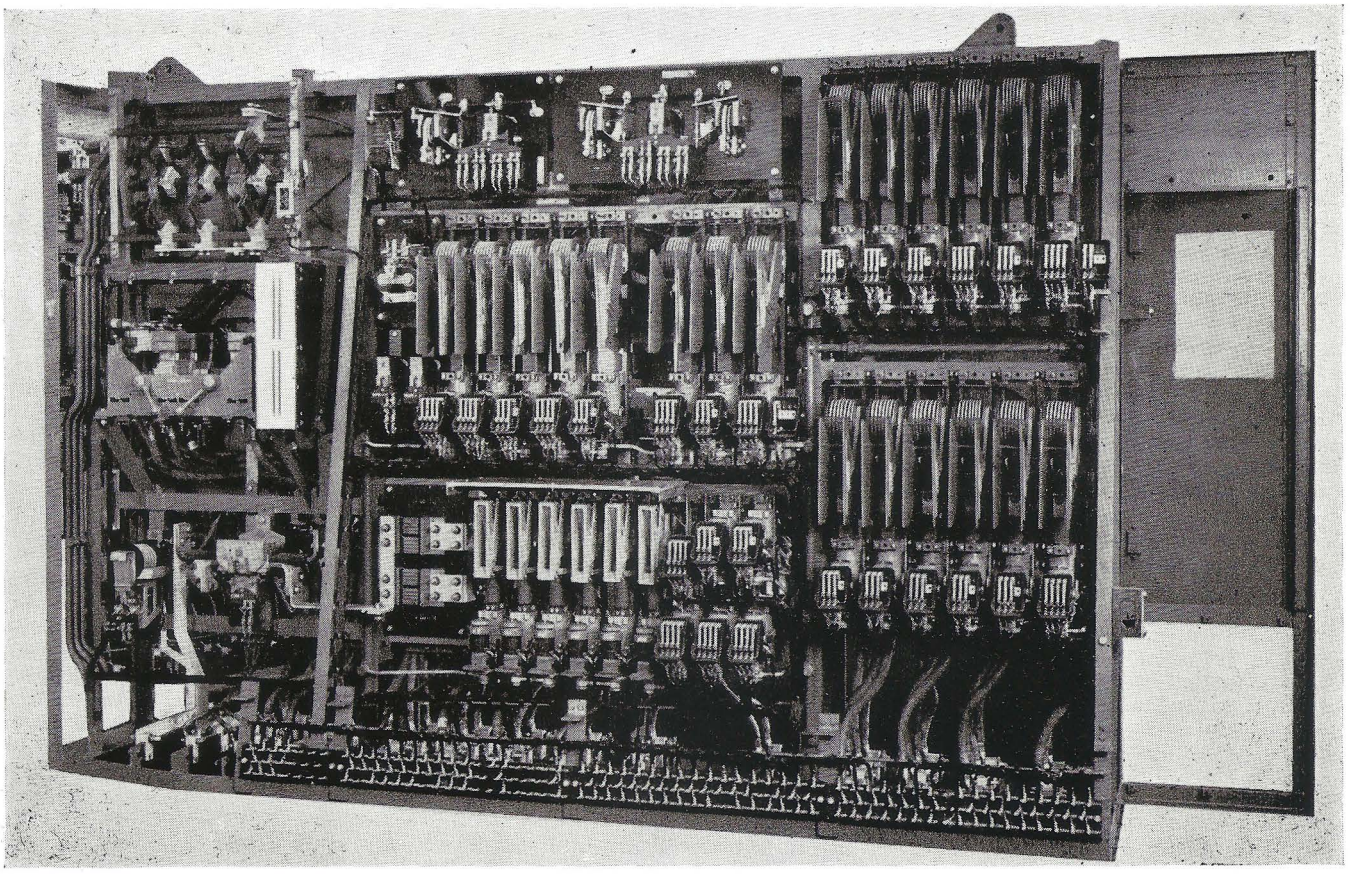
Longitudinal forces attributable to braking and acceleration between swing bolster and the bogie frames are catered for by two links, each fitted with spherical rubber-bonded bushes at each end.

To keep flange forces to a minimum when running on curved track, a spring-loaded inter-coupling is provided between the bogies. To reduce wear, flange lubricators of the stick type are fitted to each wheel.

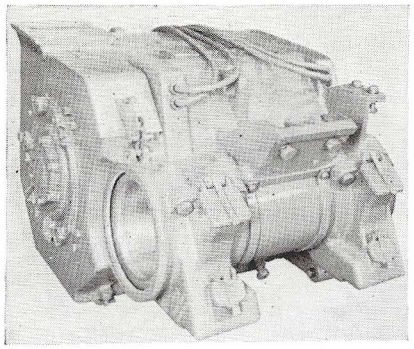


A.E.I. controller in fibreglass housing

Axleboxes are of the S.K.F. double-row



Front view of one of the two main switchgroup panels fitted in each locomotive



Type EE541A traction motor manufactured by The English Electric Co. Ltd.

spherical-roller variety supported on leaf-type primary-suspension springs with rubber auxiliary springs at each end. Longitudinal forces on the axleboxes are carried by Alsthom-type links on each side of each box, these links being fitted with rubber bushes at each end.

Sanding gear is of the pneumatic type with eight sanders, four for each direction of travel.

Each traction motor has four main interpoles with compensating windings in the pole faces; they are ventilated from two fan units mounted in the superstructure on the end of each motor-generator set. Although the traction motors have been constructed to conform to Class H insulation requirements, the ratings are governed by Class B temperature rises.

The brake gear, which is of the Oerlikon type supplied by Davies & Metcalfe Limited, incorporates independent locomotive release, anti-clip application, and a change-over switch for goods or passenger rate of brake application. Clasp-type brakes are fitted, with four shoes to each wheel. The airbrake cylinders are Westinghouse type "J.S.L." 9-in. dia. and include automatic slack adjusters.

The list of sub-contractors for these locomotives includes the following:—

Cable	Associated Electrical Industries (Woolwich) Limited British Insulated Callender's Cables Limited
Brake equipment ...	Davies & Metcalfe Limited
Brake cylinders ...	Westinghouse Brake & Signal Co. Ltd.
Compressors (auxiliary)...	Bristol Pneumatic Tools Limited
Compressors (main) ...	Westinghouse Brake & Signal Co. Ltd.
Axleboxes	Skefko Ball Bearing Co. Ltd.
Wheels and axles ...	Owen & Dyson Limited
Fans	Airscrew Co. & Jicwood Ltd.
Quill drive links ...	Silentbloc Limited
Batteries	Nife Batteries Limited
Capacitors	British Insulated Callender's Cables Limited
Bonded rubber centre pivot and auxiliary rubber springs ...	Metalastik Limited

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