AEI

A.C. TYPE 'A' LOCOMOTIVES FOR BRITISH RAILWAYS

Nos E3046—E3055

Associated Electrical Industries Limited

PUBLICATION No. 1737-73

A. C. LOCOMOTIVES FOR BRITISH RAILWAYS, TYPE 'A'

Bo-Bo type, 3,300-h.p. mixed traffic design for London Midland Region lines electrified at 25/6·6-kV.

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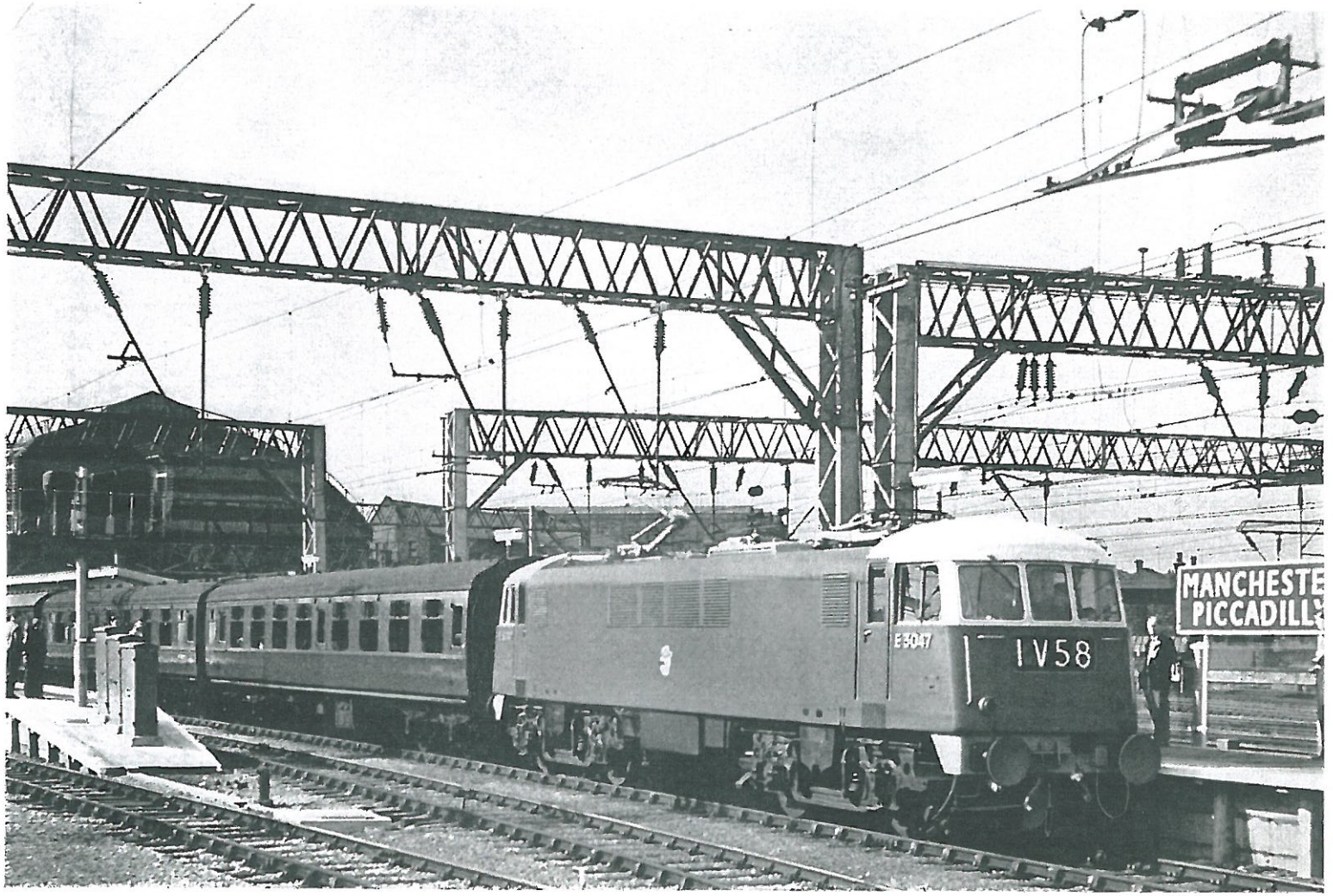
ASSOCIATED ELECTRICAL INDUSTRIES LTD
TRACTION DIVISION

