

# FLEETLINE



With effect from the 1st July 1978 any reference in this publication to the name of the Company should read:

Leyland Vehicles Limited

## Repair Operation Manual

**Leyland Vehicles Limited**  
**Passenger Vehicle Division**

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## SECTION 1

## Miscellaneous Information

## IMPORTANT NOTES

**Air Pressure**

A warning buzzer in the driving compartment gives an audible warning and is accompanied by a red warning light whenever the pressure in the air system is insufficient for normal brake operation.

Do not move the vehicle immediately the buzzer cuts out and the warning light is extinguished, when charging the system. Allow sufficient time for the air pressure to build up to  $8.4 \text{ kgf/cm}^2$  ( $120 \text{ lbf/in}^2$ ) to ensure complete retraction of the spring brakes when the parking brake lever is operated. This also ensures correct operation of the pneumocyclic gearbox.

The parking brake system also incorporates a red warning light which is illuminated when the parking brake lever is moved to the 'on' position and extinguishes when the lever is moved to the 'off' position. Should a fault develop in this system resulting in loss of air pressure the warning light will automatically be illuminated.

**Emergency Release of Spring Applied Parking Brake**

In order to release the spring applied parking brakes when the engine cannot be run to charge the air system, an external air-line may be connected to the auto-shut-off valve at the front of the vehicle — workshop air-line type coupling.

The supply pressure should be  $7.0 \text{ kgf/cm}^2$  ( $100 \text{ lbf/in}^2$ ) minimum,  $8.4 \text{ kgf/cm}^2$  ( $120 \text{ lbf/in}^2$ ) maximum.

**WARNING:** Before connecting an external air-line, move the parking brake control to 'on', or chock the wheels.

If an external air supply is not available the spring brakes may be manually released by removing the chamber end cover and rotating the release bolt in an anti-clockwise direction. Refer to Group 7 for further details and illustrations of spring brake construction.

**Frost Precautions**

If anti-freeze solution is not in use and the vehicle is to remain standing in the open with temperatures approaching freezing point, the cooling system must be completely drained.

After draining place a '**Cooling System Drained**' notice on the steering wheel or similar conspicuous place.

Vehicles with anti-freeze mixture in the cooling system should have a notice displayed stating '**Anti-freeze, Do Not Drain**'.

**Alternating Current Charging Systems**

Although the reverse polarity relay minimizes the risk of damage due to accidental reversal of polarity the following precautions should still be observed.

1. Never disconnect the battery whilst the alternator is running. This will cause a voltage surge in the charging system that will immediately ruin the diodes or transistors.
2. Never disconnect a lead without first stopping the alternator and turning any switches in the circuit to the 'off' position.
3. Never connect a battery into the system without checking for correct polarity and correct voltage.
4. Never 'short' connections to earth to check for current flow. No matter how brief the contact the transistor may be ruined.
5. Never experiment to try and adjust or repair the system; this is a job for a trained electrician with the correct test equipment and technical data.
6. Always identify a lead to its correct terminal when disconnecting or reconnecting. A short-circuit or wrong connection will immediately and permanently ruin transistors or diodes.
7. If 'jumper' leads are used to start the engine it is important that the existing battery leads are not disconnected.



## GENERAL RECOMMENDATIONS

**CAUTION:** If welding, soldering or brazing is necessary in the vicinity of the alternator or control unit, precautions must be taken to ensure that any heat source is kept well away from these components. Excessive heat reaching the transistors or diodes will cause irreparable damage. If arc welding is to be carried out the alternator and battery must be disconnected.

### Disposition of Units

In this Manual all references to left-hand or right-hand sides are from the driver's view point when seated in the driving position.

### Towing the Vehicle

**WARNING:** The vehicle may be towed over short distances up to 5 km (3 miles) at speeds of up to 20 km/h (12 miles/h) with the gear selector in NEUTRAL.

For distances and speeds in excess of this the propeller shaft or half-shafts must be removed. Failure to comply with these instructions can result in damage to the gearbox bearings and shaft as the oil pump is inoperative when the vehicle is being towed.

Towing brackets, threaded 1 in B.S.F., are fitted to the front frame member as standard equipment.

The brackets are for normal towing only and must not be used for suspended towing.

## MODEL RANGE

The models covered by this Manual are:

Fleetline FE30A GR, FE30A LR.  
FE33A GR, FE33A LR.

### Main Chassis Dimensions

Model	Wheelbase	Track (with standard tyres)		Overall Length	Overall Width	Turning Circle (full lock)
		Front	Rear			
FE30A LR FE30A GR	4953 mm 195 in	2069 mm 81.45 in	1816 mm 71.5 in	9.265 metres 364.8 in	2407 mm 94.8 in	18.29 metres 60 ft
FE33A LR FE33A GR	5639 mm 222 in	2069 mm 81.45 in	1816 mm 71.5 in	9.950 metres 391.8 in	2407 mm 94.8 in	18.90 metres 62 ft



Identification Plates

The chassis identification plate, which carries the model designation and chassis number, is attached to the bulkhead immediately above the engine.

The Leyland engine identification plate is attached to the cylinder block immediately above the engine oil filter.

The Gardner engine serial number is stamped on the upper surface of the crankcase adjacent to No. 1 cylinder on the fuel pump side of the engine, and on the control box of the forward fuel pump unit.

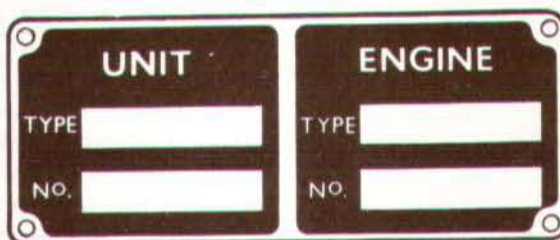
Spares for the Gardner engine should be obtained direct from the engine manufacturer or from their officially appointed Service Agents.

When writing for spares, guarantee claims, or in any connection whatsoever relating to the vehicle, **always quote chassis and engine serial numbers.**



M6542

FIG. 1. CHASSIS IDENTIFICATION PLATE



M 2532

FIG. 2. LEYLAND ENGINE IDENTIFICATION PLATE

# GENERAL RECOMMENDATIONS

## GENERAL DATA

### UNIT SPECIFICATIONS

<b>Engine types</b> . . . . .	Leyland 680 vertical diesel engine (11.1 litres) or Gardner 6LXB vertical diesel engine
<b>Net installed bhp (Leyland engine)</b> . . . . .	153 at 1 750 rev/min; or 165 at 1 900 rev/min; or 170 at 1 850 rev/min
<b>Net installed bhp (Gardner engine)</b> . . . . .	Refer to plate on fuel pump
<b>Gearbox</b> . . . . .	Daimler 4-speed Diamatic, semi-automatic
<b>Gear ratios</b> . . . . .	1st 4.15 : 1 2nd 2.36 : 1 3rd 1.56 : 1 4th 1.00 : 1 Reverse 4.88 : 1
<b>Gearbox Coupling</b> . . . . .	Fluid coupling
<b>Angle Drive (Transfer box)</b> . . . . .	Spur and bevel gear
<b>Spur gear ratios available</b> . . . . .	1.026 : 1, 0.925 : 1 and 0.883 : 1
<b>Bevel gear ratio</b> . . . . .	1.043 : 1
<b>Overall ratios (Angle drive — rear axle)</b> . . . . .	5.68 : 1, 5.12 : 1 and 4.61 : 1
<b>Rear Axle</b> . . . . .	Two-stage reduction spiral bevel
<b>Constant ratio</b> . . . . .	5.3 : 1
<b>Overall ratio with gearbox and angle drive</b> . . . . .	5.68 (top gear)
<b>Alternative overall ratios</b> . . . . .	5.12 : 1 and 4.61 : 1
<b>Steering Gear</b> . . . . .	Daimler worm and nut
<b>Gear ratio</b> . . . . .	40 : 1
<b>Turning circle (approximate):</b>	
FE30A . . . . .	21 metres (69 ft)
FE33A . . . . .	21.6 metres (71 ft)
<b>Power Steering Equipment</b>	
<b>Ram</b> . . . . .	Hydrosteer
<b>Pump</b> . . . . .	Hobourn-Eaton roller
<b>Suspension</b> . . . . .	Conventional multi-leaf springs
<b>Brakes</b> . . . . .	Air operated with spring-applied parking brake. Front system is independent of rear service and parking brake system. Mechanical handbrake, with or without power assistance, may be fitted as an alternative parking brake.



General Data — continued

UNIT CAPACITIES	Litres	Pints
Engine, Leyland . . . . .	18.2	32
<b>NOTE: For capacity of Gardner engine, refer to Gardner literature</b>		
Fluid coupling . . . . .	14.2	25
Gearbox . . . . .	12.5	22
Angle drive (Transfer box) . . . . .	4	7
Rear axle . . . . .	12.5	22
Steering box . . . . .	3.4	6
Power steering . . . . .	6.8	12
Automatic lubrication . . . . .	4.5	8
Hydraulic throttle control . . . . .	1.1	2
Fuel tanks . . . . .	204	45

## SECTION 2

## Maintenance

This section lists operations which, when carried out at the specified periods, will maintain efficient and economical running of the vehicle under normal operating and climatic conditions. It is divided into three parts, the initial service check, daily and weekly checks and the periodic servicing schedule. Any detailed procedure to be adopted when carrying out maintenance is described in the applicable Group.

**NOTE:** Absolute cleanliness is essential when carrying out maintenance. All filler caps, plugs or lubricators should be cleaned before and after attention. If units require an excessive amount of oil or if leakage from seals is noted, this should be reported and action taken at the earliest opportunity.

When draining and filling unit assemblies ensure the vehicle is standing on level ground.

**NOTE:** For maintenance periods, unit capacities and lubricant specifications of the Gardner 6LXB engine, refer to Gardner literature.

**First Service**

After the first 1 000 km (600 miles) and not later than 2 000 km (1 200 miles) running of a new vehicle or the fitment of a new or reconditioned unit the following items should receive attention.

**Engine, Leyland**

1. Drain the engine oil and refill with the correct type and grade. Renew oil filter.
2. Check the security of the engine and gearbox mountings.
3. Examine the silencer and exhaust system for security.
4. Check the security of the radiator mountings.
5. Clean the fuel filters.
6. Check for oil, water or fuel leaks.
7. Check the oil pressure.
8. Reset the valve clearances.
9. Check the injection timing.
10. Check the engine idling speed.
11. Check drive belt tension on alternator.
12. Torque up cylinder head nuts.
13. Check the injector opening pressure and the spray pattern.

**Fluid Coupling and Transmission**

1. Drain the fluid coupling, angle drive and gearbox, then refill with correct type and grade of lubricant. Clean filter during gearbox oil change.
2. Check the security of the propeller shaft flange bolts.
3. Check for play at the propeller shaft sliding and universal joints.
4. Lubricate the universal joint and splines, using a grease gun.
5. Check the security of the air feed lines to the gearbox.

**Steering Gear and Front Axle**

1. Check the security of the steering box, drop-arm, drag-links, relay lever, power steering ram, track-rod ends and steering levers.
2. Check the hub end-float.
3. Check for excessive play between the stub axle and axle beam.
4. Check the front wheel alignment.
5. Examine the power steering equipment for leakage and correct functioning.
6. Drain power steering system and refill with correct fluid.
7. Renew power steering reservoir filter.

**Brakes and Air System**

1. Check security of footbrake valve at mounting.
2. Lubricate pedal linkage and ensure that the pedal returns fully.
3. Check torque setting of spring brake chamber release bolts.
4. Check that warning tags are legible on spring brake chambers.
5. Check clamping ring and brake chambers for security.
6. Examine all air valves for security.
7. Fully charge the air system, suitably block brake pedal in fully applied position and set hand valve in park position. Carry out a soap test on pipe connections and valves. Rectify any unpermissible leak immediately.







MAINTENANCE SCHEDULE

LUBRICATION SERVICES

Engine, Leyland

- Change engine oil and renew filter element . . . . .
- Grease water pump bearings . . . . .
- Grease fan shaft joints and splines . . . . .
- Grease fan centre bearing . . . . .

Transmission

- Change oil in gearbox and renew filter element . . . . .
- Change oil in angle drive (Transfer box) . . . . .
- Check/top up oil level in fluid coupling . . . . .
- Change oil in fluid coupling . . . . .

Front axle

- Clean and repack hubs with grease . . . . .

Rear Axle

- Clean and repack hubs with grease . . . . .
- Drain and refill axle unit . . . . .

Electrical

- Recharge starter motor wick lubricator . . . . .
- Grease alternator bearings . . . . .

Steering Gear

- Change filter and fluid in power steering system:
- Check/top up oil level in steering box . . . . .

Automatic Lubrication System

- Check system for security and leakage . . . . .
- Drain and clean reservoir, renew filter element, see Group 9. . . . .

Chassis and Suspension

- Grease propeller shaft splines and joints . . . . .
- Check/top up front shock absorbers . . . . .
- Lubricate all steering joints . . . . .
- Lubricate spring shackles . . . . .
- Lubricate pedal linkage . . . . .
- Lubricate handbrake linkage, when fitted . . . . .

EVERY	
KM x 1 000	MILES x 1 000
8	5
40	25
20	12.5
ANNUALLY	
10	6
ANNUALLY	
160	100
10	6

The following components are lubricated by the 'Airdromic' automatic lubrication system:

COMPONENT	No. OF POINTS	COMPONENT	No. OF POINTS
King pins	4	Accelerator pedal pivot	1
Drag-link ends	4	Front spring shackles	6
Steering relay lever	1	Rear spring shackles	6
Track-rod ends	2	Spring brake lever pivots	2
Brake pedal pivot	1		

## GENERAL RECOMMENDATIONS

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### First Service — continued

#### Rear Axle

1. Drain the axle and refill with the correct type and grade of oil.
2. Check the hub bearing end float.
3. Clean the axle breather in a suitable solvent.

#### Electrical Equipment

1. Check cables for security and chafing, especially where they pass through drillings.
2. Examine all unit mountings for security.
3. Check the security of heavy duty cable connections.

#### Chassis and Auxiliaries

1. Visually check all points fed by the automatic lubrication system for presence of oil.
2. Check the security of the spring mountings.
3. Measure, and reset if necessary, the spring anchor plate clearance.
4. Check the security of the shock absorbers.
5. Check the body to frame mountings for security.
6. Check the fuel tank mountings and the feed and return pipes for security.

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### DAILY CHECKS

#### Engine

1. Check, and top up if necessary, the engine oil level.
2. Ensure that the fuel tank contents are adequate.
3. Check the coolant level using the 'Radolarm' equipment.

#### Driving Compartment

1. Top up the windscreen washer reservoir if required.
2. Test the operation of the horns, wipers, washers and instrument panel warning indicators.
3. Check the mainbeam, dip, side, tail and stop light.
4. Test the operation of the direction indicators and the monitor lights.
5. Inspect the interior lights and the courtesy lights with the passenger doors open.
6. Check the braking system for leaks via the air gauges.

### WEEKLY CHECKS

#### Engine

1. Check the air filter restriction indicator when fitted and service the filter if required.
2. Top up anti-freeze evaporator bottle.
3. Drain engine-mounted fuel filter agglomerator.
4. Drain chassis-mounted fuel sedimenter.
5. Check level of hydraulic fluid in accelerator reservoir.

#### Steering Gear

1. Check, and top up if required, the power steering reservoir.

#### Automatic Lubrication System

1. Top up the automatic lubrication reservoir if required.

#### Electrical System

1. Check the condition of the battery.
2. Top up, if necessary, the electrolyte solution in each battery cell.

#### Wheels and Tyres

1. Check the wheel nuts for tightness.
2. Check the tyre inflation pressures.
3. Examine the tyres for cuts, separated plies and wear.



**MAINTENANCE SERVICES**

**Engine**

- Check fan drive belt tension . . . . .
- Check engine for loose pipe and manifold connections, etc. . . . .
- Check operation and engagement of starter motor . . . . .
  
- Examine air filters; service if necessary . . . . .
- Change fuel filter elements; clean filter bowls . . . . .
- Remove compressor delivery pipe; check for carbon, clean if necessary . . . . .
- Drain sedimenter . . . . .
- Check inlet and exhaust valve clearances . . . . .
  
- Check water pump; overhaul if necessary . . . . .
- Remove, clean and check thermostat . . . . .
- Clean crankcase breather . . . . .
- Check condition of cooling system hoses; renew if required . . . . .
- Remove sump, clean oil suction filter . . . . .
- Check and record lubricating oil pressure . . . . .
- Remove injectors and test . . . . .
- Check fuel injection pump timing and drive coupling . . . . .
  
- Carry out top overhaul. See Group 2 . . . . .

**Cooling System**

- Drain system, flush out and refill . . . . .
- Check security and condition of hoses; renew if necessary . . . . .
- Test operation of thermostat; renew if necessary . . . . .
- Remove and clean radiator alarm probes . . . . .
- Thoroughly clean radiator internally, removing all deposits where hard water has been used . . . . .
- Clean radiator matrix . . . . .

**Fluid Coupling**

- Check tightness of drain plugs . . . . .
- Check for oil leakage and rectify any fault immediately . . . . .

**Gearbox, Angle Drive and Propeller Shaft**

- Check propeller shaft joints and splines for wear and flange securing bolts for tightness; rectify if required . . . . .
- Using an air pressure gauge, check output pressure of limiting valve. See Data, Group 4 for correct pressure. . . . .
- Check for leakage at limiting valve and connections using a soap solution . . . . .
- Check security of nuts, bolts, setscrews, unions . . . . .
- Check gearbox piston seals. See Group 4 . . . . .
- Examine feed pipes from electro-pneumatic unit for security . . . . .

**Rear Axle**

- Check joints for leakage . . . . .
- Check tightness of all nuts, bolts and setscrews . . . . .
- Remove axle breather and clean in paraffin . . . . .
  
- Check/adjust hub bearing end-float. See Group 6 . . . . .

EVERY	
KM x 1 000	MILES x 1 000
10	6
20	12.5
40	25
160	100
AUTUMN	
10	6
20	12.5
40	25
ANNUALLY	

In the interest of safety, it is recommended that the valves and components of the air system receive attention at the manufacturer's recommended period as follows:

**CLAYTON DEWANDRE**

**Every year or 50 000 miles**

Compressor cylinder head — overhaul

**Every 2 years or 100 000 miles**

Condenser — overhaul

**Every year or 100 000 miles**

Compressor — overhaul

Non-return valve

Alcohol evaporator — overhaul

**BENDIX WESTINGHOUSE**

**Every year or 50 000 miles**

Single diaphragm brake chambers — overhaul

Spring brake actuators — overhaul

**Vehicle overhaul**

Relay valve

Low pressure indicators

Unloader valve

Hand control valve

Pressure regulator valves

Limiting valve

Differential protection valve

Air-line strainers

Footbrake valve

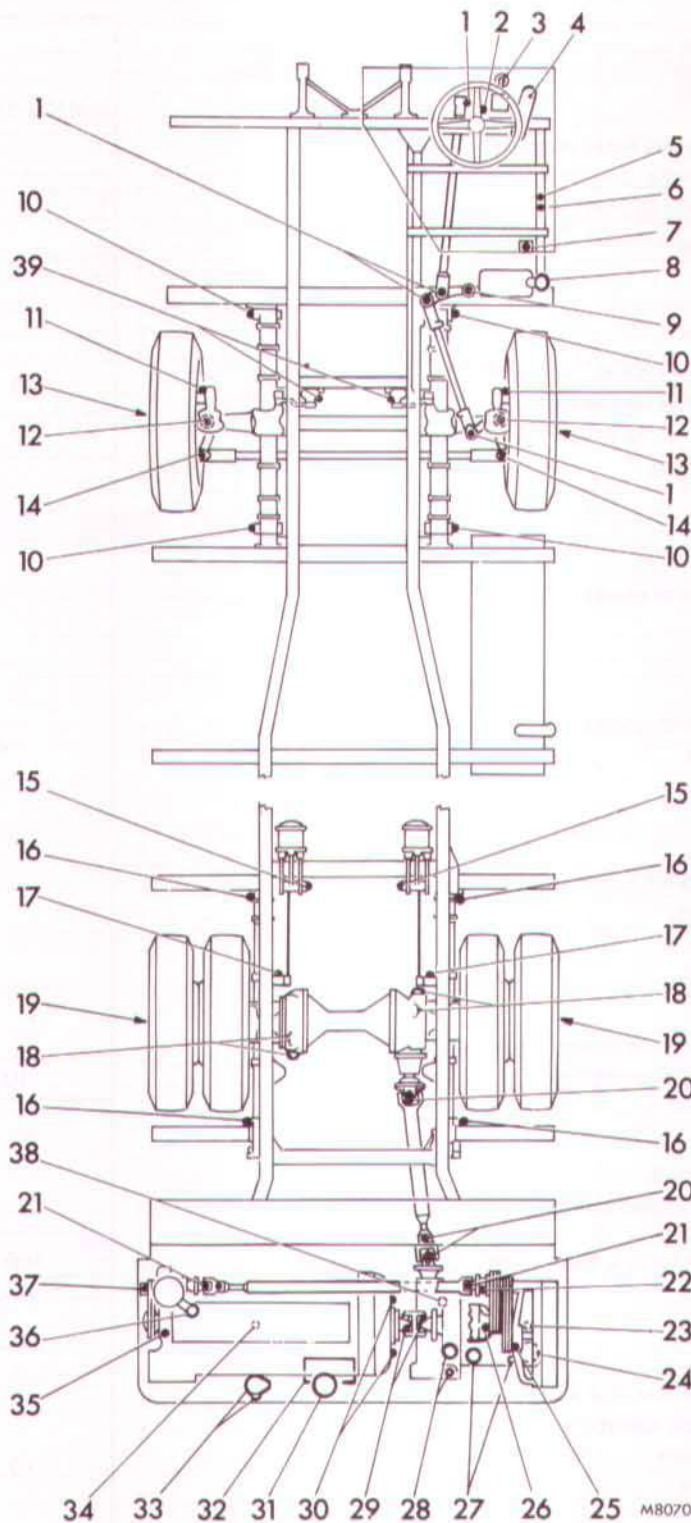


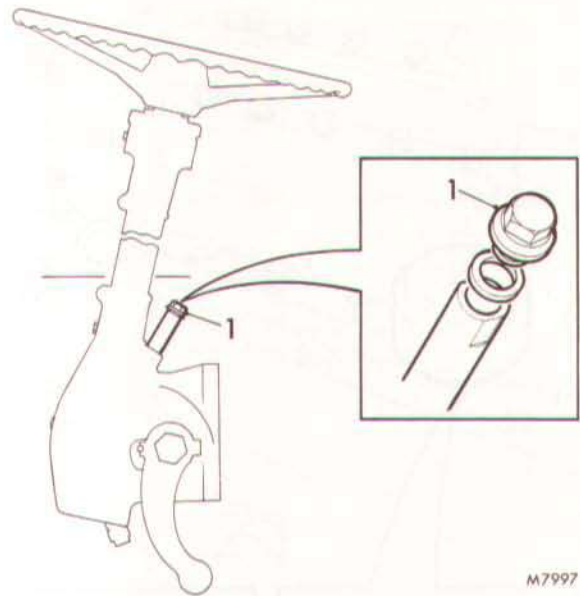
FIG. 1. CHASSIS LUBRICATION DIAGRAM

- |  |                             |                                     |
|--|-----------------------------|-------------------------------------|
| 1. Ball joints, drag link.             | 14. Track rod ball joints.  | 27. Gearbox filler and dipstick.    |
| 2. Steering box.                       | 15. Relay lever.            | 28. Angle drive.                    |
| 3. Brake pedal linkage.                | 16. Rear spring shackles.   | 29. Propeller shaft.                |
| 4. Accelerator pedal linkage.          | 17. Rear brake camshafts.   | 30. Fluid coupling.                 |
| 5. Brake pedal cross-shaft lubricator. | 18. Rear axle lube points.  | 31. Oil filter                      |
| 6. Accelerator cross-shaft lubricator. | 19. Rear hubs.              | 32. Starter motor                   |
| 7. Accelerator reservoir.              | 20. Main prop-shaft joints. | 33. Engine oil filler and dipstick. |
| 8. Auto-lube reservoir.                | 21. Fan prop-shaft joints.  | 34. Engine drain plug.              |
| 9. Relay lever.                        | 22. Fan belt tensioner.     | 35. Water pump bearing.             |
| 10. Spring shackles.                   | 23. Gearbox drain plug.     | 36. Power steering reservoir.       |
| 11. Brake camshaft.                    | 24. Gearbox filter.         | 37. Drive belt adjuster bearing.    |
| 12. King pin, top and bottom.          | 25. Fan centre bearing.     | 38. Transfer box drain plug.        |
| 13. Front hubs.                        | 26. Alternator.             |                                     |



**Steering Box (Fig. 3)**

Remove filler plug (1), located inside driver's cab, and fill slowly until oil level rises to bottom of the filler plug extension.

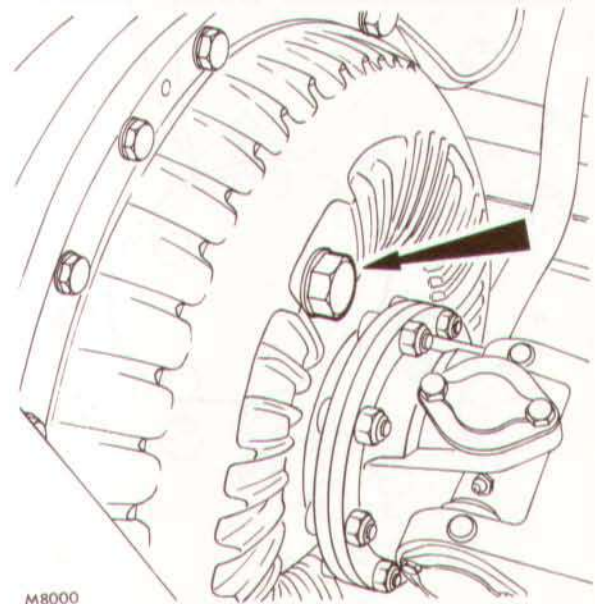


M7997

FIG. 3. STEERING BOX

**Fluid Coupling (Fig. 4)**

To top-up the fluid coupling, turn the engine until one of the two filler plugs is at T.D.C. Clean and remove the filler plug and sealing ring and add oil until the level is up to the filler plug hole. Refit plug and sealing ring.



M8000

FIG. 4. FLUID COUPLING

# GENERAL RECOMMENDATIONS

## Front Axle and Steering Gear

- Inspect drop-arm for security . . . . .
- Examine drag-link ends for wear; check clamp bolts are secure . . . . .
- Check for excessive free play at steering wheel, determine cause and rectify. See Group 5 . . . . .
- Inspect king pin bushes for wear . . . . .
- Clean drop-arm and steering levers, inspect for cracks, then re-grease . . . . .
  
- Check/adjust hub bearing end-float . . . . .

## Brakes

- Check brake linings for wear; renew as necessary . . . . .
- Check security of footbrake valve at mounting . . . . .
- Lubricate pedal linkage . . . . .
- Ensure pedal returns to fully released position . . . . .
  
- Check torque setting of spring brake chamber release bolts . . . . .
- Check that warning tags are legible on spring brake chambers . . . . .
- Check clamping ring and brake chamber retaining studs for tightness . . . . .
- Examine quick-release valves and relay valve for security . . . . .
- Inspect all piping for signs of corrosion or kinking . . . . .
- Clean the condenser filter element. See Group 7 . . . . .
  
- Fully charge air system, suitably block brake pedal in fully applied position and set hand valve in 'off' position. Carry out a soap test on pipe connections, valves and brake chambers. Rectify any unpermissible leak immediately . . . . .

## Electrical System

- Check, and adjust if required, the alternator drive belt tension. See Group 2 . . . . .
- Generally check for security and cleanliness the batteries, voltage regulator, relay panels and starter motor . . . . .
  
- Check the headlamp beam settings . . . . .
- Check the starter motor brushes and commutator . . . . .
- Check the connections at the starter motor and alternator for cleanliness and security . . . . .
- Check alternator slip-ring brushes for wear. See Group 8 . . . . .

## Suspension

- Check shock absorbers for security . . . . .
- Examine the shock absorber link rubbers for wear . . . . .
- Check shackle pin bushes in spring ends, links, suspension levers and brackets for wear. Renew if necessary . . . . .
- Clean springs and lubricate with graphited penetrating oil . . . . .
- Check security of all spring fastenings . . . . .
- Inspect springs for broken leaves and clips . . . . .
- Check anchor plate clearance; adjust if necessary . . . . .
- Check operation of shock absorbers . . . . .

## Exhaust System

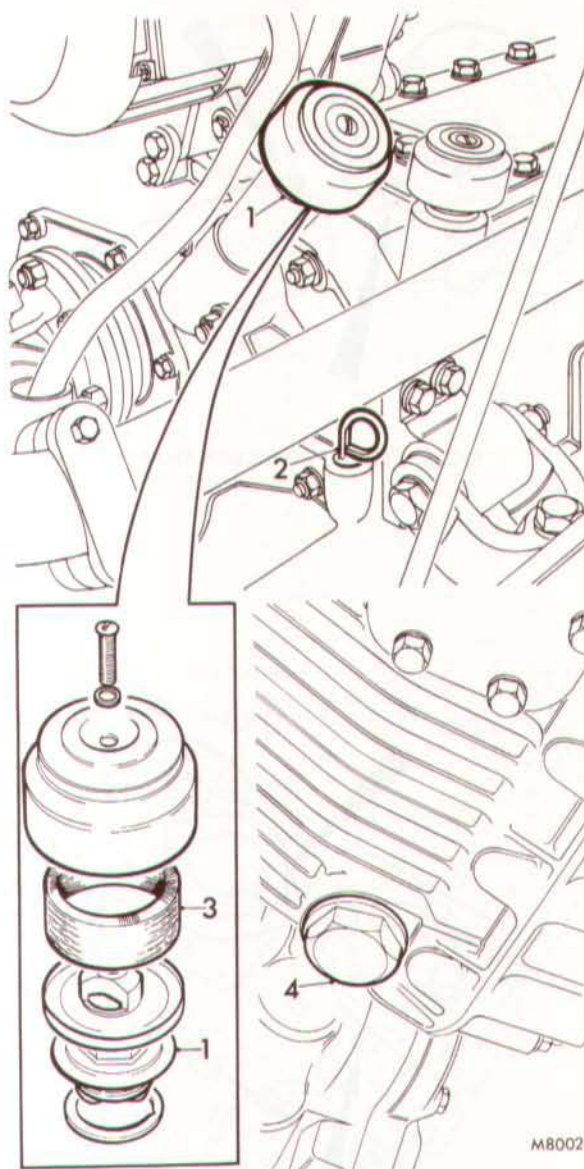
- Check for security of flanges and support brackets . . . . .
- Examine system for corrosion, damage or blowing . . . . .

EVERY	
KM x 1 000	MILES x 1 000
40	25
ANNUALLY	
10	6
20	12.5
40	25
20	12.5
ANNUALLY	
40	25

**Angle Drive (Fig. 6)**

To top-up or fill the angle drive, remove filler plug (1) and add oil until level registers with 'full' mark on dipstick (2).

Clean breather element (3), incorporated in filler plug, and renew element at each angle drive oil-change period.



M8002

FIG. 6. ANGLE DRIVE UNIT

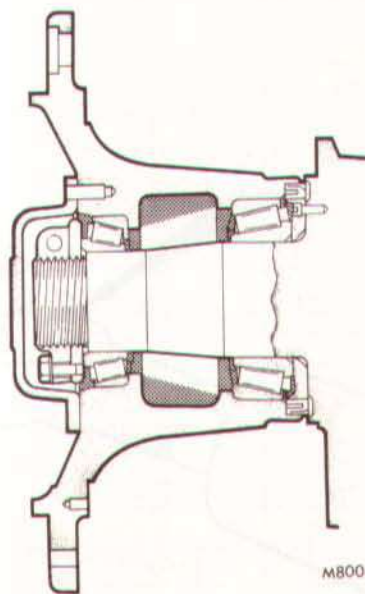
**Front Hubs (Fig. 7)**

Remove the front hubs as described in Group 5.

Remove all old grease, using a suitable solvent, and dry the hub thoroughly.

Knead grease, as specified, into the bearings and partly pack the cavity between the inner and outer bearings as shown in Fig. 7. The shaded areas in this illustration indicate where grease is to be applied.

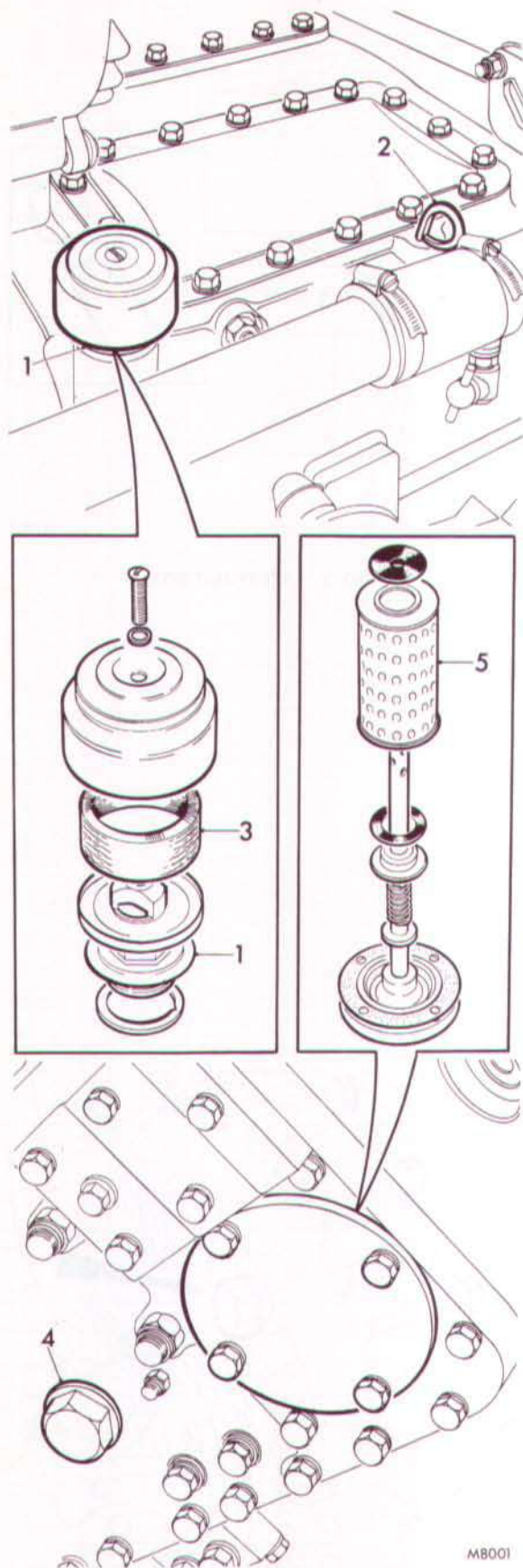
Also fill the hub cap with grease to a depth of 6 mm (1/4 in) and assemble and adjust hub as described in Group 5.



M8004

FIG. 7. FRONT HUB GREASING





**Gearbox (Fig. 5)**

Run the engine at a fast idling speed for two or three minutes to circulate the oil, then switch off engine.

Remove the gearbox filler plug (1) and top-up or refill until oil level is up to the full mark on dipstick.

**NOTE:** The breather element (3) incorporated in the gearbox filler plug should be cleaned in a suitable solvent at the specified periods, and renewed at each gearbox oil change.

To drain the gearbox, remove drain plug (4). Refit plug when drainage is complete. Draining of the gearbox is best effected when the vehicle has just returned from service.

Renew the gearbox oil filter element (5) at every gearbox oil change period.

M8001

FIG. 5. GEARBOX LUBRICATING POINTS



**Rear Axle (Fig. 11)**

Top-up or refill the rear axle through the combined filler and level plug (1) until the oil overflows.

Drain the rear axle, preferably when the vehicle has just returned from service, by removing the drain plugs (2) and (3) situated at the base of each reduction gear casing. Replace the plugs.

When refilling, allow time for the lubricant to transfer to the left-hand reduction casing.

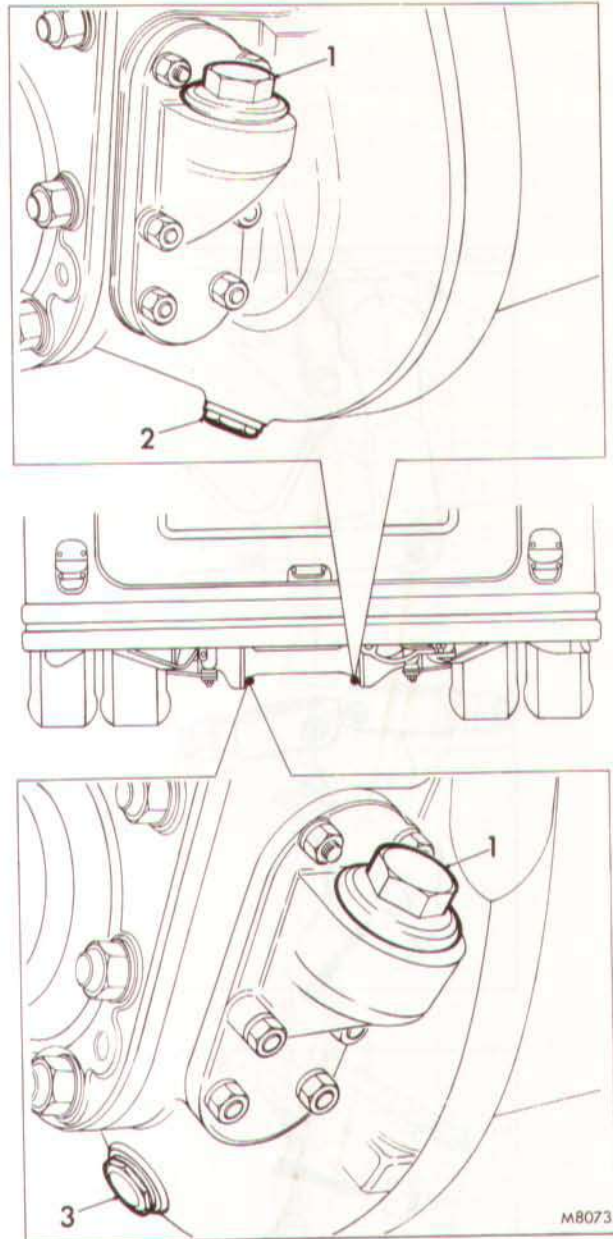


FIG. 11. REAR AXLE LUBRICATION POINTS

**Engine Fan (Fig. 12)**

Using a grease gun, lubricate the fan pulley bearings.

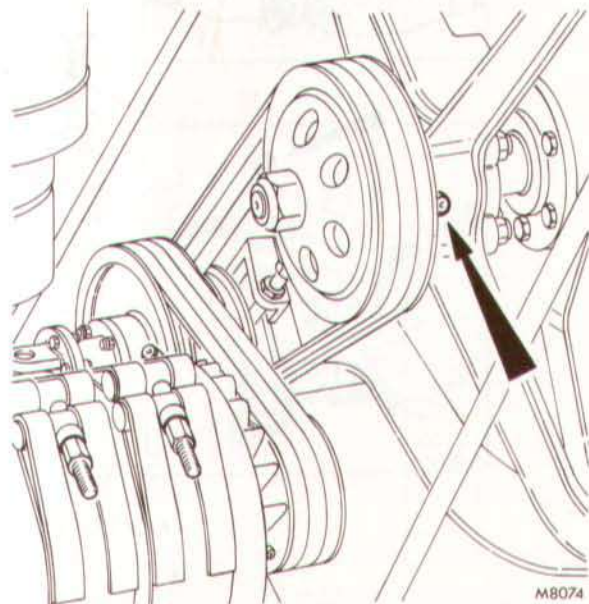
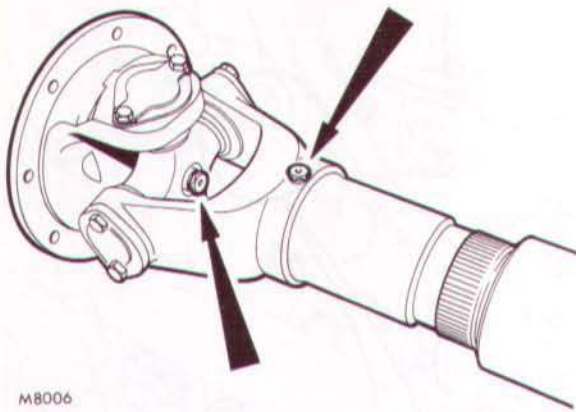


FIG. 12. ENGINE FAN BEARINGS



M8006

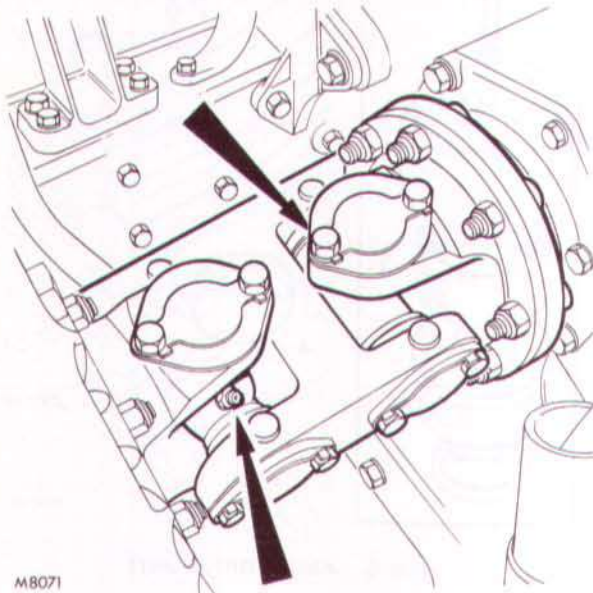
FIG. 8. MAIN PROPELLER SHAFT

**Propeller Shafts (Figs. 8, 9 and 10)**

Access to the main propeller shaft is gained from underneath the vehicle and it may be necessary to move the vehicle forward in order to gain access to each grease nipple. Using a hand-operated grease gun, lubricate each universal joint and the sliding spline.

