

# LEYLAND TITAN

a new horizon  
in public transport









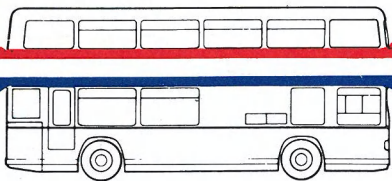


# **LEYLAND TITAN**

**a new horizon in public transport**







## Leyland Titan – the answer for tomorrow's double deck operation

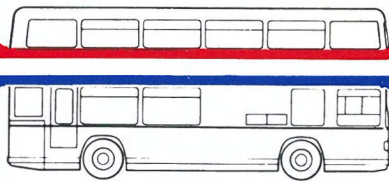
The Leyland Titan is an integrally constructed rear engine double deck bus of advanced design, the result of one of the most intensive investigations into meeting the future requirements of double deck users and operators. Design philosophy has been to use the latest technology in gaining for driver and passenger notable improvements in ride, handling, noise control, heating and ventilation: all this in a vehicle which is easy to service and maintain, having low steps and pleasingly spacious interior layout which will induce people to stay with public transport.

Single front-entrance or front-entrance/central-exit doorway versions are available, with a choice of interior colour schemes and seating layouts. Up to 73 seated and 20 standing passengers can be carried in unusually pleasant conditions and with generous luggage accommodation. Standards of spaciousness and quietness, comfort and safety provide a combination which is hard to beat on the double decker market.

In keeping with the Leyland National single-deck philosophy the Leyland Titan double decker is manufactured as a complete vehicle proved by the manufacturer prior to sale, and is designed for one-man-operation. It is a fully integral construction vehicle with an aluminium alloy corrosion proof structure which overcomes problems of chassis-body compatibility, reconciliation of electrical and heating/ventilation systems that can otherwise result in some compromise.







## A bus designed for people

Leyland Titan will make people want to stay with buses. Body design and layout has been influenced by human factors engineers from the outset. Many of the design features have been incorporated as a direct result of a lengthy human factors research programme into the use of buses by the elderly and infirm; this is a section of the population that has hitherto been restricted by difficulties in access to and movement within buses.

Now, in statistical terms, another 1.8 million of the less agile section of the population are able to board the bus because of the achievement of a three inch lower step height. The first step at 313mm (12.32in) and a second at 218mm (8.58in) leads to a near flat floor with no more than 38mm (1.5in) ramp. And the front entrance is a full 1200mm (3ft 11½in) wide with handrails positioned to fit a wide percentage of the population.



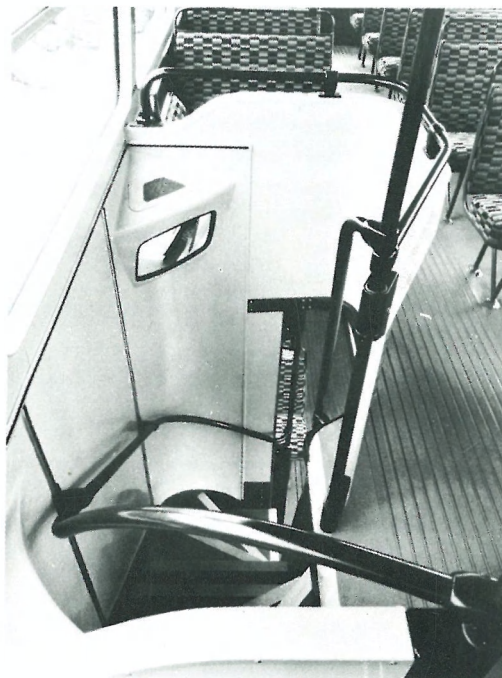
Inside the lower saloon a fresh approach to interior styling is evident with bright new colours, elegant trim panelling, fluorescent lighting, sensible non-reflective hardware, partition screens with neatly integrated grab handles, foot stools and kick plates finished in a pleasing matt grey wear-resistant material. But above all there is a new sense of space and light.



Side windows are 203mm (8in) deeper than on conventional buses and the sight line for standing passengers is 1800mm (5ft 10¾in). Saloon height is 1902mm (6ft 2¾in) sloping down to 1943mm (6ft 4½in), which is comfortable for 95% of the male and 99% of the female population; there is a roomy 68.58mm (27in) seat spacing and gangway width of 508mm (20in).

Beneath the staircase is a spacious luggage compartment with an attractive styling line carried through from the inward facing front saloon seats. The stairwell is trimmed in a light shade of melamine with matched plastic corner

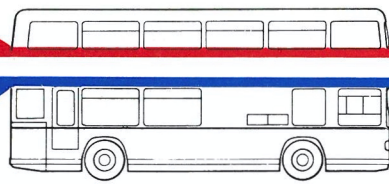
mouldings. It is an integrated design with radiused corners and white step nosing for safety. In the upper saloon numerous vertical stanchions are provided for safety and security for passengers on the move during braking and acceleration. There is a comfortable 1794mm (5ft 10¾in) headroom, higher than on any other bus. Front end interior styling in the upper saloon is transformed from conventional arrangements, with pleasing colour split lines carried around the whole saloon and fittings such as periscope and mirror faired in to the trim panels. And light grey matt pans set the windows off to best effect.