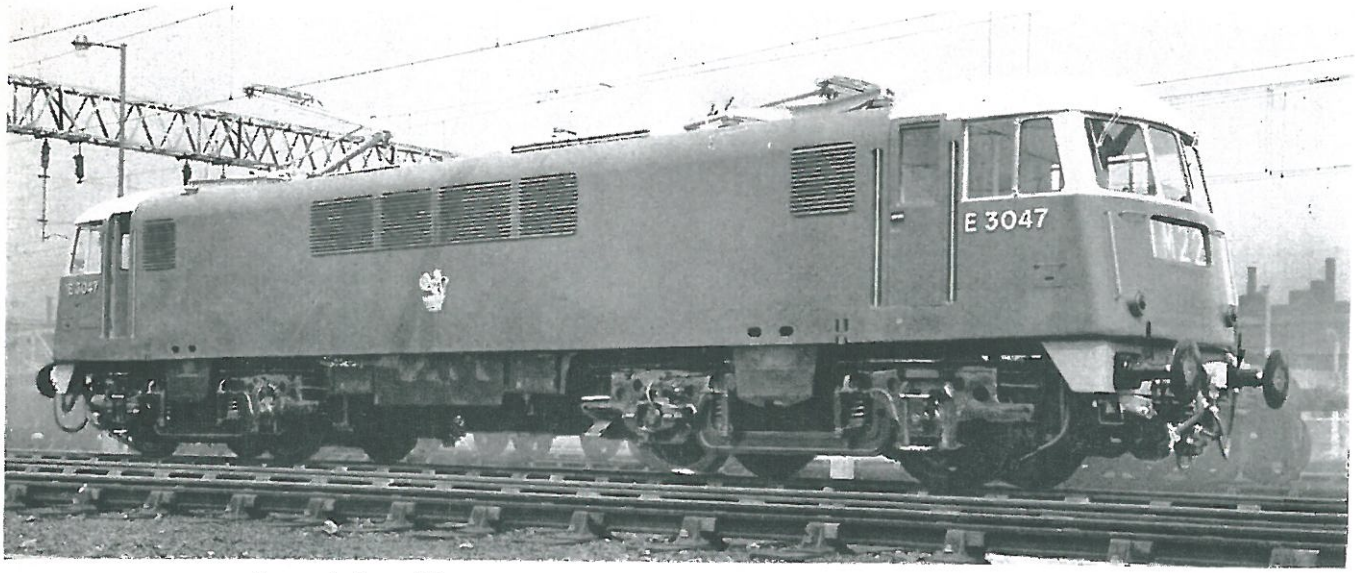


SN 1161

One of the 3,300-*h.p. AEI locomotives leaving Piccadilly Station, Manchester*

Type 'A' a.c. Locomotives for British Railways

Bo-Bo 3,300-h.p. mixed-traffic design for London Midland Region lines electrified at 25/6·6-kV.



General view of locomotive showing trailing pantograph in operating position

DELIVERIES are now in progress to British Railways of a further batch of ten 25-kV. 50-cycles, a.c. electric locomotives by Associated Electrical Industries Limited. The mechanical parts, designed by A.E.I., have been built by Beyer Peacock & Co. Ltd. as sub-contractors. With a power rating of 3,300 h.p., the fully suspended traction motors, fitted with Alsthom type quill drive, and the multi-anode mercury arc rectifiers, are identical with those fitted in the A.E.I. (Rugby) locomotives built at the Birmingham Railway Carriage & Wagon Co. Ltd. works.

High Tension Tap Changing

On the A.E.I. (Manchester) locomotives variation of the main transformer secondary voltage is achieved by tap changing on the high tension side, which has the advantage that relatively small currents have to be handled by the tap changer circuit. The air blast circuit breaker has been designed and manufactured by A.E.I. Limited.