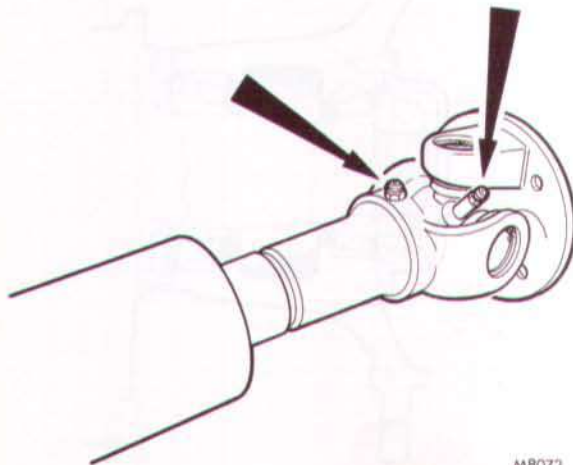
Using grease gun, lubricate the propeller shaft connecting the fluid coupling and gearbox at the points indicated.

Using grease gun, lubricate the three points on the engine fan drive propeller shaft.



M8071

FIG. 9. FLUID COUPLING/GEARBOX PROP-SHAFT



M8072

FIG. 10. FAN DRIVE PROPELLER SHAFT



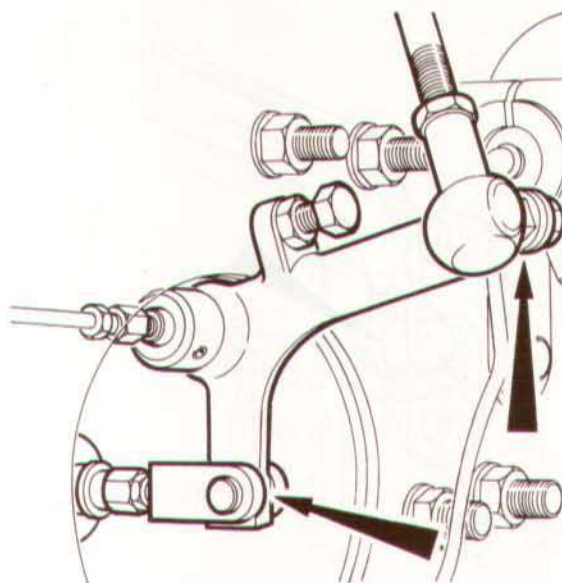
**Handbrake Linkage (Fig. 13, when fitted)**

Lubricate the inner and outer handbrake bracket bearings with a grease gun at the points indicated.

Lubricate the four relay pivots with grease gun.

Lubricate the brake rod guides with grease.

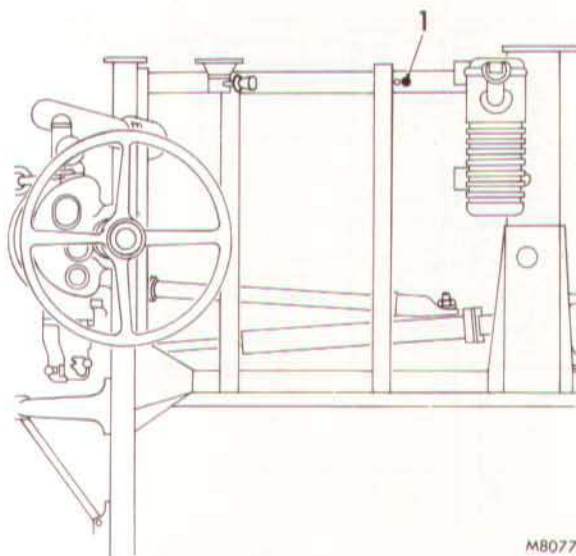
Lubricate pivot pins with oil can.



**Accelerator Linkage (Fig. 14)**

Lubricate accelerator pedal pivot with grease gun at the point indicated. (Not if automatic lubrication is fitted.)

Lubricate pivot pins with oil can.

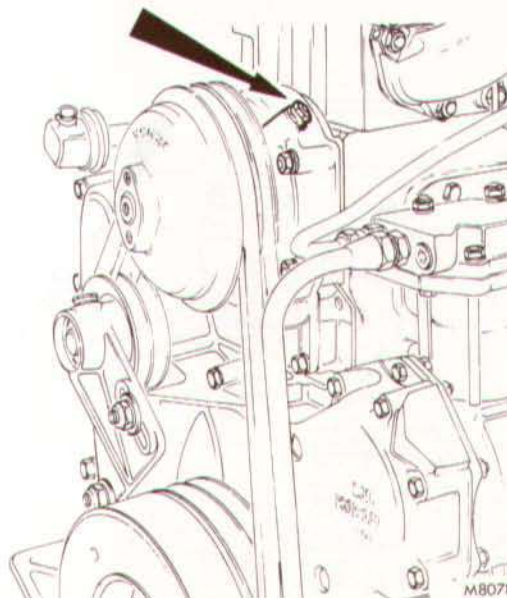


MB077

FIG. 14. ACCELERATOR LINKAGE

**Water Pump (Fig. 15)**

Using a grease gun, lubricate the water pump bearings.



MB078

FIG. 15. WATER PUMP

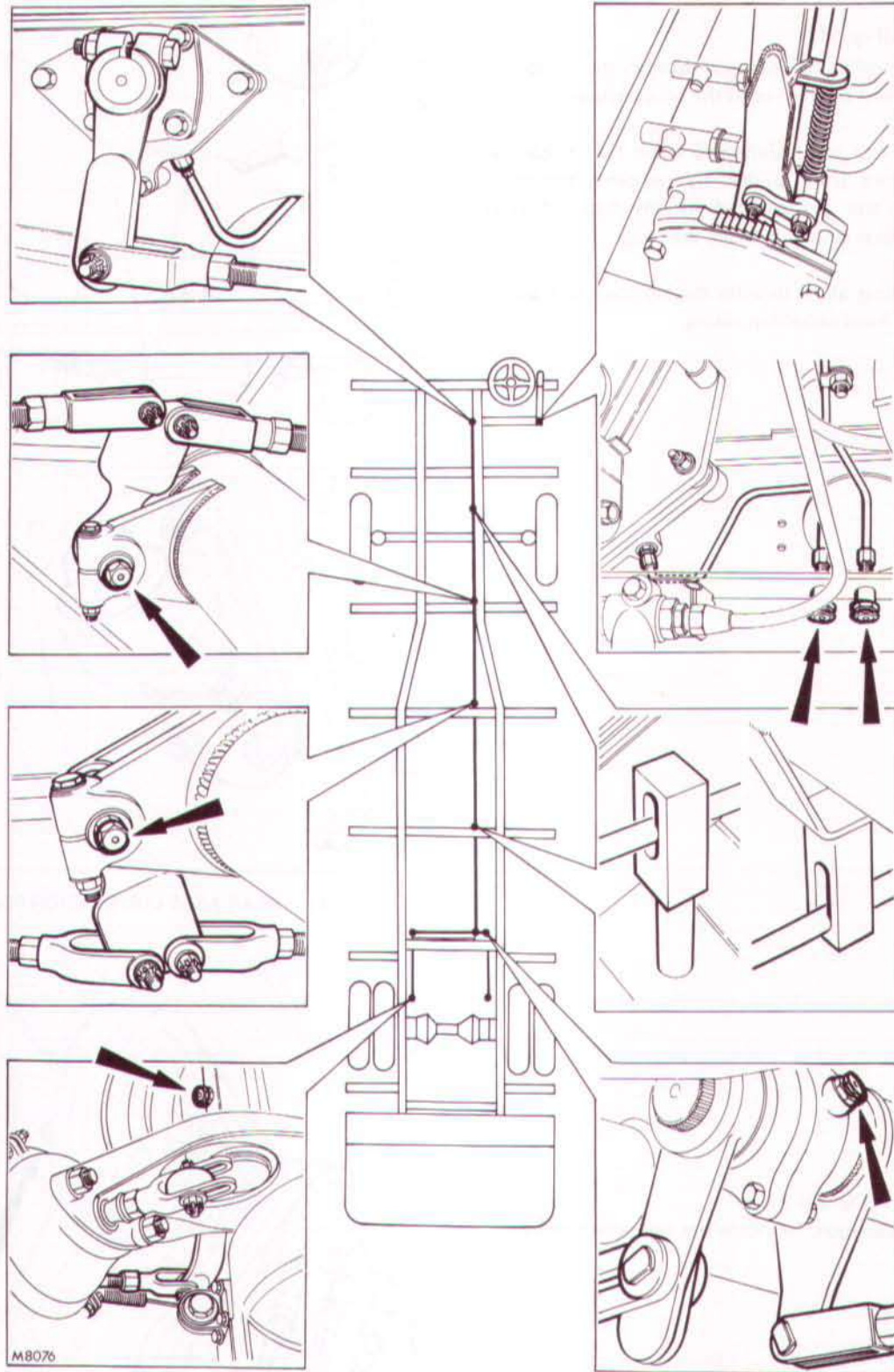


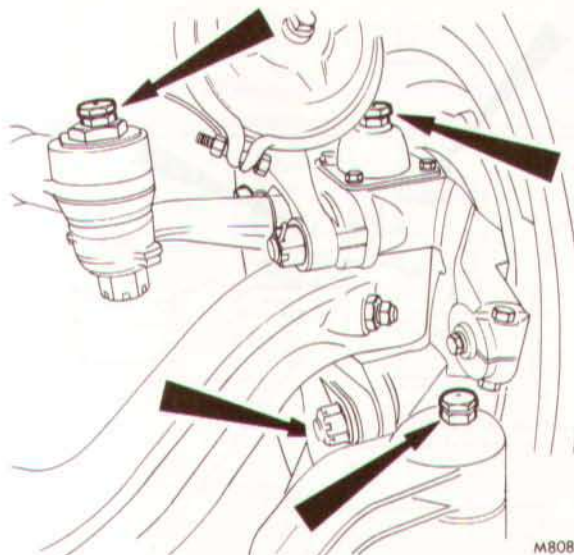
FIG. 13. HANDBRAKE LINKAGE



**King Pin and Steering Ball Joints (Figs. 18, 19 and 20)**

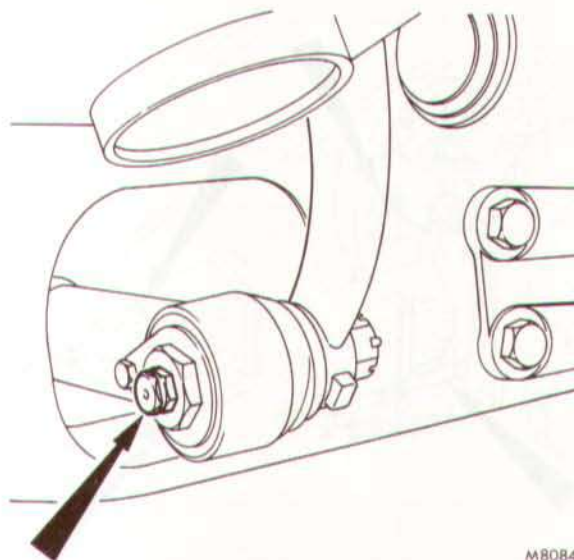
Lubricate with grease gun, the upper and lower king pin bushes and the steering ball joints on the track-rod and drag-links at the points indicated.

When automatic lubrication is fitted, routine maintenance will not be required.



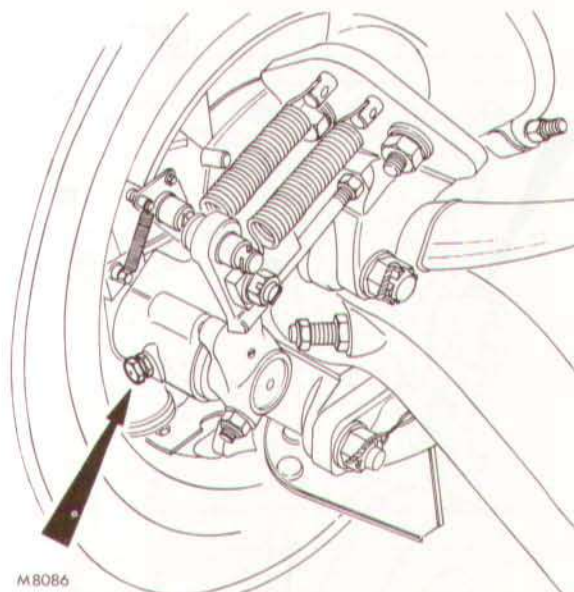
M8082

FIG. 18. KING PIN AND STEERING BALL JOINTS



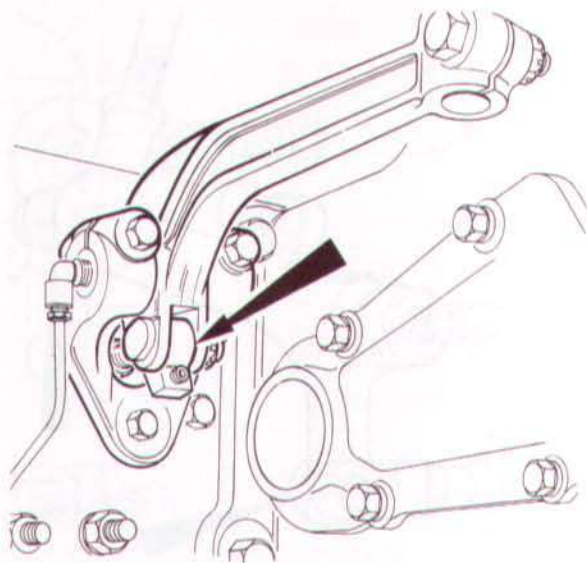
M8084

FIG. 19. STEERING BALL JOINT



M8086

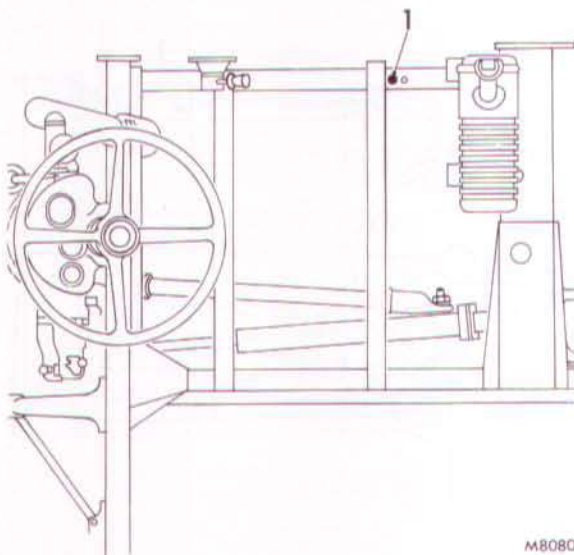
FIG. 20. STEERING BALL JOINTS



**Brake Pedal Linkage (Fig. 16)**

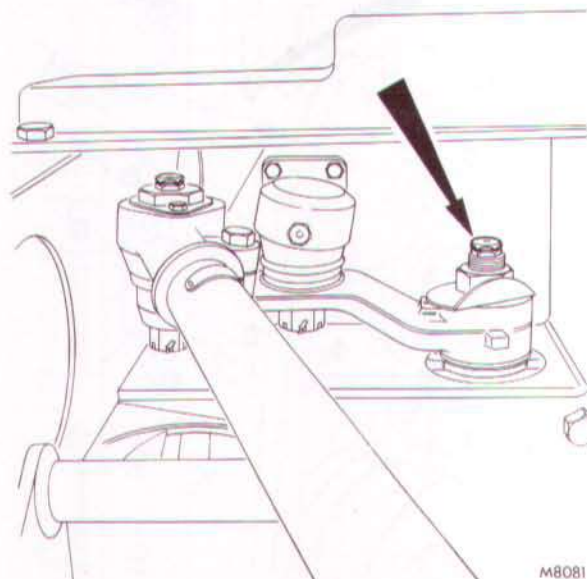
Using a grease gun, lubricate the brake pedal pivot. Lubricate the two control rod fork-ends with oil can.

**NOTE:** When automatic lubrication is fitted, the brake pedal pivot requires no maintenance.



M8080

FIG. 16. BRAKE PEDAL LINKAGE



M8081

FIG. 17. STEERING RELAY LEVER

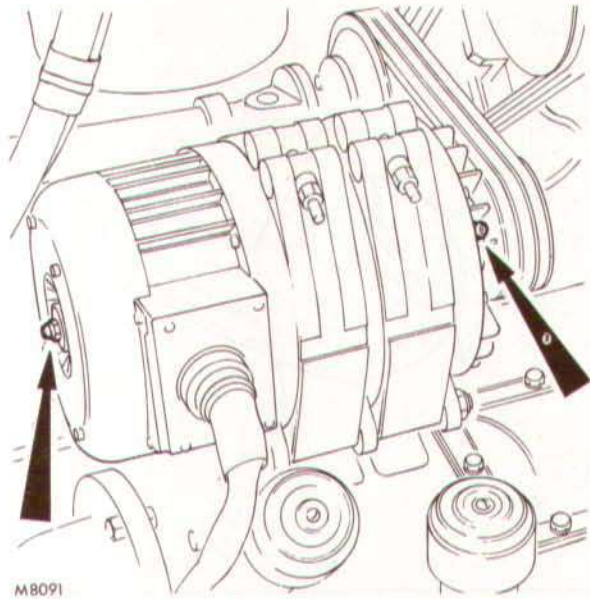
**Steering Relay Lever (Fig. 17)**

Lubricate with grease gun. (Not if automatic lubrication is fitted.)



**Alternator, CAV Type (Fig. 24)**

Using a grease gun, lubricate the alternator bearings.

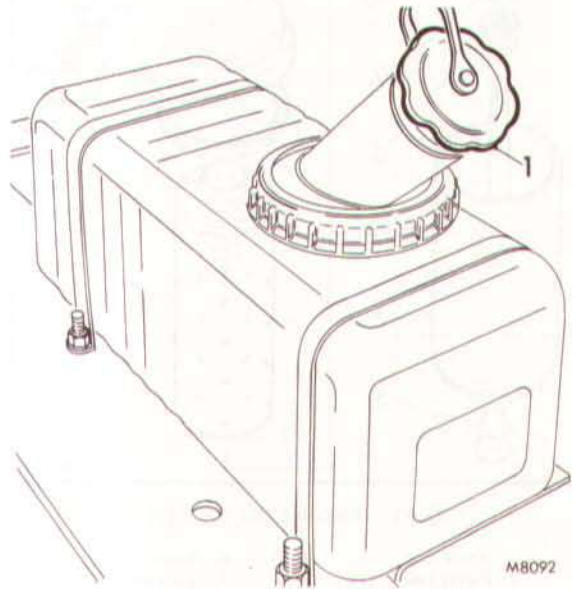


M8091

FIG. 24. ALTERNATOR LUBRICATION POINTS

**Automatic Lubrication Reservoir (Fig. 25)**

Remove reservoir cap and top-up until oil level reaches the bottom of filler neck.



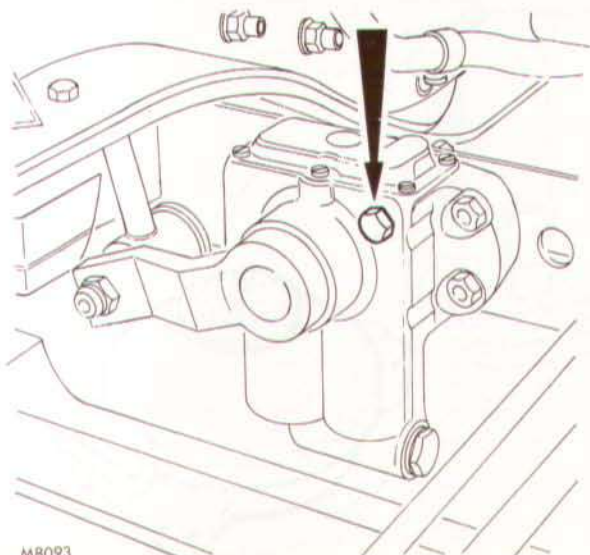
M8092

FIG. 25. AUTOMATIC LUBRICATION RESERVOIR

**Shock Absorbers (Fig. 26)**

Top-up the front shock absorbers by removing the filler plug and slowly filling with the recommended damper fluid until level rises to bottom of filler plug hole. Replace the filler plug.

The rear shock absorbers are sealed units and no routine maintenance is necessary.



M8093

FIG. 26. FRONT SHOCK ABSORBER FILLER PLUG



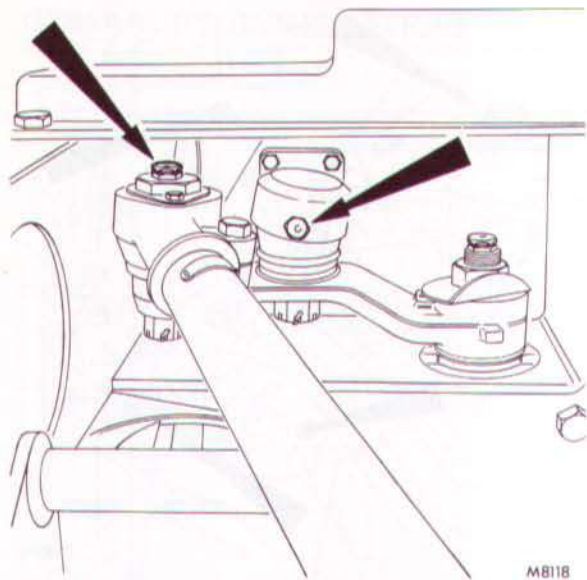


FIG. 21. BRAKE CAMSHAFT, FRONT

M8118

**Brake Camshafts (Figs. 21 and 22)**

Using a grease gun, lubricate the front and rear brake camshafts and relay lever shaft at the points indicated.

Lubricate pivot pins with oil can.

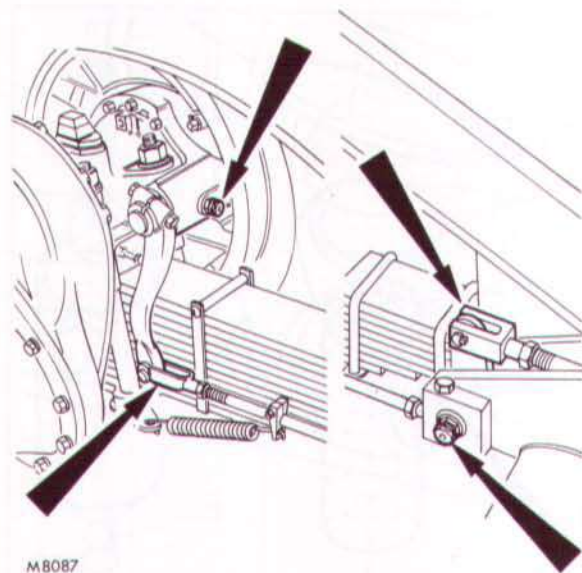


FIG. 22. REAR BRAKE CAMSHAFT AND RELAY LEVER

M8087

**Compressor Drive Belt Adjuster (Fig. 23)**

Using a grease gun, lubricate the adjuster bearings.

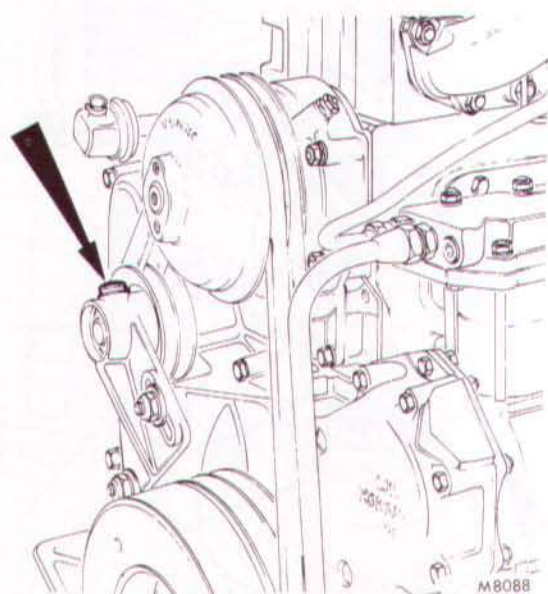


FIG. 23. COMPRESSOR DRIVE BELT ADJUSTER

M8088



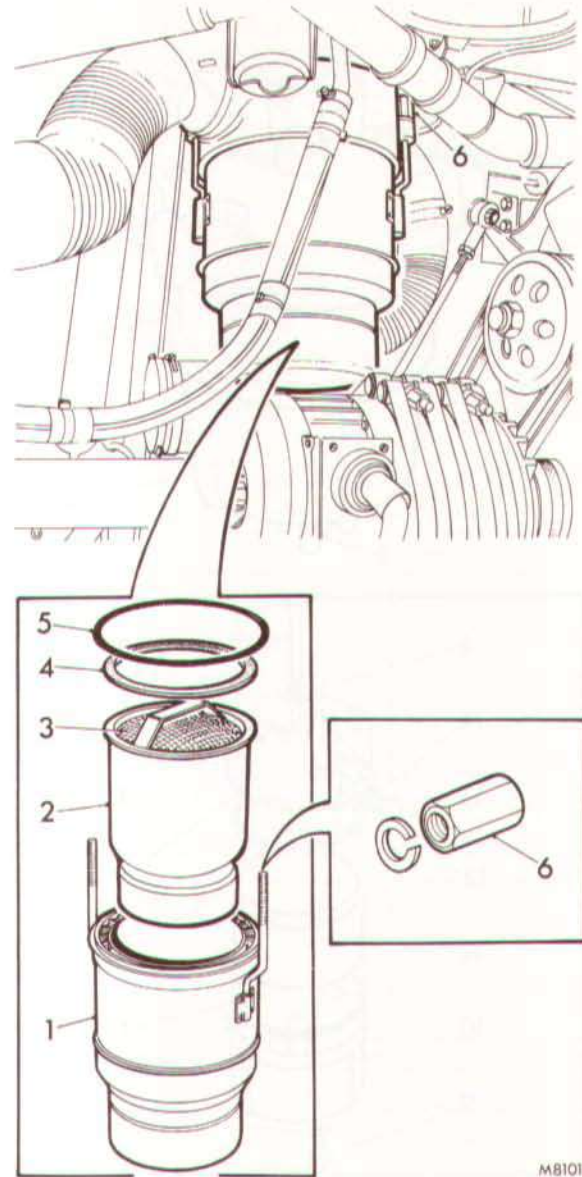
**Air Filter (Fig. 29)**

A definite period cannot be set for element servicing or replacement due to variations in operating conditions; therefore frequency of servicing should be governed by the conditions under which the vehicle operates, excessive smoke or loss of power being good indications that the element should be serviced or renewed.

**To Service Air Filter**

1. Unscrew the two brass nuts securing filter body to filter head.
2. Lower filter body and remove filter gauze, then clean in a suitable solvent.
3. Drain off the old oil and wash the canister in a suitable solvent. Wipe dry with a lint-free cloth.
4. Refit the canister to the filter element and replenish with clean engine oil to the mark indicated by the arrow.
5. Refit the canister and filter into the main filter body and refit the body to the filter head.

**NOTE:** Check the condition of the two rubber sealing rings in the filter head, and fit new ones if they are worn or damaged.



M8101

FIG. 29. ENGINE AIR FILTER

- |                 |                 |
|-----------------|-----------------|
| 1. Filter body  | 4. Sealing ring |
| 2. Canister     | 5. Sealing ring |
| 3. Filter gauze | 6. Brass nut    |

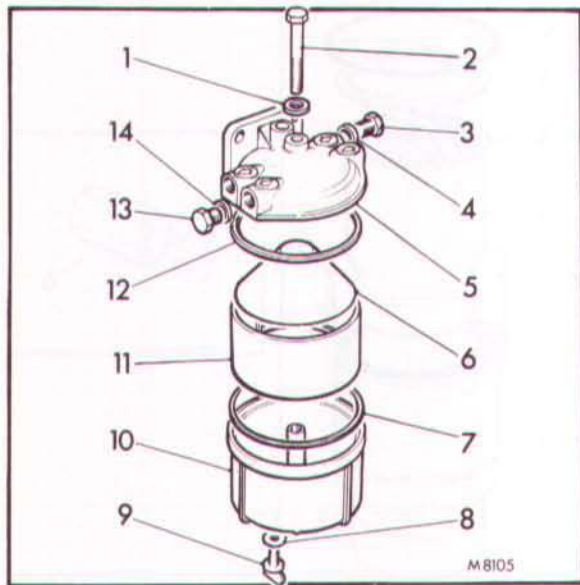
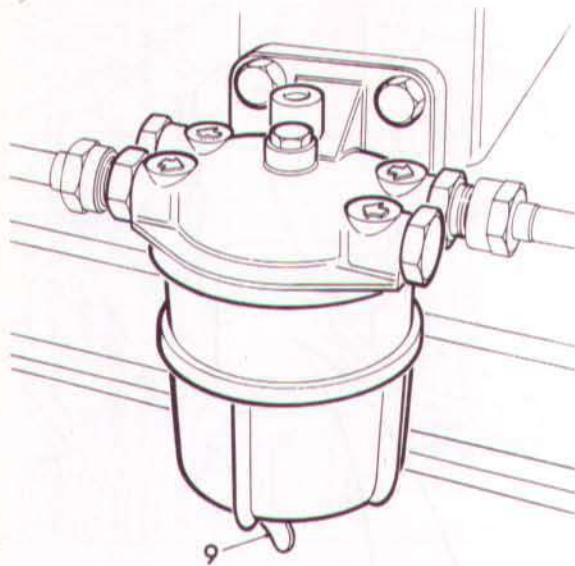


FIG. 30. FUEL SEDIMENTER

- |                 |                   |
|-----------------|-------------------|
| 1. Sealing ring | 8. Sealing washer |
| 2. Centre bolt  | 9. Drain plug     |
| 3. Plug         | 10. Bowl          |
| 4. Washer       | 11. Inner bowl    |
| 5. Filter head  | 12. Sealing ring  |
| 6. Sedimenter   | 13. Plug          |
| 7. Sealing ring | 14. Washer        |

**Fuel Sedimenter (Fig. 30)**

**Draining Procedure**

1. Slacken or remove the drain plug in the base of the unit and allow the accumulated water and solid matter to drain. Replace and tighten the plug.
2. Prime the sedimenter by operating the priming lever on the lift pump. Displaced air will pass to the twin element fuel filter and then return to the fuel tank via the permanent air-bleed.

**To Dismantle and Reassemble**

1. Remove retaining bolt located in centre of filter head.
2. Dismantle the fuel sedimenter as shown in Fig. 30, and clean all components in a suitable solvent.
3. During reassembly ensure that the sealing rings are in good condition and seated correctly.
4. Prime the sedimenter by operating the priming lever on the lift pump. In view of the larger volume of air involved in this instance, it will assist the priming procedure if the vent plug on the twin element fuel filter head is slackened.



**Fuel Filter (Fig. 31)**

**To Renew Filter Element**

1. Clean off external dirt from unit and remove drain screws to allow filters to drain.
2. Unscrew centre bolts (1) from filter head (3) and at same time hold elements (6) and bowls (8) if they have a tendency to rotate.
3. Detach elements and bowls from filter head and discard elements along with rubber sealing rings (5 and 7) and small 'O' ring (4).
4. Thoroughly clean filter head and bowls and refit drain screws in bowls.
5. Place new elements, sealing rings and 'O' rings, supplied with each element, in position and in same order as shown in Fig. 31.
6. Secure elements and bowls to filter head with centre bolts and tighten to a torque of 0.6 to 0.9 kgf m (5 to 8 lbf ft).

**NOTE:** Do not overtighten in an attempt to cure a subsequent leak at the sealing faces, but rectify by removing the element and examining the rings and sealing faces to determine the cause of the leak.

7. Prime system through to the injection pump as described in this section.

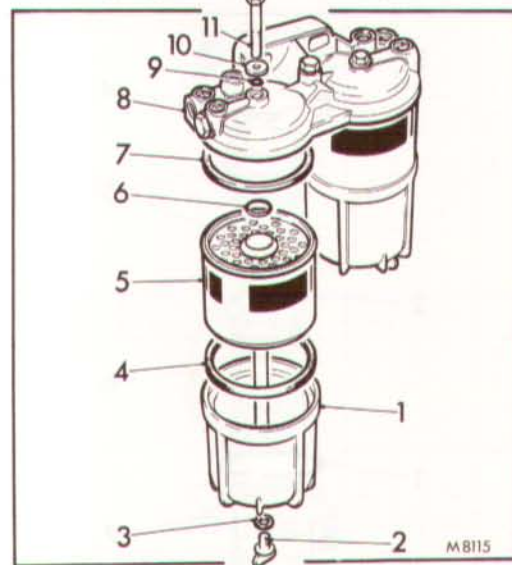
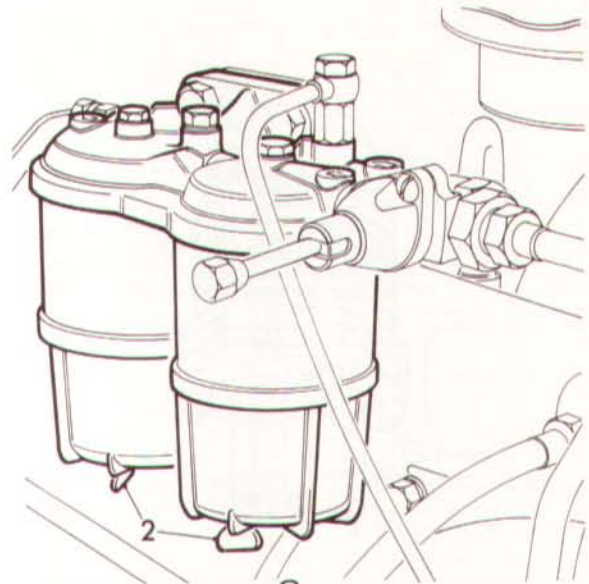


FIG. 31. FUEL FILTER

- |                   |                 |
|-------------------|-----------------|
| 1. Filter bowl    | 7. Seal         |
| 2. Drain screw    | 8. Filter head  |
| 3. Sealing washer | 9. Sealing ring |
| 4. Sealing ring   | 10. Washer      |
| 5. Element        | 11. Centre bolt |
| 6. Sealing ring   |                 |

**Priming the Fuel System (Fig. 32)**

The fuel system must be primed on initial installation; when any part of the system has been removed for servicing or renewal; when the vehicle has been allowed to run out of fuel; and if air has gained access to the system for any other reason. The priming procedure is as follows:

1. Ensure that fuel tank has an adequate supply of fuel.
2. Rotate the engine until a full stroke can be obtained on the fuel lift pump when operating the hand priming lever (3).
3. Open the two bleed screws (1) in the fuel injection pump, and open the bleed screw (2) in the pump inlet banjo bolt.
4. Operate hand priming lever on lift pump until fuel, completely free from air bubbles, flows from bleed points. Tighten each screw as soon as air-free fuel emerges.
5. Prime injector feed pipes by turning engine with starter motor for a few seconds, with the pipe to injector union nuts slackened. When air-free fuel emerges, tighten nuts and start engine.

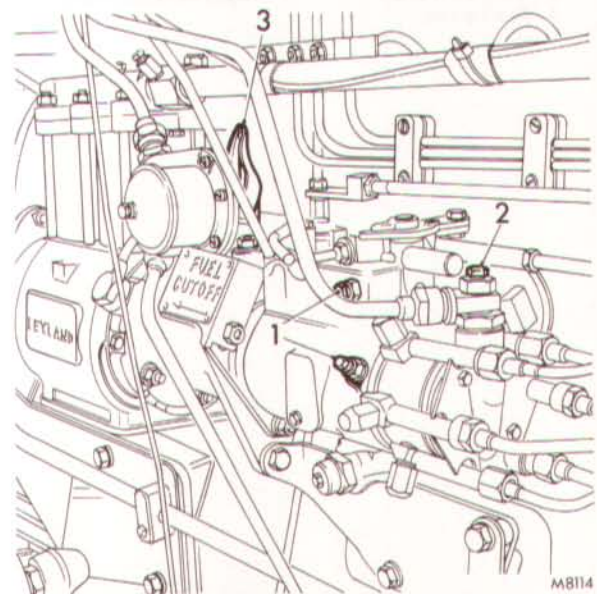


FIG. 32. FUEL SYSTEM BLEED POINTS

- |                           |                           |
|---------------------------|---------------------------|
| 1. Bleed point, fuel pump | 2. Bleed point, fuel line |
| 3. Priming lever          |                           |

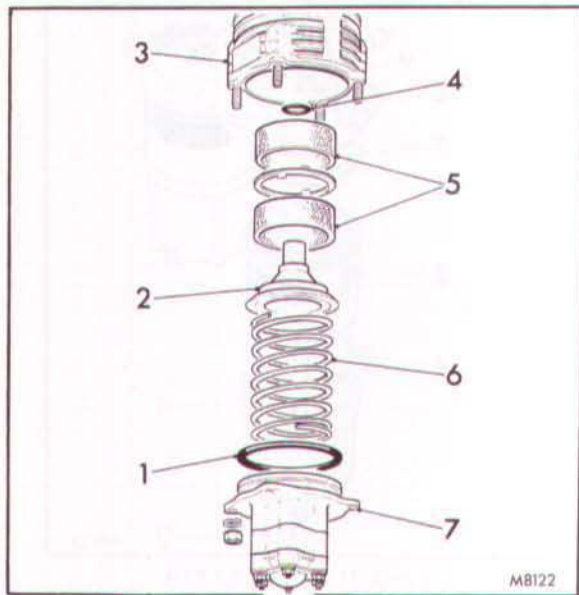
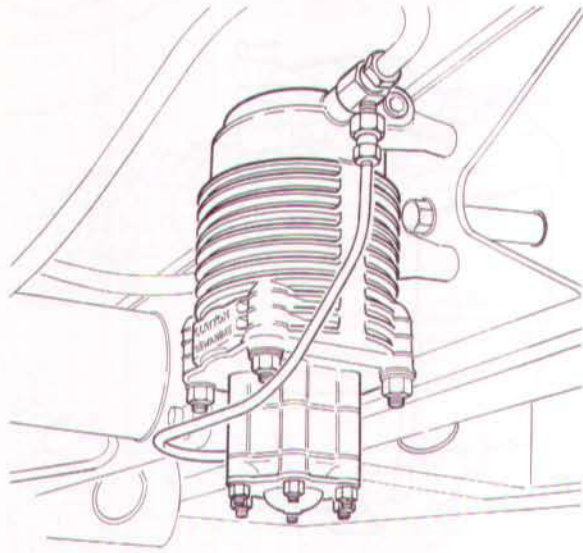


FIG. 33. CONDENSER/DRAIN VALVE

- |                    |                            |
|--------------------|----------------------------|
| 1. Sealing ring    | 5. Filter assembly         |
| 2. Filter retainer | 6. Filter retaining spring |
| 3. Condenser body  | 7. Drain valve assembly    |
| 4. Sealing ring    |                            |

Condenser/Drain Valve (Fig. 33)

To Clean Filter

1. Release all air pressure from system.
2. Clean dirt from valve, then disconnect the bridge pipe and suitably plug the connection to prevent ingress of foreign matter.
3. Remove the nuts securing drain valve to cylinder, holding drain valve against spring pressure. Withdraw the drain valve, spring, retainer and filter.
4. If paper-type filter is fitted, discard and fit copper wire-mesh type. If copper mesh type is fitted, clean thoroughly.
5. Clean accumulated sludge from cylinder. Check sealing rings on filter retainer and cylinder baseplate; renew if in poor condition.
6. Refitment of filter is a reversal of the removal procedure ensuring the sealing rings are smeared with CDS 156 grease, and the drain valve retaining nuts are tightened to a torque of 2.2 kgf m (16 lbf ft).



**Changing the Hydraulic Oil and Reservoir Filter**

1. Jack and block the front of the vehicle to leave the road wheels clear of the ground.
2. Position a suitable container under the flexible pipe connections of the steering gear.
3. Disconnect both pipes and allow all oil to drain. Remove the oil reservoir filler cap to relieve any vacuum.
4. Turn the steering slowly from lock to lock to expel all oil from the steering gear cylinders.
5. When drainage has ceased, reconnect the pipes.
6. Release oil reservoir cover by removing the retaining setscrew. Lift off the cover and remove the filter element.
7. Soak up any oil remaining in the reservoir and, using a clean non-fluffy cloth moistened with suitable solvent, clean out the interior of the reservoir.
8. Position a new filter element in the reservoir.
9. Position location plate, washers and spring above the element and refit the cover. Ensure that the rubber seal around the periphery of the cover and under the cover retaining setscrew are in good condition. Fit and tighten the retaining setscrew.
10. Fill up the reservoir with new oil of the grade specified in Group 1. The level should be topped up until it remains at slightly above the correct point.
11. Bleed the system as described in Group 5.

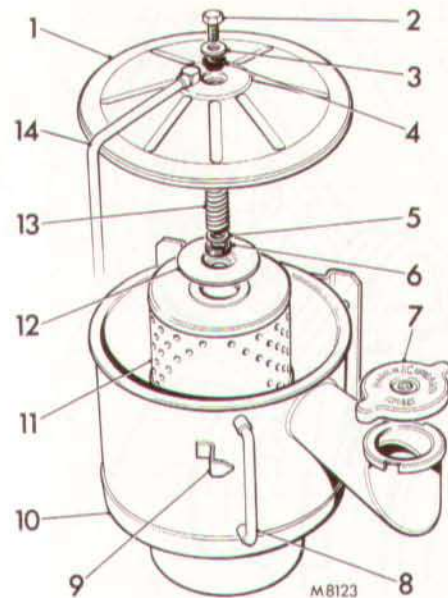


FIG. 34. POWER STEERING RESERVOIR

- |                 |                    |
|-----------------|--------------------|
| 1. Cover        | 8. Indicator tube  |
| 2. Centre screw | 9. Level indicator |
| 3. Washer       | 10. Reservoir      |
| 4. Gasket       | 11. Element        |
| 5. Washer       | 12. Pressure plate |
| 6. Felt washer  | 13. Spring         |
| 7. Filler cap   | 14. Breather tube  |

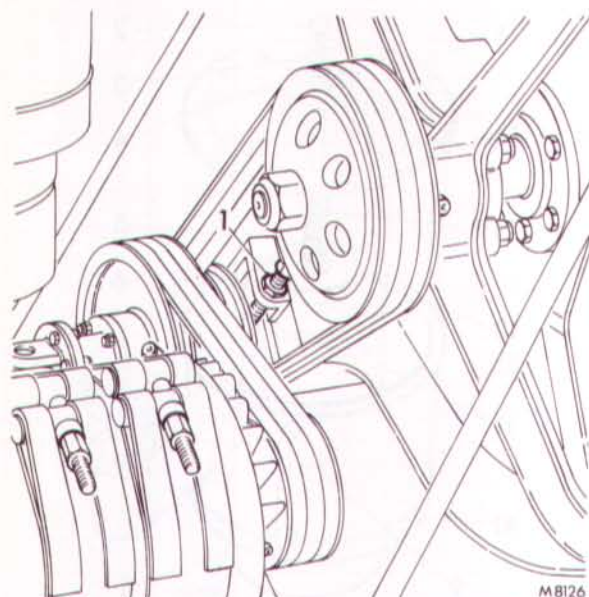


FIG. 35. FAN DRIVE BELT ADJUSTMENT

M8126

Adjustment of Driving Belts

Fan Driving Belts (Fig. 35)

To adjust the tension of the fan belts proceed as follows:

1. Slacken the locknut (1) on the fan/alternator pulley housing.
2. Rotate the adjuster bolt to either tighten or slacken the belt adjustment, to the correct tension.
3. Tighten the locknut.