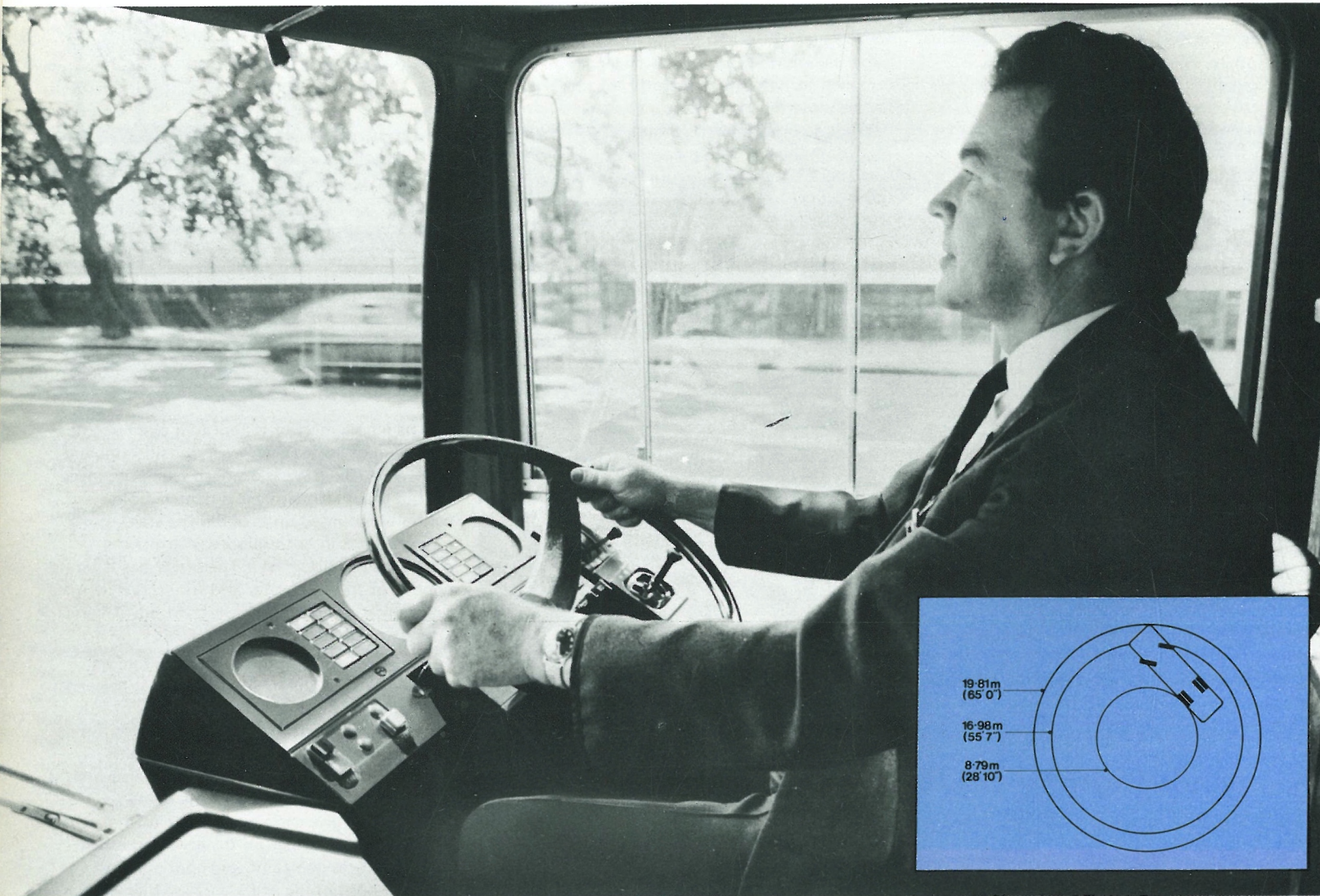
The whole interior is kept to a comfortable minimum of 16°C, even when outside ambient is down to -5°C. Air is changed regularly, meeting bus grant standards; it is ducted from centrally mounted units under the stairs along integral ducts in both saloons. Warm air is distributed at floor level. The driver has separate control of the cab heater and windscreen demist unit which complies with the stringent American/Australian defrost/demist standards.

One part of the extensive human factors programme was the study of potential passenger congestion areas on disembarking. Use of full scale mock-up tests with human subjects filmed during disembarking was carried out with adjustable staircase position, varying aisle widths and seat spacing. Relation of the items was optimised to give easiest passenger flow. Further human factors studies on the aged and infirm led to the best choice of step configuration, grab rail positioning and stanchion diameter.



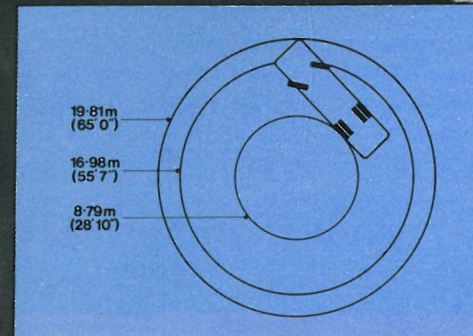


## A bus designed for people

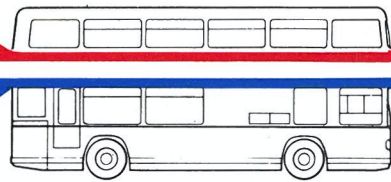


In the drivers' cab many of the attractive features of the Leyland National single decker have been carried through. Aesthetically pleasing facet-form styling is incorporated with scientifically laid out instruments and controls to minimise driver fatigue and thus ensure maximum safety. The compartment is comfortable, spacious and quiet. Levels of effort required to operate the driving controls have been minimised without losing out on sensitivity; a small diameter (18in) steering wheel is comfortably raked, has lock-to-lock turns similar to that on a private car, and by virtue of power steering a comfortable hand pull at the rim. Infinitely adjustable swivel seating is featured with commanding visibility for the driver, in an anti-glare environment which is protected in vehicle impact.

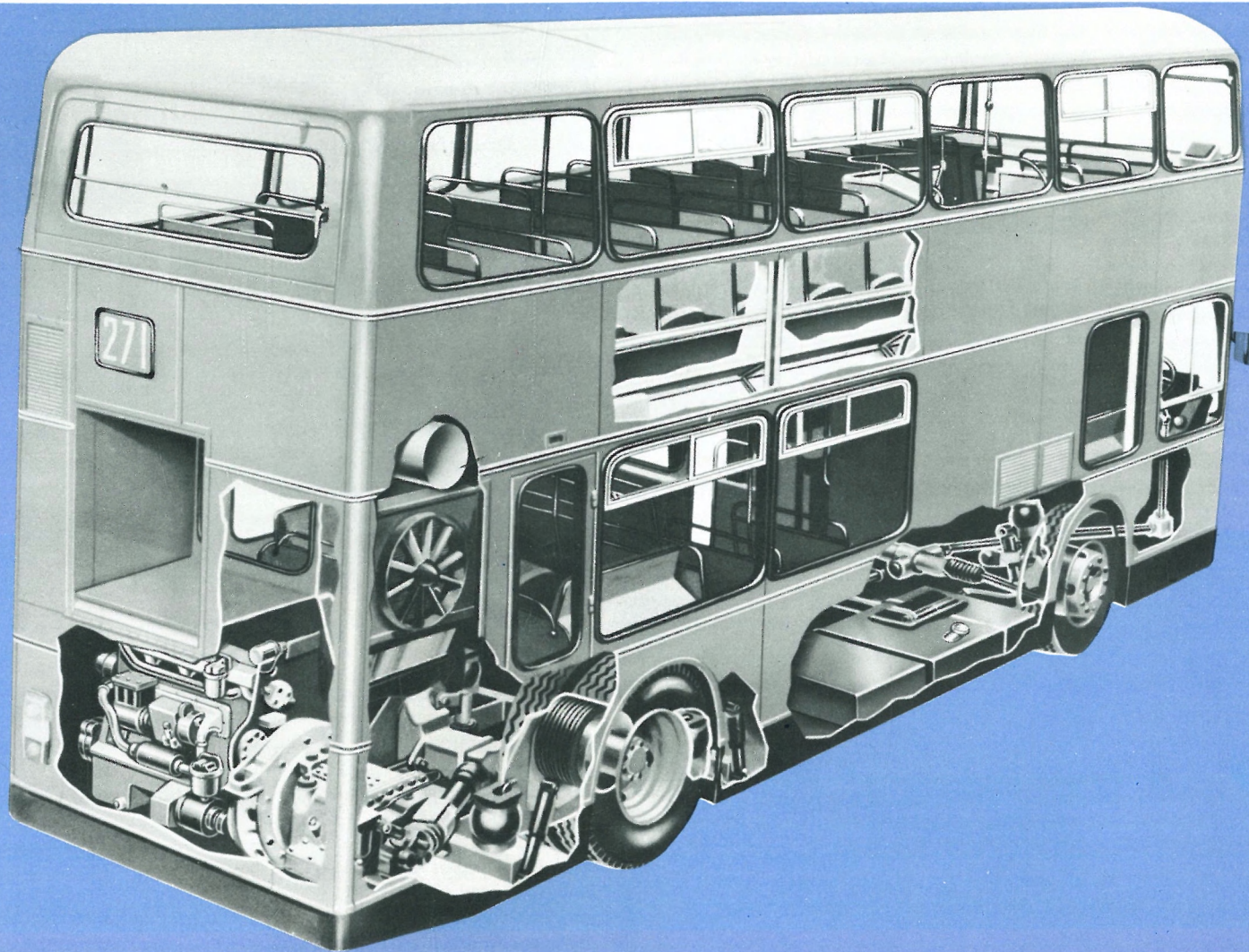
On the road the bus has a very competitive performance with comfortable reserves of engine torque; low noise output from the fully encapsulated rear engine makes the bus unobtrusive in environmental terms. Swept turning circle is 19.81m (65ft). Fully automatic transmission makes for a virtually jerk-free ride; power hydraulic braking gives smooth deceleration, helped by the friction transmission retarder which effectively keeps down service brake running temperatures. The bus will reach 48 km/h (30 mile/h) in 25 seconds loaded to 16.25 tonne (16 ton) gross with full complement of passengers. Maximum speed varies between 64 km/h (40 mile/h) and 96 km/h (60 mile/h) depending on transmission ratio, with restart capability up to 1:5.6.