Leading particulars are as follow:—

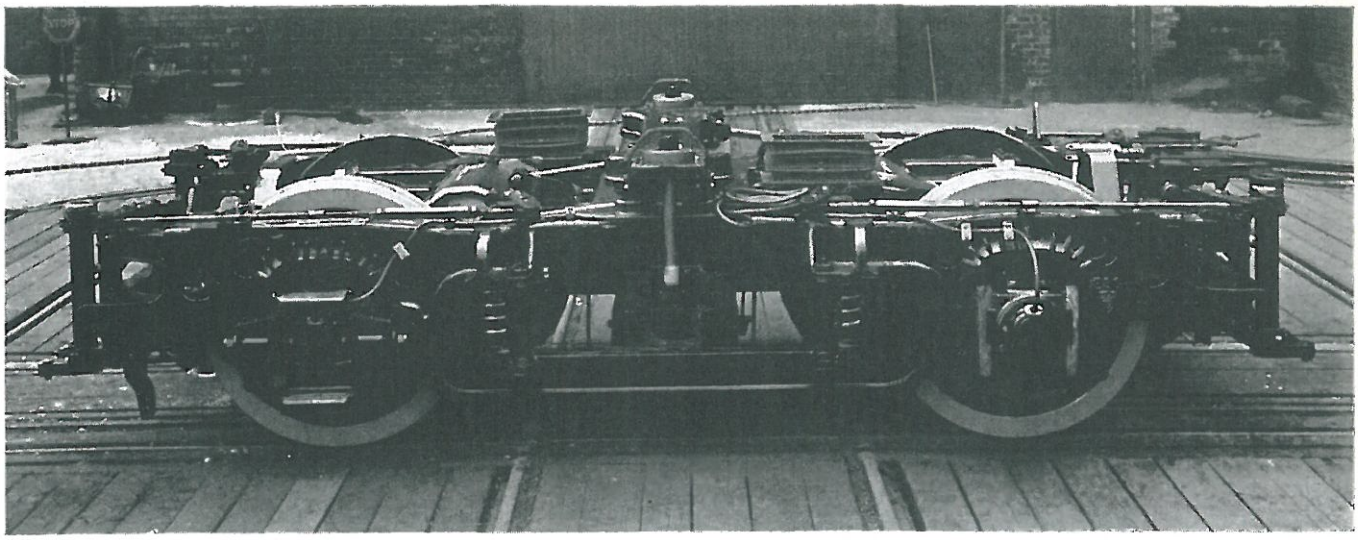
Wheel arrangement	Bo-Bo
Maximum speed	100 m.p.h.
Starting tractive effort	48,000 lb.
Continuous ratings:	Full field / Weak field
Tractive effort	20,000 lb. / 17,000 lb.
Speed	63 m.p.h. / 73 m.p.h.
Power	3,320 h.p. / 3,310 h.p.
Gear ratio	29-76
	ft. in.
Length over buffers	56 0
Bogie wheelbase	10 0
,, centres	30 9
Wheel diameter	4 0
Body width	8 9
Cab roof height	12 4

Suspension of the vehicle body is a development of the Metrovick swing link suspension system, which is claimed to provide good riding characteristics at high speed. Aluminium and resin-bonded glass fibre mouldings are used extensively in the body structure and equipment to achieve minimum weight. The serial numbers of the 10 locomotives are E3046-E3055 inclusive.

Arrangement of Equipment

The main transformer is centrally located in the power compartment, with the rectifiers and rectifier cooling unit grouped at one end. At the other end is the transformer radiator, smoothing choke, and high tension equipment frame. This equipment is fully enclosed by a surround of resin-bonded glass fibre and aluminium panels, leaving a corridor at one side for passage between the two cabs. The access door from the corridor to this enclosure is full interlocked with the pantograph lifting gear, ensuring that the door is locked when the pantograph is raised.

Adjacent to No. 1 cab bulkhead are two traction motor blowers, the air brake compressor, and an auxiliary compressor. This is a battery powered 3 c.f.m. machine used to supply air for raising the pantograph and closing the circuit breaker, should the main supply not be available. At the opposite end of the compartment are two traction motor blowers and the brake exhauster. Auxiliary equipment fitted in the corridor includes the battery charging panel, l.t. equipment frame, e.p. brake valve frame, pantograph selector, motor cut-out switch, and fault lamp panel. The l.t. cables in the corridor are enclosed in resin-bonded glass fibre ducting. The cab bulkheads are lined with navyboard insulation on the power compartment side. Underslung below the frame, between the bogies are the



Commonwealth cast-steel frame used for swing-link bogie

weak field resistances, air reservoirs, and the battery.

The A.E.I. air blast circuit breaker performs the dual function of switching the supply current to the locomotive and interrupting the supply under fault conditions. The interrupting contacts of the breaker are mounted in a horizontal porcelain insulator and when these are closed the current flow is through the interrupter contacts and the series sequence isolator.

During an opening operation air from the blast valve acts on a piston which separates the contacts and the air blast between the contacts extinguishes the arc. Air is also fed from the blast valve to the operating mechanism which opens the sequence isolator after the circuit has been broken by the interrupter. The storage reservoir incorporated in the breaker contains sufficient air for one make-break operation.