**NOTE:** The tension is correct when the belts can be depressed midway between the pulleys by approximately 20 mm (0.75 in).

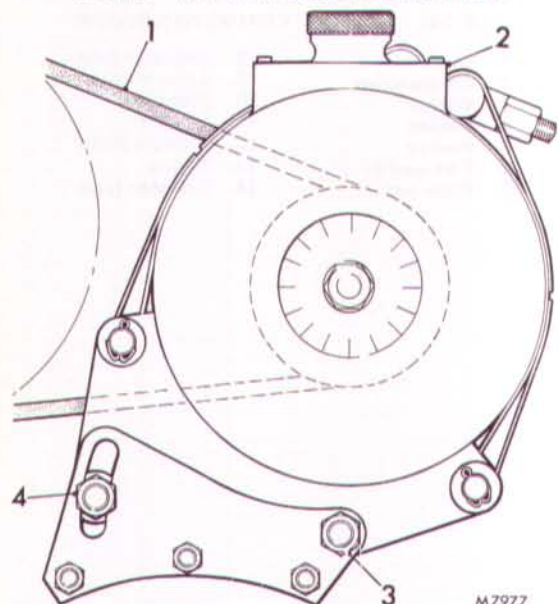


FIG. 36. ALTERNATOR DRIVE BELT ADJUSTMENT

M7977

- |                  |                 |
|------------------|-----------------|
| 1. Driving belts | 3. Pivot bolt   |
| 2. Alternator    | 4. Adjuster nut |

Alternator Driving Belts (Fig. 36)

To adjust the tension of the alternator drive belts, proceed as follows:

1. Slacken pivot bolts (3) and adjuster nut (4).
2. Pivot the alternator to slacken or tighten the driving belts.
3. Obtain the correct belt tension and re-tighten the adjuster nut and pivot bolt.

**NOTE:** The tension is correct when the belts can be depressed mid-way between the pulleys by approximately 20 mm (0.75 in).

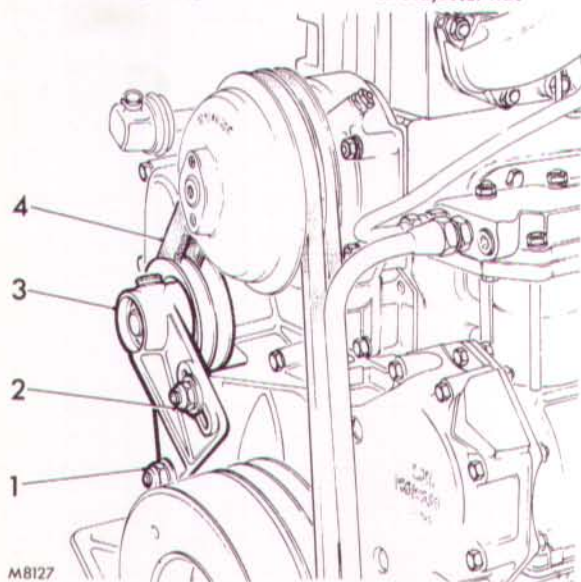


FIG. 37. WATER PUMP DRIVE BELT ADJUSTMENT

M8127

- |                 |                   |
|-----------------|-------------------|
| 1. Pivot bolt   | 3. Belt tensioner |
| 2. Adjuster nut | 4. Drive belts    |

Water Pump Drive Belts (Fig. 37)

To adjust the tension of the water pump drive belts proceed as follows:

1. Slacken nut of pivot bolt (1) and nut of adjuster (2).
2. Pivot the tensioner (3) away from engine to tighten and towards engine to slacken driving belts (4).
3. Obtain the correct tension and re-tighten the adjuster nut and pivot bolt nut.

**NOTE:** The tension is correct when the belts can be depressed midway between the crankshaft pulley and the water pump by approximately 6 mm (0.25 in).



**To Adjust the Tappets**

1. Remove cylinder head covers.
2. Turn engine onto T.D.C. position until timing mark on flywheel is in line with timing pointer on engine back plate and No. 1 piston is at the top of its compression stroke.
3. Adjust inlet and exhaust tappets for No. 1 cylinder by releasing locknut on tappet adjusting screw and adjust screw until correct clearance is obtained (refer to Data).
4. Tighten locknut when clearance has been set and re-check clearance.
5. Turn engine one-third of a turn to bring No. 5 piston on compression stroke, and set the tappets. Repeat procedure on Nos. 3, 6, 2 and 4 cylinders in succession.





SECTION 3

Lubricants and Fluids

This section defines the specifications and grades of lubricants recommended for Leyland units. It should be read in conjunction with the Maintenance Schedule which gives the recommended lubrication mileages and the Lubrication Diagram which indicates the position of filling points. Refer to Section 1 of this Group for unit capacities.

The recommendations given are for general guidance only, and at all times close collaboration should be maintained with the oil supplier. Where different grades of lubricant are shown for various atmospheric temperature ranges, the grade chosen should be that applicable to the temperature range which is operative for a significant proportion of the season during which the oil is in use.



**UNIT RECOMMENDATIONS**

The use of additive treated (heavy duty) engine oils is essential. At present the only internationally recognized standards for engine oil performance level consist of military specifications, based on a defined series of functional tests in specified engines. Leyland engines should be lubricated with oil of a performance level not less than the requirements of the specifications quoted below:

**Engines**

Engines should be lubricated with oil meeting the performance requirements of the American Petroleum Institute (A.P.I.) Engine Service Classification shown below. Where two A.P.I. classifications are shown, the oil must meet the requirements of both.

Type	A.P.I. Service Classification	Related Military Specification Requirements
Normally aspirated	CC	MIL-L-46152 or MIL-L-2104B
Turbocharged	CD plus CC	MIL-L-45199B plus MIL-L-46152 or MIL-L-45199B plus MIL-L-2104B or MIL-L-2104C

**Notes:**

1. The Military Specifications quoted include types which are officially obsolete, but commercial grades of oil meeting their requirements are available.
2. The lubricants recommended for turbocharged engines may also be used in normally aspirated engines.
3. Oils referred to as 'Series 3 oils' are acceptable for all engines providing they meet the requirements CD plus CC.

**Initial Fill Up.** Engines in chassis delivered from the works are filled with additive treated (heavy duty) oil of the recommended type.

**Multigrade Oils.** Multigrade (multiviscosity number) lubricating oils must have a qualification engine test performance at least equal to that required of corresponding single viscosity number lubricants.

**Recommended Viscosity (S.A.E.) Grades**

Atmospheric Temperature Range	Recommended Viscosity Number
Below 0°C (below 32°F) . . . . .	S.A.E. 5W/20
0° to 30°C (32° to 86°F) . . . . .	S.A.E. 20W/20 or S.A.E. 10W/30
Above 30°C (above 86°F) . . . . .	S.A.E. 30

**CAUTION:** Leyland Truck and Bus cannot accept any responsibility for trouble experienced by operators arising from any of the following causes:

- (i) The use of oil of lower performance level than the minimum requirement for the operating conditions, or
- (ii) The use of oils of lower viscosity than the recommended grades, or
- (iii) The continued use of oils after the recommended oil change mileage or period.

## FUEL OIL AND FLUIDS

## Fuel Oil for Leyland Diesel Engines (Revised April 1968)

The fuel oils which are suitable for use in Leyland Diesel engines are generally known as Diesel fuel oil, distillate Diesel fuel, automotive gas oil or Derv fuel. Users are recommended to obtain their supplies from a source which can be depended upon to maintain a consistent standard of quality and service. Waste or residual oils of any sort are to be avoided.

It is recommended that the fuel should conform to British Standard 2869: 1967, Class A1, which includes the following requirements:

If fuel to British Standard 2869, Class A1, is not available, fuel to Class A2 may be used but it is likely to be less satisfactory.

## ANTI-FREEZE FLUIDS

## Engine Cooling System

The use of anti-freeze which conforms to B.S. 3151 or B.S. 3152 is recommended if the temperature is likely to fall to 0°C (32°F) or less.

The following chart shows protection provided by various concentrations of anti-freeze solutions which meet the above British Standards.

Solution	Commences to freeze		Frozen solid	
	°C	°F	°C	°F
25	-13	9	-26	-15
33	-19	- 2	-36	-33
50	-36	-33	-48	-53

When anti-freeze fluid is not in use it is recommended that a corrosion inhibitor fluid is added to the cooling system.

## Air Pressure System

The use of a volatile anti-freeze fluid is recommended in the air pressure system anti-freezer if the temperature is likely to fall to 0°C (32°F) or less.

The recommended fluid is methanol (methyl alcohol) but if this is unobtainable, ethanol (ethyl alcohol) or industrial methylated spirits may be used. The initial water content of any fluid used should not exceed 1%. Suitable fluids are usually referred to by their alcoholic strength of 74 Over Proof (British System) or 198 Proof (American System).

**CAUTION:** Non volatile anti-freeze fluids such as ethylene glycol (ethanediol) must not be used in the anti-freezer units of air-pressure systems.



# GENERAL RECOMMENDATIONS

## LEYLAND SPECIFICATIONS

**Leyland Specification E Oil** (revised January 1964) for pneumocyclic gearboxes, fluid flywheels and fluid clutches.

Oils used for the above applications must be consistent with the requirements of high quality hydraulic or turbine lubricants.

The oils should be based on mineral oil with a viscosity index of not less than 90, and be fully inhibited against corrosion, oxidation and foaming. The pour point should be well below the anticipated lowest atmospheric temperature.

The resistance to oxidation should be such that, when tested by I.P. Method 114/56T, the increase in acidity of the oil does not exceed 0.1 mg KOH/g, and the total acidity after oxidation does not exceed 0.2 mg KOH/g.

The table below is given as a guide to the viscosity requirements.

Atmospheric Temperature Range	Viscosity Redwood No. 1 Seconds at 140°F	Equivalent Viscosity Saybolt Universal, Seconds at 140°F
Below 0°C (below 30°F) . . . . .	75 to 100	85 to 112
0° to 30°C (30°F to 90°F) . . . . .	100 to 135	112 to 150
Above 30°C (above 90°F) . . . . .	135 to 180	150 to 200

**Leyland Specification H Hydraulic Fluid** (revised January 1964) for power steering hydraulic equipment.

Fluids used for the above applications should be based on highly stable mineral oils, fully inhibited against corrosion, oxidation and foaming.

In order to maintain the hydraulic characteristics over a wide temperature range, they should have a high viscosity index (preferably not less than 130) and a low pour point (preferably not above minus 40°F).

The viscosity, Redwood No. 1, of suitable fluids will be normally between 300 and 400 seconds at 70°F, and between 45 to 50 seconds at 200°F (equivalent Saybolt Universal viscosities 340 to 400 at 70°F, and 50 to 56 at 200°F).

A widely distributed fluid meeting the above requirements is known as 'Automatic Transmission Fluid Type A'.

Under certain circumstances, the use of alternative types of hydraulic fluid of suitable characteristics may be recommended by the oil supplier.

**CAUTION:** Although this is a hydraulic fluid, it is not suitable for use in hydraulic brake systems or hydraulic throttle and clutch controls.

**Leyland Specification G Grease (Lithium-based)** for road wheel bearings and other applications.

All greases used for the lubrication of road wheel bearings must conform to the British Timken Specification for lithium-based greases, originally issued under reference ALG 1/57. The proprietary grade must have been approved by British Timken Limited.

It is most important that lithium-based greases should not be mixed with grease of other types in road wheel bearings, as this would have the effect of producing a melting-point lower than either of the constituent greases.

When changing the type of grease, the road wheel bearings should be thoroughly cleaned out.

When packing wheel hubs with lithium-based grease, care should be taken to ensure that the bearings and cage assemblies are fully packed, but the hub itself should not be over-packed with grease — see the appropriate group of this Manual for the correct amount to be used.



**SPECIAL LUBRICANTS, FLUID AND COMPOUNDS**

- Butec alternator . . . . .
- Butec starter motor . . . . .
- Multi-way plugs and sockets . . . . .

**Overhaul Applications**

- Leyland engine . . . . .
- Fluid coupling } . . . . .
- Gearbox } . . . . .
- Angle-drive } . . . . .
- Rear axle } . . . . .

**Brake Valves**

- Bendix Westinghouse . . . . .
- Clayton Dewandre . . . . .

- Chevron SR1-2 grease
- S.A.E. 5W/20 and light graphite grease
- Midlands Silicones MS4 silicone grease

Wellseal jointing compound

Hylomar jointing compound

- Westinghouse Air Brake grease, Grade A
- Clayton Dewandre CDS 156 grease

**GENERAL RECOMMENDATIONS**

UNIT	MINIMUM PERFORMANCE REQUIREMENT		ATMOSPHERIC TEMPERATURE RANGE	VISCOSITY REQUIREMENT	B.P.	CASTROL
	MILITARY	OTHER				
Fluid Flywheel Gearbox and Angle-drive		Leyland Specification E	Below 0°C (32°F)		Autran G	TQF
			0°C to 30°C (32°F to 86°F)		LA 62 or Autran G	Deusol PSG or TQF
			Above 30°C (86°F)		Autran G or Energol 125HB	TQF
Rear Axle Angle-drive (Initial fill only)	U.S.-MIL-L-2105B		Below 0°C (32°F)	S.A.E. 80	Gear Oil 80 EP	Hypoy B 80W
			0°C to 30°C (32°F to 86°F)	S.A.E. 90	Gear Oil 90EP	Hypoy or Deusol 90EP
			Above 30°C (86°F)	S.A.E. 140	Gear Oil 140EP	Deusol 140EP
Steering Box (Leyland)	U.S.-MIL-L-2105B		Below 0°C (32°F)	S.A.E. 90	Gear Oil 90EP	Hypoy 90
			0°C to 30°C (32°F to 86°F)	S.A.E. 140	Gear Oil 140EP	Deusol Medium 140 or D
			Above 30°C (86°F)		Gear Oil 140EP	Deusol 140EP
Power Steering System	General Motors 'Dexron'	Leyland Specification H Hydraulic Fluid	Below 0°C (32°F)		Autran DX	Dexron TQ
			0°C to 30°C (32°F to 86°F)		Autran DX	Dexron TQ or TXA
			Above 30°C (86°F)		Autran DX	Dexron TQ
Chassis Lubrication (Automatic)			Below 0°C (32°F)	S.A.E. 90	Gear Oil 90	Deusol 90
			0°C to 30°C (32°F to 86°F)	S.A.E. 140	Gear Oil 90 or 140	Deusol 90 or 140
			Above 30°C (86°F)		Gear Oil 140	Deusol 140
Hydraulic Throttle Controls			All Temperatures			Crimson Brake Fluid
Axle Hubs and Grease Points		Leyland Specification G	All Temperatures		Energrease L2	LM

**GENERAL RECOMMENDATIONS**

DALTON'S	DUCKHAMS	ESSO	GULF	MOBIL	SHELL	TEXACO
Ford Type 986	Fleetmatic F	Glide	Automatic Transmission Fluid Type F	ATF 210	Donax TF	Texamatic Type G
Ford Type 986	Fleetmatic F	Teresso 68 or Glide	Harmony 53 or ATF Type F	Mobilfluid 98 or ATF 210	Donax TF or Donax TL	Torque Fluid E or Texamatic Type G
Ford Type 986	Fleetmatic F	Teresso 100 or Glide	Harmony 61 or ATF Type F	DTE Heavy or ATF 210	Turbo T37 or Donax TF	Texamatic Type G
Mamba 80	Fleetoid 80	Gear Oil 80	Gear Lubricant 80	Mobilube HD80	Spirax 80EP	Universal 80EP
Python 90 or Boa 90	Fleetoid 90	Gear Oil 90/140	Gear Lubricant 90	Mobilube HD90	Spirax 90EP	Universal 90 or Fleet 90/140
Viper 90/140	Fleetoid 140	Gear Oil 90/140	Gear Lubricant 140	Mobilube HD140	Spirax 140EP	Universal 140EP
Python 90	Fleetmesh 90	Gear Oil 90/140	Transmission Oil 90	Mobilube C90	Dentax 90	Thuban 90
Rhino 140	Fleetmesh L17 or 140	Gear Oil 90/140	Transmission Oil 140	Mobilube C140	Dentax 140	Thuban 140
Viper 90/140	Fleetmesh 140	Gear Oil 90/140	Gear Lubricant 140	Motorlube HD140	Dentax 140	Thuban 140
Dexron 987R	Fleetmatic CD	Dexron ATF	Dexron ATF	ATF 200 or 220	Dexron ATF	Texamatic Fluid 667 Dexron
Dexron 987R or Zebra 75ATF	Fleetmatic A or CD	Dexron ATF	Dexron ATF	ATF 200 or 220	Dexron ATF	Texamatic Type F
Dexron 987R	Fleetmatic A or CD	Dexron ATF	Dexron ATF	ATF 200 or 220	Dexron ATF	Texamatic Type F
Python 90	Fleetoid 90	Gear Oil 90	Transmission Oil 90	Mobilube C90	Dentax 90	Thuban 90
Regular 140	Fleetmatic 90 or 140	Gear Oil GP90/140	Transmission Oil 90 or 140	Mobilube C140	Dentax 90 or 140	Thuban 90 or 140
Regular 140	Fleetoid 140	Gear Oil 90/140	Transmission Oil 140	Mobilube C140	Dentax 140	Thuban 140
Brake Fluid 859	Clear Brake Fluid	Brake Fluid	Super HD Brake Fluid	Hydraulic Brake Fluid 46	Universal Brake and ClutchFluid	—
G.55/T	Admax L2	Beacon 2	Gulf Crown 2	Mobilgrease MP or Super	Retinax A	Marfak or Multifak EP2





## SECTION 4

## Special Tools

Special tools to assist in overhauling this vehicle are listed in this section and are available from the following address unless otherwise stated:

V. L. Churchill and Co. Ltd.  
P.O. Box No. 3  
London Road  
Daventry  
Northants  
NN11 4NF  
England

<b>ENGINE, LEYLAND 680</b>	<b>Tool No.</b>
<b>Cylinder Head</b>	
Valve grinding tool	18G 29
Basic valve spring compressor tool	6118 B
Adaptor for use with LC 6118 B	
<b>Cylinder Block</b>	
Cylinder liner removal/replacement equipment	LC 147-2
<b>Piston Rings</b>	
Piston ring compressing tool	No. 8
<b>Injectors</b>	
Injector extracting tool	LC 267708
Extractor adaptor for CAV injectors	LC 400115
Injector seat cleaning tool	LC 109 B
<b>Miscellaneous</b>	
Basic extractor tool	155
Water pump impellor extractor	LC 155-1
Basic extractor	55
Fan pulley extractor (current engines)	LC 55-1
<b>REAR AXLE</b>	
Assembly test plug	D 701
Pinion oil seal remover	D 702
Pre-load locking wrench	D 703
Differential bearing cup replacer	D 704
Pre-load locking key	D 705
Adaptor for differential bearing R.H.	D 707-4
Adaptor for differential bearing L.H.	D 707-5
Checking tool	LC 818
<b>ANGLE DRIVE (TRANSFER BOX)</b>	
Assembly jig	D 706
Bearing remover	D 707
Adaptor for L.H. bevel pinion bearing	D 707-1
Adaptor for R.H. bevel pinion bearing	D 707-2
Adaptor for output sleeve roller bearing	D 707-3
Taper bearing pre-load tool	LC 273

# GENERAL RECOMMENDATIONS

## POWER STEERING RAM

Ball cup spanner	HY 10
End plug and lock ring spanner	HY 11
Hose port centralizer	HY 17
Bearing assembly gland seal replacer	HY 19
Bearing assembly seal protector	HY 20
	HY 21
Bearing assembly outer 'O' ring protector	HY 22
Pressure test equipment	MS 64
Adaptors for test equipment	MS 64-3

## BRAKES

### Spring Brake Actuators

Tool to depress spring for circlip removal	MS 61
Adaptor for MS 61, Westinghouse actuators	MS 61-5
Adaptor for MS 61, Clayton Dewandre actuators	CD 61-2



## SECTION 5

## Conversion Factors and Abbreviations

## Weights and measures with approximate equivalents

## Length

1 millimetre	=	0.0394 inch	1 inch	=	25.4 millimetres
1 metre	=	3.28 feet	1 foot	=	304.8 millimetres
1 metre	=	1.094 yards	1 yard	=	0.914 metre
1 kilometre	=	0.62 mile	1 mile	=	1.609 kilometres

## Area

1 square centimetre	=	0.155 square inch	1 square inch	=	6.452 square centimetres
1 square metre	=	10.764 square feet	1 square foot	=	929.03 square centimetres
1 square metre	=	1.196 square yards	1 square yard	=	0.836 square metres
1 square kilometre	=	0.386 square mile	1 square mile	=	2.59 square kilometres

## Volume

1 cubic centimetre	=	0.061 cubic inch	1 cubic inch	=	16.387 cubic centimetres
1 cubic metre	=	31.315 cubic feet	1 cubic foot	=	0.0283 cubic metre
1 cubic metre	=	1.308 cubic yards	1 cubic yard	=	0.7646 cubic metre

## Capacity

1 litre	=	1.760 Imperial pints	1 Imperial pint	=	0.568 litre
1 litre	=	2.10 U.S. pints	1 U.S. pint	=	0.476 litre
1 litre	=	0.22 Imperial gallon	1 Imperial gallon	=	4.546 litres
1 litre	=	0.264 U.S. gallon	1 U.S. gallon	=	3.80 litres

## Weight

1 gramme	=	0.035 ounce	1 ounce	=	28.35 grammes
1 kilogramme	=	2.205 pounds	1 pound	=	453.6 grammes
1 tonne	=	0.984 ton	1 hundredweight	=	50.8 kilogrammes
			1 ton	=	1.016 tonnes

## Torque

1 kilogramme centimetre	=	0.87 pound inch	1 pound inch	=	1.15 kilogramme centimetres
1 kilogramme metre	=	7.23 pound foot	1 pound foot	=	0.138 kilogramme metre

## Pressure

1 kilogramme per square centimetre	=	14.22 pounds per square inch	1 pound per square inch	=	0.0703 kilogramme per square centimetre
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# GENERAL RECOMMENDATIONS

## Abbreviations

Across flats (bolt head sizes)	A.F.	Millimetres	mm
After bottom dead centre	A.B.D.C.	Minimum	min.
After top dead centre	A.T.D.C.	Minus (of tolerance)	—
Alternating current	a.c.		
Amperes	A	Negative (electrical)	—
Ampere-hour	Ah	Newton metres	Nm
Atmospheres	Atm.		
		Ohms	ohm or $\Omega$
Before bottom dead centre	B.B.D.C.	Ounces	oz
Before top dead centre	B.T.D.C.	Outside diameter	o.dia.
Bottom dead centre	B.D.C.		
Brake horse-power	bhp		
British Standard	B.S.	Pints (Imperial)	pt
		Plus or minus	$\pm$
Centigrade (Celsius)	C	Plus (of tolerance)	+
Centimetres	cm	Positive (electrical)	+
Centimetres of mercury	cmHg	Pounds (force)	lbf
Cubic centimetres	cm <sup>3</sup>	Pounds (mass)	lb
Cubic inches	in <sup>3</sup>	Pounds feet (torque)	lbf ft
		Pounds inches (torque)	lbf in
		Pounds force per square inch	lbf/in <sup>2</sup>
Degree, minute, second (angle)	° ' "		
Degree (temperature)	°	Ratio	:
Diameter	dia.	Revolutions per minute	rev/min
Direct current	d.c.	Right-hand	R.H.
		Right-hand drive	R.H.D.
Fahrenheit	F		
Feet	ft	Society of Automobile Engineers	S.A.E.
		Specific gravity	sp. gr.
Gallons (Imperial)	gal	Square centimetres	cm <sup>2</sup>
Grammes	g	Square inches	in <sup>2</sup>
		Standard wire gauge	s.w.g.
Inches	in		
Inches of mercury	inHg	Top dead centre	T.D.C.
Internal diameter	i.dia.		
		United Kingdom	UK
Kilogrammes (force)	kgf		
Kilogrammes (mass)	kg	Volts	V
Kilogramme centimetre (force)	kgf cm		
Kilogramme metre (force)	kgf m		
Kilogrammes per square centimetre (force)	kgf/cm <sup>2</sup>	Watts	W
Kilometres	km		
Kilowatts	kW	<b>Screw Threads</b>	
		British Association	B.A.
Left-hand	L.H.	British Standard Fine	B.S.F.
Left-hand drive	L.H.D.	British Standard Pipe	B.S.P.
Maximum	max.	Unified Coarse	U.N.C.
Metres	m	Unified Fine	U.N.F.
Microfarad	$\mu$ f	Metric (millimetres)	M





## GROUP 2

## ENGINE

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## SECTION 1

## Power Unit Removal and Refitment

The power unit, comprising engine, fluid coupling, gearbox with angle-drive, and radiator, is mounted on a sub-frame at the rear end of the chassis frame. When removing the power unit from the vehicle the sub-frame is disconnected and removed with the power unit, thus leaving the flexible mountings undisturbed.

## TO REMOVE

1. Isolate batteries by means of battery cut-off switch situated at rear right hand side of vehicle.
2. Remove engine cover side panels and valance.
3. Turn off fuel cut-off tap situated on frame immediately under fuel injection pump, and disconnect fuel lines at bracket adjacent to engine oil filling point.
4. Disconnect air compressor flexible hose.
5. Remove socket head screw from speedometer and automatic lubrication air control unit assembly. The assembly can then be withdrawn from the gearbox.
6. Disconnect flexible air feed pipes from adaptors at gearbox.
7. Disconnect electrical connections to alternator and starter motor. Release cable clips where necessary.
8. Disconnect Radolarm electrical cables at socket on rear of bulkhead.
9. Disconnect water temperature and engine stop solenoid electrical cables at socket on rear of bulkhead.
10. Disconnect oil pressure switch electrical connections at switch and release cables from clips on brackets at power unit rear left hand

mounting.

11. Disconnect auto-lubrication flexible pipe from fan belt drive bearing housing.
12. Disconnect flexible pipes from coolant system return pipe.
13. Disconnect flexible pipe from radiator header tank overflow pipe.
14. Drain power steering reservoir.
15. Disconnect flexible pipes from hydraulic pump.
16. Disconnect exhaust pipe from exhaust manifold.
17. Disconnect exhaust tail pipe from power unit rear sub-frame member.
18. Disconnect power unit steady stay from bracket at bottom of bulkhead.
19. Disconnect accelerator linkage at bracket situated at front of power unit.
20. Disconnect the propeller shaft from the gearbox output flange.
21. With the aid of a fork-lift truck and suitable lifting tackle support the weight of the power-unit.

**Note:** The approximate weight of the power unit is 1,520 kg (3,360 lb).

22. Remove bolts securing sub-frame to chassis frame.
23. Lift and withdraw power unit rearwards from the chassis frame.

## TO REFIT

Refitment of the power-unit is a reversal of the removal procedure. Ensure that new self-locking nuts are fitted, and the three right-hand front mounting bolts are fitted from the underside of the frame.

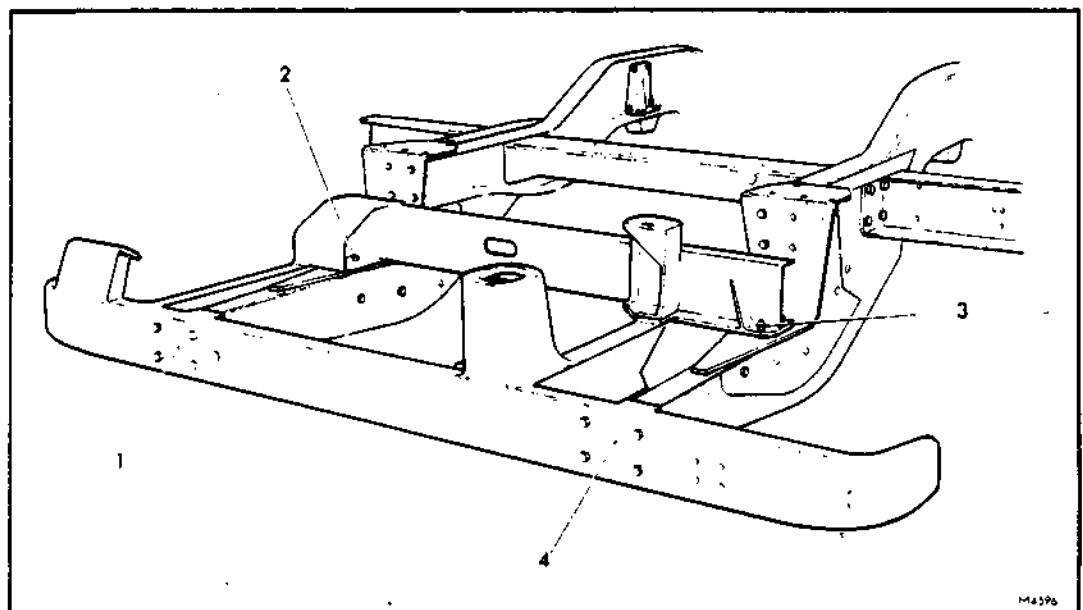


FIG. 1. POWER UNIT SUB-FRAME MOUNTING POINTS

1. Left-hand rear mounting (4 bolts)
2. Left-hand front mounting (3 bolts)

3. Right-hand front mounting (3 bolts)
4. Right-hand rear mounting (4 bolts)



## SECTION 2

## Maintenance and Lubrication

**AIR FILTERS (Fig. 1)**

A definite period cannot be set for element servicing or replacement due to variations in operating conditions, therefore, frequency of servicing should be governed by the conditions under which the vehicle operates, excessive smoke or loss of power being good indications that the element should be serviced or renewed.

**Element Cleaning**

The air filters are fitted with 'treated' elements. These considerably extend service life where atmospheric pollution by exhaust carbon prevails, however, unlike 'untreated' elements used for off highway applications, the 'treated' element should not be washed, since this will remove the treatment and the second and subsequent element life will be greatly reduced.

In an emergency, a 'treated' element could either be washed and thoroughly dried or serviced by reverse blowing with compressed air of 7.03 kg/cm<sup>2</sup> (100 lbf/in<sup>2</sup>) maximum pressure, i.e. nozzle held inside the element and directed towards the clean side, moving the nozzle up and down whilst rotating the element. This second method is suitable only when the element is holding dry dust, and with either method the subsequent life is considerably reduced.

The element can be inspected for damage by placing a bright light inside. Thin spots, pin holes or the slightest rupture will render the element unfit for further use.

**To Service Air Filter**

1. Unscrew dust cap clamping band bolt and remove the dust cap.
2. Remove the baffle from the dust cap and clean both items.
3. Remove any foreign material which may have collected around the element, and, if necessary, tighten the wing bolt. If element replacement is necessary remove wing bolt and element. Areas of concentrated dust on the clean side of the element indicates a damaged element which should be replaced.  
**Important:** Pre-cleaning fins are not removable from filter body.
4. Reassembly of the filter is a reversal of the dismantling procedure, noting the following points. Ideally use a new element and ensure that all seals are in good condition. Ensure that the arrows on the dust cap point vertically upwards. Inspect, and if necessary, tighten all air filter and induction system connections.

**CAUTION:** Do not use oil in the dust cap.

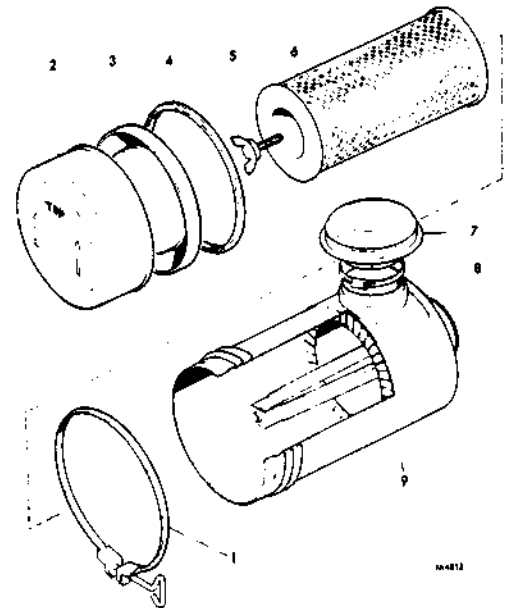


FIG. 1. EXPLODED VIEW OF AIR FILTER—CYCLOPAC TYPE

- |                  |              |                      |
|------------------|--------------|----------------------|
| 1. Clamping band | 4. Seal      | 7. Stack cap         |
| 2. Dust cap      | 5. Wing bolt | 8. Body              |
| 3. Baffle        | 6. Element   | 9. Pre-cleaning fins |

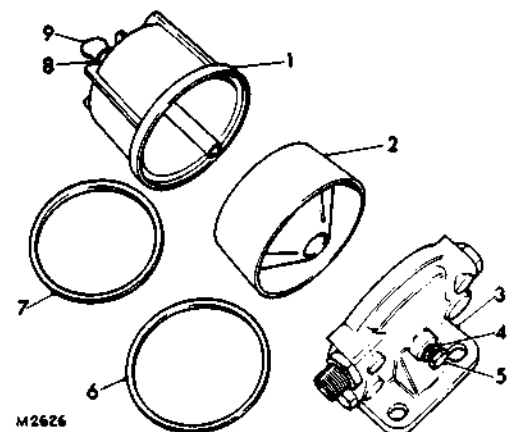


FIG. 2. EXPLODED VIEW OF THE SEDIMENTER

- |                       |                 |
|-----------------------|-----------------|
| 1. Bowl               | 6. Sealing ring |
| 2. Sedimenter element | 7. Sealing ring |
| 3. Filter head        | 8. Washer       |
| 4. Washer             | 9. Drain plug   |
| 5. Retaining bolt     |                 |

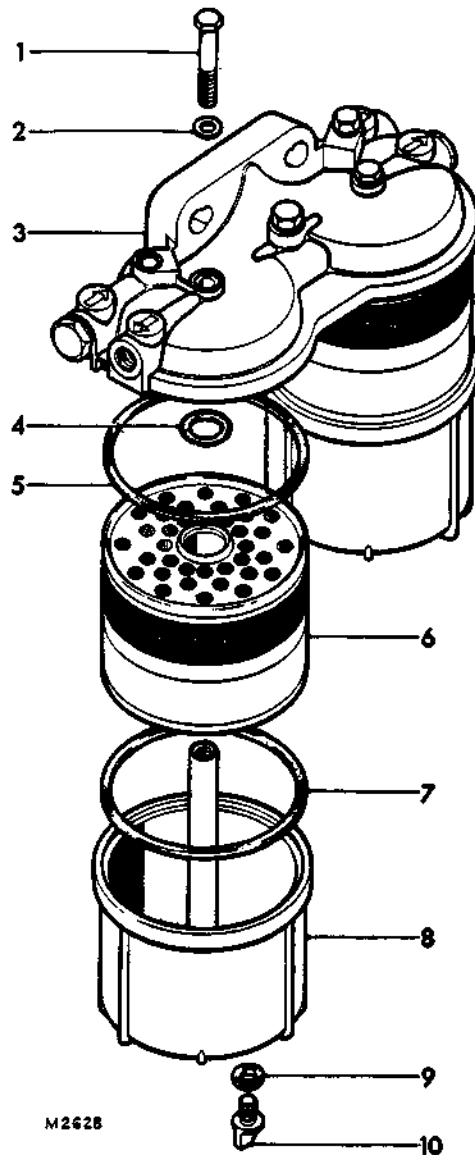


FIG. 3. EXPLODED VIEW OF C.A.V. FILTER

- |                 |                 |
|-----------------|-----------------|
| 1. Centre bolt  | 6. Element      |
| 2. Washer       | 7. Sealing ring |
| 3. Filter head  | 8. Bowl         |
| 4. O-ring seal  | 9. Washer       |
| 5. Sealing ring | 10. Drain screw |

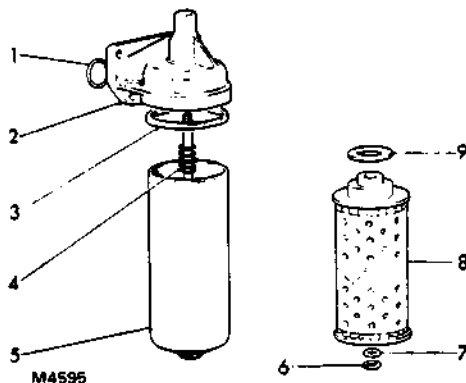


FIG. 4. EXPLODED VIEW OF OIL FILTER

- |                |                   |                   |
|----------------|-------------------|-------------------|
| 1. O-ring      | 4. Element spring | 7. Plain washer   |
| 2. Filter head | 5. Bowl           | 8. Element        |
| 3. Seal        | 6. Felt washer    | 9. Sealing washer |

**FUEL SEDIMENTER (Fig. 2)**

**Draining Procedure**

1. Slacken or remove the drain plug in the base of the unit and allow the accumulated water and solid matter to drain. Replace and tighten the plug.
2. Prime the sedimenter by operating the priming lever on the lift pump. Displaced air will pass to the twin element fuel filter and then return to the fuel tank via the permanent air-bleed.

**To Dismantle and Re-assemble**

1. Remove retaining bolt located in centre of filter head.
2. During re-assembly ensure that the sealing rings are in good condition and seated correctly.
3. Prime the sedimenter by operating the priming lever on the lift pump. In view of the larger volume of air involved in this instance, it will assist the priming procedure if the vent plug on the twin element fuel filter head is slackened.

**FUEL FILTER (Fig. 3)**

**To renew Filter Element**

1. Clean off external dirt from unit and remove drain screws to allow filters to drain.
2. Unscrew centre bolts (1) from filter head (3) and at same time hold elements (6) and bowls (8) if they have a tendency to rotate.
3. Detach elements and bowls from filter head and discard elements along with rubber sealing rings (5 and 7) and small O-ring (4).
4. Thoroughly clean filter head and bowls and replace drain screws in bowls.
5. Place new elements, new sealing and O-rings, supplied with each element, in position and in same order as shown in Fig. 3.
6. Secure elements and bowls to filter head with centre bolts and tighten to a torque of 0.6/0.9 kgf m (5/8 lbf ft).

**Note:** Do not overtighten in an attempt to cure a subsequent leak at the sealing faces, but rectify by removing the element and examining the rings and sealing faces to determine the cause of the leak.

7. Prime system through to the injection pump as described in Section 10 of this Group.

**OIL FILTER (Fig. 4)**

It is important that only filter elements approved by British Leyland Truck and Bus Division, obtained through service outlets, should be used.

**To renew Filter Element**

1. Unscrew tie bolt and release the bowl.
2. Lift out element and discard. Examine the lower felt sealing ring and renew if it has deteriorated.



3. Insert new element into the bowl and fit the sealing ring into the groove in the filter head. (A new sealing ring is supplied with each element.)
4. Fit the bowl to the filter head and replace tie bolt. Do not overtighten as this may damage the sealing ring.

#### To Remove and Refit Filter

1. Remove four nuts and washers from studs securing filter to crankcase and remove filter.
2. Correctly position new rubber joint rings before fitting filter to crankcase.
3. Check engine sump oil level after engine has had a short run.

### ADJUSTMENT OF DRIVING BELTS

#### Fan Driving Belts (Fig. 5)

To adjust the tension of the fan belts proceed as follows:

1. Slacken bolts (1) and (3) securing pulley and bearing assembly.
2. Using a bar in cored boss at top of bearing housing (2) pivot assembly away from engine to tighten belts or towards engine to slacken.
3. Tighten bolts (1) and (3) when tension is correct.

**Note:** The tension is correct when the belts can be depressed midway between the pulleys by approximately 20 mm (0.75 in).

#### Water Pump and Alternator Driving Belts (Fig. 6)

To adjust the tension of the water pump and alternator driving belts proceed as follows:

1. Slacken nut of pivot bolt (5) and adjustment clamping bolt (2).
2. Pivot alternator cradle (6) away from engine to tighten and towards engine to slacken driving belts (4).
3. Ensure that clamp plate (1) is seated in serrations of mounting bracket quadrant (3) and tighten nut of pivot bolt (5) and clamping bolt (2).

**Note:** The tension is correct when the belts can be depressed midway between the alternator and the water pump by approximately 6 mm (0.25 in).

### LUBRICATION SYSTEM

When topping-up or changing oil, reference should be made to Group 1 for the correct grade and quantity of oil to be used.

Never add lubricant to the engine unless it is the same type and grade as that already in use. If the same lubricant is not available, drain, flush and refill with the appropriate quantity of approved oil.

An oil gauge connection point with tap is provided in the oil line from the crankcase pressure oil gallery to the oil pressure switch.

#### Topping Up

If the oil level is below the full mark on the dipstick add lubricant to the engine through the oil filler until the oil level registers with the full mark.

