

4,000 HP



KESTREL

BRUSH

INTRODUCTION

This conspectus lists the main features of the 4,000 hp Kestrel prototype diesel-electric locomotive, designed and built by Brush Electrical Engineering Company Limited.

The locomotive comprises a full body superstructure of chassisless, monococque, construction with two operating cabs, complete with power unit and all ancillaries and mounted on two 3-axle bogies; all axles motored.

The power unit consists of one Sulzer 16 LVA 24 diesel motor having an input of 4,000 hp to the traction generating machines comprising main alternator, dynastarter, and train heating/auxiliary alternator.

The major control functions are integrated electronically; a range of standard plug-in printed circuit cards being used in a variety of combinations to provide control of power, wheelslip detection, dynamic brake control, etc.

The locomotive is designed to operate as a single unit on all main-line railroad applications.

All materials, construction, and testing are to the highest standards established by Brush Electrical Engineering Company Limited.

LEADING PARTICULARS

MODEL	.. .. .	.. ..	KESTREL
DESIGNATION	.. .. .	.. ..	C-C
DUTIES	.. .. .	.. ..	Passenger, freight
ENGINE	.. .. .	.. ..	Sulzer 16 LVA 24
RATING	.. .. .	.. ..	4000 hp
			110 mile/h (cont.)
SPEED (19 : 60 gear ratio, 43 in wheels)		.. ..	125 mile/h (max)
TRACK GAUGE	.. .. .	.. ..	4 ft 8½ in
PRINCIPAL DIMENSIONS			
Length over buffers	.. .. .	.. ..	66 ft 6 in
Total wheel base	.. .. .	.. ..	51 ft 8½ in
Distance between bogie centres	.. .. .	.. ..	37 ft 2 in
Maximum height	.. .. .	.. ..	13 ft 0½ in
Maximum width (over handrails)	.. .. .	.. ..	9 ft 2 in
Maximum width (over bodyside)	.. .. .	.. ..	8 ft 9¾ in
Wheel diameter (new)	.. .. .	.. ..	43 in
Radius of min. curve	.. .. .	.. ..	264 ft
WEIGHT			
With full supplies	.. .. .	.. ..	126 ton
Maximum axle loading	.. .. .	.. ..	21 ton
SUPPLIES			
Diesel fuel oil	.. .. .	.. ..	1000 gal
Sand	.. .. .	.. ..	8 ft³
DRAWINGS			
General arrangement	.. .. .	.. ..	4005378
Tractive effort/speed curve	.. .. .	.. ..	9/5404



M 680

HS 4000

STRUCTURE

All welded, monocoque assembly, using a stressed skin form of construction consisting of steel sections and plates and incorporating cross stretchers to form an integral load-bearing structure. The ends of the underframe are reinforced to provide dragboxes capable of withstanding a 200-ton centre buffing load. End loading is distributed to the upper structure members through side trusses.

The all-steel roof is provided with doors for access to equipment, and the whole roof is detachable in four sections for equipment removal.

All walkways are provided with anti-slip floor plates.

The structure is divided by bulkheads into three main compartments in which the main items of equipment are disposed.

No. 1 End Radiator Compartment: Contains engine cooling, and intercooler, radiators in double bank assembly mounted in the detachable roof section together with two a.c. motor-driven cooling fans.

Dynamic brake resistance bank with two d.c. motor-driven cooling fans.

Traction motor ventilation blower, a.c. motor driven.

Brake system cubicle containing air and vacuum system equipment.

Electrical and electronic equipment cubicles.

Engine Compartment: Contains diesel engine, traction alternator/exciter, gearbox with take-off drive to air filter intake fan, and main power rectifier bank. Inertia filter assembly mounted in, and detachable with, the roof section.