Transformer and Tap Changer

The main transformer is housed in a rectangular vertical aluminium tank, which sits in a shallow well inside the locomotive and extends up to roof level. This enables the h.t. terminal to be mounted directly on the tank without using a lead-in roof insulator. The oil-cooled transformer is a combination of an auto-transformer and a double-winding step-down transformer, both built on a partly common core. Protection is provided against an overload on the transformer secondary or an earth fault on the primary side.

The tap changer unit, together with the two air break switches which carry out the actual transition from tap to tap, are mounted on the outside of the tank.

The auto-transformer has a total of 38 tappings, one of which is used for the supply of h.t. when the locomotive is operating at the alternative supply voltage of 6.25 kV. Two tappings are used for auxiliary purposes; one at 800 V. for train heating and one at 240 V. for motor-driven auxiliaries.

A single pole oil-immersed h.t. change-over switch, operated by a flange mounted air motor on the tank side, is mounted inside the transformer tank, while the tap changer and its associated equipment are contained in an oil-filled extension of the main tank. The tap changer consists of two sliding contacts moving along a vertical row of contact studs connected to the 38 taps on the auto-transformer. The sliding contacts are actuated by a chain drive from an electric motor, through a Geneva wheel mechanism. This enables the operation of the air break switches and tap changer to be accurately synchronised.

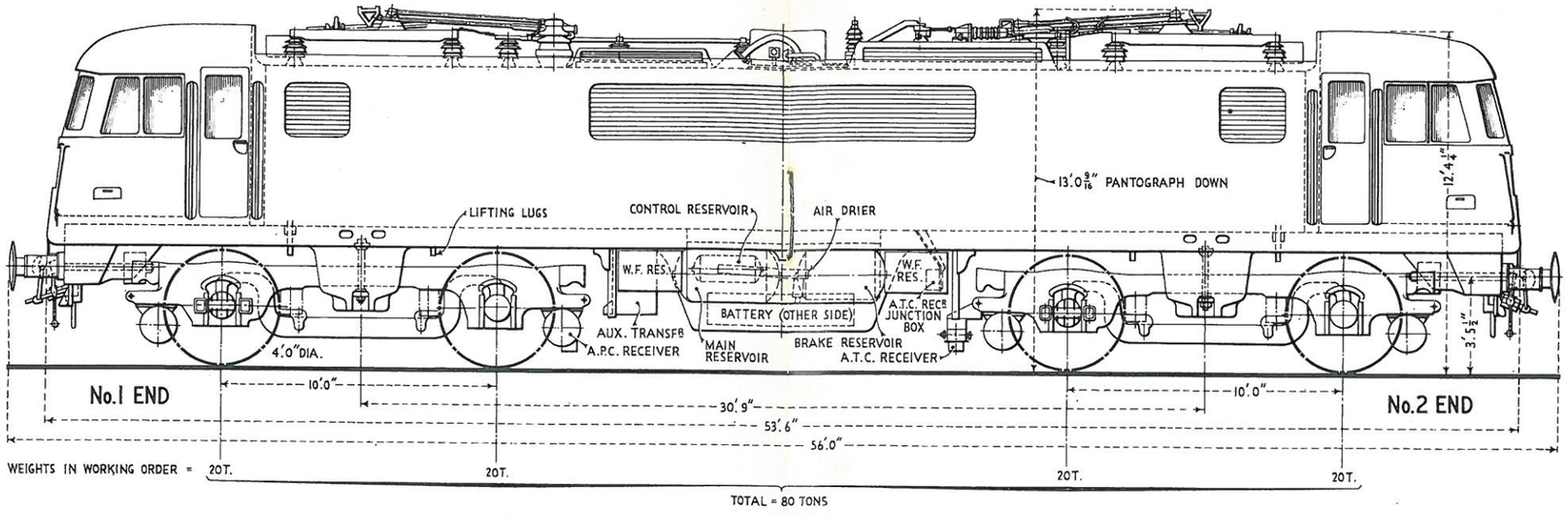
Cooling of the transformer oil is by pump circulation of the oil through a roof-mounted Serck radiator, through which air is blown at 16,700 c.f.m. by a Keith Blackman fan. The oil circulating pump has a delivery of 200 g.p.m. Automatic protection against pump failure or low oil level is provided.