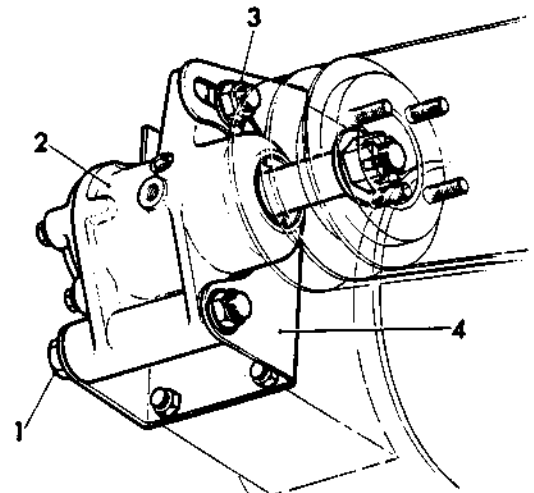


FIG. 5. FAN DRIVE BELT ADJUSTMENT

- |                    |                            |
|--------------------|----------------------------|
| 1. Pivot bolt      | 3. Clamping bolt           |
| 2. Bearing housing | 4. Bearing housing bracket |

#### Oil Changing

Oil changing is best carried out following a run when the oil will be warm and flow more freely.

1. With vehicle standing on level ground, remove sump drain plug. Sufficient time should be allowed to ensure complete drainage.
2. When drainage is complete replace sump drain plug checking that sealing washer is in good condition.
3. Replenish engine with correct quantity of specified lubricant, see Group 1.

Change the oil filter element at every engine oil change.

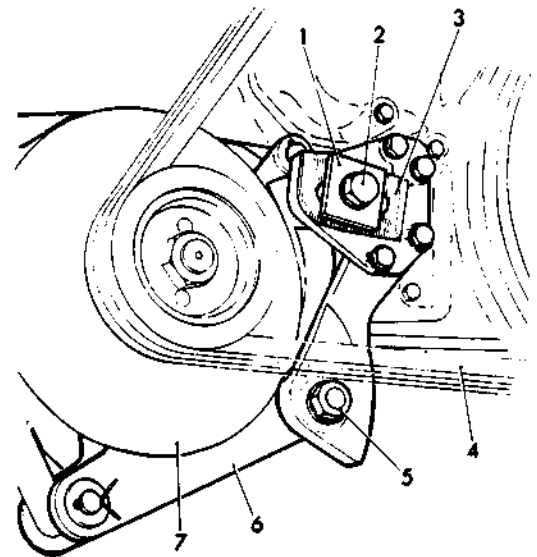


FIG. 6. WATER PUMP AND ALTERNATOR DRIVE BELT ADJUSTMENT

- |                     |                      |
|---------------------|----------------------|
| 1. Clamp plate      | 4. Driving belts     |
| 2. Clamp bolt       | 5. Pivot bolt        |
| 3. Bracket quadrant | 6. Alternator cradle |
|                     | 7. Alternator        |



SECTION 3

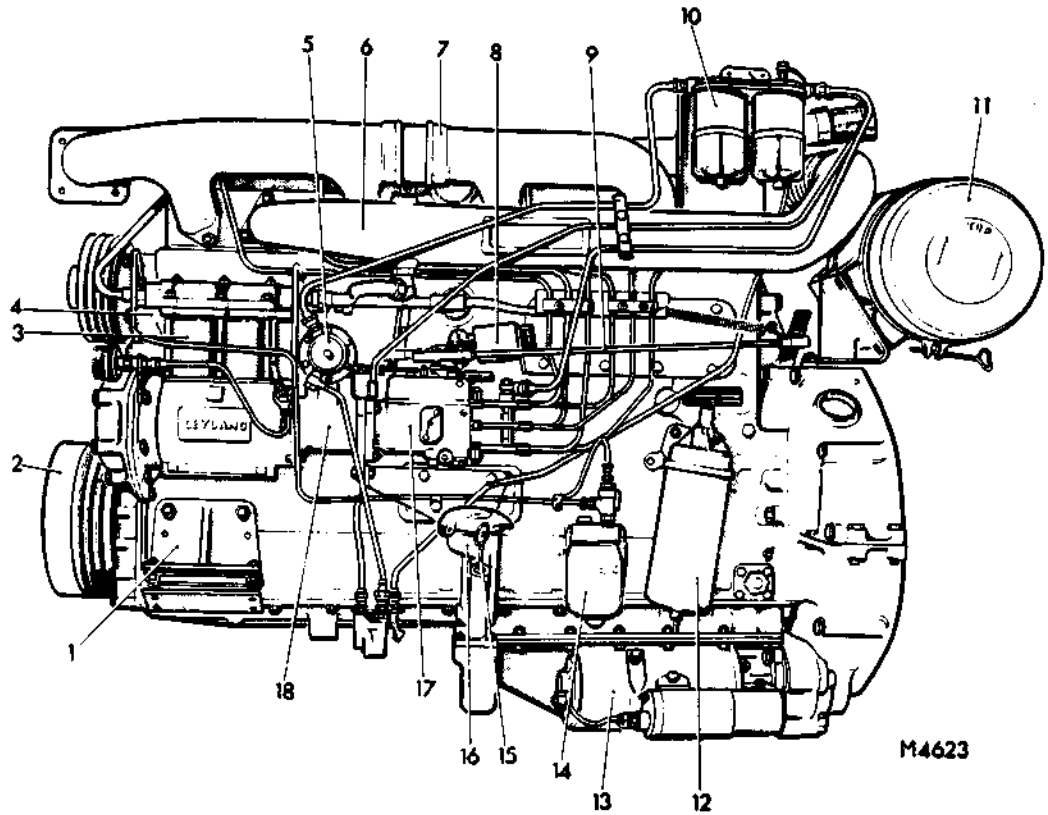
General Data

DATA

Type . . . . .	Leyland 680 Vertical Diesel engine (11.1 litres)
Bore . . . . .	127 mm (5.00 in)
Stroke . . . . .	146.05 mm (5.75 in)
Cubic capacity . . . . .	11093 cc (677 in <sup>3</sup> )
Net installed bhp . . . . .	Approx. 114 kw (153 bhp) at 1,750 rev/min
Maximum torque . . . . .	Approx. 640 Nm (475 lbf ft) at 1,200 rev/min
Compression ratio . . . . .	15.75 to 1
Firing order . . . . .	1, 5, 3, 6, 2, 4
Rotation . . . . .	Clockwise when viewed from the timing-case end

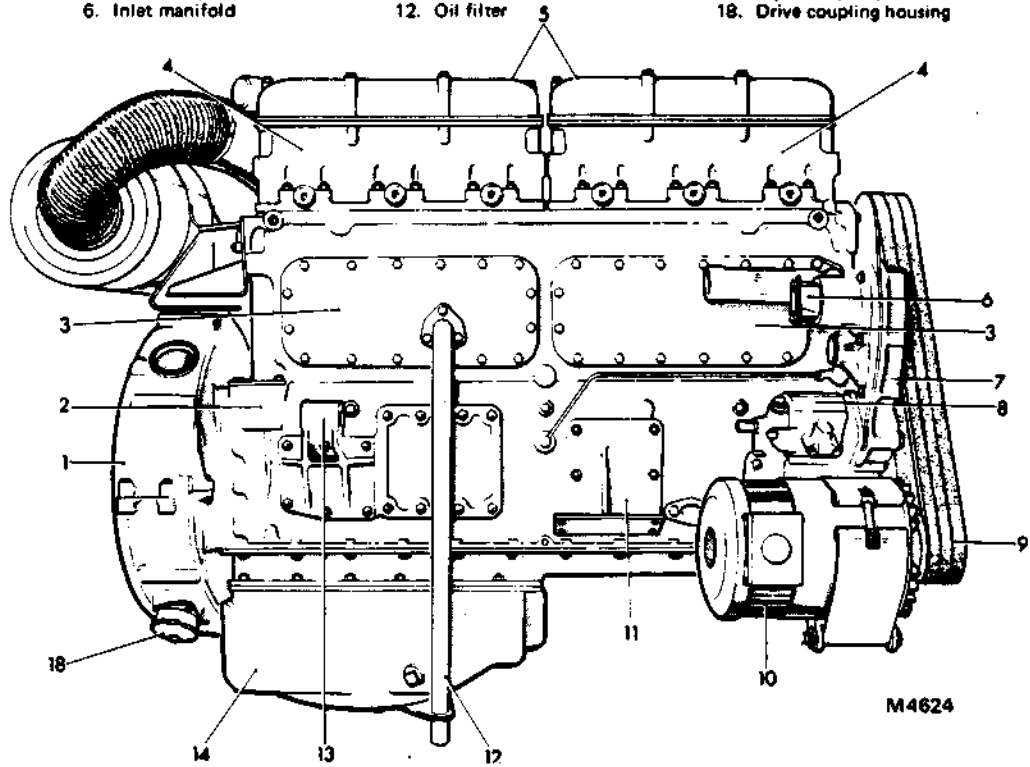


**ENGINE**



**FIG. 1. LEFT HAND SIDE OF ENGINE**

- |                      |                     |                            |
|----------------------|---------------------|----------------------------|
| 1. Mounting bracket  | 7. Exhaust manifold | 13. Starter motor          |
| 2. Crankshaft damper | 8. Stop solenoid    | 14. Alcohol evaporator     |
| 3. Air compressor    | 9. Throttle linkage | 15. Oil dipstick           |
| 4. Water pump        | 10. Fuel filters    | 16. Oil filler neck        |
| 5. Fuel feed pump    | 11. Air filter      | 17. Injection pump         |
| 6. Inlet manifold    | 12. Oil filter      | 18. Drive coupling housing |



**FIG. 2. RIGHT HAND SIDE OF ENGINE**

- |                           |                       |                    |
|---------------------------|-----------------------|--------------------|
| 1. Flywheel housing       | 6. Fan drive coupling | 11. Front mounting |
| 2. Oil pump drive housing | 7. Timing case        | 12. Breather pipe  |
| 3. Valve chest cover      | 8. Hydraulic pump     | 13. Rear mounting  |
| 4. Cylinder head          | 9. Drive belts        | 14. Sump           |
| 5. Cylinder head cover    | 10. Alternator        | 15. Timing plunger |



## SECTION 4

## Engine Lubricating System

## DATA

Type . . . . .	Wet sump, gear-type pump
Pump data . . . . .	Interference of pump gear on shaft, 0.007/0.033 mm (0.0003/0.0013 in)
	Initial diametrical clearance between idler-gear and spindle, 0.0305/0.0559 mm (0.0012/0.0022 in)
	Backlash between gears 0.5588/0.6604 mm (0.022/0.026 in)
Clearance between drive shaft and bush in engine block . . . . .	0.056/0.088 mm (0.00220/0.00345 in)
Oil pressure . . . . .	3.8/4.5 kgf/cm <sup>2</sup> (55/60 lbf/in <sup>2</sup> ) at 1,600 rev/min or higher speeds with warm engine. Not below 1.05 kgf/cm <sup>2</sup> (15 lbf/in <sup>2</sup> ) with engine idling
Oil pressure relief valve setting . . . . .	4.2 kgf/cm <sup>2</sup> (60 lbf/in <sup>2</sup> )
Pump delivery . . . . .	22.7 litres (40 pints) approx. per min at 1,000 rev/min crankshaft speed
Filter . . . . .	Leyland full flow

## REMOVAL AND REFITMENT

## Oil Pump

## To Remove

1. Drain and remove sump.
2. Remove suction filter and suction pipe from pump.
3. Disconnect oil feed pipe from crankcase bottom face.
4. Break locking wire and remove nuts securing the pump body to crankcase and withdraw oil pump.

## To Refit

Refitment is a reversal of removal procedure. Refill system with recommended lubricant. Check performance of oil pump, see Data.

## Driving Gear

To inspect the oil pump driving gear remove the thrust housing on the rear right-hand side of the engine block and withdraw the gear by screwing a  $\frac{1}{8}$  in B.S.F. bolt of suitable length into the gear.

If it is found necessary to renew the driving gear bush in the engine block ensure that the oil hole in the bush flange is directed towards the gear on the camshaft.

## RELIEF VALVE

## To Adjust the Relief Valve

The oil pressure relief valve, Fig. 3, mounted at the rear left-hand side of the engine block, consists simply of a spring-loaded valve, provided with an adjusting screw.

To adjust the relief valve, remove the cover, slacken the locknut and turn the adjusting screw. Screw in to increase and out to decrease the pressure. Lock the screw and replace the cover after adjustment.

The valve should be adjusted to give a maximum pressure of 4.2 kgf/cm<sup>2</sup> (60 lbf/in<sup>2</sup>) with a warm engine running at 1,000 rev/min.

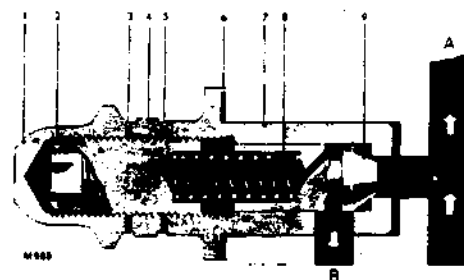


FIG. 3. SECTIONED VIEW OF OIL PRESSURE RELIEF VALVE

- |                           |                      |
|---------------------------|----------------------|
| A. Main oil pressure feed | B. Return to sump    |
| 1. Domed nut              | 6. Joint             |
| 2. Adjusting screw        | 7. Relief valve body |
| 3. Copper washer          | 8. Spring            |
| 4. Locknut                | 9. Oil relief valve  |
| 5. Copper washer          |                      |

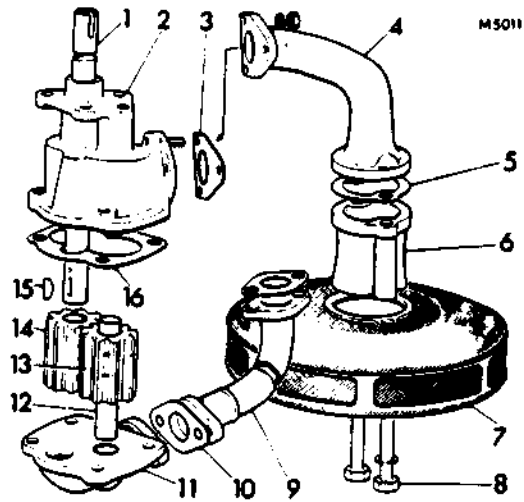


FIG. 4. TYPICAL OIL PUMP

- |                   |                      |
|-------------------|----------------------|
| 1. Drive shaft    | 9. Delivery pipe     |
| 2. Pump body      | 10. Joint            |
| 3. Joint          | 11. Bottom cover     |
| 4. Suction pipe   | 12. Idler gear shaft |
| 5. Joint          | 13. Idler gear       |
| 6. Extension pipe | 14. Drive gear       |
| 7. Suction filter | 15. Key              |
| 8. Set bolt       | 16. Joint            |

OVERHAUL

Oil Pump

To Dismantle

1. Remove the oil pump end cover and withdraw the gear and spindle.
2. All parts should be examined for wear and checked against the limits as laid down in Data.

To Reassemble

Reassembly is a reversal of dismantling procedure with the following points to note.

Ensure that an oil-tight joint is made between the pump end cover and casing, also between the oil pump driving gear thrust housing and crankcase.

## SECTION 5

## Cooling System

## MAINTENANCE

## To Drain System

To drain the cooling system two plugs have to be removed. One plug is situated at the rear left-hand side of the cylinder block and the other beneath the radiator bottom tank at the same side of the engine.

## To Remove Radiator

1. Drain cooling system.
2. Disconnect top and bottom water hose connections at the flanged joints on the radiator.
3. Disconnect drive shaft from fan drive pulley and support shaft in some convenient position.
4. Disconnect support stay from the radiator top tank.
- \*\* 5. Disconnect stay bar at fan cowl and engine block bracket.
6. Remove bolts securing radiator and fan assembly to bracket on top of gearbox.
7. Lift radiator and fan assembly from vehicle.\*\*

## To Remove Water Pump

1. Drain cooling system.
2. Slacken belt tensioner on alternator cradle, as described under Adjustment of Driving Belts, Reference 2-2-3, and remove driving belts from water pump pulley.
3. Remove bolts securing pump to crankcase and withdraw pump.

## To Remove and Refit Thermostat

1. Drain cooling system.
2. Disconnect hose from coolant manifold outlet pipe.
3. Disconnect outlet pipe from manifold to expose thermostat.
4. Remove thermostat by using the two tapped holes (size No. 10-32 UNF) in the valve seat flange to withdraw the thermostat from its location in manifold.
5. When refitting, ensure that location slot on thermostat locates on locating screw in thermostat housing, and that new joints are fitted.

## To Test Thermostat Operation

1. Suspend thermostat in a pan of water in which a thermometer is immersed.
2. Heat water gradually, stirring continuously to ensure uniformity of temperature.
- \*\* 3. Check that valve starts to lift off its seat at 74°–76.7°C (165°–170°F).
4. Continue heating to 87.8°C (190°F) when valve should be fully open, the total valve lift being 9.5 mm (0.375 in).\*\*

If the thermostat does not operate as described above it should be renewed as it is not adjustable or repairable.

## OVERHAUL

## Overhaul of the Radiator

During annual overhaul the radiator should be thoroughly cleaned internally. If hard water has been used, the top and bottom tanks should be removed and any deposit in the tubes loosened by passing a rod down each tube.

When refitting the tanks, use new joints and paint with red lead before fitting.

## To Remove and Refit the Radiator Tubes

1. Insert a lever under the locating washer of each tube and exert pressure to push the tube into the top tank of the radiator until the lower end of the tube is clear of the rubber ferrule in the bottom tank. The tubes can then be withdrawn from top ferrules.
2. Before refitting, lightly coat the bores of the rubber ferrules and the outer surfaces at the end of each tube with petroleum jelly.
3. To refit the tubes, enter the longer end of each tube into the rubber ferrule of the top tank and press upwards until the short end of the tube is clear of the ferrule in the bottom tank. Carefully enter the bottom of the tube into the rubber ferrule and press down firmly until the locating washer rests on the flange of the rubber ferrule.





**To Remove and Replace Radiator Rubber Ferrules**

1. Remove radiator tubes as described above.
2. Lever out worn ferrules.
3. Smear tube holes in top and bottom tanks lightly with petroleum jelly.
4. Coat rubber ferrules with petroleum jelly, then press ferrules into tube holes in tanks.

**Note:** Ensure that the ferrule flanges fit flush on the tube plate face. This is accomplished by lightly striking the top of each ferrule with a hammer.

**To Dismantle Water Pump**

1. Remove back plate.
2. Using two  $\frac{1}{8}$  in B.S.F. holes drilled in end face of impeller for withdrawal tool, withdraw impeller from driving shaft.
3. Withdraw water pump seal.
4. Remove pulley.
5. Remove setscrews securing bearing cover to bearing housing and withdraw driving shaft.
6. Dismantle driving shaft by pressing shaft through bearings and distance pieces.

**To Reassemble Water Pump**

To reassemble the water pump, reverse the procedure for dismantling.

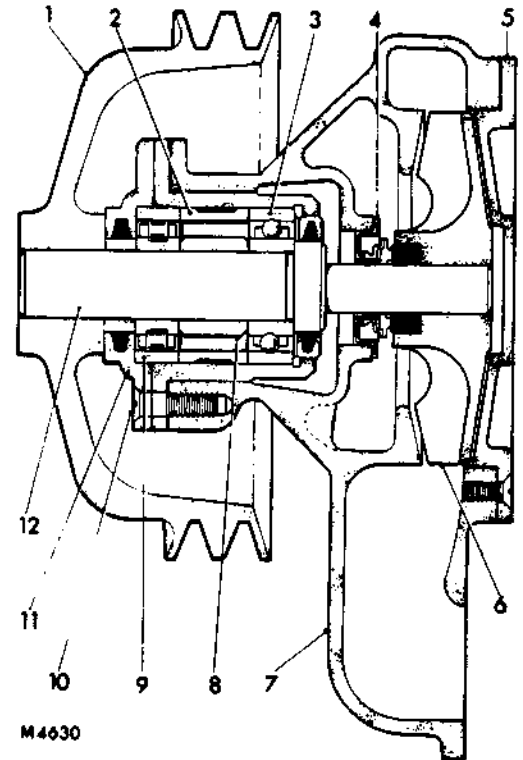


FIG. 2. SECTIONAL VIEW OF WATER PUMP

- |                           |                           |
|---------------------------|---------------------------|
| 1. Pulley                 | 7. Body                   |
| 2. Distance piece (outer) | 8. Distance piece (inner) |
| 3. Ball bearing           | 9. Roller bearing         |
| 4. Seal                   | 10. Screw                 |
| 5. Back plate             | 11. Bearing cover         |
| 6. Impeller               | 12. Driving shaft         |

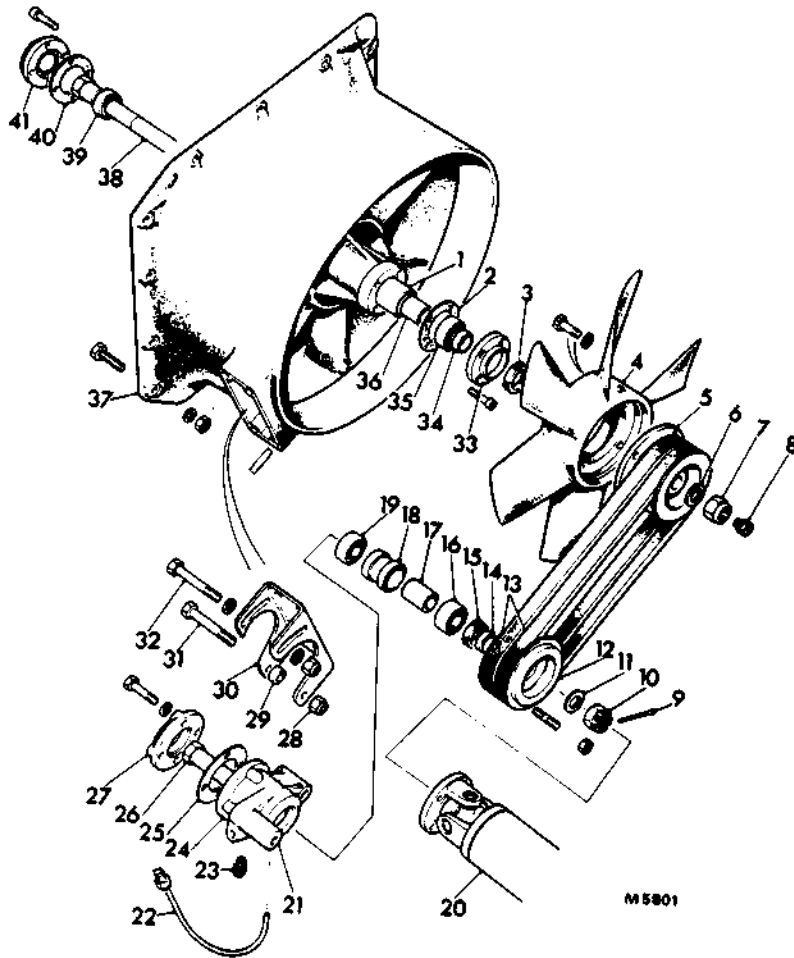


FIG. 1. EXPLODED VIEW OF FAN DRIVE AND COWL

- |                          |                           |                      |                           |
|--------------------------|---------------------------|----------------------|---------------------------|
| 1. Distance piece, outer | 12. Pulley                | 22. Pipe, grease     | 32. Bolt                  |
| 2. Joint                 | 13. Drive belts           | 23. Adaptor          | 33. Bearing cover         |
| 3. Oil seal              | 14. Distance piece        | 24. Bearing housing  | 34. Distance piece        |
| 4. Fan                   | 15. Oil seal              | 25. Joint            | 35. Bearing, roller       |
| 5. Pulley                | 16. Bearing, roller       | 26. Shaft            | 36. Distance piece, inner |
| 6. Washer                | 17. Distance piece, inner | 27. Cover            | 37. Fan cowl              |
| 7. Nut                   | 18. Distance piece, outer | 28. Nut              | 38. Shaft                 |
| 8. Greaser               | 19. Bearing, ball         | 29. Distance piece   | 39. Bearing, ball         |
| 9. Split pin             | 20. Drive shaft           | 30. Mounting bracket | 40. Joint                 |
| 10. Nut                  | 21. Distance piece        | 31. Bolt             | 41. Cover                 |
| 11. Washer               |                           |                      |                           |



## SECTION 6

### Cylinder Heads

**DATA****Cylinder Head**

Crack detention test pressure . . . . .	1.8/2.1 kgf/cm <sup>2</sup> (25/30 lbf/in <sup>2</sup> )
Depth of cylinder head . . . . .	141.96/142.29 mm (5.598/5.602 in)
Minimum depth of cylinder head after refacing . . . . .	141.68 mm (5.578 in)
Maximum permissible distortion . . . . .	0.02 mm per 250 mm (0.001 in per foot)
Diameter of valve seat recess	{ Inlet . . . . . 59.164/59.182 mm (2.3293/2.3300 in) Exhaust . . . . . 55.862/55.880 mm (2.1993/2.2000 in)
Torque cylinder head nuts to	{ $\frac{7}{16}$ in . . . . . 9.0/9.7 kgf/m (65/70 lbf ft) $\frac{9}{16}$ in . . . . . 18.7/19.4 kgf m (135/140 lbf ft)
Torque exhaust manifold nuts . . . . .	3.45 kgf m (25 lbf ft)

**Valve Seats**

Seat angle (Inlet and Exhaust) . . . . .	30°
Desirable width (measured along sloping face) . . . . .	3.6 mm (0.142 in) Inlet and Exhaust
Outside diameter of service Valve insert (press fit)	{ Inlet . . . . . 59.309/59.317 mm (2.3349/2.3354 in) Exhaust . . . . . 55.996/56.004 mm (2.2044/2.2049 in)
Maximum permissible eccentricity between valve seat and valve guide bore . . . . .	0.025 mm (0.001 in) total clock reading
Maximum permissible eccentricity between valve seat and valve stem . . . . .	0.051 mm (0.002 in) total clock reading

**Valve Guides**

Inside diameter . . . . .	11.106/11.125 mm (0.43725/0.4380 in)
Interference fit of guide in cylinder head . . . . .	0.025/0.051 mm (0.001/0.002 in)
Guide protrusion above Spring Seat . . . . .	13.208 mm (0.520 in)

**Valves**

Valve stem diameter	{ Inlet . . . . . 11.030/11.043 mm (0.43425/0.43475 in) Exhaust . . . . . 10.992/11.004 mm (0.43275/0.43325 in)
Clearance fit of Valve stem in guide	{ Inlet . . . . . 0.063/0.095 mm (0.0025/0.00375 in) Exhaust . . . . . 0.102/0.133 mm (0.004/0.00525 in)
Valve head diameter	{ Inlet . . . . . 55.88 mm (2.20 in) Exhaust . . . . . 48.26 mm (1.90 in)



**MAINTENANCE****To Adjust the Tappets**

1. Remove cylinder head covers.
2. Lift and turn timing plunger to T.D.C. position and turn engine until plunger engages in flywheel and No. 1 piston is on compression stroke.
3. Adjust inlet and exhaust tappets for No. 1 cylinder by releasing locknut on tappet adjusting screw and adjust screw until correct clearance is obtained (Refer to Data).
4. Tighten locknut when clearance has been set and recheck clearance.
5. Disengage timing plunger, and give engine one-third of a turn to bring No. 5 piston on compression stroke and set the tappets. Repeat procedure on No. 3, 6, 2 and 4 cylinders in succession.

**OVERHAUL**

The mileage covered or number of hours an engine has run should not alone determine when removal of the cylinder heads become necessary. The principal factors to take into account should be ease of starting and overall engine performance.

**To Remove the Cylinder Head**

1. Drain cooling system by opening two drain plugs; one situated at the base of the radiator and the other situated adjacent to the engine oil filter.
2. Disconnect battery terminal to avoid possibility of a short circuit or accidental operation of starter motor.
3. Remove air cleaner.
4. Remove water hose between radiator and water manifold.

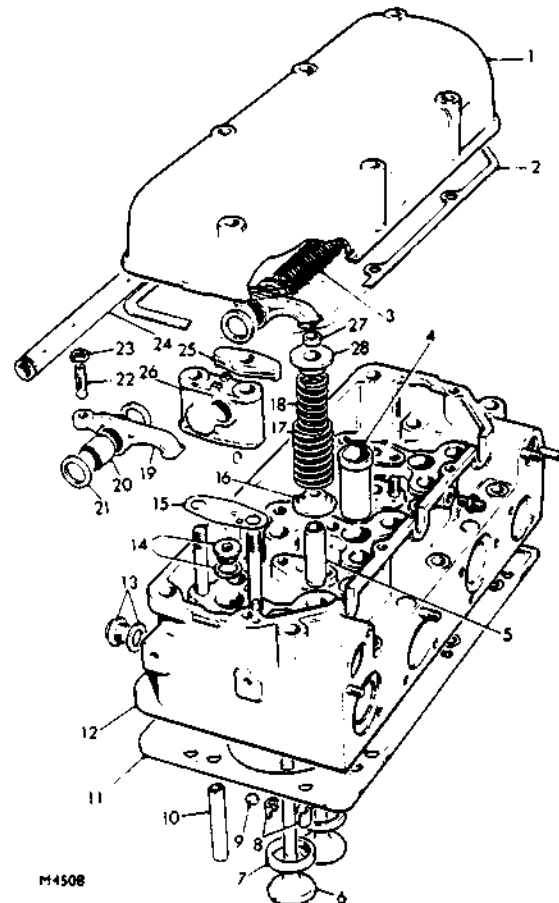


FIG. 1. EXPLODED VIEW OF CYLINDER HEAD

- |                      |                          |                          |                         |
|----------------------|--------------------------|--------------------------|-------------------------|
| 1. Rocker gear cover | 8. Valve split cone      | 15. Rocker bracket joint | 22. Adjusting screw     |
| 2. Cover gasket      | 9. Valve cap             | 16. Lower spring collar  | 23. Nut                 |
| 3. Rocker spring     | 10. Liner                | 17. Outer spring         | 24. Rocker shaft        |
| 4. Injector sleeve   | 11. Cylinder head gasket | 18. Inner spring         | 25. Injector clamp      |
| 5. Valve guide       | 12. Cylinder head        | 19. Rocker lever         | 26. Rocker bracket      |
| 6. Valve             | 13. Plug and washer      | 20. Rocker lever bush    | 27. Valve stem seal     |
| 7. Valve seat        | 14. Plug and washer      | 21. Thrust washer        | 28. Upper spring collar |



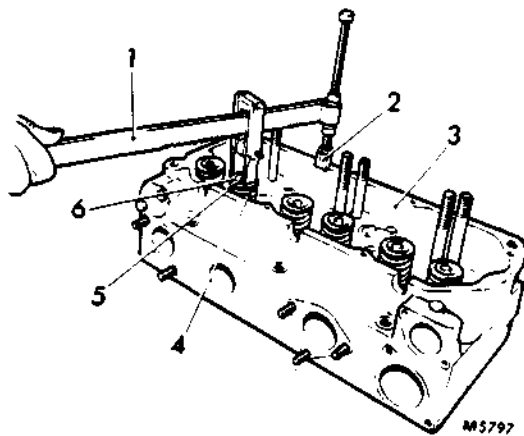


FIG. 2. VALVE SPRING COMPRESSOR

5. Remove high pressure fuel injection pipes complete with clamps. Blank off the injectors and injection pump.
6. Disconnect air and water pipes from air compressor.
7. Disconnect high temperature warning switch at water manifold
8. Disconnect exhaust pipe at manifold flange and remove exhaust, inlet and water manifolds from cylinder heads.
9. Remove cylinder head covers, leak-off pipe assemblies and injectors (Refer to Section 11).
10. Release evenly and remove nuts securing rocker shaft assemblies and lift assemblies clear of studs.

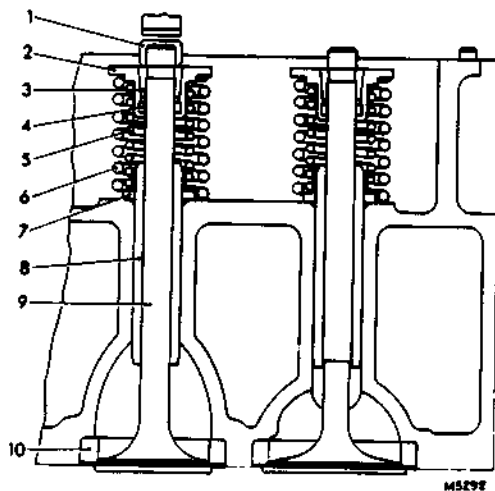


FIG. 3. VALVES AND SPRINGS IN POSITION

- |                         |                         |
|-------------------------|-------------------------|
| 1. Valve cap            | 6. Valve spring, outer  |
| 2. Spring collar, upper | 7. Spring collar, lower |
| 3. Valve split cone     | 8. Valve guide          |
| 4. Rubber seal          | 9. Exhaust valve        |
| 5. Valve spring, inner  | 10. Valve seat          |

11. Remove push rods.
12. Remove cylinder heads.

#### To Remove the Valves

The valves for each cylinder head are numbered 1-6 so that they can be fitted in their original locations. They must therefore be identified with the head from which they were removed.

1. Position cylinder head with pressure face downwards on a suitable surface.
2. Remove valve caps.
3. Using valve spring compressing tool LC 6118B, adaptor LC 6118B-3 and stirrup LC 6118B-6 remove split cones, spring collars, seals and springs from each valve.

#### To Dismantle the Rocker Shaft

Removal of the retaining circlips from each end of the rocker shaft will allow the washers, springs, rocker levers and brackets to be withdrawn from the shaft.

#### Cleaning

Before cleaning the cylinder head pressure face, blank off all ports and oilways.

Abrasives must not be used for cleaning carbon from the piston crowns, cylinder head and block faces. Carborundum paste for lapping the valves must be confined to the vicinity of the valves and seats and all traces removed before re-assembly.

Remove superficial carbon by carefully scraping it from the piston crown.

**Note:** A light ring of grease placed between the piston and the top of the cylinder bore will help to contain loose carbon particles.

Carbon should be removed from the cylinder head pressure face, ports and valve guides.

Any carbon deposit may be removed from the bottom of the injector sleeves with the aid of tool LC 110.

Excessive deposits caused by hard water within the cylinder head water jacket can be removed with the aid of a proprietary solution designed specifically for this purpose. Water test the cylinder head at the recommended pressure after such treatment.

Clean and examine all studs and nuts, renew any with damaged threads.



**Examination****Cylinder Head**

Check for distortion of the bottom face and for damage to the face. The head may be skimmed in stages down to the minimum thickness quoted in Data if the above are evident. The valve seats may require recutting to bring the valve head protrusion within the tolerance shown in Data.

**Valve Guide**

Check the valve guide stem clearance (Refer to Data). If this is excessive, renew the guide. If the stem is worn, renew the valve. Check the fit of a valve in the new guides. They must have the clearances quoted.

When renewing guides use tool Part 245259 which will give the correct guide protrusion above the valve spring seat. After fitting a new guide regrind the valve seat to ensure concentricity with the guide.

**Valve Spring**

Check that spring ends are square to the axis and that the pressure required to compress the spring to the specified length quoted in Data can be obtained. Renew weak springs as necessary.

**Valve and Valve Seat**

Check the valves dimensionally. Check the valves and valve seat faces for burning, pitting and cracks. Recondition the valves and seats to full gas tightness consistent with minimum permissible valve head thickness, desirable seat width and valve head protrusion from the cylinder head pressure face. Refer to Data.

**Valve Seat Insert**

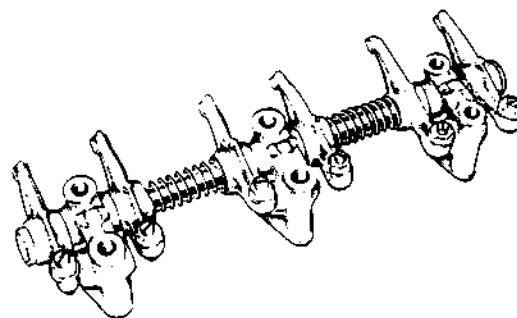
Inlet and exhaust valve seat inserts are renewable. Ensure that the valve seat bore is perfectly clean before fitting the new seat. Lightly lap the valves to the new seats if the seating face is not concentric within the limit quoted in Data. Check the valve guide for wear and renew if necessary.

**Rocker Shaft**

The shaft should be examined for wear at the rocker arm positions and the rocker arm for excessive wear in the bushes. Either or both should be renewed if worn excessively (Refer to Data).

**Push Rod**

Check the push rods for straightness. Any rod outside the limits quoted in Data should be renewed.



M450a

FIG. 4. ROCKER SHAFT ASSEMBLY

**To Re-assemble the Rocker Shaft**

Re-assembly is a reversal of the dismantling procedure and should be carried out with all components lightly oiled. When assembled the rockers should be checked for freedom of movement.

**To Refit the Valve Assemblies**

Ensure that the cylinder heads and all component parts are clean. New valve seals should be fitted.

1. Lightly lubricate each valve stem with engine oil and insert valves in correct guides.
2. Position cylinder head with pressure face downwards on a flat surface and fit spring collars, inner and outer springs and seals to each valve.
3. Compress valve spring assemblies with tool No. 6118B and adaptor LC 6118B - 3 then fit split cones.
4. Tap each valve stem lightly with a hide hammer to ensure correct location of split cones.
5. Fit valve caps to each valve stem.

**To Refit the Cylinder Head**

New cylinder head gaskets should be fitted and the cylinder head and block pressure faces must be clean.

1. Place each cylinder head gasket carefully in position.

**Note:** They are marked to ensure correct positioning and must be fitted DRY. Jointing compound must not be used.

2. Lower each head squarely over retaining studs and onto engine block.
3. Tighten cylinder head retaining nuts in sequence shown in Fig. 5 to the final torque figures given in Data.
4. Install push rods and refit the rocker shaft assemblies.
5. Set valve clearances to dimension shown in Data.



## SECTION 7

Engine Block, Liners,  
Camshaft and Timing Gears

## DATA

## Engine Block and Liners

## Pressure test:

Water passages . . . . .	1.76/2.1 kgf/cm <sup>2</sup> (25/30 lbf/in <sup>2</sup> )
Oilways . . . . .	5.6 kgf/cm <sup>2</sup> (80 lbf/in <sup>2</sup> )
Water manifold . . . . .	1 kgf/cm <sup>2</sup> (15 lbf/in <sup>2</sup> )

Cylinder barrel diameter . . . . . 133.0960/3.1163 mm (5.2400/5.2408 in)

Liners . . . . . Pre-finished, dry, press-fit, shoulder located

Materials . . . . . Cast iron, Chromium plated

Liner outside diameter . . . . . 133.1036/133.0439 mm (5.2403/5.2411 in)

Interference fit of liner in engine block . . . . . 0.0127/0.0279 mm (0.0005/0.0011 in)

Initial bore of liner before fitting to engine block . . . . . 127.043/127.0686 mm (5.0017/5.0027 in)

Projection of liner above top face of engine block . . . . . 0.0254/0.0762 mm (0.001/0.003 in)

Projection obtained by shims . . . . . 0.0508 mm (0.002 in) thick

Reline when wear of liner at top of bore exceeds . . . . . 127.000 + 0.508 mm (5.000 + 0.020 in)

Cylinder liner ovality (maximum) . . . . . 0.0381 mm (0.0015 in)

Oversize liners available for rebored engine blocks . . . . . 0.254 mm (0.010 in) oversize on outside diameter.  
Identified by 3.175 mm (0.125 in) wide groove around  
shoulder periphery  
0.508 mm (0.020 in) oversize on outside diameter.  
Identified by 0.794 mm (0.031 in) wide groove around  
shoulder periphery

## Tappets

Overall length . . . . . 66.04 mm (2.600 in)

Minimum permissible overall length . . . . . 65.66 mm (2.585 in)

Outside diameter . . . . . 40.564/40.589 mm (1.597/1.598 in)

Tappet bore diameter in engine block . . . . . 40.634/40.646 mm (1.59975/1.60075 in)

Tappet running clearance in engine block . . . . . 0.044/0.082 mm (0.002/0.003 in)

Maximum permissible running clearance . . . . . 0.127 mm (0.005 in)



**Camshaft**

Drive . . . . .	Single helical gear
Number of bearings . . . . .	Seven
Interference fit of all bearings in engine block . . . . .	0.0127/0.0381 mm (0.0005/0.0015 in)
Journal diameters —	
front and intermediate . . . . .	60.858/60.883 mm (2.396/2.397 in)
rear . . . . .	46.888/46.914 mm (1.846/1.847 in)
Initial diametral clearance in front and intermediate bearings . . . . .	0.1016 mm (0.004 in) average
Initial diametral clearance in rear bearing . . . . .	0.140 mm (0.005 in) average
End float . . . . .	0.051/0.203 mm (0.002/0.008 in)
End float obtained by shims . . . . .	0.0762 mm (0.003 in) thick
Renew bearings when clearance exceeds . . . . .	0.254 mm (0.010 in)
Camshaft renewal . . . . .	See Fig. 7

**Timing Gears**

Type . . . . .	Single-helical gears
Permissible backlash between each pair of gears . . . . .	0.025/0.102 mm (0.001/0.004 in)
Idler gears, initial diametral clearance between bush and gear . . . . .	0.025/0.083 mm (0.001/0.003 in)
Diametral clearance between bush and idler spindle . . . . .	0.025/0.083 mm (0.001/0.003 in)
End float between thrust washers and idler gear . . . . .	0.0635/0.2413 mm (0.0025/0.0095 in)
Renew thrust washers when end clearance exceeds . . . . .	0.305 mm (0.012 in)
Interference fit of timing gear on crankshaft . . . . .	0.019/0.057 mm (0.00075/0.00225 in)





## OVERHAUL

## Cylinder Liner

The cylinder liners should be checked for wear with a cylinder gauge, checking in particular the area just below the highest point of ring travel where maximum wear occurs. If wear exceeds the limits quoted in Data or the bores are badly scored then the liners and pistons should be renewed.