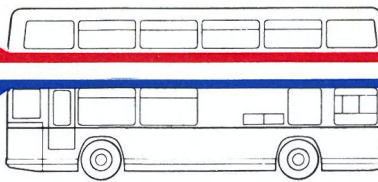




## **Service and maintenance**







## Service and maintenance

Early attention to component and service point accessibility during the design stage has paid off in terms of low man-hour times for most maintenance tasks. Here are some examples of key times for remove and refit (hours):

|                   |      |                      |       |
|-------------------|------|----------------------|-------|
| Oil filter        | 0.16 | Rear brake shoes     | 2.10  |
| Thermostat        | 0.50 | Gearbox piston seals | 3.00  |
| E P valve block   | 0.83 | Prop. shaft          | 3.26  |
| Alternator        | 1.25 | Angle drive          | 4.50  |
| Spring brake unit | 1.66 | Gearbox              | 8.03  |
| Rear hub          | 2.00 | Engine               | 10.00 |

While the engine compartment is completely enclosed, removal of the undertrays is possible in three easily handled sections within a few minutes. Framework carrying the undertrays is also easily removable for total access to the engine/gearbox assembly. Outer engine mountings being suspended from the integral structure simplifies engine removal. Mounting of the engine/gearbox unit to a common ring frame around the fluid coupling permits simple separate withdrawal of either gearbox or engine.

Both Gardner and Leyland TL 11 (derived from 680) engines have millions of miles of reliable operating experience in trucks and buses, and have been developed over the years to a high level of durability in bus applications. Easy access to oil filters, fuel injection pump and compressor is available on the outward face of the engine at the rear of the bus.

Engine cooling is by the Leyland-developed 'no loss' system; when required, a choice of coolant refilling methods, from inside the upper saloon (by hand), or normally by ground level pressure hose point, gives maximum versatility of approach. A coolant level check and

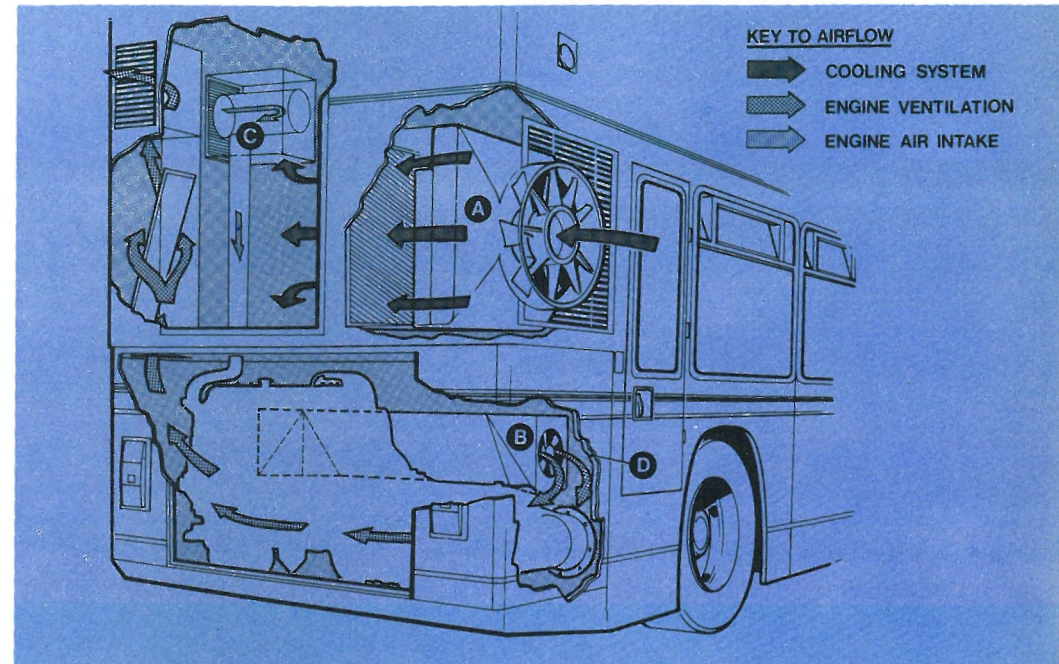
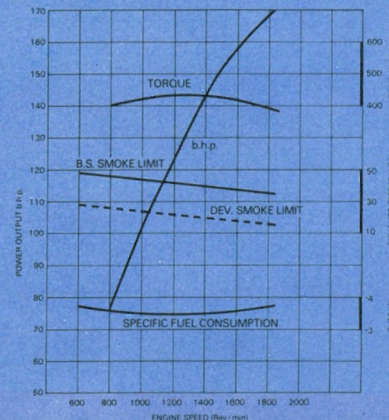
warning system removes the need to take off the filler cap. With the hydraulic system for cooling fan drive and braking, diagnostic test tapping points are provided in the following places: between fan/power-steering pump and hydraulic valve block, between manifold and fan motor, between manifold and power steering rack and within the brake line system.