Multi-anode Mercury Arc Rectifiers

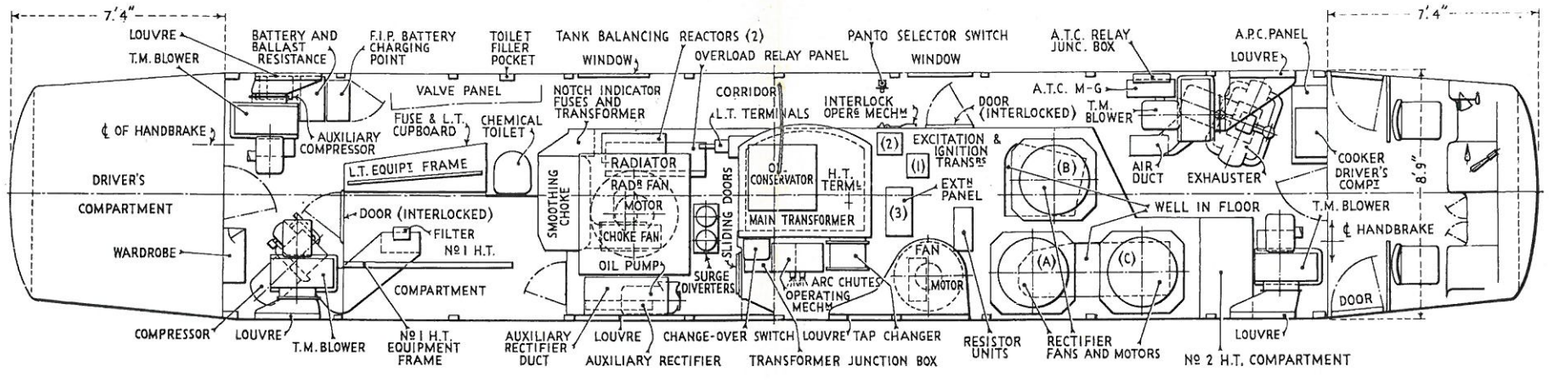
Conversion from a.c. to d.c. is by three six-anode air-cooled steel tank mercury arc rectifiers. These incorporate special anti-spill arrangements and other features developed to meet the shock loading encountered with rail traction. Each is connected in push-pull and the cathodes of the three rectifiers are connected to a single busbar at earth potential. Inter-tank reactors are included in the feed to each of the rectifiers to ensure equal current distribution, and anode reactors are used to ensure equal load sharing between individual anodes. Nine anodes are in parallel for each half-cycle.

Rectifier cooling is by a continuously-running axial flow fan mounted below each tank. Each fan, which has a delivery of 4,000 c.f.m., is driven by a 240 V. a.c. induction motor and circulates air through the rectifiers and rectifier compartment. Air in the compartment is maintained at the correct operating temperature by thermostats which control a Keith Blackman centrifugal ventilating fan and space heaters. The fan, having a delivery of 10,000 c.f.m., draws outside air through the compartment and discharges through shuttered louvres in the roof. The rectifier load-sharing reactors are also cooled by this air stream.