## To Remove Cylinder Liners

1. Drain the cooling system.
2. Drain and remove the sump.
3. Remove the cylinder heads, see Section 5.
4. Remove the pistons and connecting rods, see Section 8.
5. Commencing at No. 1 cylinder turn the crankshaft until the crank throw is at right angles to the cylinder.
6. Place the protecting ring over the cylinder head studs surrounding the cylinder.
7. Screw the three long pillars into the ram support plate. Position the pillars and plate on top of the protection ring and place the hydraulic ram and thrust race on top of the support plate, as shown in Fig. 1.
8. Pass the lead-screw through the ram and cylinder and adjust the hexagon nut so that sufficient length protrudes at the bottom to allow the appropriate liner extractor and inserter plate to be located in the bottom of the liner by the knurled nut as shown in Fig. 2.
9. When the tool is assembled connect the hose of the hydraulic pump to the ram. Ensure that the pump release valve is closed and check that the pillars have not sprung inwards to impede the passage of the liners.
10. Commence operating the pump handle until the ram protrudes approximately 63.5 mm (2.5 in) and resistance is felt at the pump.
11. Open the release valve on the pump and as the ram retracts screw down the hexagon nut on the lead screw to compensate for the initial travel of the ram.
12. Close the release valve and carry out operations 10 and 11 until the liner is fully withdrawn.

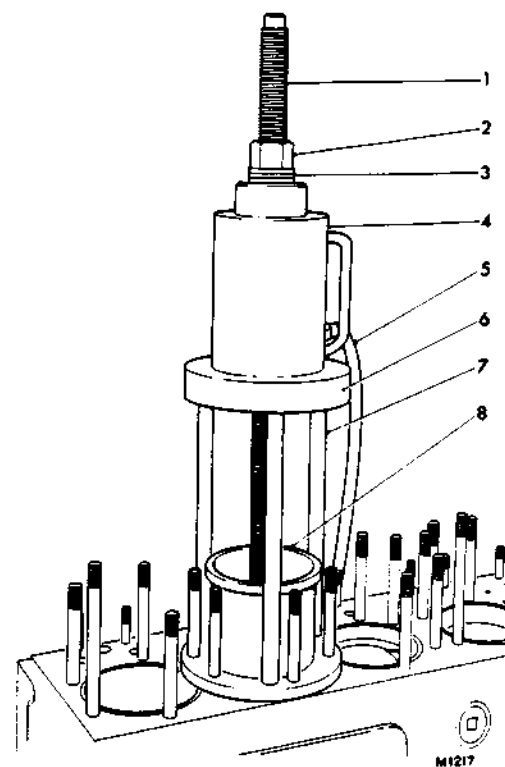


FIG. 1. TYPICAL ARRANGEMENT FOR EXTRACTING CYLINDER LINER

- |                  |                      |
|------------------|----------------------|
| 1. Lead-screw    | 5. Pump hose         |
| 2. Hexagon nut   | 6. Ram support plate |
| 3. Thrust race   | 7. Support pillars   |
| 4. Hydraulic ram | 8. Cylinder liner    |

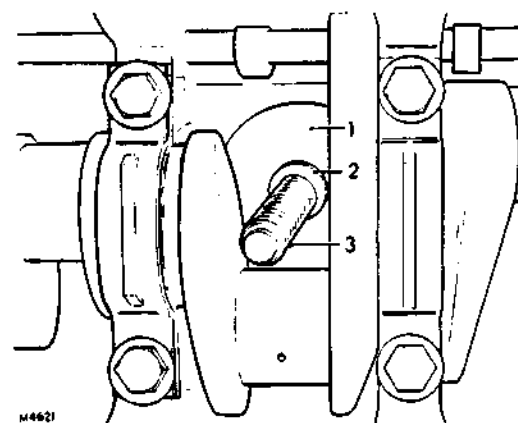
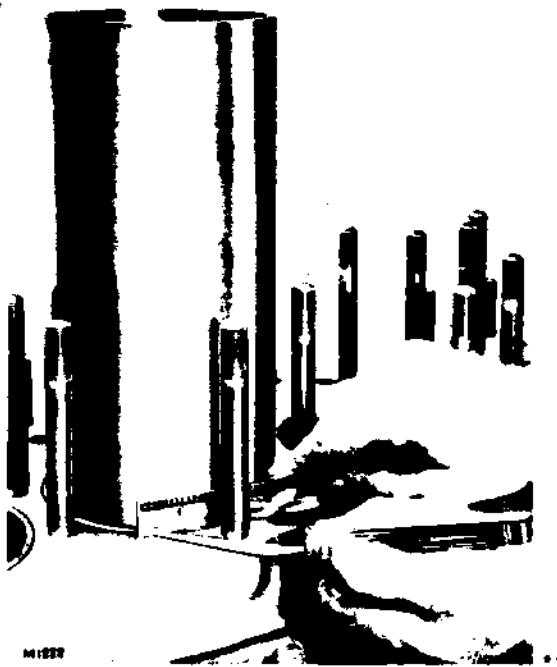


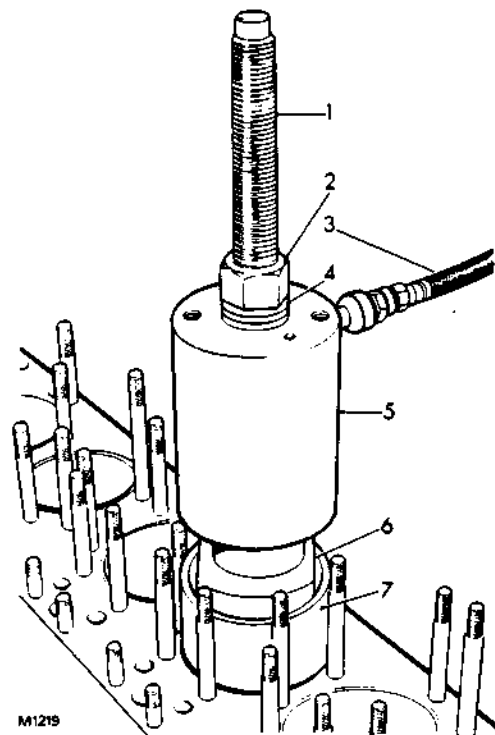
FIG. 2. EXTRACTOR PLATE IN POSITION

- |                    |                |
|--------------------|----------------|
| 1. Extractor plate | 2. Knurled nut |
| 3. Lead-screw      |                |



M1222

FIG. 3. CHECKING CYLINDER LINER PROTRUSION



M1219

FIG. 4. TYPICAL ARRANGEMENT FOR INSERTING CYLINDER LINER

- |                |                   |
|----------------|-------------------|
| 1. Lead-screw  | 5. Hydraulic ram  |
| 2. Hexagon nut | 6. Inserter plate |
| 3. Pump hose   | 7. Cylinder liner |
| 4. Thrust race |                   |

- Repeat this procedure for each cylinder in turn ensuring that the crank throw is at right angles to its associated cylinder.

**Note:** After the liner has been eased sufficiently by the hydraulic ram it may be extracted by screwing down the hexagonal nut on the lead screw.

#### To Fit Cylinder Liner

- Before fitting a new liner thoroughly clean out the cylinder bore and the shoulder recess. Invert the liner and place the liner flange in the recess and using a straight edge and feelers, Fig. 3, check that the liner projection above the top face of the engine block conforms to the limits quoted in Data. A shim may be placed under the liner flange to attain the correct projection.
- Lightly smear the cylinder bore and the outside of the liner with clean engine oil and place the liner in position in the cylinder bore.
- Fit the appropriate liner extractor and inserter plate, ram and thrust race on top of the cylinder liner as shown in Fig. 4.
- Insert the lead-screw through these items and the cylinder and adjust the hexagon nut until sufficient length protrudes at the bottom to enable the channel beam to be secured with the knurled nut across the sump face. Before securing the channel beam remove any sump studs that may obstruct its correct location.
- Check that the liner is at right angles to the engine block face. Commence, initially, to insert the liner by screwing down the hexagon nut on the lead-screw and at the same time noting that the liner is entering the cylinder squarely.
- Continue inserting the liner with the hexagon nut until the frictional resistance increases. At this stage the liner insertion can be completed using the hydraulic pump.

**Note:** When inserting the liner in No. 6 cylinder suitable distance pieces should be placed beneath both ends of the channel beam to allow it to bridge the oil pump.

- Refit the pistons and connecting rods, cylinder head and sump as described in the relative sections.
- Refill lubrication system with approved grade of oil.
- Refill the cooling system.



### To Remove Camshaft

1. Remove cylinder head covers, rocker gear and push rods, see Section 5. tappets.
2. Remove right-hand side covers and extract tappets.
3. Remove water pump and alternator driving belts.
4. Remove vibration damper and pulley from the crankshaft.
5. Remove timing case taking care not to damage oil seal housed in bore surrounding the crankshaft end.
6. Remove four setscrews and locking plates securing gear to camshaft and withdraw gear, taking care to note position of timing mark on gear in relation to mark on timing back plate when No. 1 piston in on T.D.C. of firing stroke, Fig. 9.
7. Break locking wire and remove four setscrews securing camshaft thrust washer. Remove washer and withdraw camshaft.
8. Check the camshaft, bearings and tappets for wear against the limits quoted in Data.

**Note:** The camshaft should be renewed when difference between base circle diameter and nose dimension is 9.1 mm (0.358 in) or less.

### To Refit Camshaft

Refitting the camshaft is a reversal of the removal procedure but in addition the camshaft timing has to be set before the camshaft drive gear is secured to the shaft. The camshaft and valve timing is set as follows:

1. Turn engine until No. 1 piston is coming up on compression stroke (both valves closed) and stop before T.D.C.
2. Lift and turn timing plunger until the legend, T.D.C., appears in window.
3. Continue turning engine slowly until plunger engages hole in flywheel.

**CAUTION:** The starter must not be used to turn the engine when the timing plunger is engaged.

4. Fit the camshaft gear to engage with the idler gear when the dowel (Fig. 8) in the camshaft end and the arrows on the camshaft gear face and timing backplate are in line (Fig. 9).

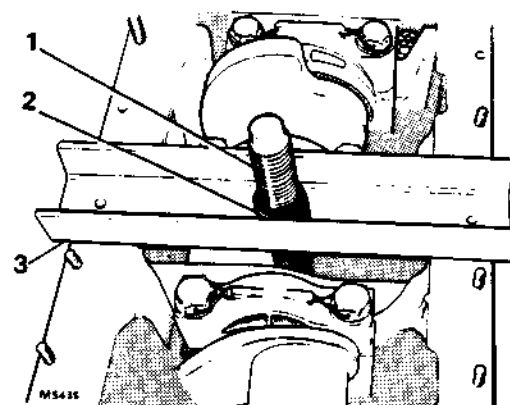


FIG. 5. CHANNEL BEAM IN POSITION

1. Channel support beam 2. Lead-screw 3. Knurled nut



FIG. 6. CUT-AWAY VIEW OF CAMSHAFT AND TAPPETS

- |                                  |                   |
|----------------------------------|-------------------|
| 1. Push-rod                      | 4. Camshaft       |
| 2. Tappet                        | 5. Connecting rod |
| 3. Camshaft bearing intermediate | 6. Big end bolt   |
|                                  | 7. Crankshaft     |

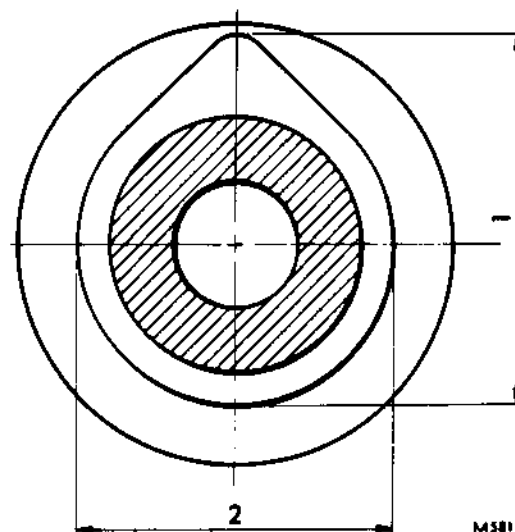


FIG. 7. CAM WEAR DIAGRAM

1. Cam lift dimension 2. Base circle diameter



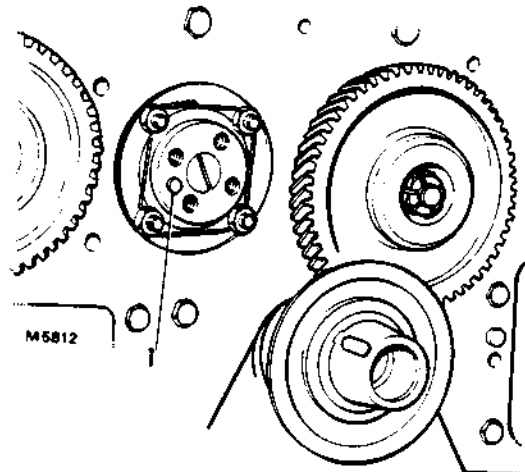


FIG. 8. GEAR LOCATION DOWEL IN CAMSHAFT END

1. Position of dowel in end of camshaft when No. 1 piston is on T.D.C. of firing stroke

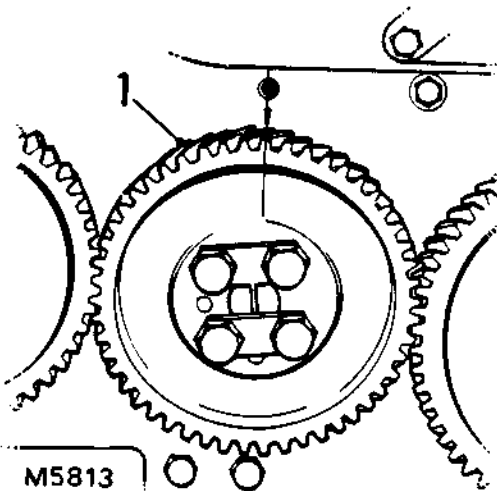


FIG. 9. CAMSHAFT TIMING MARKS

1. Position of camshaft timing marks when No. 1 piston is on T.D.C. of firing stroke

**To Remove Idler Gear**

1. Remove timing case.

**Note:** The idler gear bolt has a left hand thread.

2. Remove split pin and nut and withdraw idler gear complete with spindle, floating bush, thrust washers and plain washer.

**To Refit Idler Gear**

Refitment is the reversal of the removal procedure ensuring that the flat machined on the bolt coincides with the oil feed hole in the spindle.

**To Remove Crankshaft Gear**

1. Remove timing case.
2. Remove idler gear and camshaft drive gear.
3. Assemble crankshaft gear withdrawal tool on end of the crankshaft and draw off gear and oil flinger.

**To Replace Crankshaft Gear**

1. Oven heat gear to a temperature of 120/125°C (248/257°F).

**Note:** Do not exceed the limit quoted otherwise the original heat treatment of the gear may be affected.

2. Line-up keyway and drive gear on crankshaft.
3. Replace oil flinger, camshaft and idler gears.
4. Check backlash, see Data.
5. Refit timing case.



## SECTION 8

## Pistons and Connecting Rods

## DATA

## Pistons

Piston height in relation to top face of block . . . . .	0.25 mm (0.001 in) BELOW to 0.127 mm (0.005 in) ABOVE
Bore diameter for gudgeon pin . . . . .	41.272/41.280 mm (1.6249/1.6252 in)
Top ring groove width . . . . .	3.632 mm (0.143 in) nominal
2nd ring groove width . . . . .	3.632 mm (0.143 in) nominal
3rd ring groove width . . . . .	6.413/6.439 mm (0.2525/0.2535 in)
4th ring groove width . . . . .	6.413/6.439 mm (0.2525/0.2535 in)

## Piston Rings

## 1st and 2nd Grooves

Type . . . . .	Tapered sides, internally stepped, straight cut gap
Width . . . . .	3.510/3.536 mm (0.1382/0.1392 in)
Initial ring gap (in cylinder bore) . . . . .	0.508/0.686 mm (0.020/0.027 in)

## 3rd Groove

Type . . . . .	Spring-loaded, parallel sides, straight cut gap
Width . . . . .	6.325/6.350 mm (0.249/0.250 in)
Initial ring gap (in cylinder bore) . . . . .	0.508/0.686 mm (0.020/0.027 in)

Renew rings when	{	working gap exceeds . . . . .	2.50 mm (0.100 in)
		side clearance exceeds . . . . .	0.38 mm (0.015 in)

## Gudgeon Pin

Type . . . . .	Fully floating, hollow section, circlip located
Outside diameter . . . . .	41.275/41.281 mm (1.6250/1.62525 in)
Length . . . . .	111.51/111.76 mm (4.39/4.40 in)

## Connecting Rod

Connecting rod bolt	{	elongation . . . . .	0.125/0.203 mm (0.006/0.008 in)
		torque (ref only) . . . . .	17.95/19.35 kgf m (129/140 lbf ft)
Big end parent bore diameter . . . . .		79.827/79.845 mm (3.1428/3.1435 in)	
Small end parent bore diameter . . . . .		46.031/46.065 mm (1.81225/1.81325 in)	
		Standard Rod	
		46.412/46.437 mm (1.82725/1.82825 in)	
		Service Rod	



## ENGINE

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Distance between centres . . . . .	266.662/266.738 mm (10.4985/10.5015 in)
Side clearance of rod on crankpin . . . . .	0.102/0.356 mm (0.004/0.014 in)
Connecting rod bore alignment . . . . .	Refer to Fig. 1
<b>Small End Bush</b>	
Type . . . . .	Phosphor-bronze
Length . . . . .	44.298/44.602 mm (1.744/1.756 in)
Fit of small end bush in rod . . . . .	0.057/0.108 mm (0.00225/0.00425 in) INTERFERENCE
Inside diameter after boring . . . . .	41.312/41.319 mm (1.62645/1.62675 in)
Initial fit of gudgeon pin in bush . . . . .	0.0305/0.0444 mm (0.00012/0.00175 in) CLEARANCE
Renew bush when clearance exceeds . . . . .	0.063 mm (0.0025 in)
<b>Big End Bearings</b>	
Type . . . . .	Pre-finished, steel backed, lead indium coated bearing surface
Initial running clearance . . . . .	0.033/0.086 mm (0.0013/0.0034 in)
Renew bearings when clearance exceeds . . . . .	0.203 mm (0.008 in)
Service sizes available . . . . .	Pre-finished in five sizes to suit shaft diameters from 75.941/ 75.959 mm (2.9898/2.9905 in) down to 74.925/74.943 mm (2.9498/2.9505 in) in increments of 0.254 mm (0.010 in)



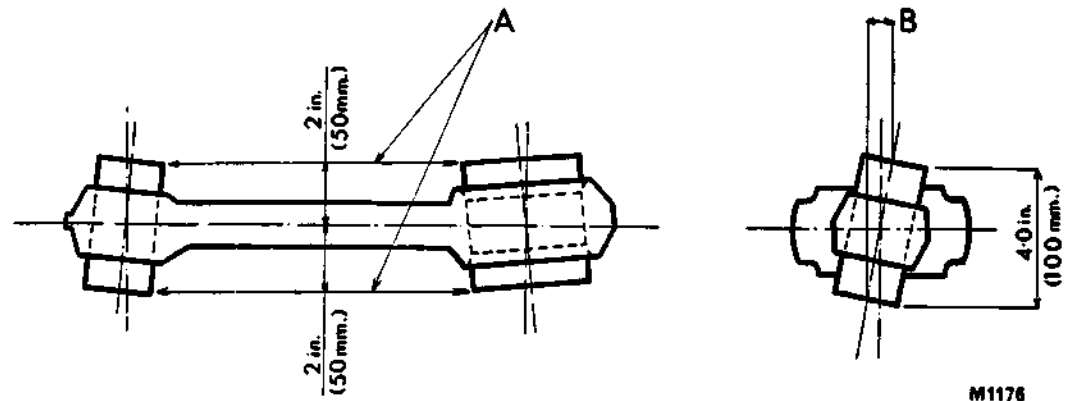


FIG. 1. CONNECTING ROD BORE ALIGNMENT

Difference between dimensions at A not to exceed 0.025 mm (0.001 in)

Dimensions at B not to exceed 0.05 mm (0.002 in) in this or opposite plane

## OVERHAUL

### To Remove Piston and Rod Assemblies

1. Remove cylinder head assembly (Refer to Section 6).
2. Remove sump.
3. Rotate crankshaft until one pair of big ends are at B.D.C. then remove bearing caps.
4. Remove piston and rod assemblies.
5. By repeating item 3, remove remaining three pairs of piston and rod assemblies.
6. Assemble bearings, caps and bolts to rods in their original relative positions and to maintain identity of each piston and rod assembly.

### To Dismantle Piston and Rod Assemblies

Before dismantling, pistons should be suitably marked to identify them to their cylinder and rod assembly.

1. Remove the pistons rings from each piston.
2. Remove circlip and heat piston in boiling water to facilitate removal of gudgeon pin.

Note: Where a scraper ring groove is provided below the gudgeon pin it will normally be left vacant on initial assembly. The purpose of this groove is to enable operators to fit an additional slotted ring when operating conditions make it necessary.

### Inspection

1. Clean all components.
2. Examine pistons for scoring or signs of groove damage.
3. Check clearance of piston rings in their grooves.
4. Check each piston ring gap in its cylinder bore.

Note: In the case of worn cylinder bores, the gaps should be checked with the rings sited in the bores at the lower limit of ring travel.

5. Check fit of gudgeon pin in small end bush; if clearance is excessive, renew bush.

6. Check connecting rods for bend and twist by checking bore alignment, Refer to Fig. 1.
7. Examine big end bearing shells for wear or pitting. Refer to Data. Renew as necessary.
8. Check crankpins visually and dimensionally for damage and wear. Remove the crankshaft for regrinding or renewal if either is excessive. Refer to Section 9 for crankshaft removal procedure.

### To Assemble Pistons to Connecting Rods

All serviceable parts must be refitted in their original positions.

1. Heat the piston to 100° C (212° F), this will enable the gudgeon pin to be located easily in the piston boss when piston and rod are correctly aligned.
2. Insert the gudgeon pin ensuring that the offset combustion chamber in the piston crown faces away from the identification numbers stamped on the side of the rod and cap.

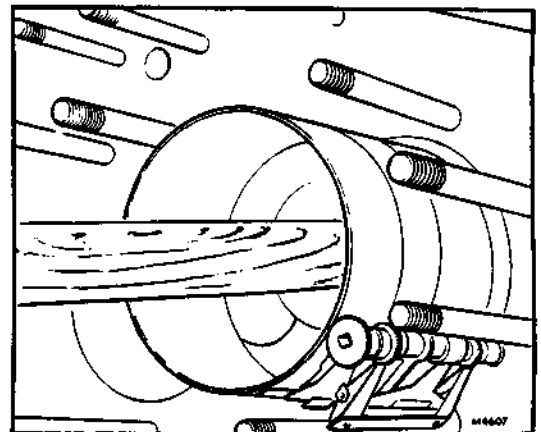


FIG. 2. PISTON RING COMPRESSION TOOL NO 8

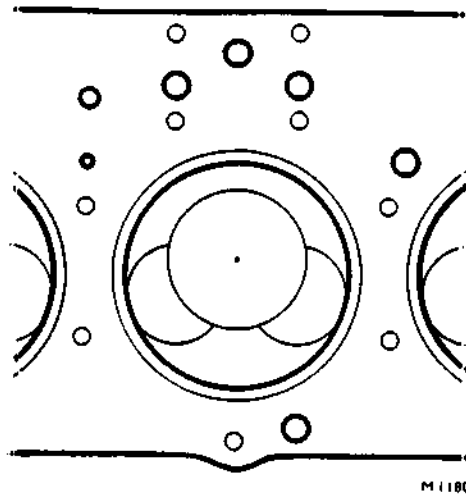


FIG. 3. PISTON CORRECTLY POSITIONED IN ENGINE BLOCK

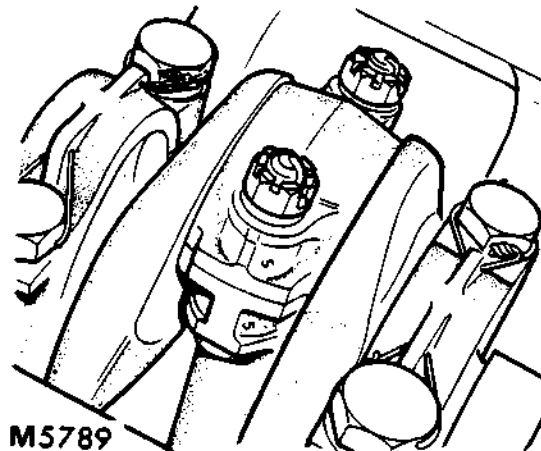


FIG. 4. CONNECTING ROD AND CAP IDENTIFICATION NUMBERS

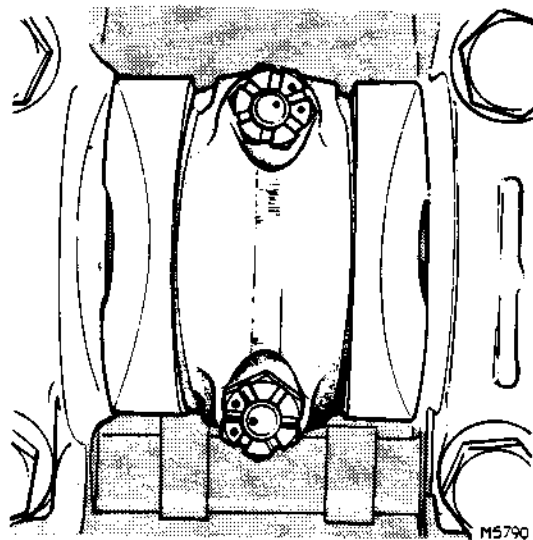


FIG. 5. CONNECTING ROD CAP SHOWING CORRECT ALIGNMENT OF POP MARKS

3. Locate gudgeon pin with circlips.
4. Repeat items 1-3 for remaining piston and rod assemblies.

#### To Fit Piston Rings

The piston rings should be fitted in the following sequence using the tool shown in Fig. 2.

1. Spring loaded scraper—3rd groove.
2. Stepped compression, tapered sides—2nd groove.
3. Stepped compression, tapered sides—Top groove.

**Note:** Stepped compression rings fitted in 2nd and Top grooves are marked 'TOP' to indicate correct positioning.

#### To Fit Piston and Connecting Rod Assemblies

Ensure that all components are clean and lubricate with clean engine oil.

1. Position crankshaft to receive first pair of piston and connecting rod assemblies, i.e. Nos. 1 and 6.
2. Stagger piston ring gaps at intervals of approximately 180°C.
3. Using a piston ring compressing tool. Refer to Fig. 2. Tap each piston lightly into its cylinder bore with offset combustion chamber on camshaft side of engine (Fig. 3).
4. Locate rod and cap bearing shells correctly and fit caps ensuring that identification numbers stamped on sides are the same and adjacent as shown in Fig. 4.
5. Tighten the connecting rod bolts until the indexed centre pop marks are aligned as shown in Fig. 5, then fit the retaining split pins.
6. Turn crankshaft to appropriate position to receive next pair of piston and rod assemblies and repeat items 2-5.
7. Repeat for remaining pair of piston and rod assemblies.

**Note:** On original assembly the connecting rod bolts are tightened until the correct elongation of 0.152/0.203 mm (0.006/0.008 in) is obtained, they are then marked whilst in this state as follows.

Centre pop marks are made on the top face of the nut either side of the relevant slot, an off-centre pop mark is also made on the end of the bolt above the split pin hole.

Consequently when the nut is tightened and the pop marks aligned as shown in Fig. 5 the bolt elongation will be correct and the fitment of the split pin quite straightforward. One of each pair of nuts has an additional pop mark on its side to indicate that it belongs to the bolt on the opposite side to the camshaft.

In the event of a new connecting rod nut and bolt being fitted, the procedure is to tighten the nut until the correct bolt elongation is obtained and then index mark in accordance with the procedure detailed above.

This elongation should be accurately measured using a micrometer.





## SECTION 9

## Crankshaft and Main Bearings

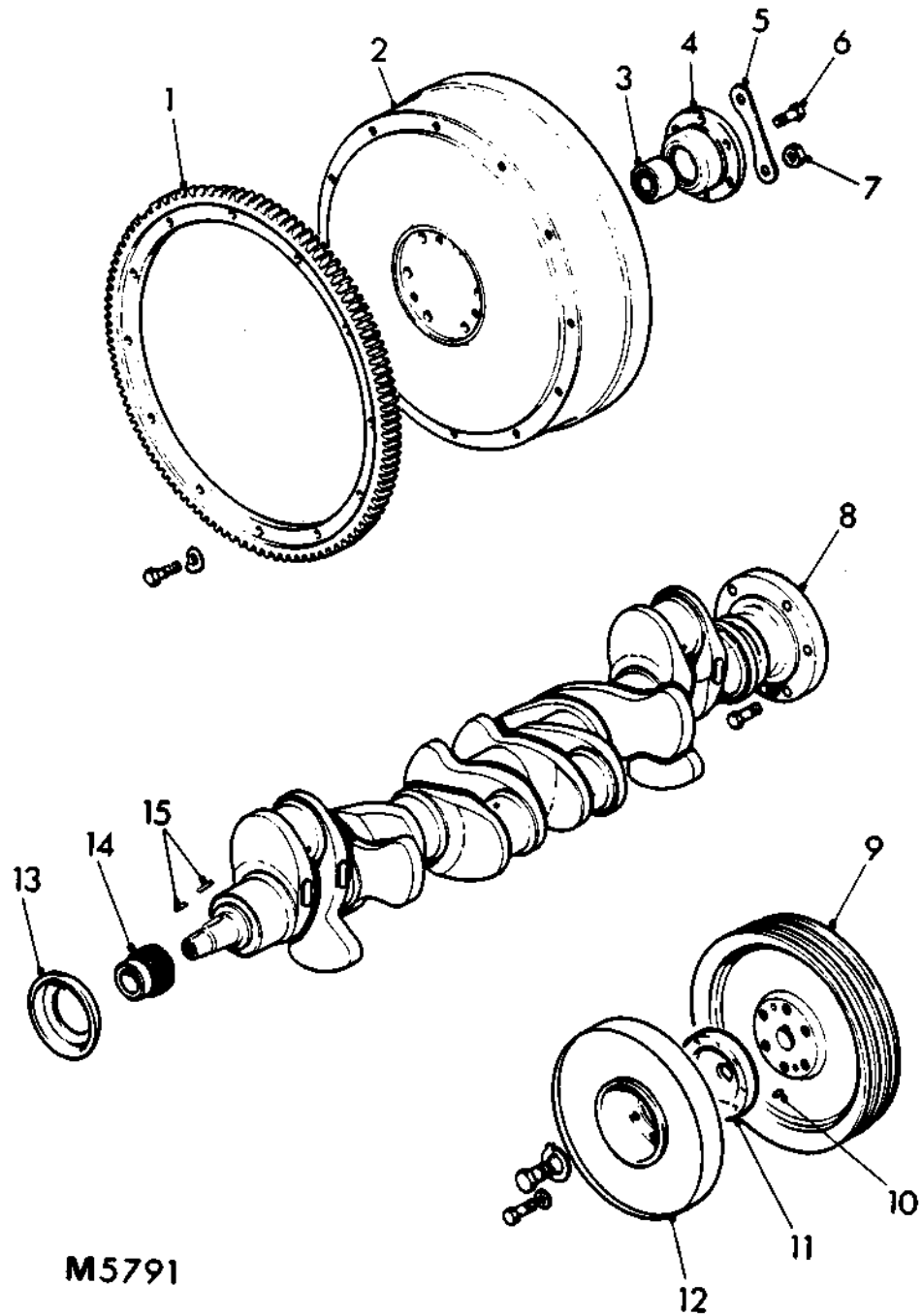
## DATA

Number of main bearings . . . . .	Seven
Main bearing type . . . . .	Pre-finished strip bearings
Type of bearing surface . . . . .	Lead indium plated
Crankshaft type . . . . .	Forging, incorporating balance weights
Crankshaft material . . . . .	Alloy-steel nitrided
Thrust taken on . . . . .	Thrust washers at centre journal
Centre journal initial end clearance . . . . .	0.102/0.254 mm (0.004/0.010 in)
Renew thrust washers when end clearance exceeds . . . . .	0.3556 mm (0.014 in)
Enlarge thrust washers available . . . . .	Three enlargements available in steps of 0.127 mm (0.005 in) each
Regrind journals and crankpins . . . . .	When 0.0762 mm (0.003 in) oval
Enlarge main bearings available . . . . .	Five, in steps of 0.254 mm (0.010 in) each
Main bearing initial diametral clearance . . . . .	0.051/0.107 mm (0.002/0.0042 in)
Renew when diametral clearance exceeds . . . . .	0.2286 mm (0.009 in)
Maximum run-out on shaft . . . . .	0.0762 in (0.003 in), total clock reading 0.1524 mm (0.006 in) (0.006 in)
Maximum run-out between two adjacent bearings . . . . .	0.0762 mm (0.003 in) total clock reading
Crankshaft damper . . . . .	Rubber bonded or viscous type

TABLE OF CRANKSHAFT DIMENSIONS

	Standard Service		1st Service		2nd Service		3rd Service		4th Service		5th Service	
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
CRANKPIN DIAMETER	76.213 76.195	3.0005 2.9998	75.959 75.941	2.9905 2.9898	75.705 75.687	2.9805 2.9798	75.451 75.433	2.9705 2.9698	75.197 75.179	2.9605 2.9598	74.943 74.925	2.9505 2.9498
CRANKPIN WIDTH	55.956 55.880	2.203 2.200	55.956 55.880	2.203 2.200	55.956 55.880	2.203 2.200	55.956 55.880	2.203 2.200	55.956 55.880	2.203 2.200	55.956 55.880	2.203 2.200
JOURNAL DIAMETER	88.913 88.895	3.5005 3.4998	88.659 88.641	3.4905 3.4898	88.404 88.387	3.4805 3.4798	88.151 88.133	3.4705 3.4698	87.897 87.879	3.4605 3.4598	87.643 87.625	3.4505 3.4498
JOURNAL WIDTH	FRONT	50.800 2.000	50.800 2.000	50.800 2.000	50.800 2.000	50.800 2.000	50.800 2.000	50.800 2.000	50.800 2.000	50.800 2.000	50.800 2.000	50.800 2.000
	CENTRE	68.631 68.580	2.702 2.700	68.631 68.580	2.702 2.700	68.631 68.580	2.702 2.700	68.631 68.580	2.702 2.700	68.631 68.580	2.702 2.700	68.631 68.580
	REAR	68.707 68.453	2.705 2.695	68.707 68.453	2.705 2.695	68.707 68.453	2.705 2.695	68.707 68.453	2.705 2.695	68.707 68.453	2.705 2.695	68.707 68.453
	INTER-MEDIATE	43.343 43.180	1.710 1.700	43.434 43.180	1.710 1.700	43.434 43.180	1.710 1.700	43.434 43.180	1.710 1.700	43.434 43.180	1.710 1.700	43.434 43.180





M5791

FIG. 1 EXPLODED VIEW OF THE CRANKSHAFT ASSEMBLY

- |                    |               |                     |
|--------------------|---------------|---------------------|
| 1. Starter ring    | 6. Setscrew   | 11. Spacer          |
| 2. Flywheel        | 7. Nut        | 12. Damper          |
| 3. Bearing roller  | 8. Crankshaft | 13. Oil flinger     |
| 4. Bearing housing | 9. Pulley     | 14. Crankshaft gear |
| 5. Locking plate   | 10. Dowel     | 15. Keys            |

## OVERHAUL

**To Remove Flywheel**

1. Remove fluid coupling, see Group 3.
2. Bend back tabs on locking plates and remove nuts securing flywheel to crankshaft flange. Support flywheel and withdraw it from crankshaft.

**Note:** If difficulty is experienced in removing the flywheel from the crankshaft, it can be removed by inserting three  $\frac{3}{8}$  in dia. B.S.F. jacking bolts in the three holes provided in the flywheel, ensuring that the flywheel is suitably supported during the operation.

Examine the starter gear ring teeth for signs of wear and if excessive the ring should be removed and fitted with original mounting face outermost to obtain further service. Use new locking tabs when refitting.

**To Refit Flywheel**

1. Remove jacking bolts and lift flywheel on to crankshaft bolts.
2. Fit new locking plates and tighten nuts securing flywheel to crankshaft.
3. Check that flywheel runs true with crankshaft to within 0.102 mm (0.004 in).
4. Lock securing nuts by bend up tabs on locking plates.

**To Remove Crankshaft**

1. Remove engine and gearbox assembly from vehicle (see Section 1).
2. Separate engine from assembly and place on a suitable stand.
3. Remove starter motor, crankshaft vibration damper, driving pulley and timing case.
4. Remove cylinder heads, push rods, side covers and tappets (see Section 6).
5. Remove sump and oil pump. Section 4.
6. Remove flywheel as described in this section.
7. Remove connecting rod assemblies. Section 8.
8. Remove flywheel housing.
9. Remove main bearing caps and lift out crankshaft.

**Note:** Retain the thrust washer from both sides of the main bearing for subsequent refitting in their original positions.

10. Check rear crankshaft seal felt inserts for signs of wear or deterioration and renew if required.

**To Refit the Crankshaft**

To ensure that the main bearing caps and bearings are refitted in their original positions the caps are marked A, B, C, etc., starting from the front of the engine. When correctly assembled the letter must correspond with the same letter marked on the bearing support web.

1. Fit top halves of main bearings in their correct seatings; check that shells bed down correctly.

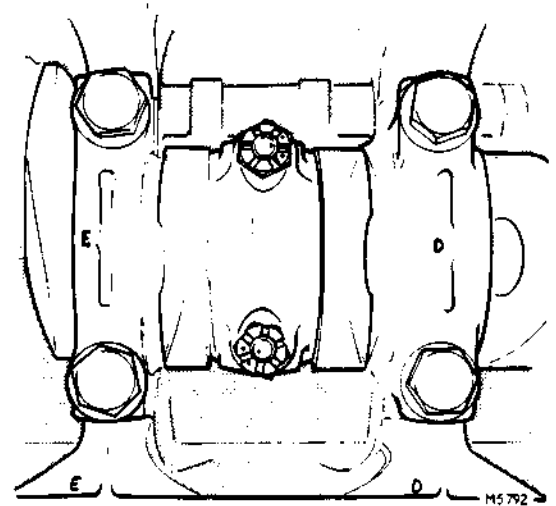


FIG. 2. MAIN BEARING CAP IDENTIFICATION MARKS

2. Fit thrust washers at centre main bearing.
3. Smear main bearing journals with clean engine oil.
4. Lower crankshaft carefully into crankcase.
5. Fit main bearing caps in their correct positions, and tighten down. A torsion spanner set at 29/31 kgf m (215/225 lbf ft) should be used to tighten the bearing cap setscrews.
6. Check crankshaft end-play at centre bearing. Refer to Data.
7. Refit flywheel housing.
8. Refit connecting rods; renew big end bearing shells if clearance exceeds 0.203 mm (0.008 in).
9. Remainder of refitting is a reversal of removal procedure items 1 to 6.

**To Fit New Main Bearings and Thrust Washers**

Normally the main bearings require renewing when the crankshaft needs regrinding. However, if one or more bearings should require changing or removal for inspection, this can be done without removing the engine from the vehicle.

1. Remove sump and oil pump. Ref. Section 4.
2. Remove cap of bearing in question, and remove lower half-bearing from cap.
3. Slacken all remaining bearing cap setscrews one or two turns to facilitate removal of top halves of bearings.
4. Carefully remove relevant upper half bearing shells.
5. Clean and inspect crankshaft bearing surface then insert new upper half bearing shell.
6. Insert new half-bearing by reversing procedure for removal.

**Note:** Ensure that the tab end is correctly lined up and located. If the old bearings were under size, new bearings of the same size must replace them.

The thrust washers are also renewable. The bottom halves of the washers are tongue-located in the bearing cap so care must be taken to ensure that the tongues fit correctly in the cap.

### To Re grind the Crankshaft

When regrinding journals and crankpins, the end faces must not be ground. If the location faces of the centre bearing have been damaged, the width should be increased to 68.834/68.885 mm (2.710/2.712 in) otherwise the dimensions should remain at 68.580/68.631 mm (2.700/2.702 in).

After grinding, support the crankshaft at the front and rear journals. Check the relative eccentricity of the centre main journal; this must not exceed 0.0762 mm (0.003 in) in radius— total turn-out of 0.1524 mm (0.006 in). The permissible error between one bearing and its neighbour must not exceed 0.0762 mm (0.003 in). Total clock reading.

No attempts should be made to straighten the crankshaft.

The crankshaft should be re-nitrided at the second and fourth regrinds.

**CAUTION:** Where the operator regrinds a crankshaft without re-nitriding, care should be taken that an excessive amount of case is not removed from the fillets.

Check the main bearing diametral clearance. This should be within the limits 0.051/0.107 mm (0.002/0.0042 in), when new bearing shells are fitted. Bearings should be renewed when diametral clearance exceeds 0.2286 mm (0.009 in).

A grinding wheel having a radius of 3.810/4.318 mm (0.15/0.17 in) must be used.

If the operator has any doubt on this point, crankshafts should be re-nitrided after regrinding irrespective of the amount of case which has been removed from the pin or journal diameter.

## SECTION 10

## Fuel Pumps

## DATA

## Injection Pump

Make . . . . . C.A.V.

Type . . . . . DPA

Timing . . . . . Injection begins at 16° before T.D.C.

## Fuel Feed Pump

Make . . . . . A.C. Delco

Type . . . . . UF

## REMOVAL AND REFITMENT

## Fuel Injection Pump

## To Remove

1. Disconnect fuel pipes between pump and filters.
2. Disconnect the high pressure injection pipes between pump and injectors.
3. Blank-off all pipes and pump connections.
4. Disconnect throttle linkage from pump.
5. Disconnect stop solenoid linkage from pump stop lever.
6. Disconnect spring from pump stop lever.
7. Remove three securing nuts and remove pump from vehicle.

## To Refit

Refitment is a reversal of the removal procedure but care must be taken that the marks on the drive housing and pump mounting flanges are in line.

If the compressor has been removed from the engine, the compressor drive gear will have to be re-set with gauge No. LC112 before the compressor is fitted to the engine to ensure the fuel injection pump timing is correct.