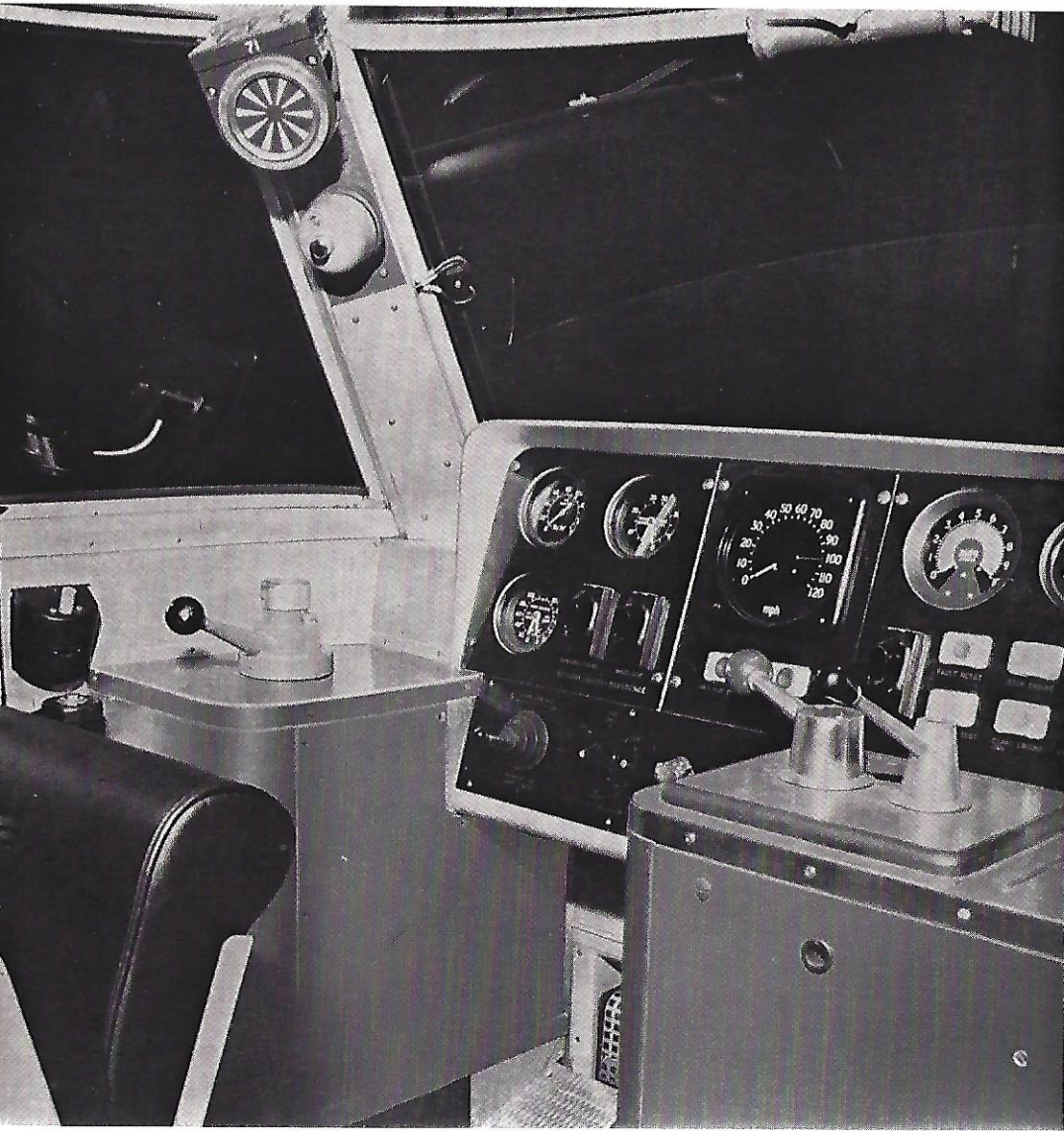
No. 2 End Radiator Compartment: Single bank intercooler radiator mounted in the detachable roof section together with two a.c. motor-driven cooling fans. The dynastarter and train heat/auxiliary alternator, line-driven from the gearbox, are located in the centre of the compartment.

The automatic voltage regulator (AVR), electrical control equipment cubicle, train heating rectifier group, divert resistors and traction motor ventilation blower are all situated in this compartment.



Main Power Equipment Cubicles: Two cubicles, located one at the rear of each driving cab compartment.

Auxiliary Subframe: Located between the bogies and suspended from the locomotive body and supporting the exhausters, compressors, storage batteries, and main fuel tank.



Fuel Capacity: 1000 gallons total, contained in the main fuel tank and in pannier tanks incorporated in the main under-frame structure.

Driving Cabs: Located at each end of the structure. Each cab is heat and sound insulated. Floors are of resin-bonded plywood with a non-slip pattern surface. All windows are fitted with toughened safety glass sealed in rubber; the wrap around windscreen glass incorporates built-in electrical heating. Drop lights fitted in side windows and doors. Glass wind deflectors fitted forward of side windows.