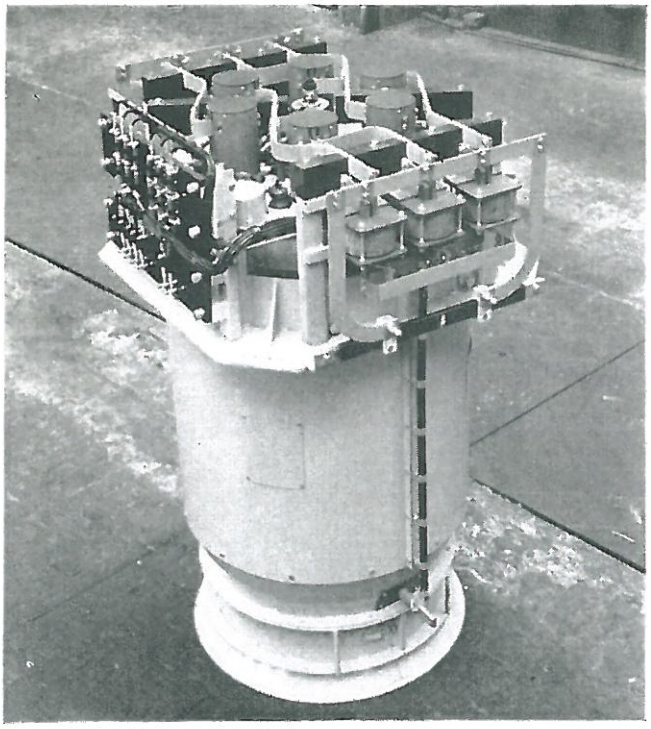
Before putting on load the rectifiers



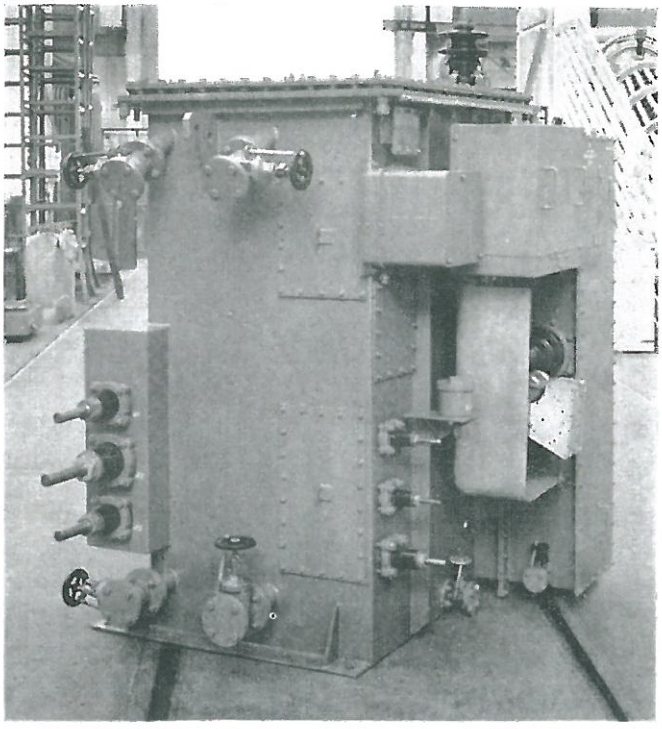
Elevation of British Railways Type " A " 3,300-h.p. 25/6.6-kV 50-cycle a.c. electric locomotive, showing principal dimensions



Plan layout of locomotive, showing general arrangement of equipment



Multi-anode rectifier, force-draught cooled from base



Oil-cooled transformer and tap changer

are preheated to the minimum working temperature by space heaters and by passing low voltage current through the rectifiers. Provision is made for the isolation of either of the rectifier units, and automatic protection is provided if a rectifier backfires.

Traction Motors

The six-pole force ventilated traction motors are fully suspended on rubber bushed resilient mountings. To improve commutation the a.c. ripple is reduced by the fitting of non-inductive resistances across the field coils, enabling the a.c. component to be by-passed. The poles are connected by a laminated ring inside the main yoke casting to ensure that the inter-pole flux and armature current are kept in phase. The iron-cored smoothing choke through which the motors are fed is cooled by a centrifugal fan. The induction air to the fan, which is rated at 2,000 c.f.m., is used to cool the auxiliary rectifier. Using class " H " insulation the motors have a continuous rating of 975 V., 700 A., 847 h.p. and a one-hr. rating of 975 V., 760 A., 920 h.p. Field weakening is introduced in two stages. The motors are connected in parallel and any single motor or pair of motors can be isolated.

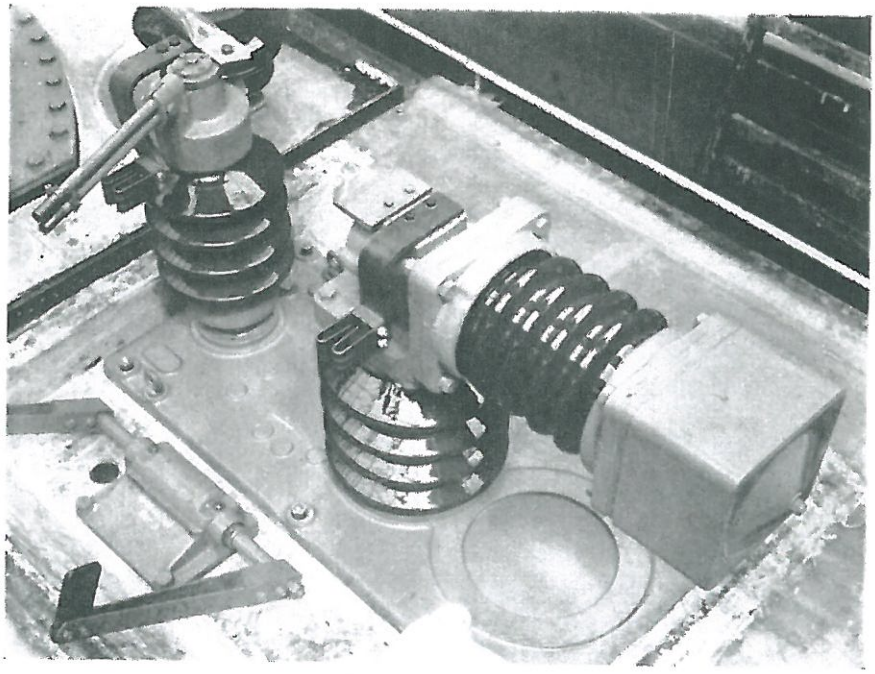
The drive from the straight spur reduction gear to the road wheel is through an Alsthom type quill drive. This provides a cushioned drive between motor and wheel and allows the relative vertical movement between the bogie mounted motor and the axle. From the reduction gear the drive is taken through a hollow shaft to a universal link assembly which in turn drives the wheel. The use of rubber bushed pivots in the link assembly provides the cushioned drive and eliminates lubrication of the linkage.