The procedure for resetting the compressor drive is as follows:

1. Lift and turn timing plunger on flywheel housing to the INJ position.

2. Rotate crankshaft slowly by hand until plunger locates in the flywheel and No. 1 piston is on compression stroke, that is both valves closed.
3. With drive housing assembled to compressor, rotate compressor drive gear until locating spline (largest spline) of drive coupling is positioned so that gauge can be engaged with drive coupling and hole in gauge is engaged with outer stud of drive housing flange.
4. Fit compressor to engine timing gear train and temporarily secure to timing gear housing, then re-check setting with gauge to ensure that drive gear has not moved into next tooth location.
5. Secure compressor to engine.
6. Fit fuel injection pump to drive housing, taking care to align marks on mating flanges.

**Note:** Further information and overhaul instructions for fuel injection equipment can be obtained from the makers local agents (CAV/Simms) or from:

CAV and Simms Service  
CAV Limited  
PO Box 36  
Warple Way  
London W3 7SS

Quote engine and fuel pump serial number and type on application.



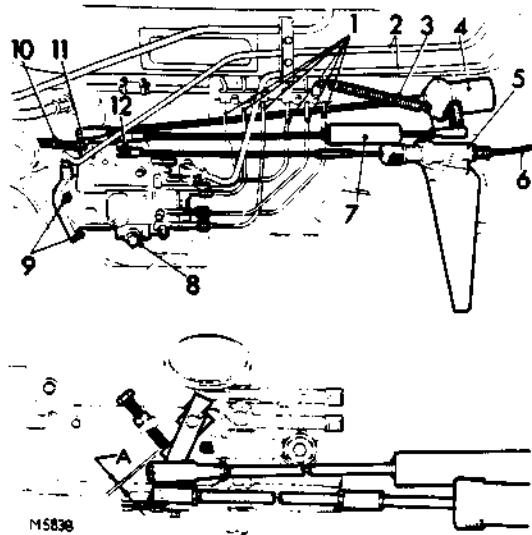


FIG. 1. FUEL PUMP CONTROL LINKAGE

\*\*A Set gap to 1.27/3.81 mm (0.05/0.15 in)\*\*

- |                                  |                            |
|----------------------------------|----------------------------|
| 1. Pipes, fuel pump to injectors | 7. Spring link             |
| 2. Pipes, fuel pump to filters   | 8. Fuel pump               |
| 3. Throttle return spring        | 9. Fuel pump mounting nuts |
| 4. Stop solenoid                 | 10. Stop return spring     |
| 5. Throttle override cylinder    | 11. Stop lever             |
| 6. Air cylinder inlet pipe       | 12. Throttle lever         |

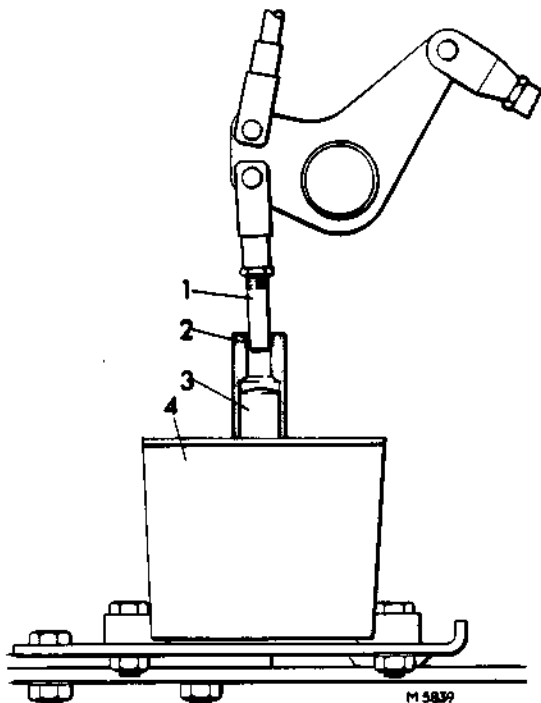


FIG. 2. PERFORMANCE LEVEL (KICK-DOWN) SWITCH

- |                |            |
|----------------|------------|
| 1. Control rod | 3. Plunger |
| 2. Guide tube  | 4. Switch  |

**Throttle Override Cylinder**

**To Remove**

1. Disconnect air inlet pipe.
2. Disconnect control linkage at jaw-end on pump throttle lever.
3. Remove setscrews securing cylinder to mounting bracket then remove cylinder complete with control linkage.

**To Refit**

Refitment is a reversal of removal procedure with the following points to note:

- \*\* 1. Set cylinder at maximum stroke then adjust linkage to give 1.27/3.8 mm (0.05/0.15 in) gap between stop screw and fuel pump throttle lever.

**Operating Test for Throttle Dip (Override) Control**

1. Fully charge the air system, then stop engine.
2. Switch on master switch and select neutral, or position 'S' when fitted.
3. Depress accelerator pedal and ensure that full throttle position is reached on fuel pump linkage, i.e. maximum fuel stop.
4. With the accelerator depressed, select 'A' and ensure that the throttle linkage on fuel pump returns momentarily towards the idling stop position.
5. If the throttle linkage does not return, the fault may be due to the linkage sticking, or a malfunction of the throttle dip valve and associated electrical system, see Group 8.
6. To repeat the test, select reverse gear, then move selector back to 'A'.\*\*

**Performance Level (Kick-down) Switch**

**To Remove**

1. Disconnect electrical connections.
2. Remove securing bolts then withdraw switch.

**To Refit**

Refitment is a reversal of removal procedure with the following points to note:

1. Depress accelerator pedal until fuel pump lever is at maximum position then set control rod to touch plunger on switch.
2. Set accelerator pedal stop to allow a further travel of 6.35 mm (0.25 in) of accelerator pedal.

**Engine Stop Solenoid**

**To Remove**

1. Isolate batteries and disconnect terminals from solenoid.
2. Disconnect stop control rod at lever on back of governor.
3. Remove nuts securing solenoid to mounting bracket then release return spring and remove solenoid and control rod complete.



**To Refit**

Refitment is a reversal of removal procedure. If a new solenoid or control rod is to be fitted adjustment is as follows:

1. Secure solenoid onto mounting bracket.
2. Hold stop lever on governor in 'off' position, then push control rod into solenoid and adjust linkage to ensure that stop position of pump is obtained by travel of solenoid.
3. Reconnect linkage and replace return spring.
4. Reconnect terminals to solenoid, then run engine and test operation of stop solenoid.

**OVERHAUL****Fuel Feed Pipe****To Dismantle and Reassemble**

1. Scribe a reassembly mark across body joint flanges.
2. Remove domed cover, sealing ring and filter.
3. Remove securing screws and separate pump chamber from body of pump.
4. Press diaphragm lightly downwards, rotate it through 90° and withdraw diaphragm and spring.
5. Check rocker arm pin and linkage for wear or damage. If necessary, secure rocker arm in a vice and tap mounting flange face to dislodge rocker arm pin and components. Renew components as necessary.
6. Assemble rocker arm, operating link and packing washers onto rocker arm pin.
7. Place assembly and rocker arm spring in position in pump body and tap rocker arm pin retainers fully into their recesses.
8. Renew valves if necessary by levering old valves out carefully and pressing in new valves and gaskets then stake them in position.
9. Renew diaphragm if necessary.
10. Check diaphragm spring and renew if necessary. Ensure that new spring is of the same colour as the original.
11. Assemble pump by reversing procedures 1 to 4.

**PRIMING THE FUEL SYSTEM**

The fuel system must be primed on initial installation, when any part of the system has been removed for servicing or renewal, when the vehicle has been allowed to run out of fuel and if air has gained access to the system for any other reason.

The priming procedure is as follows:

1. Ensure that fuel tank has an adequate supply of fuel.
2. Check that combined stop tap/filter is turned on.
3. Open one bleed screw in main fuel filter head two in the fuel injection pump and one in inlet banjo connection to pump.

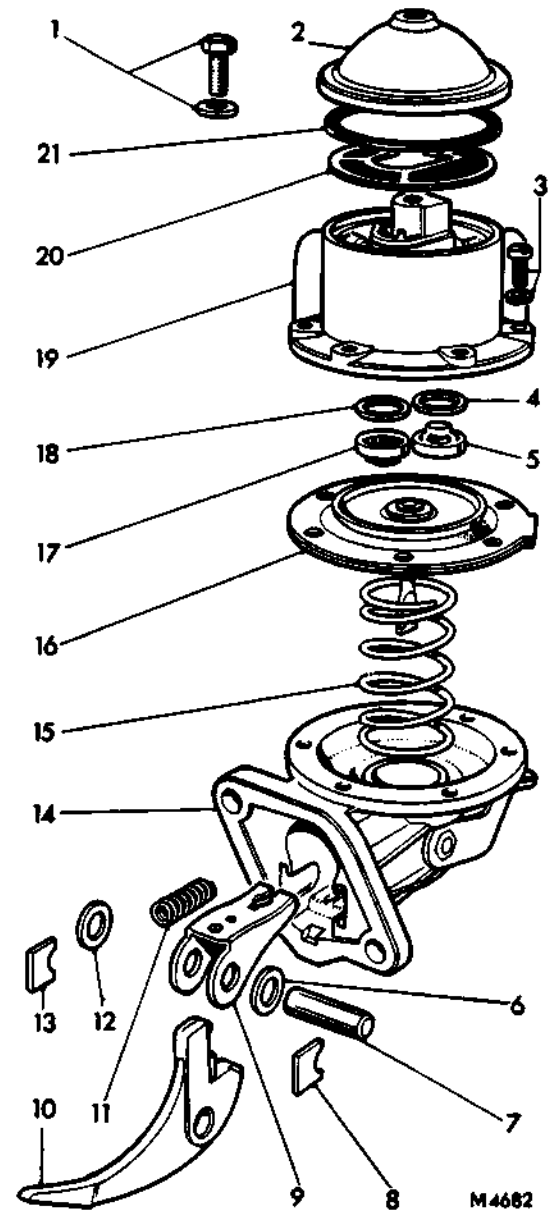


FIG. 3 EXPLODED VIEW OF FUEL FEED PUMP

- |  |   |
|--|---|
| 1. Dome attachment bolt and washer         | 11. Rocker arm return spring and washer |
| 2. Dome                                    | 12. Washer                              |
| 3. Body attachment screw and spring washer | 13. Pin retainer                        |
| 4. Valve gasket                            | 14. Pump body                           |
| 5. Inlet valve                             | 15. Diaphragm return spring             |
| 6. Washer                                  | 16. Diaphragm                           |
| 7. Rocker arm pin                          | 17. Outlet valve                        |
| 8. Pin retainer                            | 18. Gasket                              |
| 9. Actuating lever                         | 19. Pump chamber                        |
| 10. Rocker arm                             | 20. Filter                              |
|  | 21. Sealing ring                        |

4. Operate hand priming lever on lift pump until fuel completely free from air bubbles flows from bleed points. Tighten each screw as soon as air-free fuel emerges.
5. Prime high pressure pipes by turning engine with starter motor for a few seconds, with pipe to injector union nuts slackened. When air-free fuel emerges from around union nuts tighten and start engine.



## SECTION 11

## Fuel Injectors

**\*\*DATA**

Make . . . . .	C.A.V.
Discharge pressure . . . . .	160/170 atmospheres (165/176 kgf/cm <sup>2</sup> , 2352/2499 lbf/in <sup>2</sup> )
Nozzle seat angle . . . . .	62°
Angle of sprays . . . . .	140°
Number of spray holes . . . . .	Four
Diameter of spray holes . . . . .	0.3556 mm (0.014 in)
Length of spray holes . . . . .	0.5334 mm (0.0212)

**REMOVAL AND REFITMENT****To Remove**

1. Remove the valve cover and joint.
2. Disconnect and remove the leak-off pipe. It is important that the leak-off pipe is not bent when removing.
3. Disconnect the fuel injection pipe.
4. Remove the nut securing the injector clamp, then remove clamp.
5. Use suitable extractor tool to withdraw the injectors.
6. Remove the injector seating washer.

**To Refit**

Before refitting an injector it is essential to remove any carbon from the injector seating faces and the injector sleeves. A new seating washer should be fitted to each injector.

It is important, that when refitting the clamps and nuts, that the nuts be tightened to a torque setting of 4.2/4.8 kgf m (30/35 lbf ft). Re-connect the leak-off pipe and injector pipe ensuring that the connections are securely made.

Prime the system, Ref. 2-10-3.

**OVERHAUL**

**Note:** Further information and overhaul instructions for fuel injection equipment can be obtained from the makers.

C.A.V. and Simms Service  
C.A.V. Limited  
P.O. Box 36  
Warple Way  
London W3 7SS

Quote engine and fuel pump serial number and type on application.\*\*





## SECTION 11

## Fuel Injectors

## DATA

Make . . . . .	C.A.V.
Discharge pressure . . . . .	160/170 atmospheres 165/176 kgf/cm <sup>2</sup> 2352/2499 lbf/in <sup>2</sup>
Nozzle seat angle . . . . .	62°
Angle of sprays . . . . .	140°
Number of spray holes . . . . .	Four

## DIAGNOSIS OF INJECTOR TROUBLE

Provided the fuel filters receive regular attention thereby ensuring that only clean fuel is fed to injectors no attention is likely to be required for long periods. Any inefficiency can usually be detected by one of the following symptoms:

1. Pronounced knocking on one (or more) cylinders.
2. Engine misfiring.
3. Smoky exhaust (black).
4. Increased fuel consumption.
5. Engine overheating.
6. Loss of power.

To locate a faulty injector, slacken off the injector pipe union nut two or three turns and allow the fuel to leak past the threads while the engine is running slowly. This cuts out the injector and if no change in engine performance can be detected, it is reasonable to assume that the injector is faulty and should be removed and replaced by a new or reconditioned unit of the same type as already fitted.

## TO REMOVE

The injectors can be removed by using extractor 267708 and adaptor 400115.

To ensure that no damage is caused to a leak-off pipe when removing a single injector, the complete leak-off pipe assembly should first be removed.

1. Remove the valve cover and joint.
2. Disconnect and remove the leak-off pipe. It is important that the leak-off pipe is not bent when removing.
3. Disconnect the fuel injection pipe.
4. Remove the nut securing the injector clamp, remove clamp.
5. Remove the injector end-plug and screw the appropriate adaptor into the injector body. Position the extractor with the longest leg resting on the edge of the valve cover and the shortest leg on the rocker bracket.

6. Screw the withdrawal screw into the adaptor and withdraw the injector by screwing down the nut on top of the tool.
7. Remove the injector seating washer.

## To Refit

Refitment is a reversal of removal procedure.

**Note:** Further information and overhaul instructions for fuel injection equipment can be obtained from the makers local agents (CAV/Sims) or from:

CAV and Simms Service  
CAV Limited  
PO Box 36  
Warple Way  
London W3 7SS

Quote engine and fuel pump serial number and type on application.

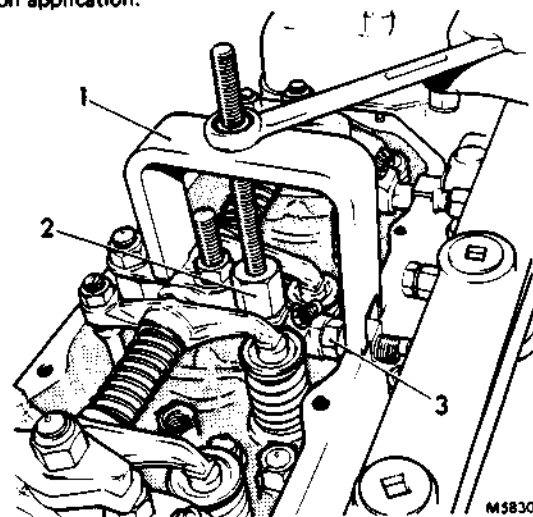


FIG. 1. INJECTOR REMOVAL  
1. Withdrawal tool  
2. Adaptor  
3. Injector

**GROUP 3**  
**FLUID COUPLING**

**SECTION 1—FLUID COUPLING**

	Reference
Data . . . . .	3-1-1
Oil Seal . . . . .	3-1-3
Fluid Coupling . . . . .	3-1-3

**SECTION 1****FLUID COUPLING****DATA**

Size .....	482 mm (19 in) diameter
Oil capacity .....	13.0 litres (3.1 galls)

**Torque figures:**

	<b>kgf m</b>	<b>lbf ft</b>
Fluid coupling retaining bolts ..... (Leyland)	4.9	35
Fluid coupling retaining bolts ..... (Gardner)	4.2	30
Runner retaining bolts .....	4.9	35
Yoke retaining bolt ..... (Gardner)	27.65 to 34.56	200 to 250
Bearing retaining nut ..... (Leyland)	27.65 to 34.56	200 to 250

# FLUID COUPLING

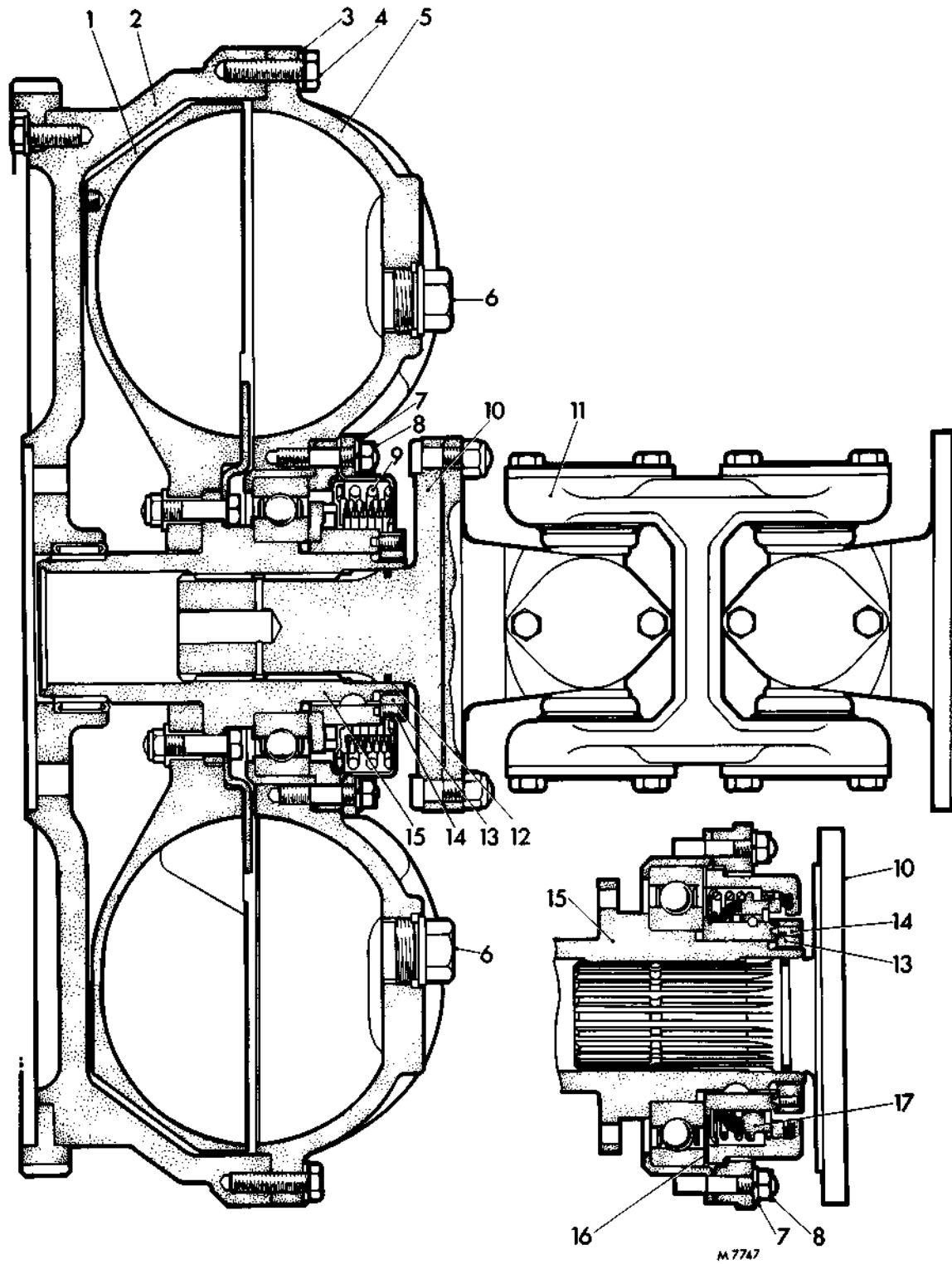


FIG. 1. FLUID COUPLING — LEYLAND ENGINE

- |                      |                                 |                         |
|----------------------|---------------------------------|-------------------------|
| 1. Runner            | 7. Spring washer                | 13. Locking nut         |
| 2. Front casing      | 8. Locknut                      | 14. Setscrew            |
| 3. Spring washer     | 9. Oil seal, British thermostat | 15. Runner shaft        |
| 4. Setscrew          | 10. Coupling flange             | 16. Joint               |
| 5. Rear casing       | 11. Universal coupling          | 17. Oil seal, Llewellyn |
| 6. Drain/filler plug | 12. O-ring                      |                         |

**OIL SEAL**

**To Remove**

1. Remove trailing link or universal coupling.
2. On vehicles fitted with trailing links remove lock washer setscrew and washer, then remove bolt, lock washer, plain washer and 'O' ring. Withdraw the yoke from the fluid coupling. On vehicles fitted with universal couplings withdraw the coupling flange from the fluid coupling and remove the 'O' ring from the flange.
3. On vehicles fitted with trailing links remove setscrews and spring washers securing oil seal to fluid coupling, withdraw oil seal. On vehicles fitted with universal couplings remove setscrews securing locknut to runner shaft, remove locknut. Remove nuts and spring washers securing oil seal to fluid coupling, remove oil seal.

**To Refit**

Refitment is a reversal of removal procedure with the following points to note:

1. If the Llewellyn gland is fitted, slide the inner sleeve assembly onto shaft, then position a new joint and fit outer housing assembly.

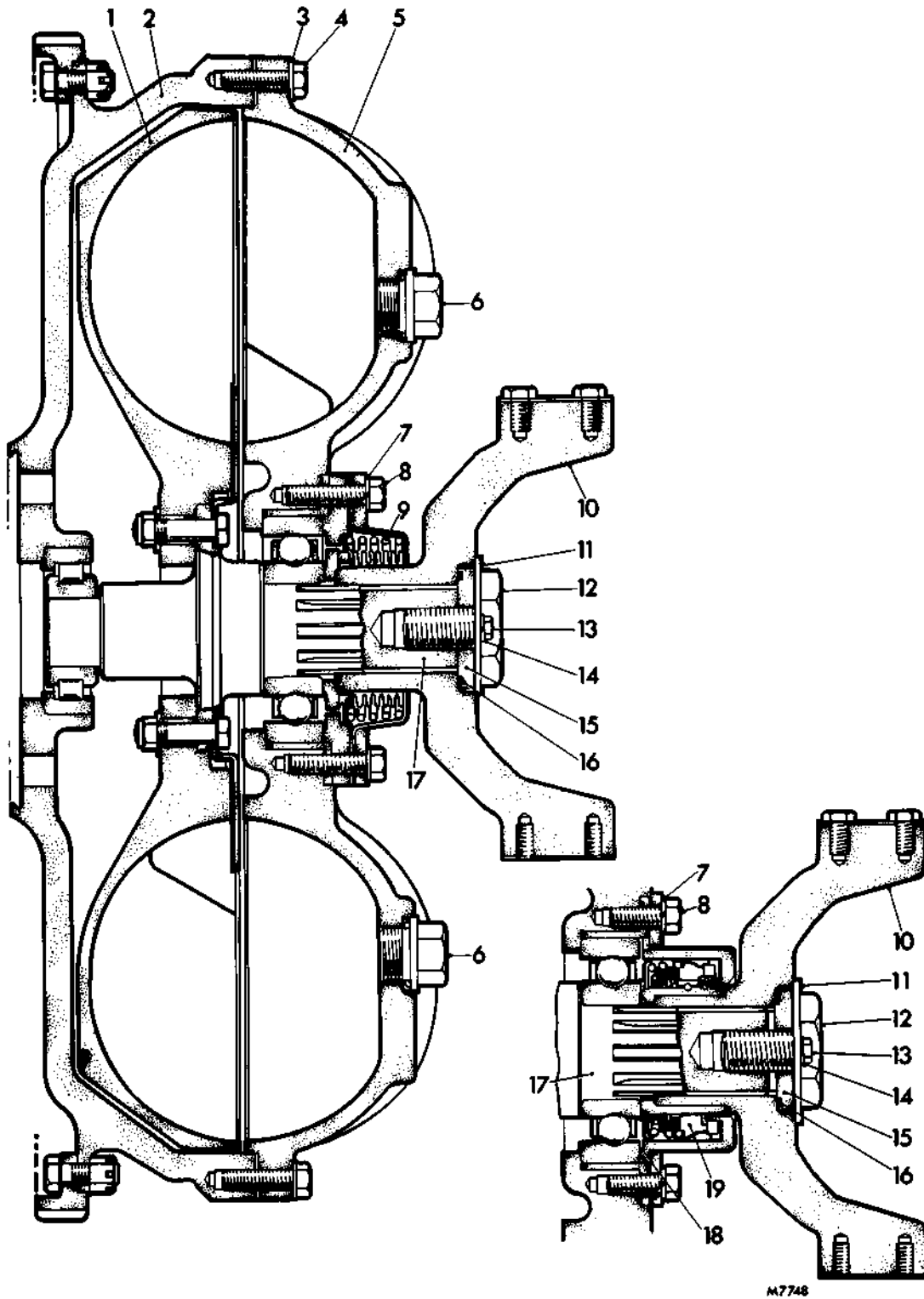
**FLUID COUPLING**

**To Remove**

1. Remove oil seal.
2. Rotate the fluid coupling until one of the drain plugs is at the bottom, remove the plugs and drain the oil into a suitable container. Refit plugs.
3. Remove the setscrews and spring washers from the periphery of flywheel, insert two  $\frac{1}{8}$  U.N.C. extractor screws into the tapped holes provided and withdraw the fluid coupling from the flywheel.

**To Refit**

1. Assemble the rear casing as a unit with runner and gland seal assembly.
2. Clean the mating faces of the fluid coupling and the flywheel, then apply a thin coat of Hylomar jointing compound.
3. Refit the setscrews and tighten evenly.
4. Refit oil seal.
5. Refill fluid coupling with correct quantity and grade of oil, see Group 1.



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FIG. 2. FLUID COUPLING – GARDNER ENGINE

- |                      |                                 |                         |
|----------------------|---------------------------------|-------------------------|
| 1. Runner            | 8. Setscrew                     | 15. Washer              |
| 2. Front casing      | 9. Oil seal, British thermostat | 16. O-ring              |
| 3. Spring washer     | 10. Coupling yoke               | 17. Runner shaft        |
| 4. Setscrew          | 11. Locking plate               | 18. Joint               |
| 5. Rear casing       | 12. Bolt                        | 19. Oil seal, Llewellyn |
| 6. Drain/filler plug | 13. Setscrew                    |                         |
| 7. Spring washer     | 14. Spring washer               |                         |



**GROUP 4**  
**TRANSMISSION**

	Reference
<b>SECTION 1—PROPELLER SHAFT</b>	
Removal and Refitment . . . . .	4-1-1
Overhaul. . . . .	4-1-2
<b>SECTION 2—GEARBOX REMOVAL AND REFITMENT</b>	
To Remove . . . . .	4-2-1
To Refit . . . . .	4-2-2
<b>SECTION 3—GEARBOX OVERHAUL</b>	
Data . . . . .	4-3-1
Description . . . . .	4-3-3
Operation . . . . .	4-3-4
Overhaul . . . . .	4-3-7
<b>SECTION 4—TRANSFER BOX</b>	
Data . . . . .	4-4-1
Removal and Refitment . . . . .	4-4-1
Overhaul . . . . .	4-4-3

## SECTION 1

## Propeller Shaft

**To Remove**

1. Suitably mark coupling flanges for subsequent refitment.
2. Remove nuts and bolts securing propeller shaft to gearbox and rear axle flanges. Compress shaft and remove.

**To Refit**

Refitment is a reversal of removal procedure, with the following points to note:

1. When a slip stub shaft has been removed it should always be replaced with the arrows aligned.
2. Clean the mating faces of the coupling flanges and ensure that the pilot spigot registers correctly and the faces bed evenly all round.
3. The dust caps should be screwed up by hand as far as possible.
4. The slip joint of the propeller shaft is fitted to the gearbox output coupling flange.

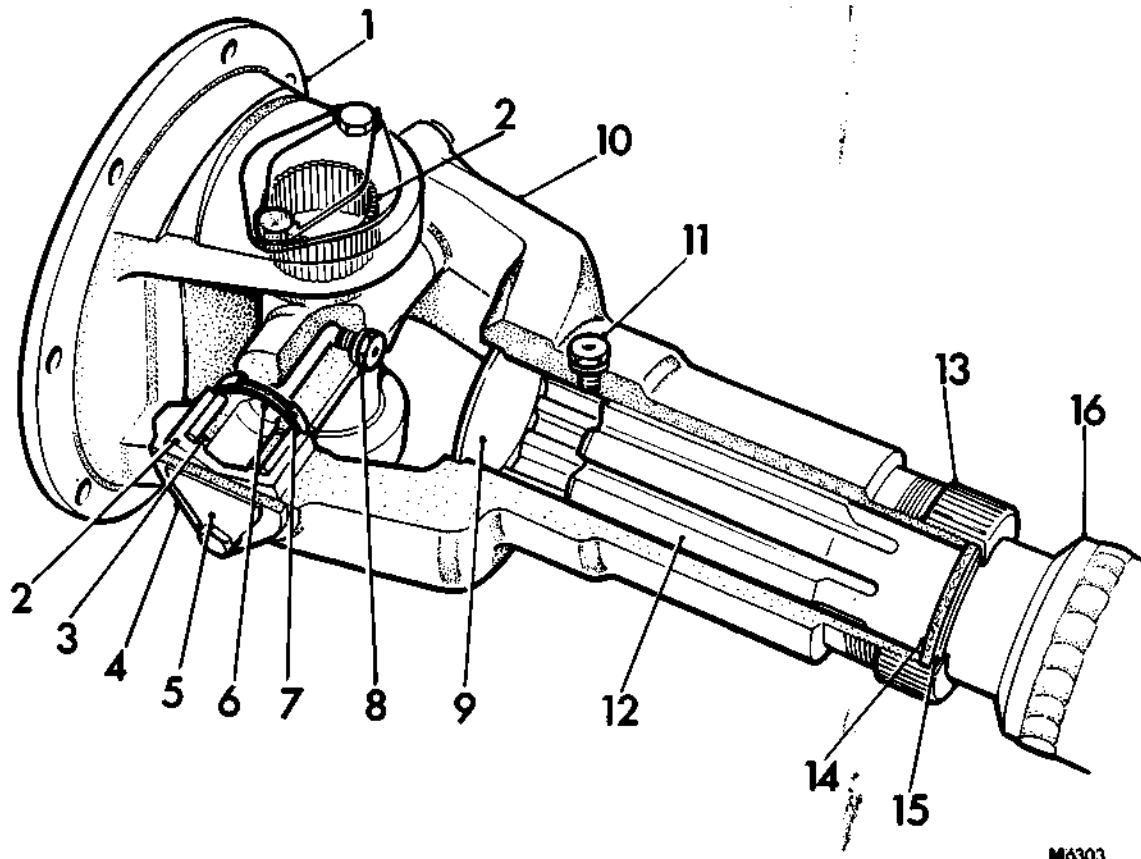


FIG. 1. SECTION THROUGH TYPICAL UNIVERSAL JOINT

- |                     |                   |                     |                  |
|---------------------|-------------------|---------------------|------------------|
| 1. Flange yoke      | 5. Locking plate  | 9. Closing washer   | 13. Dust cap     |
| 2. Bearing assembly | 6. Bearing seal   | 10. Sleeve yoke     | 14. Felt washer  |
| 3. Journal          | 7. Journal gasket | 11. Lubricator      | 15. Steel washer |
| 4. Bearing cap      | 8. Lubricator     | 12. Slip stub shaft | 16. Tube         |



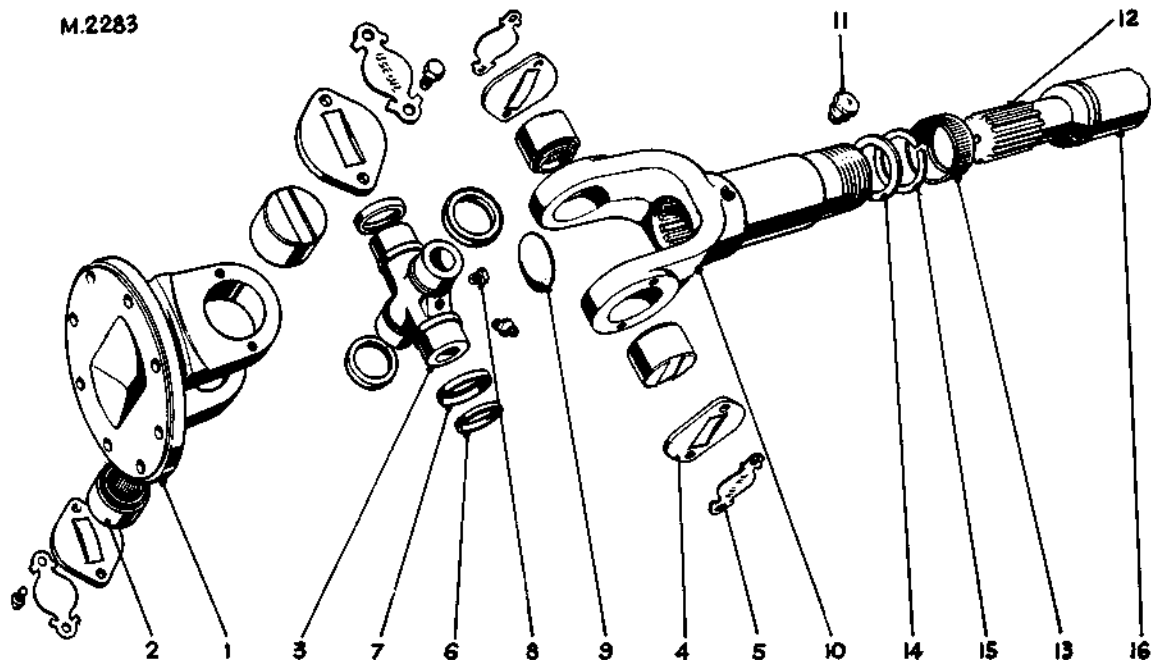


FIG. 2. EXPLODED VIEW OF TYPICAL UNIVERSAL JOINT

- |                     |                     |                  |
|---------------------|---------------------|------------------|
| 1. Flange yoke      | 7. Journal gasket   | 13. Dust cap     |
| 2. Bearing assembly | 8. Lubricator       | 14. Felt washer  |
| 3. Journal          | 9. Closing washer   | 15. Steel washer |
| 4. Bearing cap      | 10. Sleeve yoke     | 16. Tube         |
| 5. Locking plate    | 11. Lubricator      |                  |
| 6. Bearing seal     | 12. Slip stub shaft |                  |

**OVERHAUL**

If there is excessive noise or vibration from the transmission, examine the propeller shaft for:

1. Check the tightness of all nuts, bolts and setscrews.
2. Check lubrication.
3. Check for wear on the needle roller bearings by lifting the universal joints, either by hand or by using a length of wood suitably supported.
4. Check for circumferential wear by attempting to turn the shaft in relation to the flanges. If movement is evident, this indicates wear on the needle roller bearings or the splines of the slip joint.
5. Check for misalignment or out of balance due to faulty assembly on the vehicle.
6. Check that the propeller shaft is not bent as a result of accident damage.

**To Dismantle**

1. Knock down the tabs on the lock strap and remove the setscrews.
2. Remove the bearing caps.

3. Support the flange and sleeve yokes on two wood blocks with the lug of the sleeve yoke uppermost. With a soft metal drift, slightly smaller than the outside diameter of the needle bearing race, drive out the underneath bearing housing. The bearing will gradually emerge and can be removed finally with the fingers. Take care not to lose any needle rollers out of the bearing race. Reverse the joint and repeat the operation for the opposite bearing, using the drift on the exposed end of the journal trunnion.
4. Repeat operation 3 with lug of the flange yoke uppermost.
5. Separate the yokes from the journal trunnion.
6. Unscrew the dust cap and pull the slip stub shaft out of the sleeve yoke.

To remove individual bearings from joints in position on the vehicle, remove the bearing cap and tap the opposite yoke with a copper or hide hammer until the bearing can be pulled out with the fingers. Repeat for each bearing in turn.

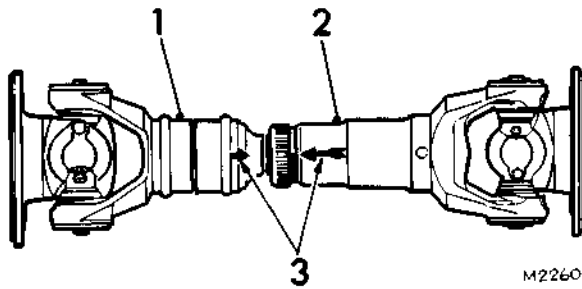


FIG. 3. PROPELLER SHAFT ALIGNMENT MARKS

1. Sleeve yoke 2. Slip stub shaft 3. Alignment arrows

#### Inspection

1. Wash all parts except the seals in paraffin and dry thoroughly. Do not use compressed air.
2. The parts most likely to show signs of wear after long usage are the bearing assemblies and journal trunnions. Should looseness in the fit of these parts, load markings, or distortion be observed, they must be renewed complete, as no oversize journals or bearing housings are provided. It is essential that the bearings are a light drive-fit in the flange and sleeve yoke lugs. If wear has taken place in the holes in the yoke lugs, the holes will most certainly be oval, and the yokes must be renewed.  
In the case of wear of the holes in a stub ball yoke, which is part of the tubular shaft assembly, it must be replaced by a complete tubular shaft assembly.
3. The other parts likely to show signs of wear are the sleeve yoke, or the slip stub shaft. A maximum of 0.25 mm (0.010 in) circumferential movement, measured on the outside diameter of the spline, should not be exceeded. Should the stub shaft require renewing, this must be dealt with in the same way as the stub ball yoke, that is, a replacement tubular shaft assembly must be fitted.

#### To Reassemble

1. Assemble the needle rollers in the bearing races and fill with oil. Smear the walls of the race with petroleum jelly if necessary to retain the needle rollers in place.
2. Renew the cork journal gaskets and retainers on the journal trunnion. The journal shoulders should be smeared with shellac prior to fitting the retainers to get a good oil seal. Use a tubular drift to ensure that the gaskets and retainers fit down on the trunnion shoulders.
3. Insert the journal trunnion in the yokes. Tap the bearings into position at opposite ends of the journal trunnion in turn, with a soft drift. It is essential that the slot in the top of the bearing race is in line with the bearing cap setscrew holes; this ensures that the race is prevented from turning by the key in the bearing cap.
4. Replace the bearing caps, lock straps and setscrews.
5. If the joint appears to bind, tap the lugs lightly with a wooden mallet, which will relieve any pressure of the bearing race on the end of the journal trunnion arm.
6. When replacing a sliding joint on a shaft, be sure that the lugs on the flange and sleeve yoke are in line. This can be checked by observing whether the arrows stamped on the sleeve yoke and slip stub shaft are in line. Screw up the dust cap over the cork and steel washers by hand.
7. Refill the joints and sleeve yoke with oil through the lubricators provided.

## SECTION 2

## Gearbox Removal and Refitment

**To Remove**

1. Isolate batteries.
2. Drain the oil from the gearbox and angle drive. Clean and replace the drain plugs.
3. Remove engine compartment covers, see Group 9.
4. Remove engine air filter securing straps, release hose, clips, then remove filter and flexible hoses.
5. Remove radiator, see Group 2.
6. Remove alternator, see Group 8.
7. Disconnect and remove cooling fan drive shaft.
8. Release hose clips and remove top and bottom water pipes.
9. Disconnect the pulse generator cable at the snap connector on the bulkhead.
10. Suitably identify, then remove air control pipes from gearbox.
11. Suitably mark angle drive output coupling and propeller shaft coupling for subsequent refitment, then disconnect propeller shaft and support from a convenient point on chassis.
12. Remove universal coupling or trailing link from between fluid coupling and angle drive.
13. Support weight of gearbox with lifting equipment.
14. Remove bolts from gearbox rear mounting brackets.
15. Remove nuts from bolts in gearbox front mountings, then tap bolts out of mountings.
16. Manoeuvre gearbox clear of vehicle.

**To Refit**

1. Lower gearbox into position, then tap front mounting bolts through mountings and secure with nuts.
2. Align rear mounting brackets and secure into position with nuts and bolts.
3. Fit universal coupling or trailing link between fluid coupling and gearbox. Tighten bolts securely.
4. On vehicles fitted with trailing links, check the engine to gearbox alignment as follows:
  - a. Two tools that can be manufactured locally to assist in checking the alignment are shown in Figs. 2 and 4.
  - b. Secure the vertical alignment tool on to the top two studs of the angle drive output gear case.