Two hinged doors in each cab provide access from either side of the locomotive. All outside doors are weather-sealed and lockable.

Driving Position: Located on the left side of each cab. Power and reverser handles are mounted on a console convenient to the driver's right hand.

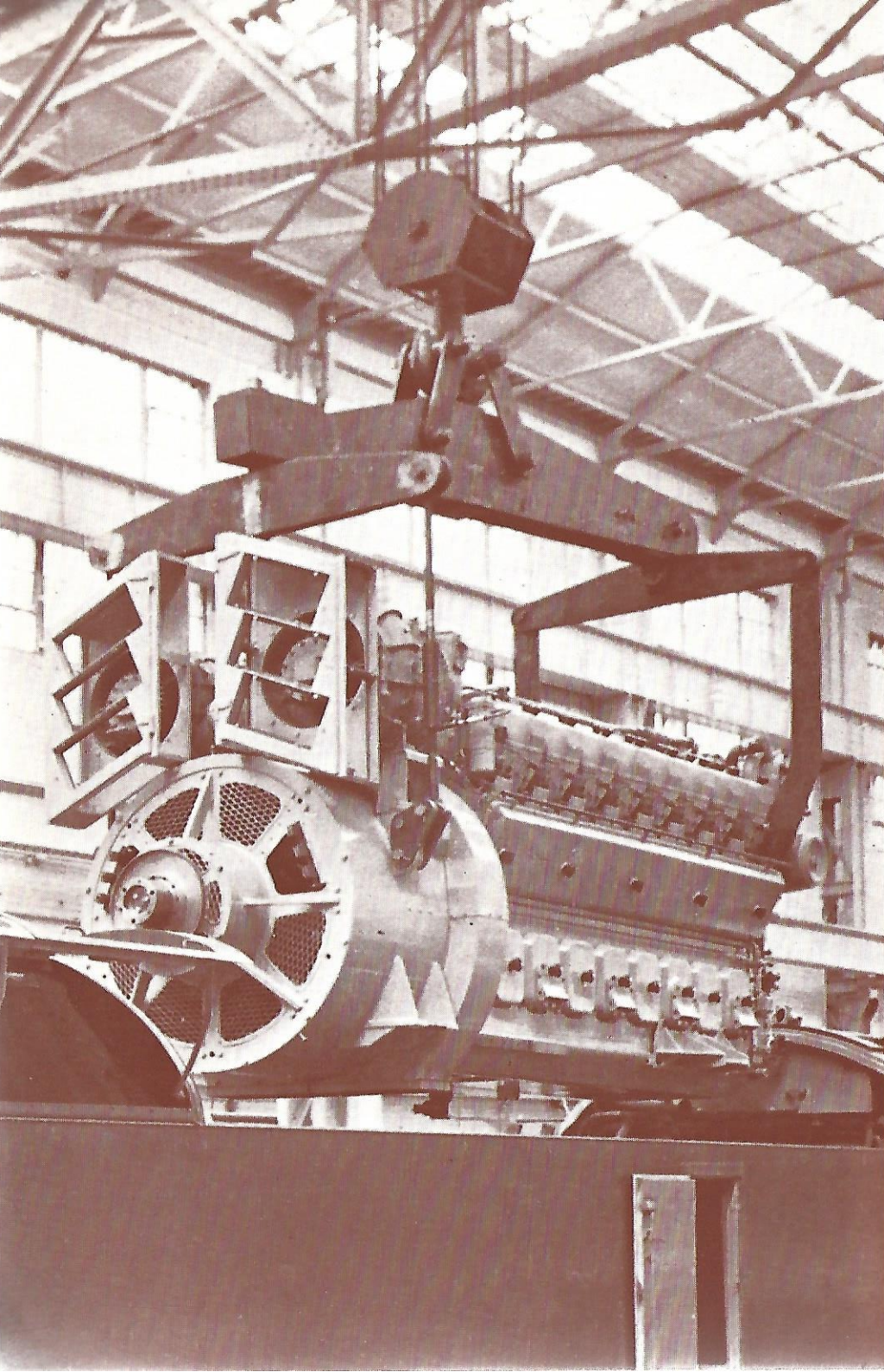
To the driver's left hand are mounted the main air/vacuum brake and locomotive air brake control levers.

Instrument panel, hooded to prevent windscreen reflections, equipped with full air and vacuum brake instrumentation, speedometer and main ammeter.