## Engine installation

The Leyland TL 11 engine fitted is a turbo-charged version of the well proven 680 bus engine fitted with 'U-flow' cylinder head. It is an 11.1 litre 6-cylinder vertical in-line diesel mounted transversely at the rear and rated at 127 kW (170 bhp) at 1850 rev/min and 725 Nm (535 lbf ft) torque at 1200 rev/min to BS AU 141a gross. Capable of a maximum power output of 250 bhp the TL 11 engine is moderately

### Leyland 6 cylinder diesel engine

170 BHP AT 1850 RPM  
535 LBS FT TORQUE AT 1300 RPM



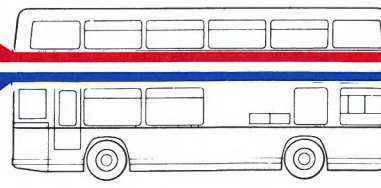
rated and is installed in a way which reduces noise emission to a minimum, inside and outside of the bus.

Slimline Ambac injectors are featured with well cooled low mass mounting bosses. The F & M P76 fuel injection pump is controlled by an air throttle. Careful matching of pump and injectors to turbocharger characteristics has led to a virtually invisible exhaust gas emission. Durability of the engine is enhanced by such premium features as chrome plated dry cylinder liners, nitrided crankshaft in chrome molybdenum steel, viscous torsional vibration damper and under crown piston oil cooling. Lube-oil pump output is 54 litres (12 gal) per

minute and there is an integral oil cooler.

The engine is mounted in a separate enclosure to the cooling radiator which is high mounted alongside the bus rear window. This puts both units in a better operating environment and considerably reduces drive-past noise level. The engine compartment is cooled by a ducted air system which contributes to the cleanliness and cool running of the engine and eases service tasks. Widely spaced rigid anchorage points for the flexible engine mounts mean excellent vibration isolation. A remote header tank beneath the rear bench seat of the upper saloon directly feeds the eye of the water pump on the engine.

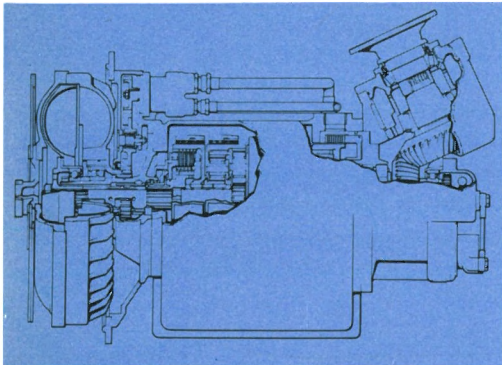




# Leyland Hydracyclic – a highly developed gearbox

Hydracyclic is developed from Pneumocyclic, Leyland's established air operated bus gearbox. Now to further improve reliability and durability it is hydraulically operated and independent of the vehicle air system, with oil pump, engine driven and built on to the gearbox housing. It ensures that the servo pressure is available and the system is charged with oil even when the vehicle is stationary and the engine at idle speed, so avoiding abuse.

It features a fully charged fluid coupling having common oil with epicyclic gearbox and angle drive and sharing a substantial oil-to-water heat exchanger into the engine cooling system. The 10 gal/min oil feed pump charges the fluid coupling to 30 lbf/in<sup>2</sup>, a limiting valve preventing over pressurisation. There is a built-in hydraulically actuated multiple plate friction retarder which dissipates its heat into the transmission oil and out through the heat exchanger.



And a new solid state self-diagnostic (integrated circuit) electronic control system effects automatic gear selection. It automatically senses speed of vehicle and throttle opening, assessing the relationship between them and

calling for a gear change by electric signal. Over 25 years of experience has gone into the new control system which uses a self diagnostic translator using light emitting diodes. Power is automatically reduced at the point of shift which produces smooth, jerk-free changes.

Normally the vehicle starts in second gear but there is a first gear pre-select option for hill starts. Overall there is a two pattern gear shift programme for either performance or economy running, selectable from a performance level switch beneath the accelerator pedal. Hold positions can be provided on all gears. Full integration of the control system with the 5-speed close ratio gearbox allows careful matching of gear selection to performance requirement. The control ensures that there are no unwanted up-changes when power is removed, a disadvantage with certain automatics in heavy traffic conditions.

Important developments have been incorporated in Hydracyclic; these result in new high levels of durability. There is 25% increase in band brake width, 10% increase in brake lining thickness and an improved brake band.

Coupling, gearbox and angle drive are an integral assembly positioned to the right of the transverse engine, looking from the rear of the bus. Between the units is a sandwiched ring frame suspended from the main engine mounting bracket. Each unit bolts separately to this member so that either can be removed independently as required. A new diaphragm drive between engine and coupling has been developed which, together with a self aligning bearing, permits a working degree of assembly tolerance between the two units, for ease of removal and replacement.

Integration of a friction retarder into the

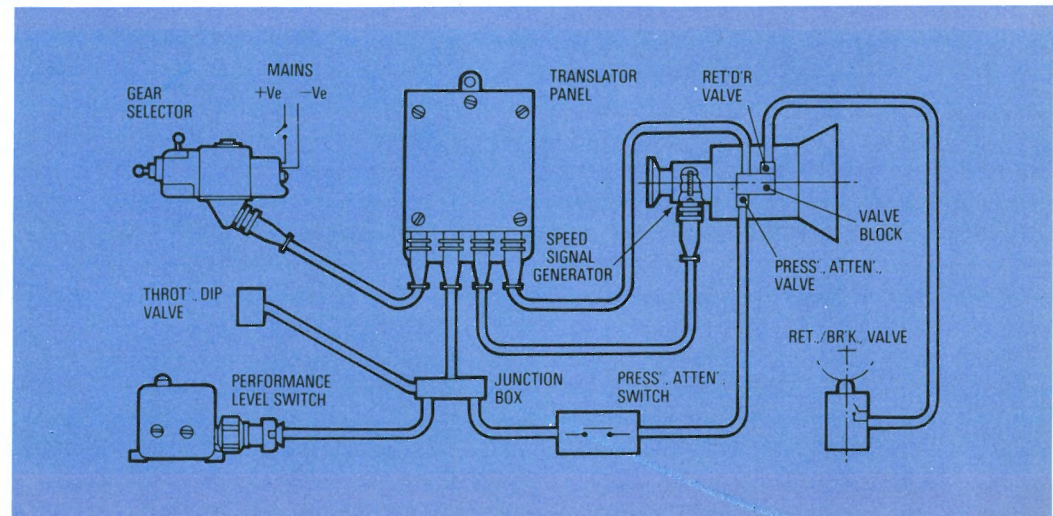
gearbox represents a breakthrough in transmission development, involving little extra bulk and only minor weight penalty. The retarder is operated by the brake pedal and is so controlled that the stability of the vehicle is unaffected on braking; it prolongs considerably the life of brake linings and is effective almost down to zero speed.