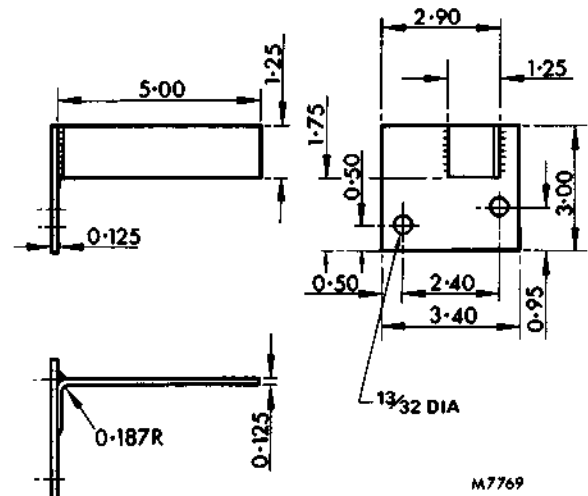


FIG. 1. VERTICAL ALIGNMENT TOOL

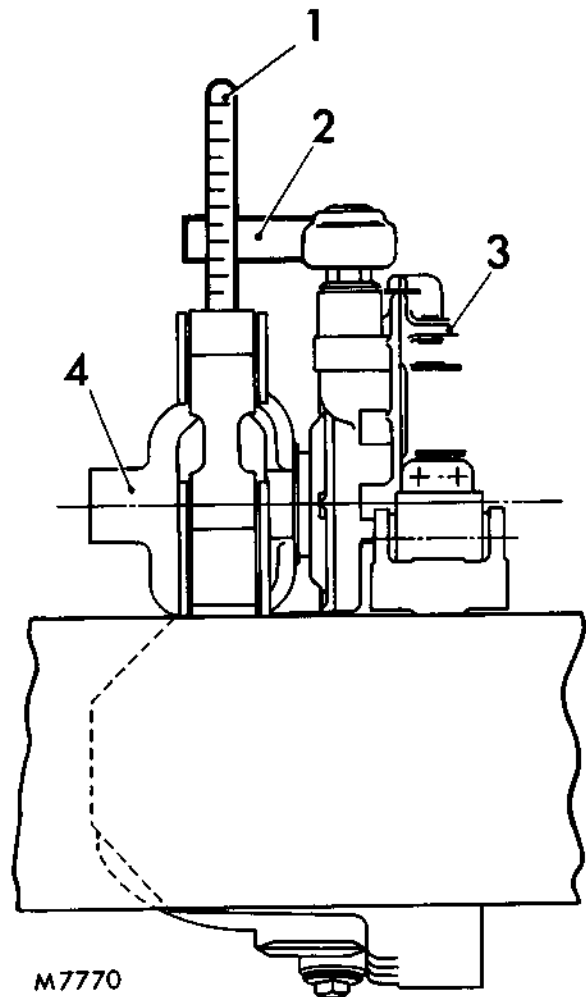


FIG. 2. CHECKING VERTICAL ALIGNMENT

- |         |                 |
|---------|-----------------|
| 1. Rule | 3. Transfer box |
| 2. Tool | 4. Yoke         |

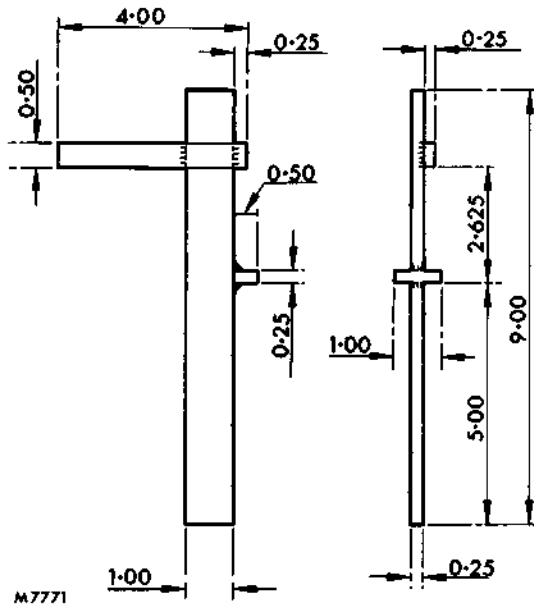


FIG. 3. HORIZONTAL ALIGNMENT TOOL

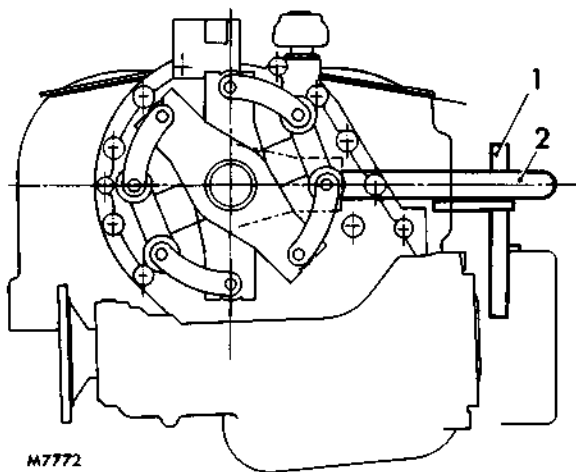


FIG. 4. CHECKING HORIZONTAL ALIGNMENT

1. Tool 2. Rule

- c. Rotate the trailing link manually until the yoke connected to the fluid coupling is in the vertical plane. Place a rule vertically on the yoke, record the dimension from the yoke to the tool.
  - d. Rotate the trailing link manually until the yoke connected to the gearbox is in the vertical plane, then repeat as in 'c'.
  - e. The difference between the two dimensions is the difference between engine and gearbox centre lines. At initial assembly the engine yoke dimension is set 3.175 mm (0.125 in) less than the gearbox yoke dimension. The maximum permissible tolerance is zero to 7.35 mm (0.250 in). Add or subtract shims between the angle drive mounting brackets and frame.
  - f. Secure the horizontal alignment tool vertically on the sub-frame inner face.
  - g. Rotate the trailing link until the yoke connected to the fluid coupling is in the horizontal plane. Rest the rule on the support of the tool. Note the dimension from the yoke to the vertical straight edge of the tool.
  - h. Rotate the trailing link until the gearbox yoke is horizontal, note the dimension from the yoke to the straight edge of the tool.
  - i. The difference between the two readings must not exceed 1.6 mm (0.062 in).
  - j. Add or subtract shims between the sub-frame inner face and the angle drive mounting brackets.
5. Fit universal coupling between fluid coupling and gearbox. Tighten bolts securely.
  6. Align propeller shaft coupling with angle drive coupling, then secure with nuts and bolts.
  7. Connect air control pipes to gearbox.
  8. Connect the pulse generator cable at the snap connector on the bulkhead.
  9. Refit top and bottom water pipes and secure with hose clip.
  10. Connect cooling fan drive shaft.
  11. Refit alternator, see Group 8.
  12. Refit radiator, see Group 2.
  13. Position engine air filter into mounting straps and secure. Fit flexible hoses and secure with hose clips.
  14. Refit engine compartment covers, see Group 10.
  15. Refill gearbox and angle drive with correct grade and quantity of oil, see Group 1.
  16. Reconnect batteries.
  17. Road test vehicle and check for operation and leaks.

## SECTION 3

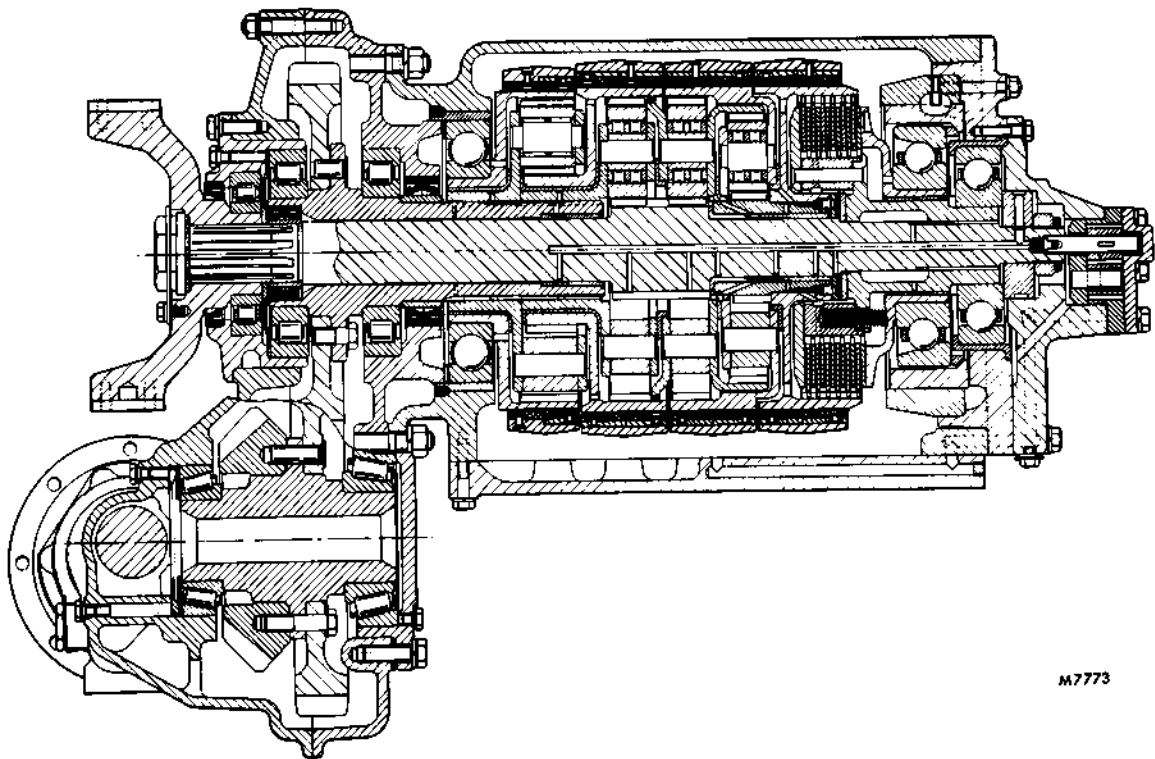
## Gearbox Overhaul

## DATA

Type .....	Epicyclic with four forward gears and reverse	
Units .....	GB 485 Leyland engine GB 486 Gardner engine	
Gear ratios .....	Reverse 4.88:1 First 4.15:1 Second 2.36:1 Third 1.56:1 Fourth 1.00:1	
Oil capacity .....	8.53 litres (15 pints)	
Operating air pressure .....	6.3 to 6.7 kgf/cm <sup>2</sup> (90 to 95 lbf/in <sup>2</sup> )	
Approximate weight (dry) .....	331 kg (730 lb)	
Top gear clutch springs free length .....	63.5 mm (2.5 in) Weak springs to be replaced as a set	
Bush sizes:	mm	in
Reverse brake drum bush .....	88.75 to 88.77	3.494 to 3.495
o.dia.	83.79 to 83.82	3.299 to 3.300
i.dia.	2.49 to 2.54	0.098 to 0.100
Flange	88.75 to 88.77	3.494 to 3.495
1st speed brake drum bushes .....	83.79 to 83.84	3.299 to 3.301
o.dia.	2.49 to 2.54	0.098 to 0.100
i.dia.	96.36 to 96.39	3.794 to 3.795
Flange	2.49 to 2.54	0.098 to 0.100
1st and 2nd speed .....	88.75 to 88.77	3.494 to 3.495
o.dia.	81.25 to 81.30	3.199 to 3.201
i.dia.	2.49 to 2.54	0.098 to 0.100
Flange	73.58 to 73.61	2.897 to 2.898
2nd speed brake drum bush .....	66.01 to 66.06	2.599 to 2.601
o.dia.	2.49 to 2.54	0.098 to 0.100
i.dia.	2.29 to 2.34	0.090 to 0.092
Flange	48.16 to 48.18	1.896 to 1.897
3rd speed support washer .....	41.27 to 41.30	1.625 to 1.626
o.dia.	28.45 to 28.57	1.120 to 1.125
i.dia.	50.70 to 50.72	1.996 to 1.997
Flange	44.42 to 44.47	1.749 to 1.751
3rd speed thrust washer .....	64.77 to 64.82	2.550 to 2.552
4th speed sun wheel bush .....	12.70 to 12.73	0.500 to 0.501
o.dia.		
i.dia.		
Output sleeve bush .....		
o.dia.		
i.dia.		
Clutch sliding member bush .....		
o.dia.		
i.dia.		
Oil pump and speedometer drive bush .....		
o.dia.		
i.dia.		
Maximum wear on above sizes .....	0.10	0.004
Brake drum clearances:		
Reverse and 1st speed .....	0.30 to 0.20	0.012 to 0.008
1st and 2nd speed .....	0.38 to 0.30	0.015 to 0.012
2nd and 3rd speed .....	0.38 to 0.30	0.015 to 0.012







M7773

FIG. 1. SECTIONAL VIEW OF GEARBOX

## DESCRIPTION

The Diamatic gearbox is of the epicyclic type providing four forward gears and reverse. Gear engagement is controlled by an electro-pneumatic system.

The brake gear and actuating mechanism is built up onto the bottom cover, which is then fitted to the underside of the gearbox. The running gear, comprising the gear trains, oil pump assembly and the gearbox front cover, is mounted on three ball races. Continuously filtered lubrication is provided for the running gear and other working parts by a gear-type oil pump driven from the end of the mainshaft. The oil is passed through a full-flow, replaceable filter, access to which is obtained from beneath the vehicle. The filter can be renewed without draining the gearbox oil.

The operating pistons are of aluminium alloy and are

fitted with two heat-resisting, synthetic rubber seals. The bottom of each cylinder is sealed with an 'O' ring and cover-plate.

The selection equipment used for semi-automatic application comprises a fingertip gear selector switch situated adjacent to the steering wheel and an electro-pneumatic valve unit attached to the gearbox. A warning light is incorporated in the gear selector switch to indicate that the electrical power is switched on and the gearbox is in neutral. An air limiting valve is installed between the auxiliary reservoir and the gearbox electro-pneumatic valve unit to limit the air pressure to the gearbox to the ideal working pressure.

The drive output from the transverse mounted gearbox is via a transfer box which incorporates spur and bevel gears to transfer the drive longitudinally to the rear axle.

## OPERATION

The individual gear trains are not used independently as in a conventional gearbox. It is by compounding the reverse or second gear train onto that of the first gear train that reverse or second gear is obtained, and by further compounding the third gear train to that of the second and first gear trains that the third gear is obtained.

The first speed gear is obtained by using a basic epicyclic gear train. The sun wheel is integral with the mainshaft. The outer periphery of the annulus acts as a brake drum to which the brake band is applied. The planet gears, between the sun wheel and the annulus, are attached to the planet carrier, which is also splined to the output sleeve.

The sun wheel is rotating with the engine and when the brake band is applied the annulus is held stationary; as the planets are meshed with both the sun wheel and the annulus they are forced to rotate inside the annulus thus turning the planet carrier in the same direction as the sun wheel but at a reduced speed.

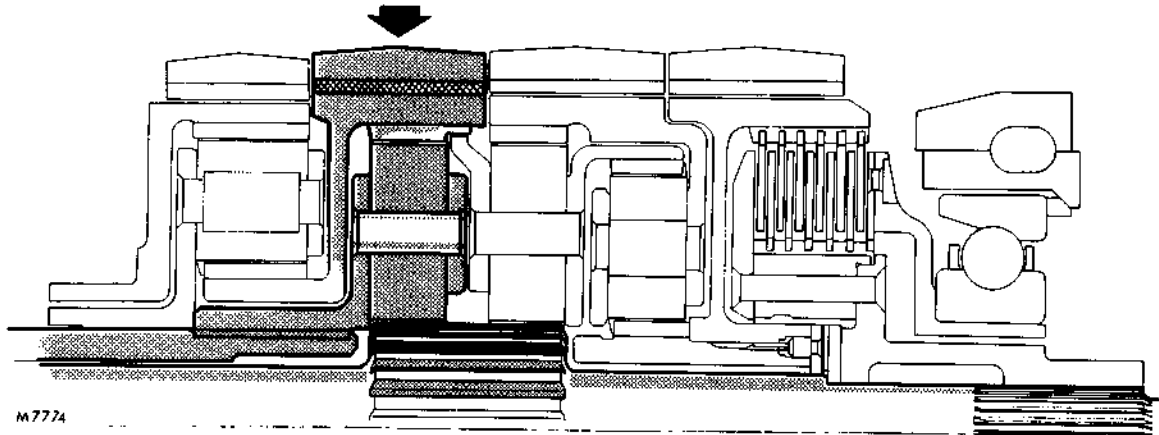


FIG. 2. FIRST SPEED POWER TRAIN

The second speed gear is obtained by releasing the first speed annulus and holding the second speed annulus stationary. As with the first gear, the planets are meshed to both the mainshaft and the annulus, therefore the planet carrier revolves in the same manner. The second speed annulus is meshed to the first speed annulus, therefore revolving the first speed annulus while its planet gears are still being driven by the sun wheel. This increases the speed of the output sleeve, thus reducing the original ratio.

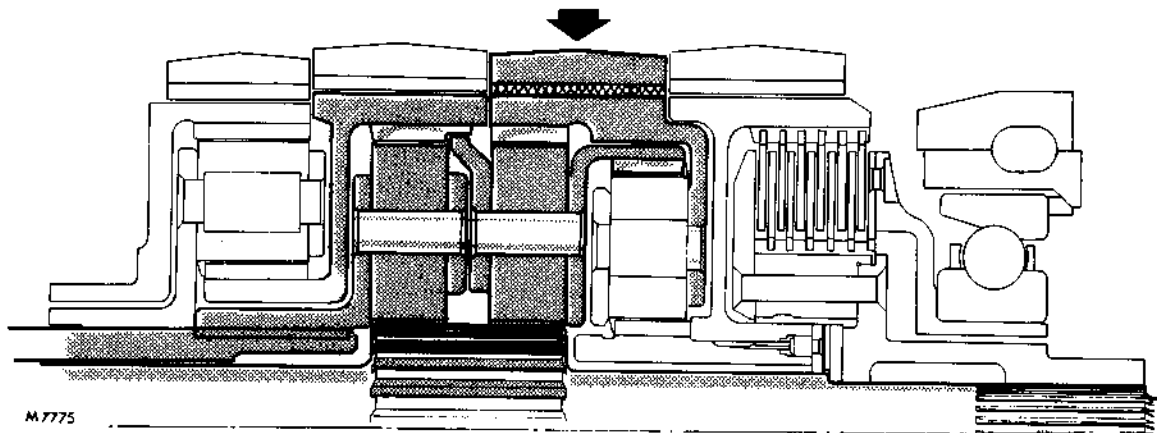
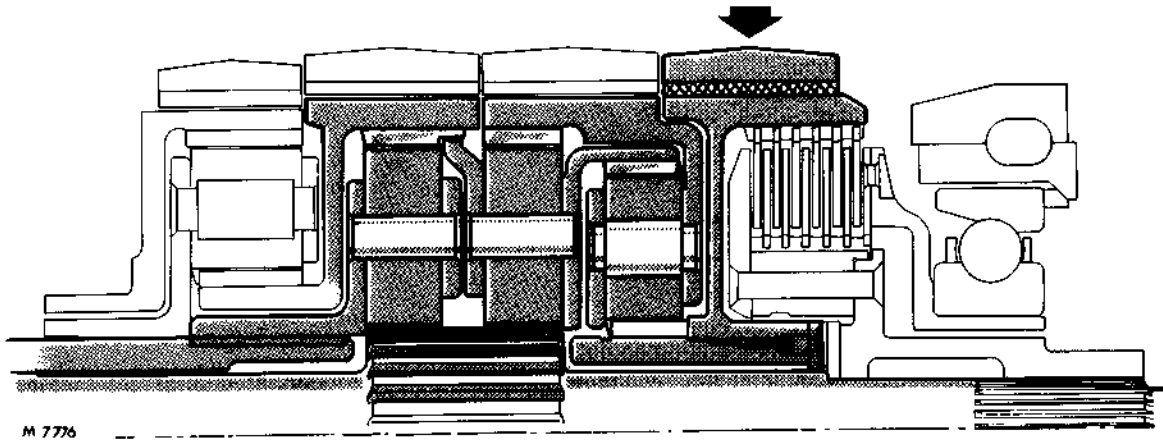


FIG. 3. SECOND SPEED POWER TRAIN



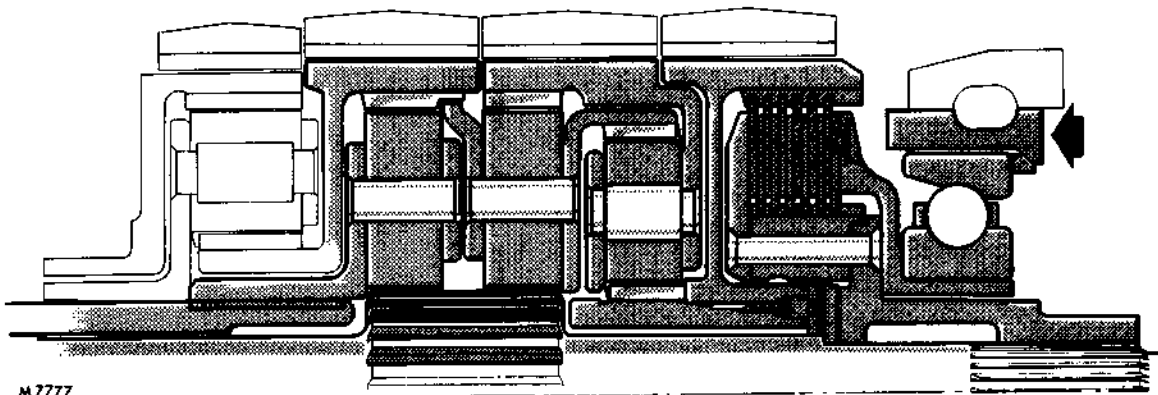
The third speed gear is obtained by releasing the second speed annulus and holding the fourth speed outer member stationary. The third speed sun wheel is splined to the fourth speed outer member, therefore the sun wheel is also held stationary. The third speed planet carrier is connected to the second speed annulus and the third speed annulus is connected to the second speed planet carrier and first speed annulus. This configuration speeds up the rotation of the first speed annulus and therefore the output sleeve speed will increase, thereby reducing the original ratio still further.



M 7776

**FIG. 4. THIRD SPEED POWER TRAIN**

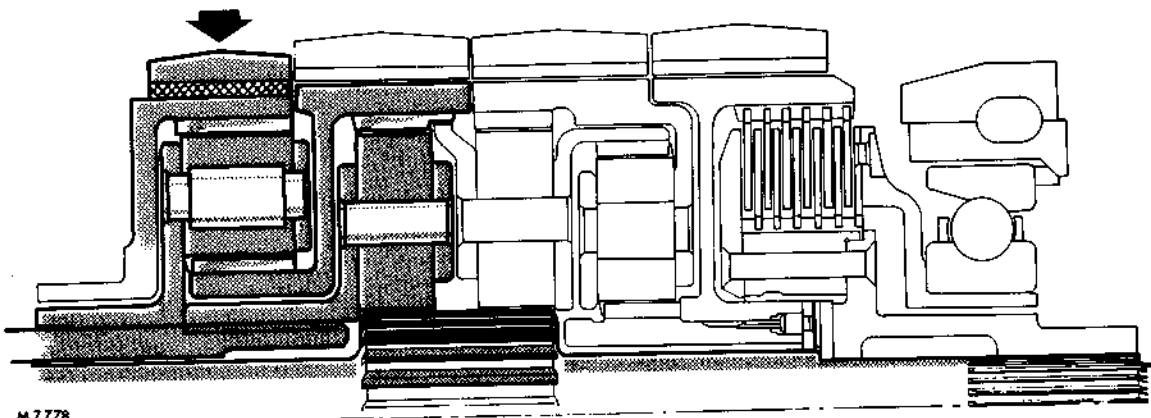
The fourth speed gear is obtained by releasing the third speed annulus and closing a multi-plate clutch between the third speed sun wheel and the mainshaft. The third speed sun wheel is then rotating at the same speed as the first and second speed sun wheel. The running gear rotates as a solid unit as the mainshaft has become locked to the output sleeve.



M 7777

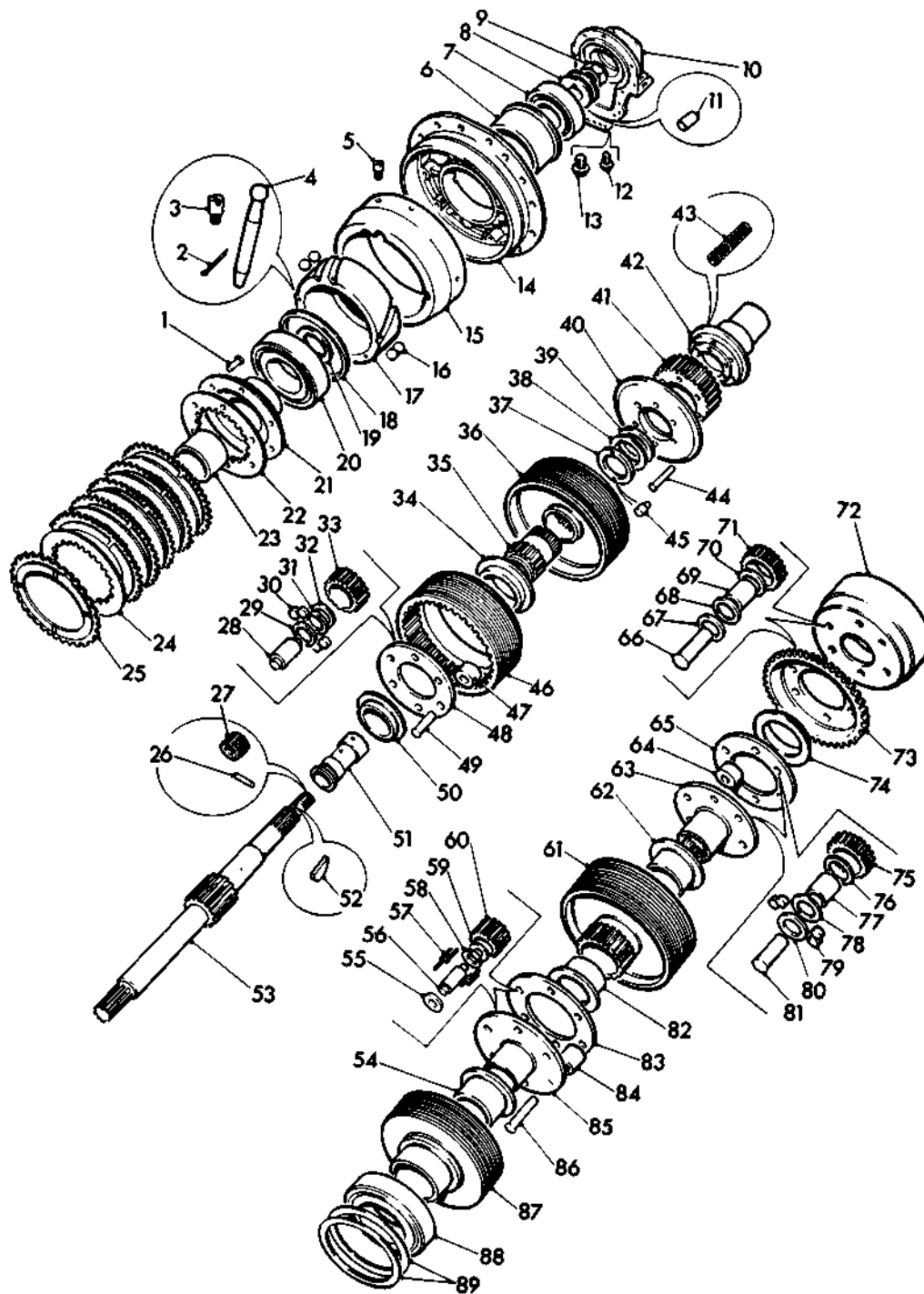
**FIG. 5. FOURTH SPEED POWER TRAIN**

Reverse gear is obtained by holding the reverse annulus stationary. The first speed planets are meshed with the mainshaft sun wheel; this forces the first speed annulus to rotate slowly in the opposite direction to the mainshaft. The first speed annulus is connected to the reverse sun wheel, therefore this change of direction and speed reduction is transferred to the reverse planets. With the reverse annulus held stationary the planets are forced to revolve inside the annulus, thus turning the planet carrier and the output sleeve in the opposite direction to the mainshaft. As the first speed is turning slowly in the opposite direction, this increases the original ratio.



M 7778

**FIG. 6. REVERSE POWER TRAIN**



M7779

FIG. 7. EXPLODED VIEW OF GEARBOX RUNNING GEAR

- |                              |                                     |                                   |                              |
|------------------------------|-------------------------------------|-----------------------------------|------------------------------|
| 1. Rivet                     | 25. Outer clutch plate              | 47. Distance piece                | 69. Inner races              |
| 2. Split pin                 | 26. Driving pin                     | 48. Plate                         | 70. Washers                  |
| 3. Peg                       | 27. Grubscrew                       | 49. Rivet                         | 71. 2nd speed planets        |
| 4. Operating pin             | 28. 3rd speed planet centre bearing | 50. Support washer                | 72. 2nd speed annulus        |
| 5. Peg                       | 29. Washer                          | 51. Sun wheel bush                | 73. 2nd speed planet carrier |
| 6. Bearing housing           | 30. Rollers                         | 52. Key                           | 74. Distance piece           |
| 7. Bearing                   | 31. Washer                          | 53. Driving shaft                 | 75. 1st speed planet         |
| 8. Oil pump muff             | 32. Washer                          | 54. Bush                          | 76. Washers                  |
| 9. Locknut                   | 33. 3rd speed planets               | 55. Washers                       | 77. Inner race               |
| 10. Oil pump cover           | 34. 2nd speed brake drum bush       | 56. Reverse planet centre bearing | 78. Washers                  |
| 11. Dowel                    | 35. 3rd speed sun wheel             | 57. Needle rollers                | 79. Rollers                  |
| 12. Drain plug               | 36. 3rd speed brake drum            | 58. Spacers                       | 80. Washers                  |
| 13. Drain plug               | 37. Thrust plate                    | 59. Washers                       | 81. Rivets                   |
| 14. Front cover              | 38. Thrust washer                   | 60. Reverse planets               | 82. Bush                     |
| 15. 4th gear outer member    | 39. Thrust washer                   | 61. 1st speed brake drum          | 83. Plate                    |
| 16. Balls                    | 40. Rear clutch plate               | 62. Bush                          | 84. Distance piece           |
| 17. 4th gear actuating ring  | 41. Inner gear ring                 | 63. Planet carrier                | 85. Reverse planet carrier   |
| 18. Thrust washer            | 42. Inner support member            | 64. Distance piece                | 86. Rivet                    |
| 19. Adjuster washer          | 43. Spring                          | 65. Plate                         | 87. Reverse brake drum       |
| 20. Bearing                  | 44. Rivet                           | 66. Rivet                         | 88. Bearing                  |
| 21. Clutch member            | 45. Dowel                           | 67. Washers                       | 89. Shims                    |
| 22. Front inner clutch plate | 46. 2nd speed brake drum            | 68. Washers                       |                              |
| 23. Bush                     |                                     |                                   |                              |
| 24. Inner clutch plate       |                                     |                                   |                              |



**OVERHAUL**

**To Dismantle**

1. Remove setscrews securing oil filter cover; using two setscrews jack off cover and filter assembly.
2. Remove setscrews securing inspection covers, remove covers and joints.
3. Check and note on each individual brake band adjuster the dimension between the abutment face of the brake adjuster stop bolt locknut and the inner face of the stop bolts, 'A', and also the dimension between the abutment face of the locknuts and the inner face of the adjuster table when the pistons are fully energized, 'B'.
4. Detach the brake adjuster spring loops from the anchoring pegs.
5. Remove the adjuster rings, pull-rod nuts and adjuster tables.
6. Remove nut and setscrews securing rear cover to gearbox.
7. Fit a plain washer 102 mm (4.0 in) outside diameter and 46 mm (1.845 in) inside diameter over the gearbox mainshaft against the reverse drum face. Fit a suitable tube over the shaft and secure tube with washer and bolt. The tube and washers retain the running gear as an assembly during removal.
8. Tap the end of the mainshaft with a soft metal drift to break the end cover joint.
9. Stand the gearbox on suitable wooden blocks, end cover uppermost.
10. Remove setscrews securing oil pump, then withdraw the oil pump assembly.
11. Attach a suitable lifting eye to the oil pump aperture, then lift the running gear vertically out of the case. Take care when lifting running gear not to trap the top gear operating pin.
12. Lower the running gear and remove the lifting eye. Turn the running gear and stand vertically on wooden block, remove locknut and distance tubes from mainshaft.
13. Measure the gap widths between the brake drums and compare the readings obtained with those quoted in Data. Any variations from the figures quoted indicates worn bushes and washers; these will have to be replaced when reassembling running gear.

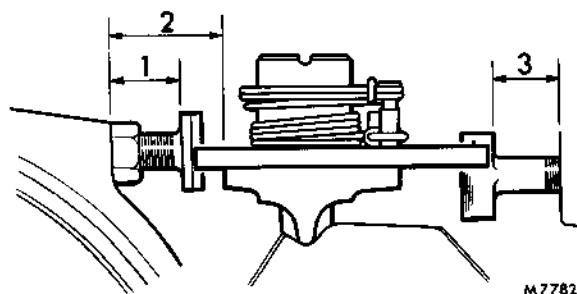
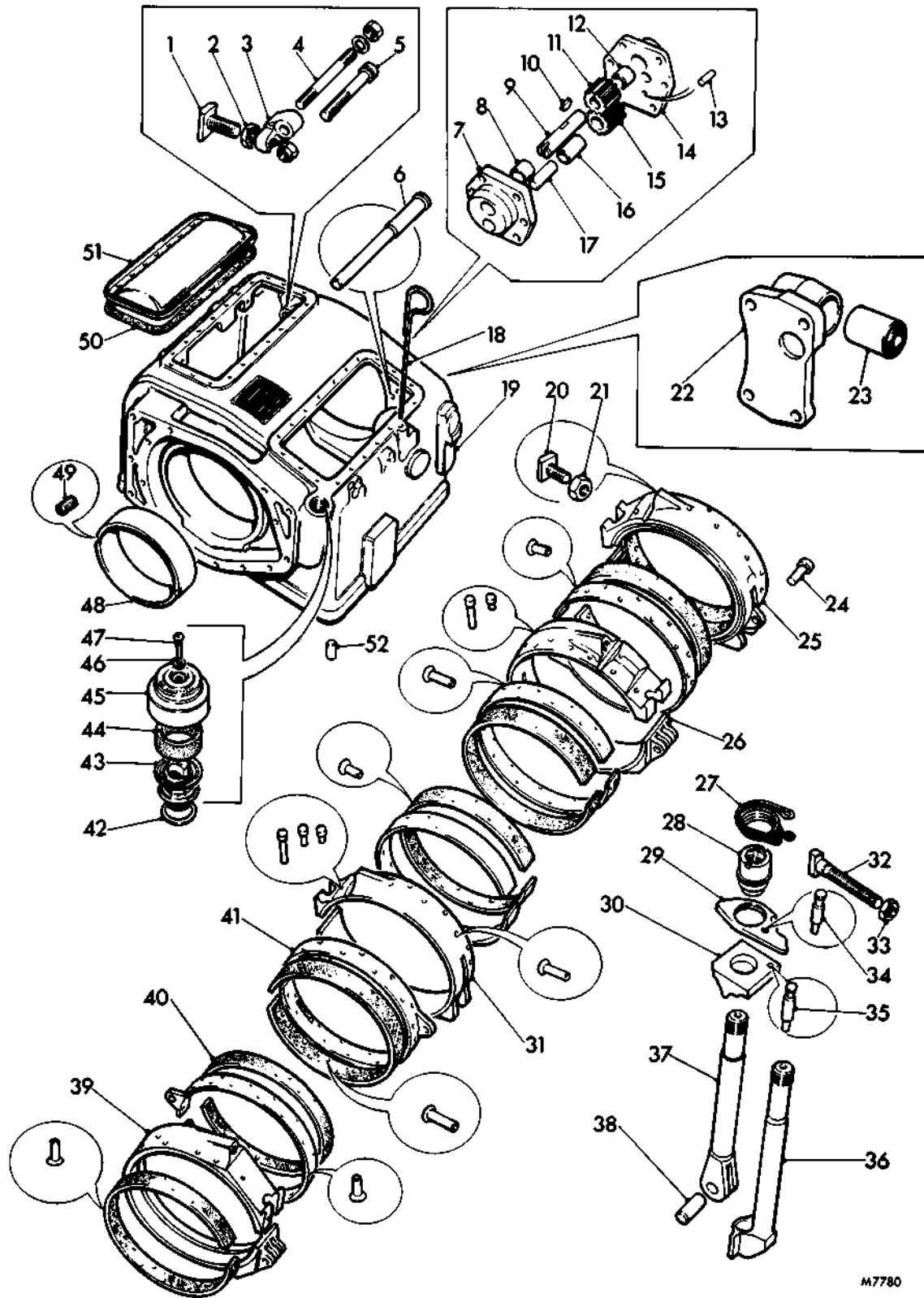


FIG. 8. TOGGLE SETTINGS

Gear	Dimension 1		Dimension 2	
	mm	in	mm	in
1st	17.8	0.70	34.5	1.36
2nd	15.9	0.625	33.5	1.32
3rd	19.0	0.75	35.8	1.41
4th	16.5	0.65	34.9	1.375
rev.	12.7	0.5	30.1	1.187

Dimension 3 should be 19 mm (0.75 in) approx.  
Dimension 1 is given as an initial setting figure and can be varied to produce the correct toggle setting.

14. Remove the reverse and first gear trains from the mainshaft, collect the various bushes.
15. Remove the running gear from the blocks and grip the mainshaft in a soft-jawed vice.
16. Remove the setscrews and nut securing the rear bearing housing cover, remove cover.
17. Remove the locknut and oil pump muff from the mainshaft.
18. Withdraw the front cover assembly.
19. Lift the third and second speed gear assemblies from the mainshaft, collect all the various bushes.
20. Position front cover assembly in a press, then press inner gear support member through the cover. Take care to collect the eight actuating balls.
21. Lift off the front cover and the fifth gear outer member.
22. Dismantle the remaining running gear parts, ensure to retain the six return springs.



M7780

FIG. 9. EXPLODED VIEW OF GEARBOX BRAKE BANDS AND CASING

- |                           |                                   |                                     |                        |
|---------------------------|-----------------------------------|-------------------------------------|------------------------|
| 1. Adjuster screw         | 14. Cover plate                   | 26. 2nd speed brake band            | 38. Pin                |
| 2. Locknut                | 15. Driven gear                   | 27. Adjuster spring                 | 39. Reverse brake band |
| 3. Adjuster screw bracket | 16. Bearing                       | 28. Adjuster nut                    | 40. Lining             |
| 4. Stud                   | 17. Spindle                       | 29. Adjuster ring                   | 41. External strip     |
| 5. Screw                  | 18. Dipstick                      | 30. Adjuster table                  | 42. Washer             |
| 6. Locating peg           | 19. Gearbox casing                | 31. 1st speed brake band            | 43. Breather           |
| 7. Oil pump body          | 20. Adjuster screw                | 32. Tail pin                        | 44. Filter             |
| 8. Bearing                | 21. Locknut                       | 33. Locknut                         | 45. Cap                |
| 9. Drive shaft            | 22. Suspension bracket            | 34. Pin                             | 46. Washer             |
| 10. Key                   | 23. Bush                          | 35. Pin                             | 47. Screw              |
| 11. Drive gear            | 24. Pin                           | 36. 4th speed pull rod              | 48. Bearing housing    |
| 12. Bearing               | 25. 3rd speed brake band assembly | 37. 1st, 2nd, 3rd and rev. pull rod | 49. Grub screw         |
| 13. Dowel                 |                                   |                                     | 50. Joint              |
|                           |                                   |                                     | 51. Top cover          |
|                           |                                   |                                     | 52. Dowel              |

23. Remove nut and Allen screw securing top gear hooks to gearbox case. Retain the distance piece.
24. Remove all the setscrews securing the bottom cover to the gearbox case. Tap cover to break joint, then lift gearbox case from bottom cover.
25. Apply pressure to the top of each brake band and prize the locks away from their location on the bands.
26. Remove the split pins, then withdraw the two fulcrum rods. Remove the hooks and retain all the distance pieces.
27. Remove the split pins, then withdraw the centralizer rods. Identify brake bands for subsequent refitment, then remove bands, centralizers and springs.
28. Remove the push-rod assemblies from the cylinders.
29. Remove pins, pull-rods and links from brake bands.
30. Remove circlips, washers and springs from cylinders, then withdraw pistons.
31. Remove circlips from pistons, then remove washers, seals and 'O' rings.
32. Remove setscrews securing cylinder bottom covers to gearbox bottom cover, remove covers and 'O' rings.

#### Inspection

Thoroughly clean all components in solvent, then examine for wear or damage; renew as necessary.

Measure all bushes and washers, ensure they conform to figures quoted in Data; renew as necessary.

All clutch plates to be examined for excessive wear, dishing and pitting of sintering. Ensure that plates are within dimensions quoted in Data. It is advisable to change the complete set of plates.

All seals must be thoroughly examined and checked for lip wear. On rotating shaft seals, check the running surface for the seal. If these are more than 0.15 mm (0.006 in) down it is advisable to change the parts. Renew all seals that show any signs of wear.

Examine all planet carrier assemblies; the diametral clearances must not exceed 0.15 mm (0.006 in). Check the planet teeth for pitting; renew as necessary.

Check brake bands for break-up or glazing of lining. It is advisable at overhaul to replace linings, especially on forward speeds. If linings are renewed, both inner and outer bands must be changed. Bands must be retained as machined pairs.

#### Reassembly

1. If removed, refit cylinders to bottom cover.
2. Position new 'O' rings, then fit cylinder bottom covers to bottom cover.
3. Install new seals and 'O' rings into pistons, secure seals with washers and circlips.
4. Slide pistons into cylinders, then fit springs, washers and circlips.
5. Place the springs into the centralizers, compress each spring and locate the brake bands onto the centralizers ensuring that the springs are correctly located between the lugs of the bands.
6. Position the internal band links and pull-rods, then secure into position with pins. Ensure to install flanged pins with flange against hooks.
7. Fit the eyebolts through the bottom cover and secure into position with nuts.
8. Position the brake bands onto the bottom cover, then feed the centralizer rods through the centralizers. Secure the rods with split pins.
9. Insert fulcrum rods through hooks, distance pieces, links and eyebolts, secure rod into position with split pins.
10. Apply pressure to the top of each brake band and locate the hooks onto the band lugs.
11. Place push-rods and thrust pads into cylinders, then locate thrust pads over hooks and pull-rods.
12. Position adjuster tables and adjuster rings onto thrust pads, then fit adjuster nuts onto push-rods. Do not tighten nuts at this stage.