Below the instruments are signal lamps indicating the status of dynamic brake, wheelslip and fault indication circuits, and 'diesel engine stopped', together with pushbutton control of anti-slip brake, sanding, fire alarm test, fault reset, and engine start/stop.

The handbrake wheel is positioned in front of the right-hand seat. Duplicated controls for horn, windscreen wipers and washers, and DSD pushbutton are also provided for second man operation.

Horn operating lever, and windscreen wiper and washer controls are also positioned in front of the driver.



DIESEL ENGINE

One Sulzer type 16 LVA 24, 16 cylinder, Vee-type four cycle, pressure charged and intercooled, bore 240 mm (9.450 in) stroke 280 mm (11.020 in). Oil cooled aluminium alloy pistons. Forged steel connecting rods. Nine bearing crankshaft with chromium plated journals. Individual detachable cylinder heads. Wet type cylinder liners.

Fuel System: Electrically driven fuel transfer pump supplies fuel to individual jerk pumps and injectors. Suction and delivery filters in transfer pump lines.

Lubrication: Lubricant contained within the engine sump. Main lubrication by engine driven gear pump and priming by electric motor driven pump. Adequate oil filtration and cooling provided. Automatic low oil pressure shut-down.

Cooling: Separate engine-driven circulating pumps for engine and charge-air cooling systems. Radiator panels cooled by electrically driven fans. Expansion tanks for each coolant circuit. Thermostatic control of coolant temperature with excess high temperature shut-down.

Air Intake: Secondary filtration of engine charge air.

BOGIES

Two; three-axle type, all axles driven, incorporating sprung, swing bolsters, and load distribution via overhung forged-steel equalizer beams. Lateral control of centre axle movement by hydraulic damper.

Frame: Cast-steel, one-piece Commonwealth type supported on coil springs, mounted on forged-steel equalizers. Tie bars fitted to all pedestals.

Springs: Coil type, made from silico-manganese, ground steel bar.

Dampers: Hydraulic piston type.

Axles: Forged-steel, manufactured to British Rail specification.

Wheels: Rolled steel, 43 in diameter in accordance with British Rail specification.

Gears: Straight spur, single reduction type, the driven member comprising a composite hub and gear rim assembly incorporating resilient units.

Axleboxes: Cast steel, incorporating spherical roller type bearings on leading and trailing axle applications, and parallel roller bearings on centre axles.

Traction Motor Mounting: Each traction motor mounted on a suspension tube which is supported on the axle by roller bearings; attachment of the motor to the bogie frame is by resilient nose link.

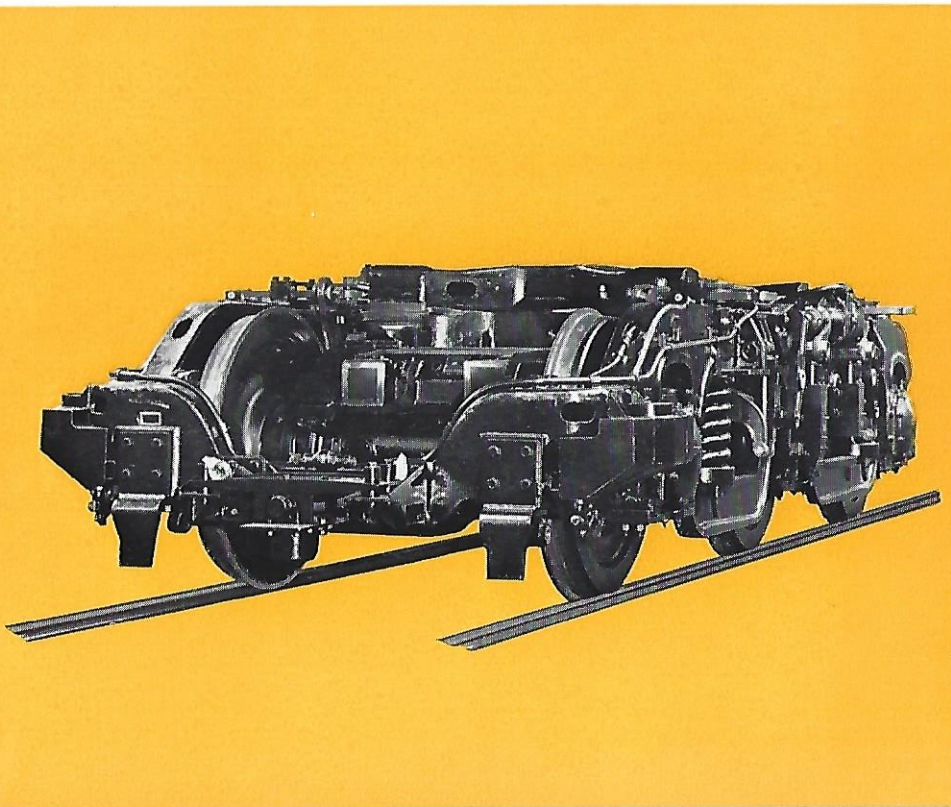
Brakes: Clasp type on all wheels, with compensated rigging operated by four brake cylinders. Hardened steel swivel and clevis pins in hard steel bushes.