The compact angle drive, use of a 'z' drive configuration and drop centre drive axle results in an unusually low saloon floor. Angle entry at 65° to the axle centre line allows a smaller spiral bevel gear drive into the axle, operating at some 20% lower tooth bending stress than a conventional drop centre axle. Torque capacity of the unit is 3500 lbf ft and there are a lower number of gear sets overall than on conventional units so that greater durability is assured.

The axle casing is a rugged construction of

iron castings with generously proportioned gear sets, yet weight is saved in a lightweight hub design and hollow centre drive shaft. This shaft is also moderately proportioned, being inboard of the main reduction gears in the drop section. Helical reduction gears mounted on the taper roller bearings make for exceptionally quiet running.

A compact oil pump is built in to the axle and provides pressure oil feed to the gear bearings. Cast-in weirs ensure preferential filling of the end casings with return oil. A scoop alongside the crown wheel feeds the pinion bearings and oil throw from the drop gears feeds the brake camshaft. This attention to designing-in maximum durability and reliability in the individual running units contribute to a confident forecast of 15 year life span for the complete vehicle; the axle has already been pave-tested for 1600 miles without failure.

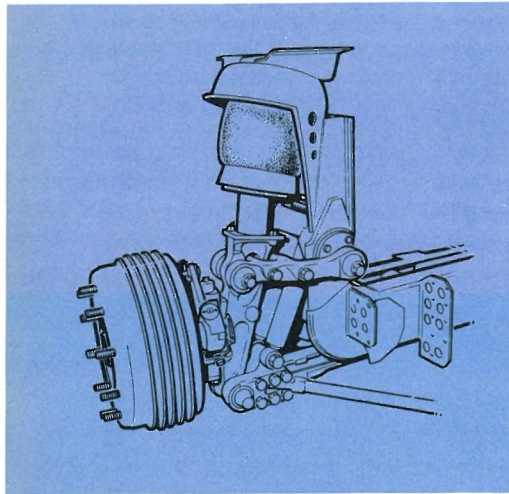




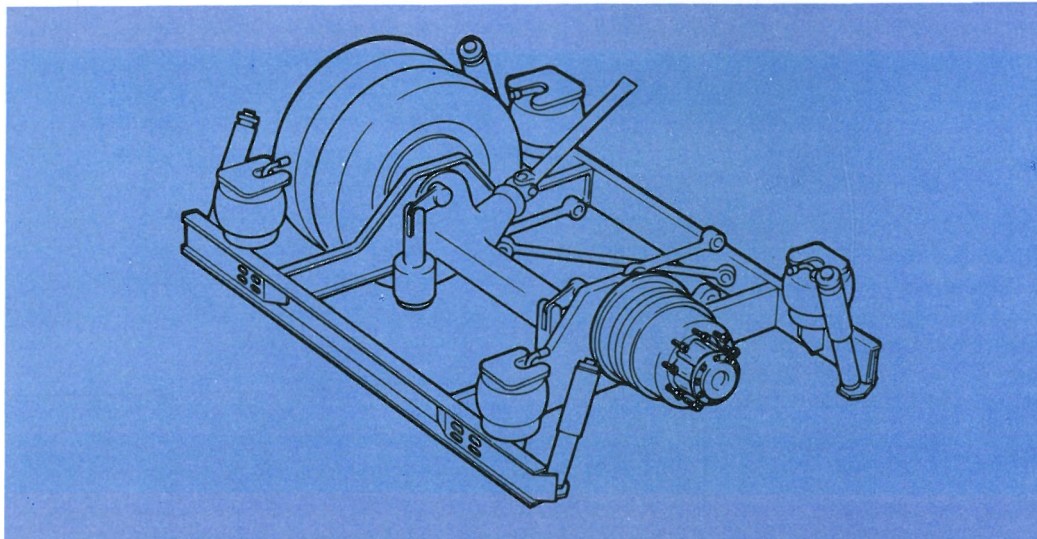
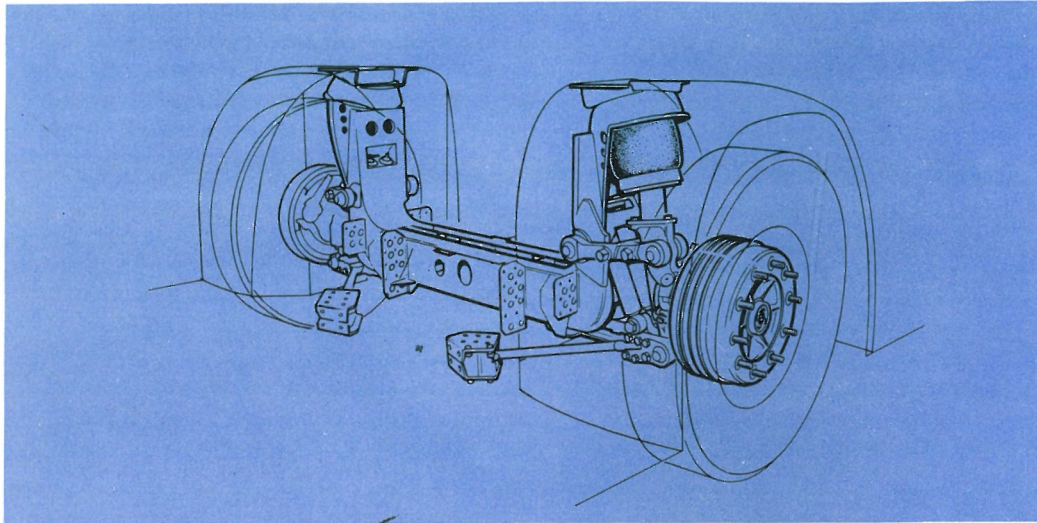
# Air-ride suspension

It's air suspension all round on the bus, with a low frequency ride that guarantees maximum passenger comfort, and wide based springing for maximum stability in handling. The system incorporates automatic levelling so that constant step height is maintained regardless of vehicle load.

Suspension is independent at the front with substantial vertical wheel travel ensuring a well cushioned ride. It also provides considerably



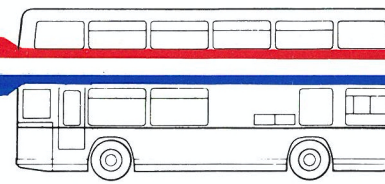
higher roll stiffness on cornering and a low front gangway height. The stiff integral body structure makes for accurate wheel alignment with precise handling control, due to the rigidity of the suspension mounting points. At the rear end a wide based H-frame carries four air-bellows units, one at each corner, giving maximum stability and a broad spread of input loading across the structure. Outrigger dampers give best possible control of vehicle roll.



All suspension location linkages are rubber bushed to prevent ride harshness and provide outstanding reliability with the minimum of maintenance. At the front end, torsion bars support most of the tare weight while the air springing suspends the additional passenger load. The air springs provide near constant low frequency ride motion and are piped into a system of levelling valves which automatically level the vehicle fore-aft and crosswise.