Each motor is force cooled by a separate Keith Blackman Tornado centrifugal blower of 3,000 c.f.m. capacity, driven by a 240 V. a.c. motor. These are switched on automatically when the driver's control is moved to the forward or reverse position. The blowers are pedestal mounted and moulded resin bonded glass fibre is used for the inlet ducting from the bodyside louvres and the delivery ducting to the floor.

Prefabricated Control Desk in Cab

The cab walls, which have an outer skin of aluminium, are timber lined and faced on the inside with Formica faced aluminium. The moulded cab roof is a double skin of resin bonded glass fibre. In the centre of the rear bulkhead is an access door to the power compartment. Full drop lights are fitted in the light-alloy cab doors and in the cab side screens. Upholstered adjustable seats are provided for the driver and second man and behind each seat is a full height draught screen. The driving screen layout of wide outer panels and a smaller centre panel provide excellent driving visibility. Electric de-misting of the screens is by fine wire heating elements enclosed in the laminated glass. Trico-Folberth pneumatic screen wipers are fitted.

The cab is well heated by A.E.I. panel type heaters installed on the rear bulkhead, side walls, and draught screens. A cooker for crew meals is recessed into the rear bulkhead of one cab. Sand hoppers, with outside traps for filling, are installed below the quarter lights in the cab sides. On the cab rear bulkhead is the hand brake wheel, hand fire extinguishers, and warning bell. A feature of the control equipment is that the control desk, fully equipped, is a prefabricated unit with all connections arranged in a



Air blast circuit breaker. Air receiver and control mechanism are mounted below

floor junction box for rapid installation and removal. On the left of the sloping Formica-faced desk are the air and vacuum brake controls and on the right the reverser and power controller. The gauges, instruments, indicator lamps, and light switches are mounted on a sloping detachable strip panel at the base of the front screens. Grooved hardwood is used for the cab floor.

The body structure has been made as light as possible. The strength required for the load carrying is provided by the very stiff underframe. Aluminium alloy $\frac{1}{8}$ in. thick is used for the bodyside panels, riveted to light alloy rails and pillars.

Glass Fibre Mouldings

On the corridor side are two fixed windows and on the opposite side three louvred air inlets, moulded in resin bonded glass fibre. The roof, which is detachable in sections for the maintenance removal of equipment, is largely formed in translucent resin bonded glass fibre. At the transformer location the body structure is braced to the transformer tank top plate to form a rigid structure. Water drainage from the pantograph roof well is by Alkathene pipes secured to the inside of the body.

The underframe is a welded assembly of steel plate and rolled sections. The side plates between the bogies are 24 in. deep. Standard screw couplings and Oleo Pneumatics side buffers are fitted. The deck is formed in aluminium and steel plate.