Parking Brake: Applied from either cab; hydraulic actuation of all brake shoes on adjacent bogie.

Wearing Plates: Renewable wearing plates applied to axle-box guides, axleboxes, bolster and bogie frame.

BRAKE EQUIPMENT

Independent air braking on the locomotive only, with either vacuum or automatic air train braking, both with proportional air brake on the locomotive; selected according to requirement. Dynamic braking completely integrated with the mechanical brake system under a single control. Copper piping used throughout. Air and vacuum train connections located at each end of the locomotive.



Air Systems: Compressors: two; located on the sub-frame; three cylinder two-stage, d.c. motor-operated, with self-contained lubrication system, provide air for air brake requirements, power control and ancillary services.

Fully automatic pressure control is provided.

Air coolers: Integral intercooler on each compressor; after-cooler provided in the line to No. 1 air reservoir.

Air reservoirs: four, all-welded, fabricated construction, total capacity 30 ft³; one located on the underslung sub-frame, two in No. 2 radiator compartment, one in No. 1 radiator compartment.

Vacuum System: Two air-cooled, rotary blade type exhausters, d.c. motor-driven, are mounted on the sub-frame between the bogies.

Adequate filtering, check valves, and sniffer valve are included in the vacuum circuit.

Two-speed operation of the exhausters is provided.

ELECTRICAL EQUIPMENT

All BRUSH electrical machines are designed for rail traction service and comply with B.S. 173/1960. A.C. and d.c. generators driven in-line from the diesel engine. Dynastarter and train heating alternator driven via a step-up gearbox which also drives the main air intake fan. All generators self-ventilated. Control equipment specially designed and constructed to rail traction standards accessibly disposed in four cubicles; printed circuit cards and solid-state equipment used in primary power control circuits.

Main Alternator: BRUSH designed and built. 10 pole, 3 phase, salient pole, with integral a.c. brushless exciter. Single bearing rotor, directly driven by the diesel engine. Continuous rating: 2520 kW at 410 V a.c., 91.6 cycles at 1100 rev/min.



Train-Heating/Auxiliary Alternator: BRUSH designed and built: 8 pole, 3 phase with integral brushless a.c. exciter, 2 bearing rotor, mounted on a sub-frame with the dynastarter and gearbox. Driven from the dynastarter through a flexible coupling.

Stator windings switched electronically to stabilize voltage during variations in engine speed.

Continuous rating: 534 kVA, 680 volts a.c. at 2750 rev/min.

Dynastarter: BRUSH designed and built, d.c. generator operated as a motor for diesel-engine starting, 2 bearing armature, driven from the gearbox through a flexible coupling. Continuous rating: 47.6 kW, 110 volts at 1125 rev/min.

Gearbox: Mounted on bedplate with dynastarter with train-heat/auxiliary alternator. Line output shaft $2\frac{1}{2}$ times engine speed. Right-angle output shaft 1.6 times engine speed.

Traction Motors: Six, BRUSH designed and built, d.c. series-wound, parallel connected, force ventilated. Armatures mounted on roller bearings. Each motor axle-mounted, and nose suspended from bogie transom. Continuous rating: 515 hp, 504 volts, 830 amps, 681 rev/min.