An important aspect of air suspension is its contribution to considerably reduced maintenance. Air bellows are generally more durable than leaf springs and are cheaper and quicker to replace when required.

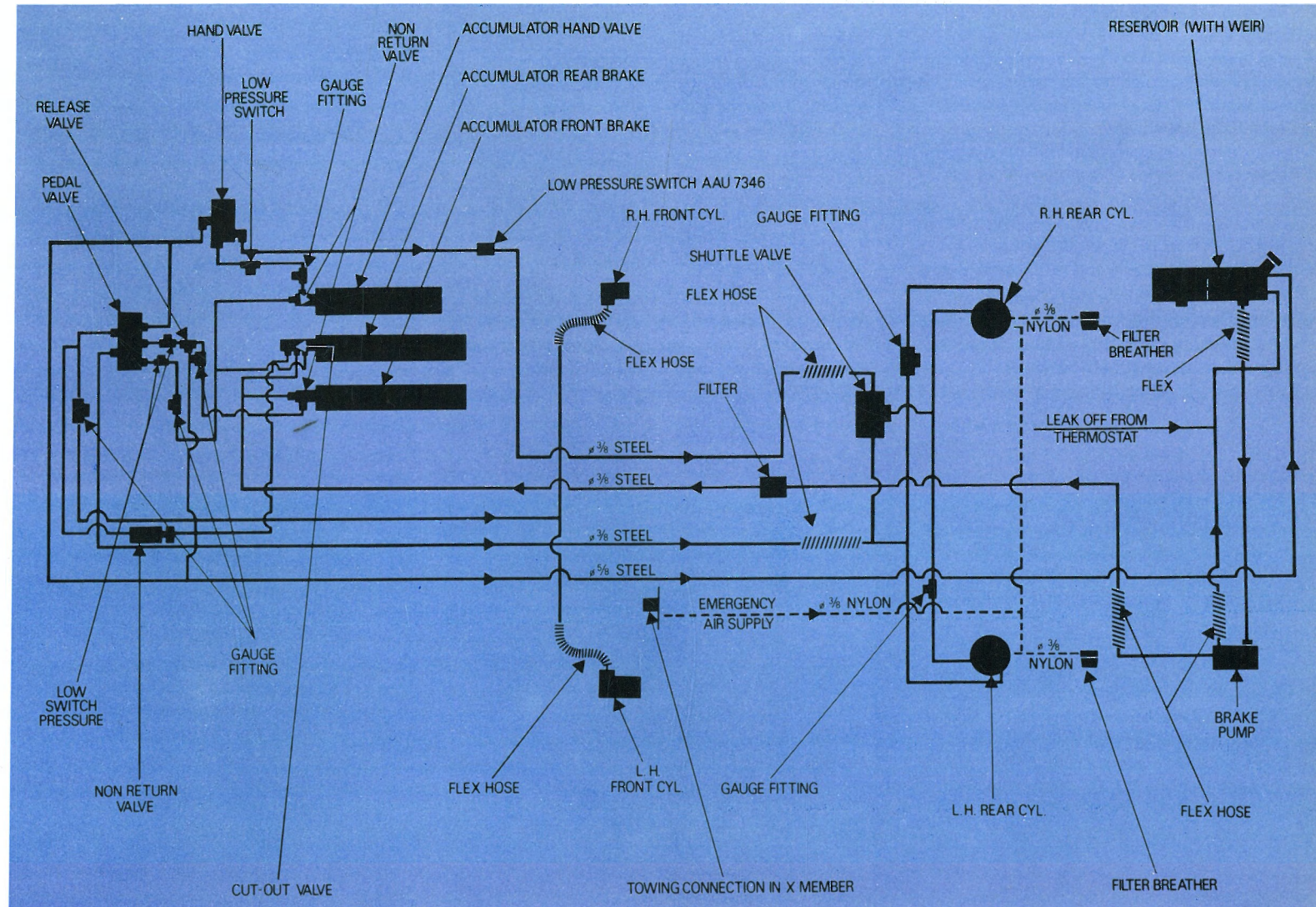




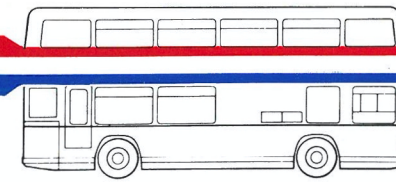
## Smooth and positive braking – accurate steering

Powerful hydraulic braking on the bus is similar to the type extensively proven on the London Transport Routemaster. It offers a more trouble-free and durable system than air, avoids problems of dirt ingress or freezing and the system is progressively responsive to driver control. An important advantage is the much less bulky hydraulic reservoir which contributes to the low floor height achieved. There is a common power supply, and hydraulic main, for certain other vehicle systems. Hydraulic accumulators have a high reserve of emergency stops in the event of power failure. The hydraulically actuated friction retarder in the gearbox affords longer overhaul intervals to the main braking system and the likelihood of brake squeal is virtually eliminated with the help of the retarder.

Steering is by powered rack and pinion mounted on the body understructure. Short adjustable tie bars connect the rack to the wheels and the rack itself is operated by a relay shaft connecting the pinion to the angle drive at the bottom of the steering column. The column is universally jointed to allow the small diameter steering wheel to be angled towards the driver for a more comfortable driving position.