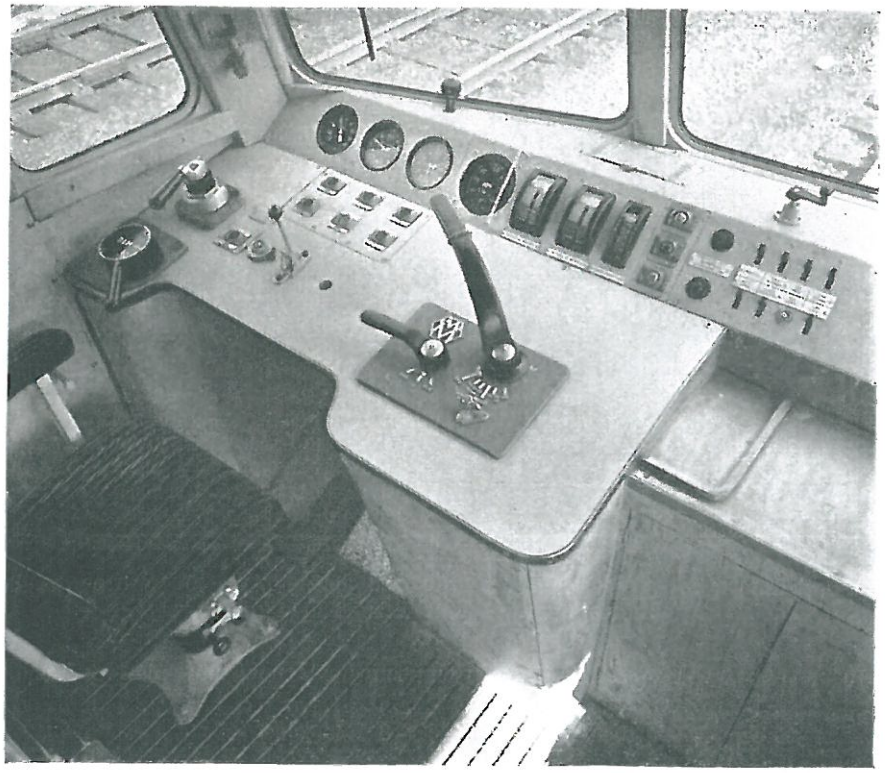
On each bogie a transverse spring plank is resiliently mounted to the bottom of the body support struts, and the body weight is transmitted from this spring plank through four nests of secondary coil springs to the bogie frame. No weight is carried on the centre pivot, which transmits, at axle height, the traction and braking forces only. Lateral movement is permitted by link anchorage of the pivot pin bush. Rubber seatings and rubber bush pivot joints are used on all suspension members, the system being a development of the Metrovick swing link suspension. The cast steel bogie frame is supported on four primary coil springs, each damped by a hydraulic damper. At the outer ends the equalising beams rest on rubber pads on the axle boxes. Timken taper roller bearing axle boxes are fitted, one box on each axle being located laterally by rubber bushed links anchored to the bogie frame. Rolled steel tyres are fitted to the cast steel wheel centres. Earthing contact brushes are fitted at the ends of the axles.

Brake Equipment

The Davies & Metcalfe brake equipment provides for independent air braking on the locomotive when running light or hauling unfitted stock, and vacuum controlled air braking when hauling vacuum braked trains. A locomotive brake release is fitted to facilitate uncoupling, and anti-slip braking to give a limited brake application to prevent wheel slip is incorporated. Two 14 in. dia. brake cylinders are fitted on each bogie, mounted transversely at the ends and operating through fully compensated clasp brake rigging. Air for the brakes is supplied by one Type VT 46 Worthington Simpson compressor of 29 c.f.m. capacity. Vacuum is provided by a two-speed type T.T. 150 Worthington Simpson exhauster.

Both machines are driven by A.E.I. motors, the 110 V. d.c. being supplied by a germanium bridge rectifier. Provision is made for running the exhauster from the battery in neutral sections. To reduce weight the air reservoirs and all brake piping are in aluminium alloy. The handbrake operates on the innerwheels of the adjacent bogie.

The sub-contractors for these locomotives are shown on page 8.



Driving position in cab, showing desk unit which is built as a prefabricated assembly before installation in the locomotive

As efforts are made constantly to improve both design and methods of manufacture apparatus supplied may differ in details from the illustrations

PRINCIPAL SUB-CONTRACTORS FOR THE A.C. LOCOMOTIVES Nos. E3046-E3055

Transformer oil pump	Pulsometer Engineering Co. Ltd.
Transformer oil cooler	Serck Radiators Limited
Fans for:	
(a) traction motor blowers	Keith Blackman Limited
(b) transformer oil cooler	
(c) rectifier compartment ventilation ...	
(d) smoothing choke fan	
Fans for cooling mercury arc rectifier tanks	Airscrew & Jicwood Limited
Battery	Nife Batteries Limited
Capacitors	British Insulated Callender's Cables Limited
Pantographs	J. Stone & Co. (Deptford) Ltd.
Mechanical parts	Beyer-Peacock Gorton Limited
Bogie castings	English Steel Castings Corporation English Steel Springs Corporation
Wheels and axles	Owen & Dyson Limited
Axle boxes	British Timken Limited
Buffers	Oleo Pneumatics Limited
Quill Drive Links and Motor Buffers, etc....	Silentbloc Limited
Main compressor and exhauster	Worthington Simpson Limited (driving motors supplied by A.E.I.)
Brake equipment and air details	Davies & Metcalfe Limited

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