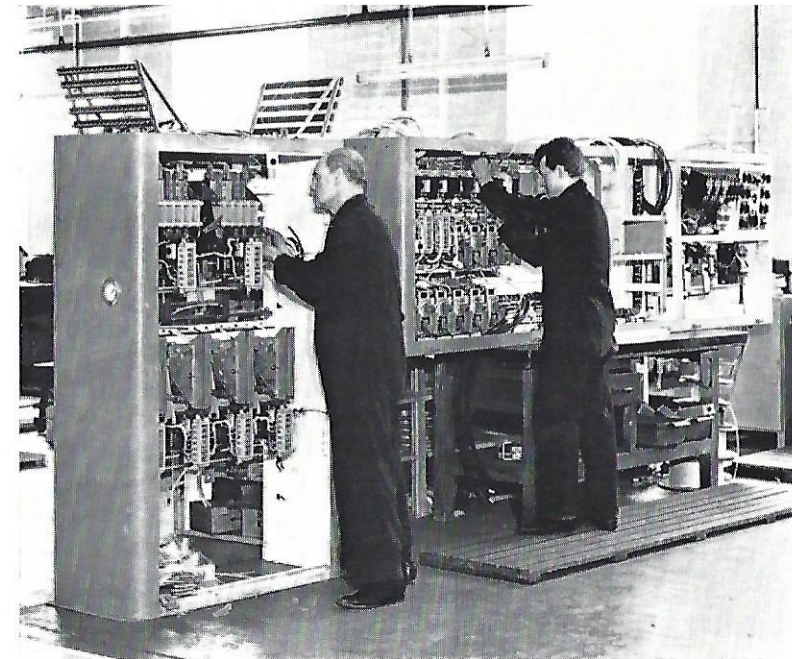
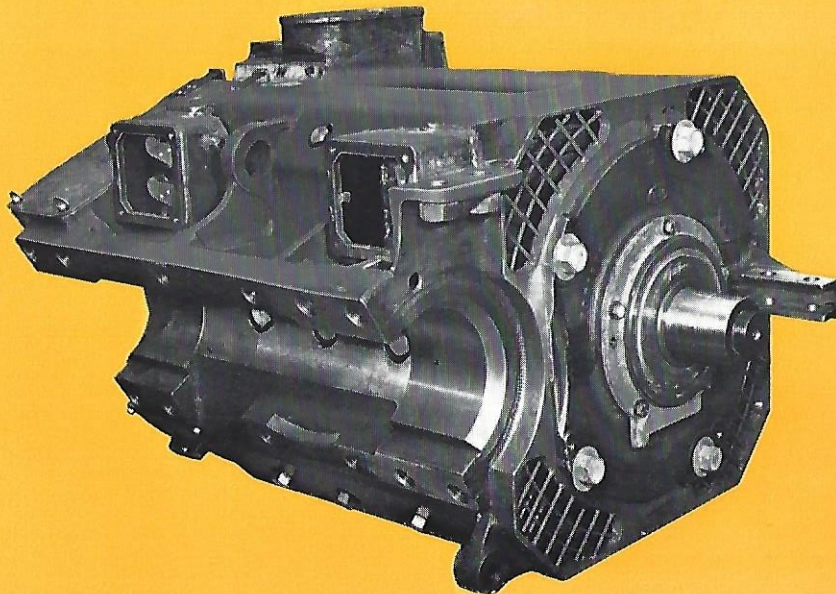
Control Equipment: Load regulator: Rotary-type positional transducer, operated by engine-governor controlled oil pressure, modulates thyristor circuits controlling main alternator exciter current, thereby adjusting electrical load and diesel-engine power output to meet immediate load condition. Contactors and switches: Traction motor field divert and train

heating contactors and the reversers are electro-pneumatically operated; all other contactors and relays are magnetically operated. Auxiliary interlock switches are actuated by the armature on the devices to which they are attached. Overload protection on auxiliary and control circuits by circuit breakers with manual reset.

Dynamic Brake: Electronic control of traction motor switching and engine/alternator load in the dynamic braking mode. Brake load resistors fan cooled.

Wheelslip: Electronic control in conjunction with load control and dynamic brake circuits.

Storage Battery: 110 volt, 48 cell, 384 ampere-hour lead-acid type mounted between the bogies on the sub-frame.



ELECTRONIC CONTROL SYSTEM

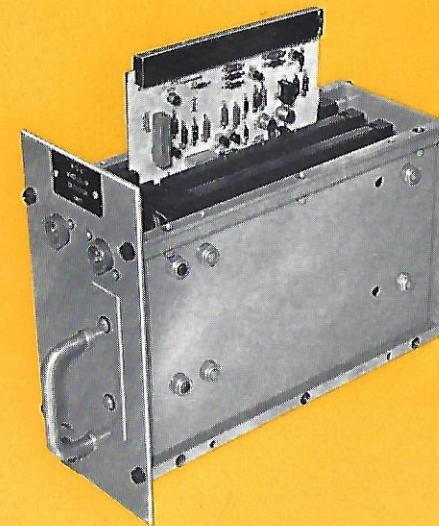
BRUSH were the first diesel locomotive manufacturers in Great Britain to use electronics extensively for important duties on series production locomotives. Experience and confidence gained from this has been exploited in Kestrel.