## Sophisticated body structure

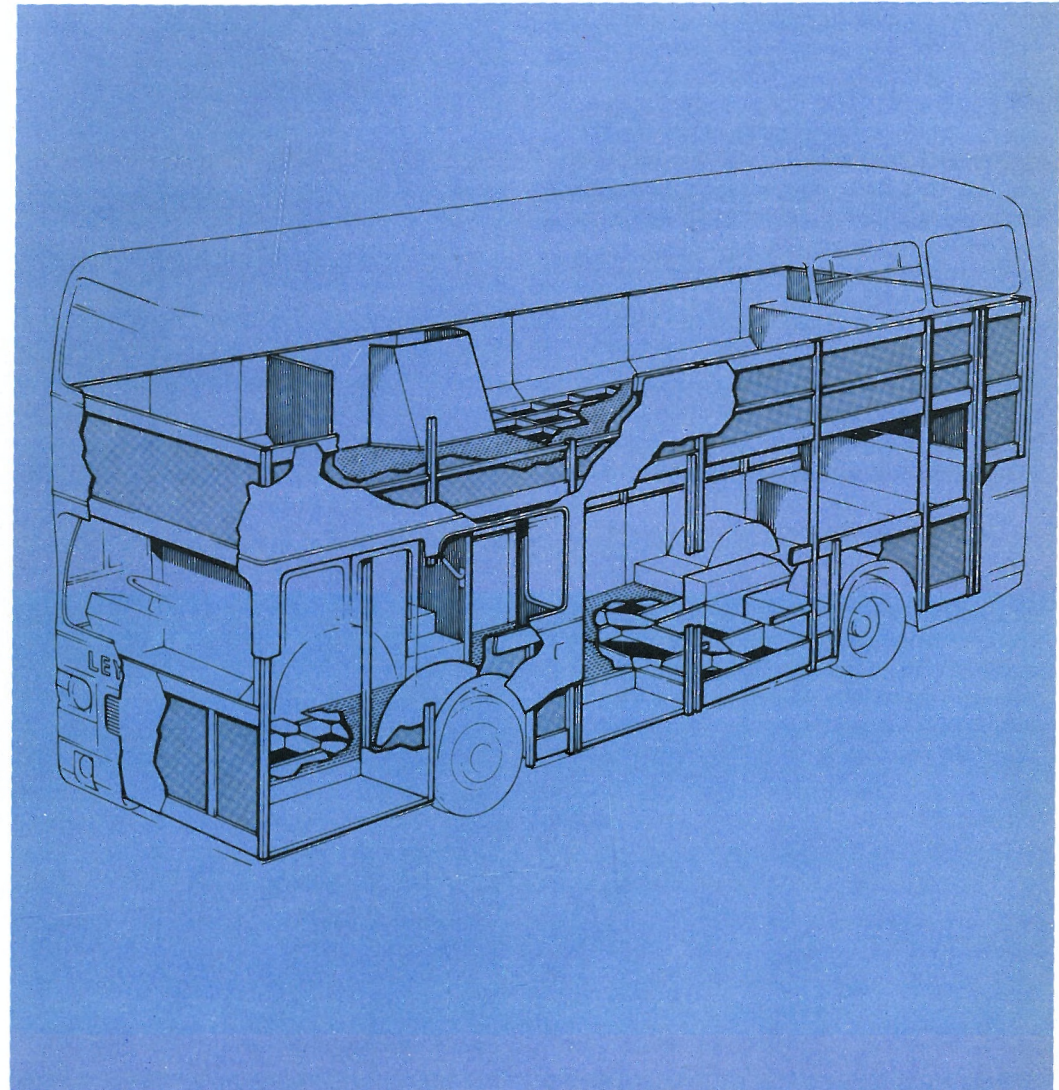
The bus has a fully integral aluminium alloy structure which assures high strength and rigidity necessary for soft independent springing and provides a high level of occupant protection in impact. The structure permits exceptionally good upper and lower saloon heights (lower 1943mm (6ft 4½in) and upper 1794mm (5ft 10 ⅝in) within overall vehicle height of 4378mm (14ft 4½in) unladen) together with compact lower deck and step heights. Generous package dimensioning as a whole will be much appreciated by passengers.

For the operator the integral aluminium alloy structure means light weight which leads to low operating costs. Stressed by computer the structure has a high efficiency with minimum redundancy. The main framework is a series of ring frames comprising side pillars, roof sticks and underframe cross-members. These ring frames are Avdel rivetted to longitudinals and to truss panels to form the main frame. The fastening process ensures extra durability, combining the advantages of conventional bolts and rivets. Frame members have simple section profiles and the simplicity of the Avdel process allows body assembly/repair to be carried out in a general coach-building body shop. Sideframes have interior truss panels which add bending and torsional rigidity.

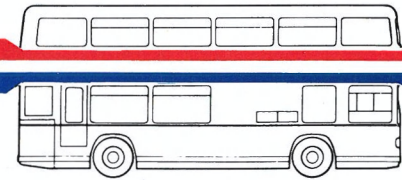
In the underfloor structure all joints are gusseted for extra strength. The floor plate is the bottom of a sandwich assembly enclosing 9mm thickness of insulation and topped by a 9mm thick plywood sheet surfaced with Treadmaster non-slip flooring.

There is no rear-engine underframe since the rear engine mounts are suspended from the superstructure while the front ones connect direct to the understructure. This results in weight saving and a more efficient use of structure. The rear wheelarch is constructed in such a way as to reduce fragmentation impact in the event of a rear tyre blow-out. Front and rear domes down to upper saloon waist height, detachable front panel below waist level and front corner panels are in rust-free glass reinforced plastic.

Comprehensive protective treatment of the structure leads to the 15 year life of the bus. All metal parts are degreased and etched prior to stove-priming, with bi-metallic joints treated with di-electric paint. The assembled underbody is finished in one coat of aluminium paint and the truss panel exterior surface and wheelarches are heavily coated with bituminous underbody sealant. Structurally important or inaccessible steel parts are in pre-galvanised steel.







## Automatic protection – electrical safety and warning systems

Electrical system on the bus is a 24 volt negative earth return with multi-point earthing for minor circuits, and a specially prepared parallel path through the body for main heavy current earth. Battery charging is by 100 amp alternator; batteries of 195 Ah @ 20 hour rate are housed in an easy access swivel carrier below the driver's cab.

The wiring system is completely colour-coded, with numbered circuit breakers for easy fault identification. Plug and socket connectors allow distinct sections of the circuit to be taken out and independently tested. An array of warning lights and test buttons on the driver's instrument panel allows system testing.

Alongside the driver a control panel of similar design to that on the Leyland National bus contains normal driving controls and electrical control switches. Behind the driver's window a section of the control and distribution panel contains manual reset circuit breakers, warning bells and buzzers. The other part of the panel containing relays, diode blocks, terminal boards and electronic control units is accessible from above the inward facing passenger seats at the front of the saloon.

This second unit is completely plug and socket connected and mounted on slides for easy removal. A further distribution board for the engine controls and fire protection equipment is again quick-removable and fitted beneath the upper saloon rear seat. Beside the engine a junction box incorporating heavy current terminal bars and charging system reverse polarity relay allows flexible connection leads to be used which isolate engine vibrational movement.

A safety interlock ensures that the starter can only operate when the gear selector is in

neutral and engine not running. There is also a seven second delay built-in to prevent repeat starting on a rotating engine. And built in to the alternator circuit is a reverse polarity protection relay to prevent damage by crossed battery terminals.

Thermostatic control of under bonnet temperature is effected by ventilation fan cut-in at 60°C. Three sensors in the compartment monitor temperatures beyond 110°C causing driver warning, isolation of the engine fan and operation of the fire extinguisher. Intermediate high temperature, at 80°C plus, also gives driver warning in the form of intermittent light and buzzer. Another thermostatic switch provides driver warning of coolant temperature exceeding 90°C, and a Radalarm system provides warning of low coolant level.

Low level of hydraulic oil in the power steering/brake fluid reservoir is given warning by indicator light and buzzer operated by a level switch mounted within the reservoir. Three low pressure switches in the hydraulic lines operate further lights and buzzers. Further warnings cover the following functions: turn indicators, charge warning, gearbox safety circuit, passenger doors open, emergency door open, low air pressure and extinguisher bottle 'fired'. Finally the warning systems themselves are tested by a three pole spring push button.

Saloon heating is thermostatically controlled, employing sensors and water valves as well as fan switching by both temperature sensing switches and alternator output. The system is fully automatic for saloon heating and there are no controls in the driver's cab; for cab heating, driver control is available.

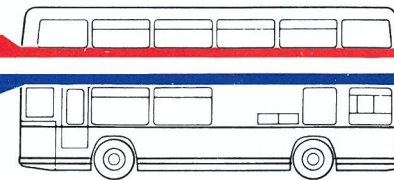
Fluorescent tube lighting to the main saloons can be switched full or 50% on, while

above each doorway fluorescent units are automatically operated as the doors are opened at the entrance and by control of the sidelights only at the exit. The driver's cab light is similarly controlled as the entrance light and both can be cancelled by exit door opening.

The door control system allows the driver to open the entrance and exit doors by push-button at speeds below 3 mile/h; the throttle is prevented from opening below this speed. If the doors are opened by the emergency control above 3 mile/h the throttle dip is overridden and the driver warned. Throttle re-engagement is prevented should the vehicle roll away from standstill with either door open.







# How Titan was developed and tested

It is unlikely that any double deck bus has been so rigorously tested in development trials. Titan has been built in four prototype forms each tried out to the limit in different test environments.

Prior to this, special tests on both static and mobile rigs were performed which included:

**Body structure** Rig testing of sections and joints and areas of high load, like suspension and engine mounts; strain gauge checking under considerable static overload, and pavé testing of the complete structure, all leading to the assurance of a substantial safety factor.

**Suspension** Endurance rig testing of independent front suspension led to a reliable design life estimation for mountings and spring elements. Special mobile test vehicles were also used to develop complete front and rear suspension units in simulated service trials.

**Transmission** The hydracyclic gearbox and angle drive were tested to 50,000 miles on laboratory rigs and subject to overload and over-speed. Automatic transmission control gear was run continuously on rigs for several years. A complete transmission was also tested for 50,000 miles in special road-going rigs.

**Engine and cooling system** A further mobile rig was used to road-prove the system prior to prototype build. The system was designed to handle a 25% increase in engine power over that currently foreseen for the bus, and then tested in ambients up to 46°C.

This is how the four prototypes were tested and proved:

**B15-01** Structure tests were followed by handling and ride trials. Alternative spring rates were examined with a variety of load conditions and correlated with the results from static and mobile test rigs.

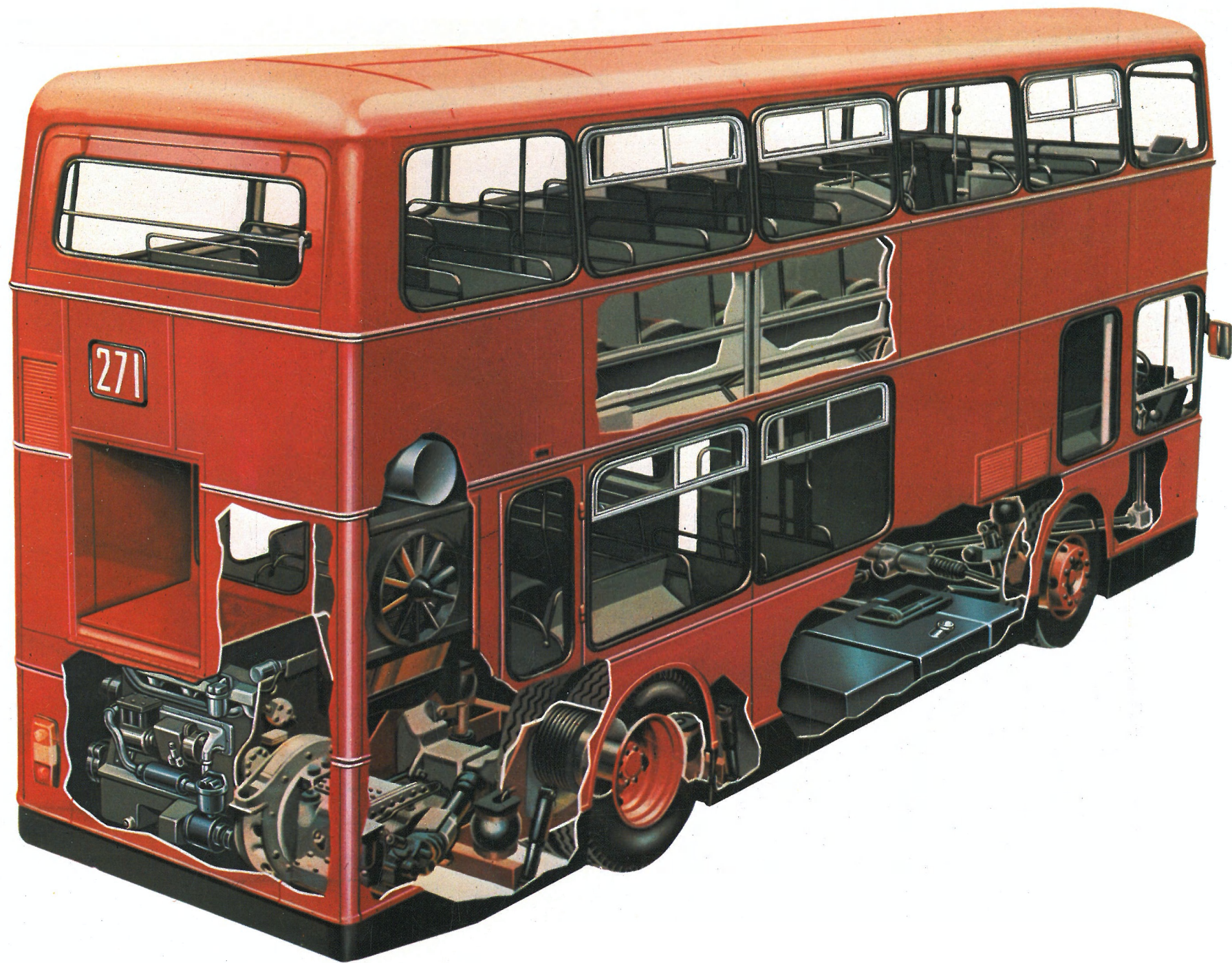
**B15-02** The pavé vehicle, so called because of its accelerated testing on a surface equivalent to 150 times the distance covered in normal road use. It covered 1100 pavé miles — equivalent to 165,000 miles of normal use — without need for modification of the basic body shell.

**B15-03** Internal and external noise tests, air and water flow examination for heating/ventilating trials and full performance tests were carried out with this prototype. This involved hill re-starts, fuel consumption, acceleration and maximum speed measurement as well as M.O.T. tilt test.

**B15-04** This vehicle undertook in-service development with London Transport. Following a two-month engineering test programme by the operator and one month driver training, the vehicle was in service on route 24 from Chalk Farm Garage for the next nine months, running through Leicester Square and Parliament Square to Pimlico. This 14-mile round trip was covered at an average speed of 9 mile/h, over an 18½ hour day; total mileage in passenger service was 23,200.











# Leyland Truck & Bus

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