The electronic units are fully integrated with the whole control system, using modular equipment cabinets with plug-in printed circuit cards. This system enables a limited number of standard cards to be used in different combinations to perform a variety of control functions such as power control, dynamic brake control, wheelslip detection and control, etc. To illustrate this one particular type of card is used in each of the following units: weak field control, engine temperature control, train heat voltage control system protection, rotating diode failure detection and dynamic brake control.

The flexibility of the system allows for easy changes to be made so that advantage can be taken of improved control techniques.



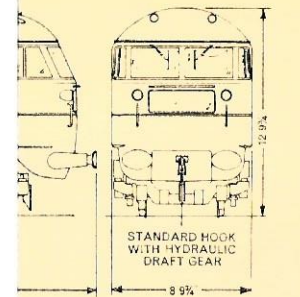
Electronic systems rack



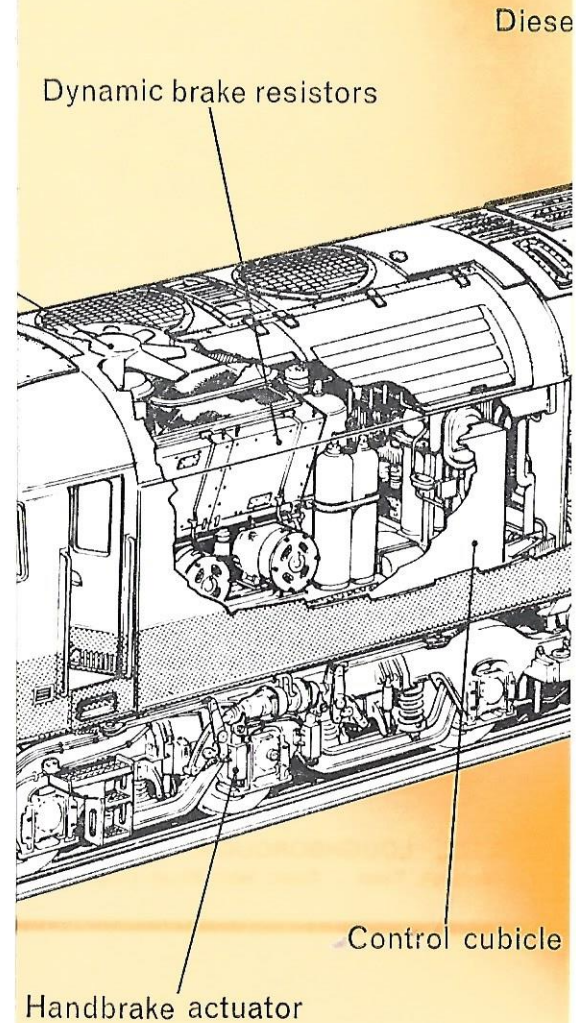
Wheelslip detector unit

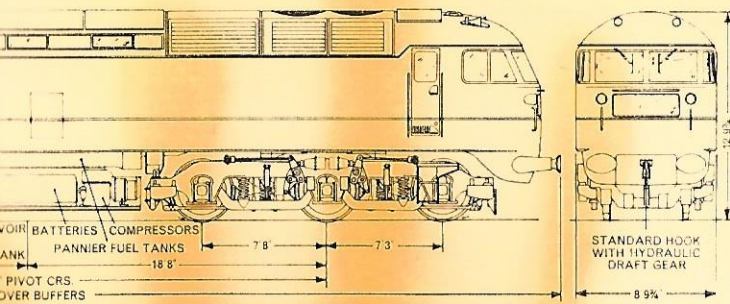
APPURTENANCES

- Driver's Safety Device:** Footpedal control at each driving position and pushbutton control adjacent to cab side windows. Two-position operation of DSD controls for vigilance device.
- Horns:** Four, diaphragm type, roof mounted, two at each end.
- Heaters:** Fan heater and two footwarmers in each cab.
- Seats:** Fully upholstered tip-up type with forward, backward, and vertical adjustment.
- Windscreen Wipers and Washers:** Four provided, air operated, two at each end.
- Windscreen Defroster:** Electrical gold film elements integral with window glass.
- Sunblinds:** Adjustable type, at each driving position.
- Marker Lamps and Classification Indicators:** At each end of the locomotive, to B.R. standards.
- Fire Extinguishers:** Automatic fire warning system; remote operated CO₂ equipment in engine and equipment compartments; B.C.F. hand type in each cab.
- Cooker:** Grill/boiler in each cab.
- Toilet Facilities:** Wash basin and urinal in No. 1 radiator compartment.

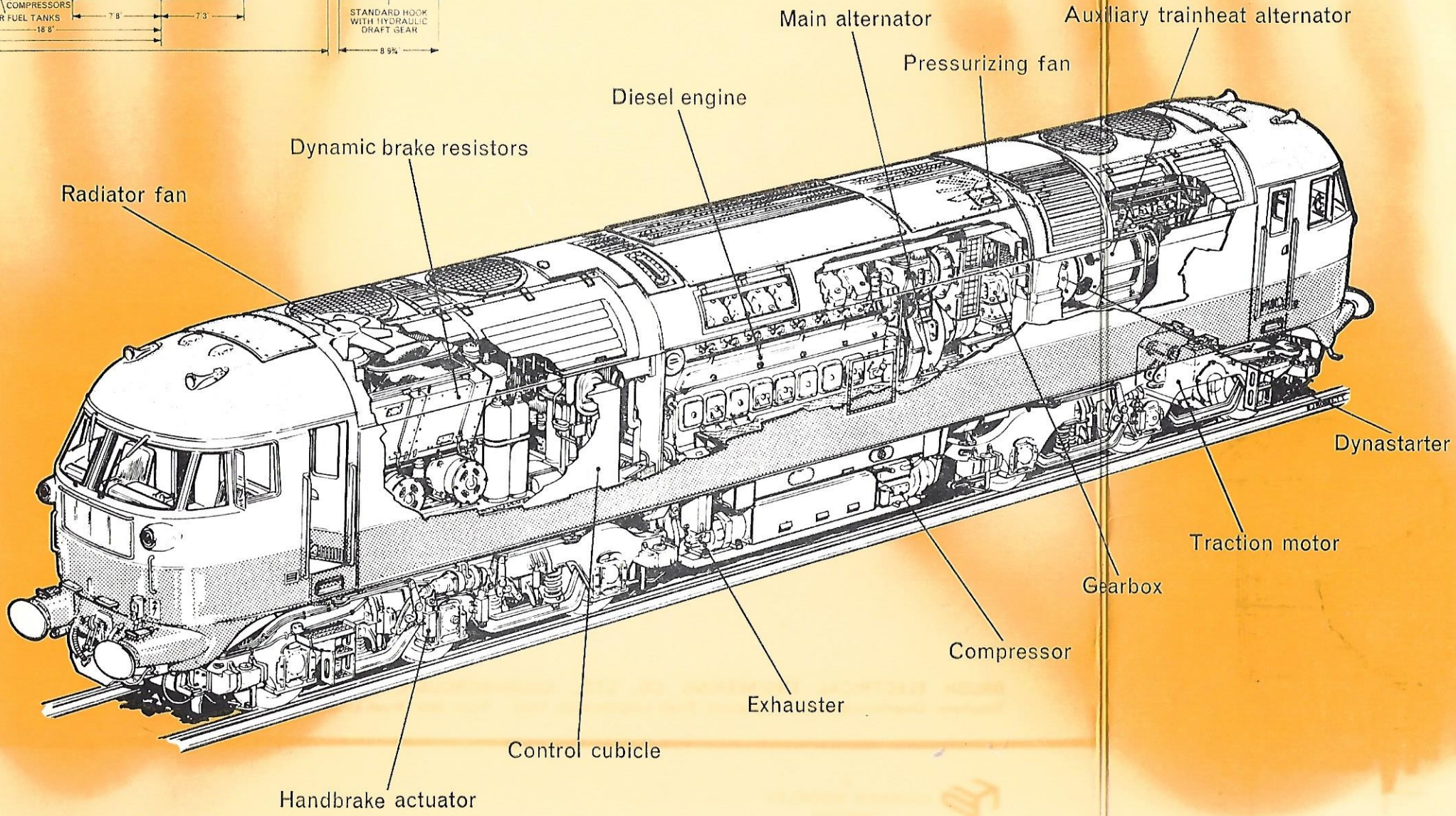


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