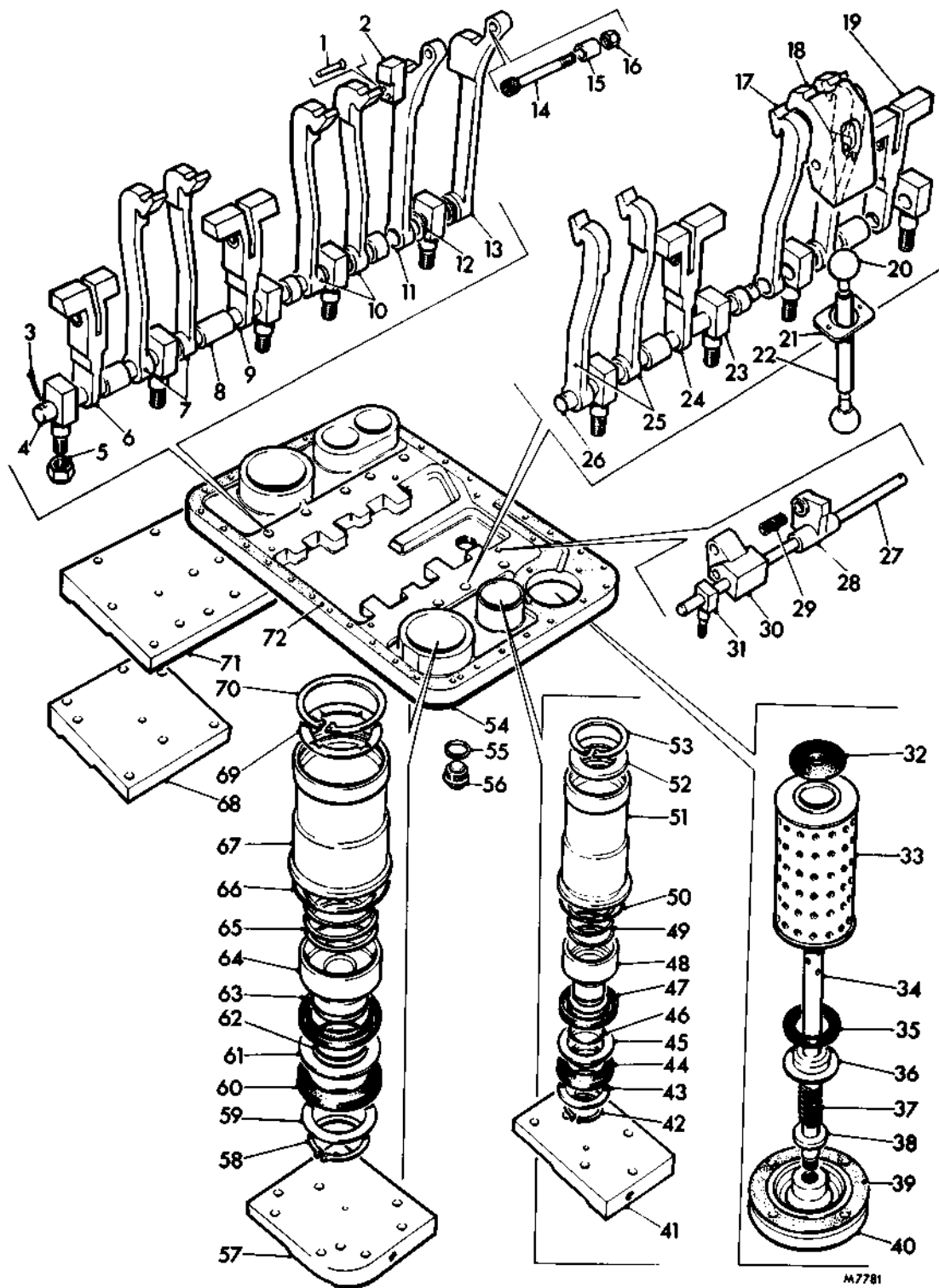


FIG. 10 EXPLODED VIEW OF GEARBOX SELECTOR GEAR

- |                          |                           |                          |                                |
|--------------------------|---------------------------|--------------------------|--------------------------------|
| 1. Rivet                 | 20. Spherical end         | 38. Distance washer      | 56. Drain plug                 |
| 2. Plate                 | 21. Retainer              | 39. Joint                | 57. Reverse cylinder cover     |
| 3. Split pin             | 22. Push rod              | 40. Cover                | 58. Circlip                    |
| 4. Fulcrum rod           | 23. Eyebolt               | 41. 2nd cylinder cover   | 59. Retaining washer           |
| 5. Locknut               | 24. Internal band link    | 42. Circlip              | 60. Piston seal                |
| 6. Internal band link    | 25. Reverse hooks         | 43. Retaining washer     | 61. Seal carrier               |
| 7. 1st speed hooks       | 26. Fulcrum rod           | 44. Piston seal          | 62. O-ring                     |
| 8. Distance piece        | 27. Centraliser rod       | 45. Seal carrier         | 63. Piston seal                |
| 9. Internal band link    | 28. Centraliser           | 46. O-ring               | 64. Piston                     |
| 10. 3rd speed hooks      | 29. Spring                | 47. Piston seal          | 65. Return spring              |
| 11. 4th speed rear hook  | 30. Pivot block           | 48. Piston               | 66. O-ring                     |
| 12. Spacing washer       | 31. Eyebolt               | 49. Return spring        | 67. Cylinder liner             |
| 13. 4th speed front hook | 32. Top sealing washer    | 50. O-ring               | 68. 1st cylinder cover         |
| 14. Screw                | 33. Element               | 51. Cylinder liner       | 69. Washer                     |
| 15. Distance tube        | 34. Centre tube           | 52. Washer               | 70. Circlip                    |
| 16. Locknut              | 35. Bottom sealing washer | 53. Circlip              | 71. 3rd and 4th cylinder cover |
| 17. 2nd speed hooks      | 36. Locating washer       | 54. Gearbox bottom cover | 72. Joint                      |
| 18. Thrust pad           | 37. Spring                | 55. Washer               |                                |
| 19. Internal band link   |                           |                          |                                |

13. Coat mating faces of bottom cover and gearbox case with Hylomar, then lower case onto bottom cover assembly and secure into position with setscrews.
14. Position the distance piece between the top gear hooks and secure into position with bolt and nut.
15. Stand mainshaft vertically, threaded end uppermost, in a vice.
16. Slide third speed sun wheel bush, flange end downwards, onto shaft against first speed sun.
17. Locate support washer against first speed gear.
18. Lower second speed drum and third speed planet assembly onto shaft against support washer.
19. Position second speed brake drum bush into second speed brake drum.
20. Lower third speed brake drum assembly onto shaft against second speed drum.
21. Place thrust washer and steel washer onto shaft against third speed assembly.
22. Position inner ring gear assembly onto splines of mainshaft. Insert a spring into each of the holes in the assembly.
23. Fit six outer and five inner clutch plates into third speed brake drum.
24. If removed, press ball bearing onto sliding clutch and press bush into sliding clutch. Ensure to roll over the ends of the bush to retain it in position.
25. Fit sliding clutch assembly, bearing uppermost, onto shaft.
26. Fit driving shaft adjuster washer, chamfered face uppermost, onto shaft.
27. Position fourth speed thrust washer, chamfered face uppermost, onto outer race of ball bearing.
28. If removed, fit operating pin into actuating ring and secure into position with split pin.
29. Fit fourth speed actuating ring, operating pin boss downwards, onto the thrust washer.
30. Smear grease into slots of actuating ring, then position two balls in each slot.
31. If previously dismantled, press bearing housing and fourth gear outer member into front cover, secure outer member into position with nuts.
32. Carefully lower front cover assembly onto actuating ring, ensure to retain balls in slots.
33. Press bearing into front cover and onto inner gear support member.
34. Locate oil pump muff, thin flange uppermost, onto key in shaft. Fit new locknut onto shaft and tighten.
35. Invert running gear and support on wooden blocks.
36. Locate second speed planet carrier and third speed annulus assembly onto first gear sun and third gear planets.
37. Locate first and second gear distance piece, locating shoulder downwards, into planet carrier.
38. Place first gear planet assembly onto shaft.
39. Slide first speed brake drum front bush onto planet carrier.
40. Locate first speed brake drum onto first speed planets and second speed planet carrier.
41. Locate first speed brake drum rear bush between brake drum and planet carrier.
42. Locate reverse planet carrier assembly onto first speed planet carrier.
43. Position reverse brake drum bush onto planet carrier.
44. If removed, press bearing onto reverse brake drum, then locate reverse brake drum onto planets.
45. Check the brake drum clearances against figures quoted in Data.
46. Fit a plain washer 102 mm (4.0 in) outside diameter and 46 mm (1.845 in) inside diameter over the gearbox mainshaft against the reverse brake drum face. Fit a suitable tube over the shaft and secure the tube with washer and bolt. The tube and washers retain the running gear as an assembly during refitment.
47. Attach a suitable lifting eye to the oil pump end of the running gear so that the gear can be raised vertically.
48. Support the gearbox on wooden blocks of sufficient height so that the running gear will clear the bench.



49. Ensure that the top gear pull-rod lies between the two top gear hooks with the cup towards the centre line of the gearbox.
50. Coat the mating faces of the gearbox and rear cover with Hylomar.
51. Lower the running gear into the gearbox and secure the end cover with setscrews.
52. Fit new oil filter and secure into position with cover, joint and setscrews.
53. Remove gearbox from wooden blocks and lower onto bottom cover.
54. Remove bolt, tube and washers from the mainshaft.
55. Coat the mating faces of the oil pump cover and end cover, then position the oil pump cover and secure with setscrews.
56. Assemble the oil pump gears into the pump body, then fit the end plate.
57. Coat the mating faces of the oil pump body and oil pump cover, then locate the oil pump assembly into the cover ensuring that the pump spindle registers correctly with the drive pin in the mainshaft; secure pump assembly with setscrews.
58. Remove the top speed adjuster nut, adjuster ring, adjuster table and thrust pad.
59. Manoeuvre the top speed pull-rod to engage operating pin into cup. Hold the pull-rod and fit the thrust pad, adjusting table, adjusting ring and adjusting nut.
60. Position the remaining push-rod and thrust pad assemblies; the adjuster nuts should only be screwed on far enough to hold the struts in position.
61. Slacken locknuts and turn adjuster stop bolts until the distance 'A', between the abutment face of the stop bolt locknut and the inner face of the stop bolt, is the same as that quoted in Data; tighten locknuts.
62. Connect a 6.33 kg/cm<sup>2</sup> (90 lbf/in<sup>2</sup>) air supply to the restrictor body with an on-off tap fitted. Turn the air supply on, and using tool LC 134, turn the adjusting nut until the dimension 'B', measured between the abutment face of the locknut and the inner face of the adjuster table, is obtained. Turn the air supply on and off several times whilst observing whether the nut turns automatically. If the nut does turn, continue to open and close the air supply until the nut stops turning. Measure the gap 'B'; if it is greater than that quoted in Data, release the air pressure, slacken the locknut and turn the stop bolt in half a turn. Tighten locknut. Release the adjuster springs and unscrew the adjuster nut one turn, refit the adjuster spring. Turn the air supply on and off until the adjuster nut ceases to turn. If the gap 'B' is smaller than that quoted in Data, unscrew the stop bolt half a turn but do not move the adjuster nut. Turn the air supply on and off until the adjuster nut ceases to turn. Repeat the procedure for the remaining adjusters.
63. Position the top covers and joints; secure with setscrews.





## SECTION 4

## Transfer Box

## DATA

Oil capacity .....	3.9 litres 7 pints
Spur gear ratios (alternatives) .....	1.026:1
	0.925:1
	0.883:1
Bevel gear ratio .....	1.043:1
Overall ratio (transfer box—rear axle) .....	5.68:1
	5.12:1
	4.61:1

## Torque figures:

	kgf m	lbf ft
Output shaft coupling nut .....	41.48 to 55.30	(300 to 400)
Gearbox coupling bolt .....	27.65 to 34.56	(200 to 250)

## REMOVAL AND REFITMENT

## To Remove

1. Remove gearbox, see Section 2 of this Group.
2. Release tab washer, then remove bolt, tab washer, plain washer and felt washer securing coupling flange or yoke to gearbox input shaft, withdraw coupling flange or yoke.
3. Raise and support gearbox in vertical position with transfer box uppermost.
4. Remove nuts and spring washers securing transfer box to gearbox, raise transfer box slightly to release the lower fixing nuts, then lift the transfer box clear of the studs.
5. Remove shims from reverse brake drum bearing.
6. Remove bush from output sleeve.

## To Refit

1. Check running gear end-float as follows:
  - a. Ensure that reverse gear bearing is correctly seated in the case.
  - b. Using a straight-edge and micrometer depth gauge, measure the distance between the gearbox flange face and the outer face of the brake drum bearing, see Fig. 1.
  - c. Using a straight-edge and micrometer depth gauge, measure the distance between the transfer box face and the input shaft bearing housing face, see Fig. 2.
  - d. Subtract the dimension obtained in 'c' from that obtained in 'b', then select appropriate quantity of shims to give gearbox mainshaft end-float quoted in Data.
2. Position shims over bearing.
3. Insert gearbox input shaft coupling flange or yoke through transfer box end bearing cover; take care not to damage oil seal.
4. Fit bush into output sleeve and retain in position with grease.

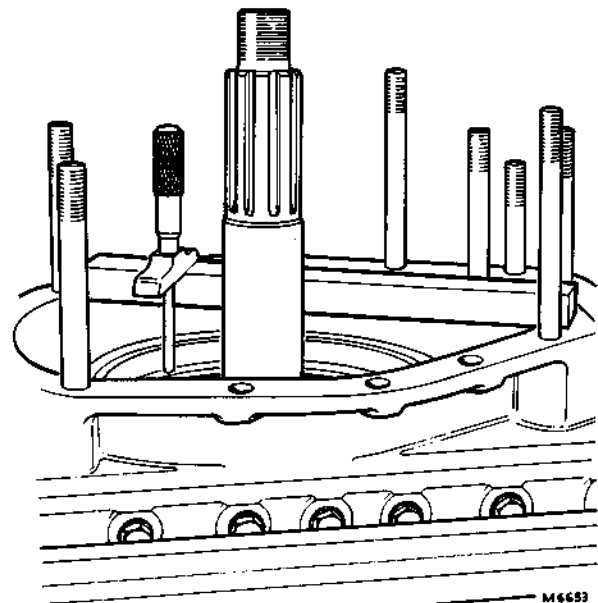


FIG. 1. MEASURING DEPTH OF BEARING

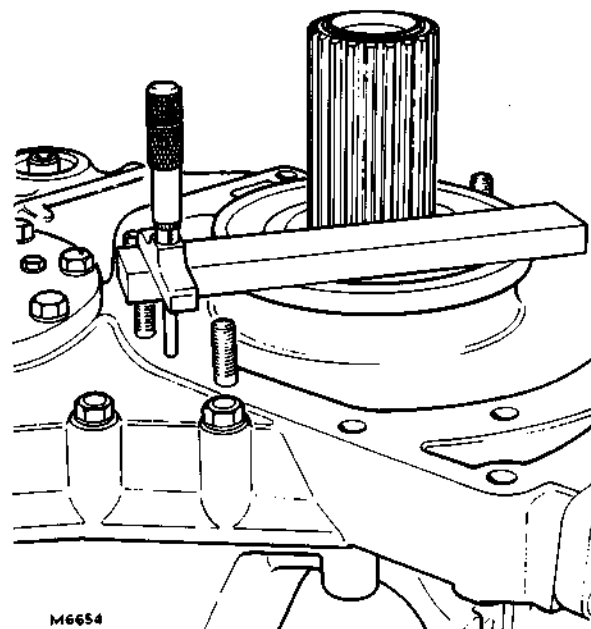
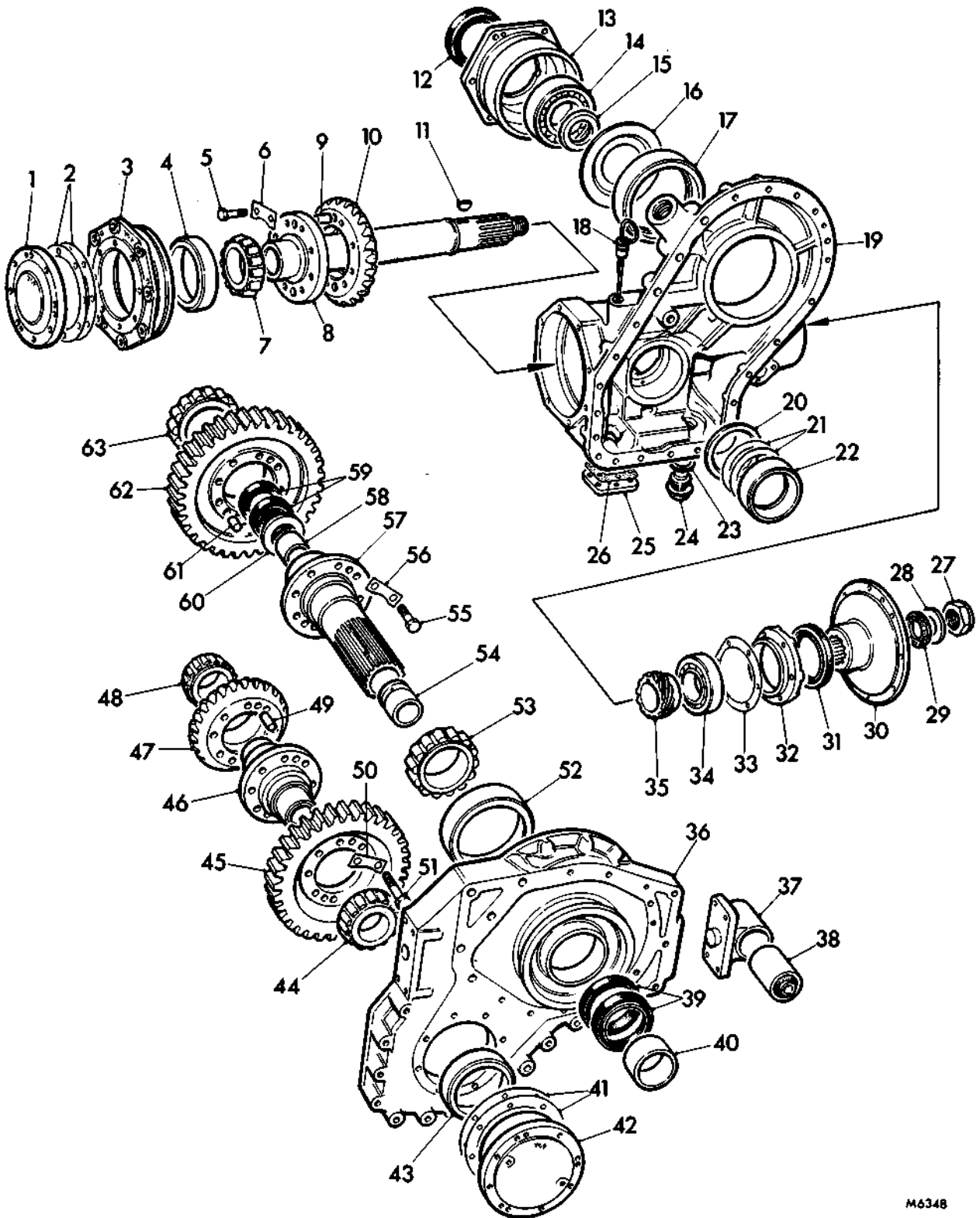


FIG. 2. MEASURING HEIGHT OF BEARING HOUSING



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FIG. 3. EXPLODED VIEW OF TRANSFER BOX

- |                         |                        |                            |                        |
|-------------------------|------------------------|----------------------------|------------------------|
| 1. End cover            | 17. Bearing outer race | 33. Shim                   | 49. Dowel              |
| 2. Shims                | 18. Dipstick           | 34. Bearing                | 50. Lockplate          |
| 3. Bearing housing      | 19. Casing             | 35. Speedometer drive gear | 51. Setbolt            |
| 4. Bearing outer race   | 20. Distance washer    | 36. Housing                | 52. Bearing outer race |
| 5. Setbolt              | 21. Shims              | 37. Support bracket        | 53. Roller bearing     |
| 6. Lockplate            | 22. Bearing outer race | 38. Bush                   | 54. Bush               |
| 7. Taper roller bearing | 23. Washer             | 39. Oil seals              | 55. Setbolt            |
| 8. Output shaft         | 24. Drain plug         | 40. Oil seal sleeve        | 56. Lockplate          |
| 9. Dowel                | 25. Inspection cover   | 41. Shims                  | 57. Input sleeve       |
| 10. Bevel gear          | 26. Joint              | 42. Bearing housing        | 58. Oil seal sleeve    |
| 11. Key                 | 27. Locknut            | 43. Bearing outer race     | 59. Oil seals          |
| 12. Oil seal            | 28. Washer             | 44. Taper roller bearing   | 60. Distance washer    |
| 13. Bearing housing     | 29. Felt washer        | 45. Driven gear            | 61. Dowel              |
| 14. Bearing             | 30. Output coupling    | 46. Bevel pinion shaft     | 62. Drive gear         |
| 15. Distance washer     | 31. Oil seal           | 47. Bevel pinion           | 63. Roller bearing     |
| 16. Oil retainer plate  | 32. Oil seal housing   | 48. Taper roller bearing   |                        |

5. Coat the mating faces of the gearbox and transfer box with jointing compound, then lower the transfer box onto the studs of the gearbox. Ensure that the coupling flange or yoke lowers with the transfer box to prevent the oil seal sleeve from rising clear of the oil seals. As the studs appear through the transfer box fit the spring washers and nuts and tighten securely.
6. Remove flange or yoke, then fit felt washer, plain washer, tab washer and coupling flange or yoke. Fit nut and tighten to torque figure quoted in Data. Knock over lock tab.
7. Refit gearbox, see Section 2 of this Group.

## OVERHAUL

### To Dismantle

1. Suitably support assembly on bench with gearbox coupling uppermost.
2. Remove nuts and setscrews securing both castings together, tap the upper casting with a hide mallet to break the seal, then lift off the top casting.
3. Lift out the drive gear assembly and the driven gear assembly.
4. Using flange holding tool LC 113 A remove the nut, washer and felt washer securing the coupling flange to the output shaft; withdraw the flange.
5. Remove setscrews and washers securing oil seal housing to output casting, remove oil seal housing, ensure to retain shims. Remove seal from housing.
6. Remove setscrews and washers securing output shaft bearing housing to casting; using three setscrews jack housing out of casting. Remove setscrews securing end cover to bearing housing, remove cover and ensure to retain shims. Using a soft metal drift, drive output shaft bearing outer race from housing.
7. Withdraw output shaft from casting.
8. Using a suitable soft metal drift, drive the speedometer drive gear and bearing from the casting.
9. Using tool D 707 and adaptor D 707-2, withdraw bearing from output shaft. If necessary, knock back lockplates and remove setscrews securing bevel gear to output shaft. Withdraw bevel gear from shaft.
10. Remove the two setscrews from the casting, then using a suitable soft metal drift drive out the driven gear shaft bearing outer race, shims and washer from the casting.
11. Remove setscrews and washers securing drive gear bearing housing to casting; using two setscrews jack housing out of casting.
12. Remove the two setscrews from the drive gear bearing housing, then using a soft metal drift drive the input sleeve bearing outer race and oil retainer plate from the housing. Withdraw oil seal, then tap out yoke bearing.
13. Using tool D 707 and adaptors D 707-1 and D 707-2, withdraw bearings from driven gear assembly. If necessary, knock back lock plates and remove setscrews securing driven gear and bevel pinion to shaft, remove gear and bevel pinion from shaft.
14. Using tool D 707 and adaptor D 707-3, withdraw bearings from drive gear assembly, then remove oil seals, oil seal tube and washer from input sleeve. If necessary, knock back lockplates and remove setscrews securing drive gear to input sleeve, withdraw gear from sleeve.
15. Remove two setscrews from driven gear bearing housing, then using a suitable soft metal drift drive the bearing outer race from the casting.
16. Remove setscrews and washers securing driven gear bearing housing to casting; using three setscrews jack housing out of casting, ensure to retain shims.
17. Remove oil seals then tap out drive gear bearing outer race from casting.

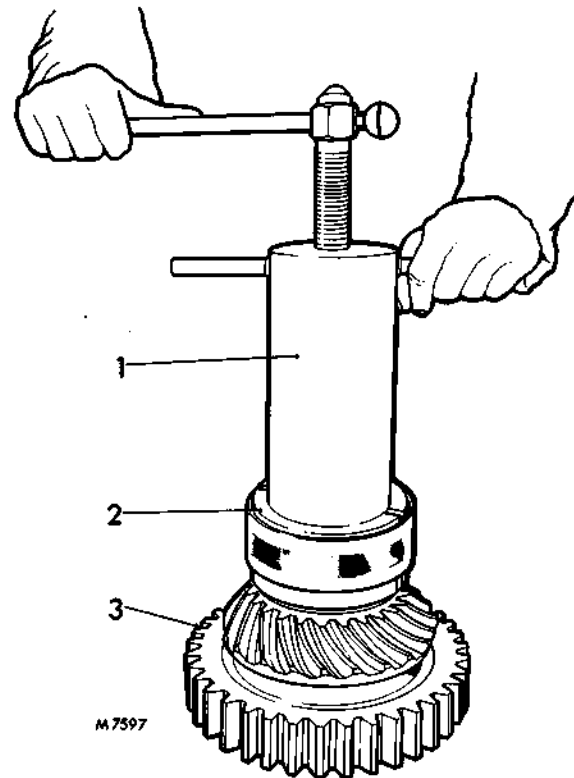


FIG. 4. DRIVEN GEAR ASSEMBLY BEARING REMOVAL

1. Main tool D707
2. Adapter D707-1
3. Driven gear

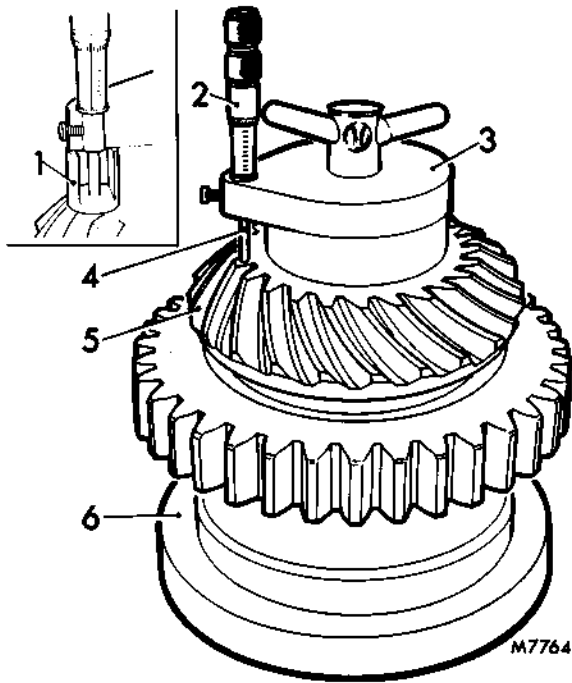


FIG. 5. MEASURING DISTANCE BETWEEN BEVEL PINION AND BEARING OUTER RACE

- 1. Setting item
- 2. Micrometer
- 3. Item D706/3
- 4. Micrometer rod
- 5. Driven gear assembly
- 6. Item D706/1

**To Reassemble**

1. Align bevel gear onto output shaft, then fit dowels and secure gear with bolts and lockplates. Knock over lockplates.
2. Press taper roller bearing onto shaft against shoulder.
3. Align drive gear, shallow dished side to flange, onto input sleeve, then fit dowels and secure gear with bolts and lockplates. Knock over lockplates.
4. Press roller bearings onto input sleeve against shoulders.

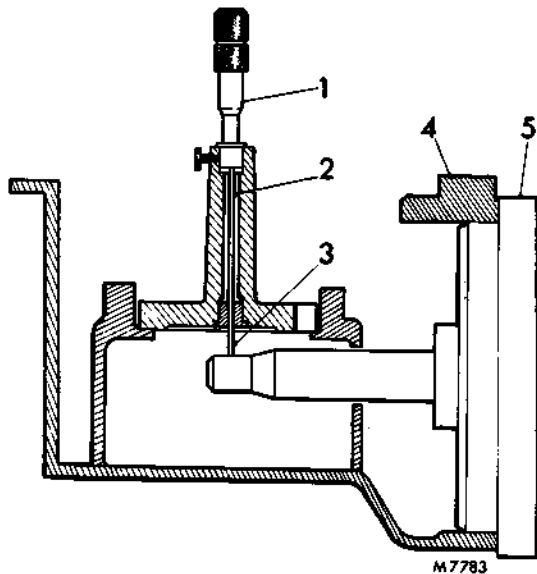


FIG. 6. MEASURING DISTANCE BETWEEN BEARING BORE AND SHAFT

5. Press oil seal sleeve onto input sleeve against roller bearing. Fit washer, double oil seal and oil seal sleeve into bore of input sleeve.
6. Measure the thickness of the bevel pinion and note the reading obtained.
7. Align bevel pinion onto shaft, then fit dowels.
8. Align driven gear, shallow dished side to flange, onto shaft, then secure driven gear and bevel pinion with bolts and lockplates. Knock over lockplates.
9. Press taper roller bearings onto shaft against shoulders.
10. Place driven gear assembly onto item D 706/1. Place bevel pinion bearing outer race onto bearing, then locate item D 706/3 onto bearing and secure with wing nut. Fit micrometer depth gauge, with small rod fitted, into hole in item D 706/3. Position item D 706/14 and turn micrometer until base of rod touches item D 706/14; check that micrometer is reading zero. Remove item D 706/14, then turn micrometer until rod touches bevel pinion face; note reading obtained.
11. Fit item D 706/1 into output shaft casing. Fit micrometer depth gauge, with large rod fitted, into item D 706/9, then locate item D 706/9 into bore in casting. Turn micrometer until rod touches shaft of item D 706/1; note reading obtained.

12. Add together the readings obtained in operations 6, 10 and 11. On current models, add or subtract the figure etched on the bevel pinion to or from the sum of operations 6, 10 and 11, then subtract 4.375 from the resultant sum. On earlier models subtract the figure etched on the bevel pinion from the sum of operations 6, 10 and 11.

Example:

Operation No.	Current models	Early models
6	1.873	1.873
10	1.142	1.142
11	1.600	1.600
	4.615	4.615
	- 0.004	- 4.379
	4.611	0.236
	- 4.375	
	0.236	

The figure obtained is the total amount of shimming, including distance washer, required to give correct bevel pinion contact.

13. Select correct quantity of shims, then place washer and shims into bore in casting.

14. Tap driven gear bearing outer race into casting bore against shims.
15. On early models it is necessary to drill and tap a hole in the centre of the driven gear bearing housing to enable the setting tool to be fitted.
16. Tap the driven gear bearing outer race into bearing housing.
17. Place driven gear assembly into bottom case, then locate and secure top case onto bottom case.
18. Position non-threaded end of tool LC 273 into bore of bevel pinion shaft.
19. Locate bearing housing into top case, then install remainder of tool LC 273 into assembly.
20. Fit setscrews and pull bearing housing down evenly until the correct pre-load is obtained, see Data. Tap bearing housing to settle bearings.
21. Using feeler gauges, measure gap between bearing housing and top case. The measurement obtained is the amount of shims required to give correct bearing pre-load.
22. Remove tool LC 273 from case.
23. Using three setscrews, jack bearing housing from case. Remove non-threaded end of tool LC 273 from bore of bevel pinion.
24. Select correct quantity of shims and position them onto case. Refit bearing housing to case, then fit plug and setscrews into bearing housing.
25. Slide output shaft into case and mesh with bevel pinion.
26. Tap output shaft outer race into bearing housing.
27. Fit bearing housing into case, secure housing with setscrews and washers.
28. Align speedometer drive gear, worm side innermost, with key on output shaft. Tap gear onto shaft against shoulder.
29. Tap taper roller bearing onto output shaft against speedometer drive gear.
30. Locate oil seal housing into case. Fit but do not tighten setscrews.
31. Locate end cover onto bearing housing. Fit but do not tighten setscrew.
32. Temporarily fit coupling flange to output shaft, secure flange with old nut.
33. Remove inspection cover from case, then position a dial test indicator onto a tooth of the bevel gear.
34. The correct backlash is obtained by adjusting the protrusion of the end cover and oil seal housing.

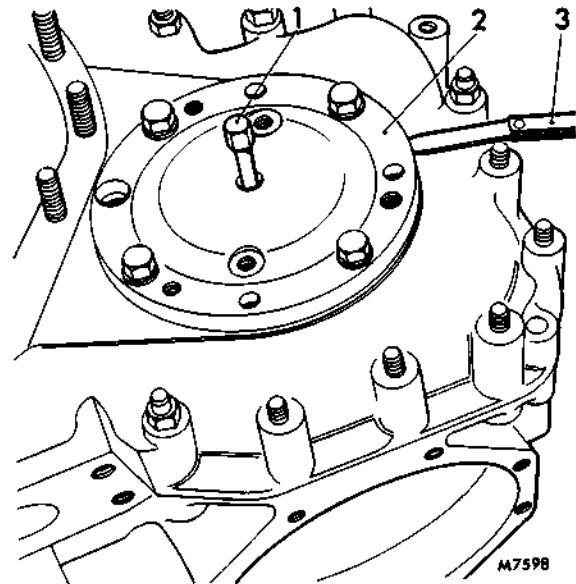


FIG. 7. CHECKING GAP UNDER BEARING HOUSING

- |                    |                 |
|--------------------|-----------------|
| 1. LC.273          | 3. Feeler gauge |
| 2. Bearing housing |                 |

35. To check the backlash, rock the coupling flange and note the reading on the dial test indicator. The correct backlash is etched on the bevel pinion.
36. Tighten the setscrews on the end cover and the oil seal housing an equal amount until a noticeable drag is obtained on the coupling flange.
37. Remove the top case and lift out the driven gear assembly.
38. Wrap a piece of string around the periphery of the coupling flange, attach a spring balance to the string and measure the pre-load. Tighten or slacken setscrews an equal amount to obtain pre-load quoted in Data.

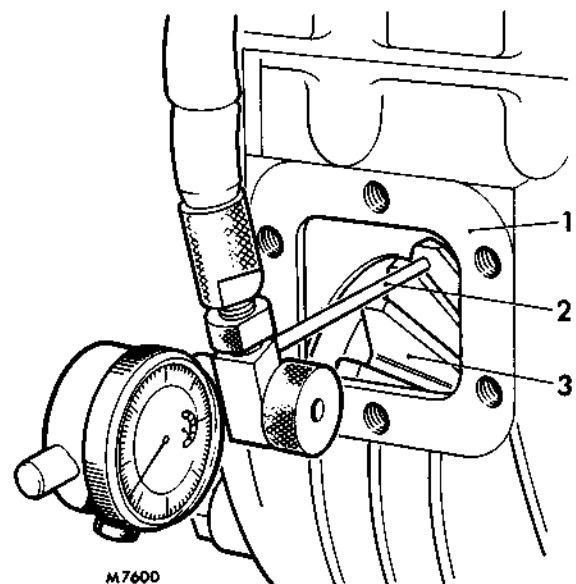


FIG. 8. CHECKING BEVEL PINION BACKLASH

- |                        |                 |
|------------------------|-----------------|
| 1. Inspection aperture | 3. Bevel pinion |
| 2. Indicator rod       |                 |

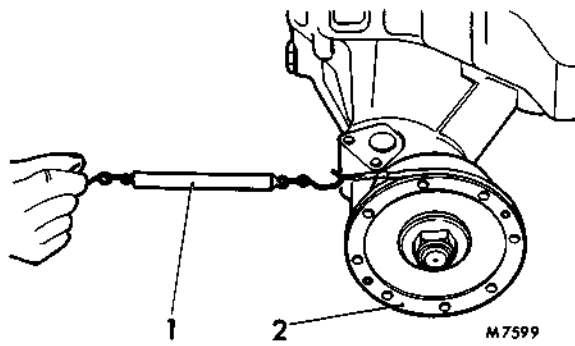


FIG. 9. CHECKING PINION BEARING PRE-LOAD

- 1. Spring balance
- 2. Output coupling

- 39. Refit the driven gear assembly and the top case.
- 40. Re-check the backlash. If the figure obtained differs from that etched on the bevel pinion, move the end cover and oil seal housing in or out an equal amount until correct figure is obtained.
- 41. Using feeler gauges, measure the gap between the end cover and case. Remove the end cover and insert the correct quantity of shims. Refit the end cover.

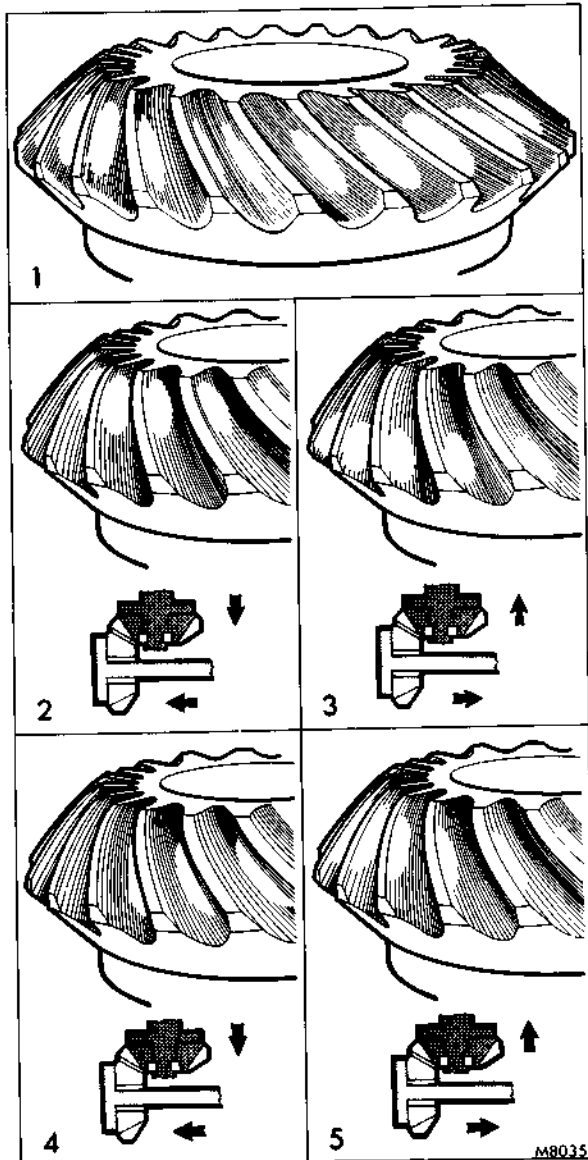


FIG. 10. PINION TOOTH CONTACT PATTERNS

- 42. Using feeler gauges, measure the gap between the oil seal housing and case. Remove the nut and coupling flange, then the oil seal housing.
- 43. Fit new oil seal into oil seal housing.
- 44. Position correct quantity of shims, then refit oil seal housing to case.
- 45. Fit coupling flange taking care not to damage oil seal, then secure flange with felt washer, plain washer and new nut; torque nut to figure quoted in Data.
- 46. Remove top case and lift out driven gear assembly. Smear engineer's marker onto both sides of four of the bevel pinion teeth.
- 47. Refit driven gear assembly and top case.
- 48. Rotate coupling flange several times in both directions to ensure spread of marker.
- 49. Remove top case and lift out driven gear assembly. Examine pinion tooth contact pattern, see Fig. 10.  
Example 1 shows ideal pattern.  
Example 2 indicates insufficient backlash. Move bevel gear away from pinion to increase lengthwise bearing. This may change the profile bearing and an adjustment of the pinion may be required.  
Example 3 indicates too much backlash. Move bevel gear towards pinion to obtain correct lengthwise bearing. This may change the profile bearing and an adjustment of the pinion may be required.  
Example 4 indicates pinion is out too far. Move pinion towards bevel gear then move bevel gear away from pinion to obtain correct lengthwise bearing.  
Example 5 indicates pinion is in too far. Move pinion away from bevel gear then move bevel gear towards pinion to obtain correct lengthwise bearing.
- NOTE:** To ensure maintaining correct bearing pre-load, any thickness of shims removed from one end must be added to the opposite end.
- 50. Press roller bearing into input sleeve bearing housing against shoulder.
- 51. Position oil retainer plate, dished side innermost, into housing, then tap taper roller bearing outer race into housing against retainer.
- 52. Align oil hole in bearing housing with oil hole in case. Locate housing into case and pull into position with setscrews. Tighten setscrews securely.
- 53. Fit oil seal into bearing housing.
- 54. Position driven gear assembly into lower case.
- 55. Cover splines of input sleeve with Sellotape, then fit drive gear assembly into lower case.
- 56. Fit roller bearing outer race into top case, then install double oil seal, lips facing outward, into case.
- 57. Fit upper case onto lower case and secure into position with nuts and setscrews. Remove Sellotape.
- 58. Refit inspection cover and secure with setscrews.



**GROUP 5**  
**STEERING GEAR**  
**AND**  
**FRONT AXLE**

SECTION 1—STEERING GEAR	Reference
Data . . . . .	5-1-1
Removal and Refitment . . . . .	5-1-3
Overhaul . . . . .	5-1-4
SECTION 2—FRONT AXLE	
Data . . . . .	5-2-1
Removal and Refitment . . . . .	5-2-3
Overhaul . . . . .	5-2-3
SECTION 3—HYDROSTEER POWER RAM	
Data . . . . .	5-3-1
Diagnostic Testing . . . . .	5-3-1
Removal and Refitment . . . . .	5-3-4
Overhaul . . . . .	5-3-5
SECTION 4A—POWER STEERING PUMP—PLESSEY	
Data . . . . .	5-4A-1
Description . . . . .	5-4A-1
Diagnostic Testing . . . . .	5-4A-2
Removal and Refitment . . . . .	5-4A-4
Overhaul . . . . .	5-4A-4
SECTION 4B—POWER STEERING PUMP—HOBOURN EATON	
Data . . . . .	5-4B-1
Description . . . . .	5-4B-1
Diagnostic Testing . . . . .	5-4B-2
Removal and Refitment . . . . .	5-4B-3
Overhaul . . . . .	5-4B-3
SECTION 5—POWER STEERING RESERVOIR	
Removal and Refitment . . . . .	5-5-1

# FRONT AXLE AND STEERING

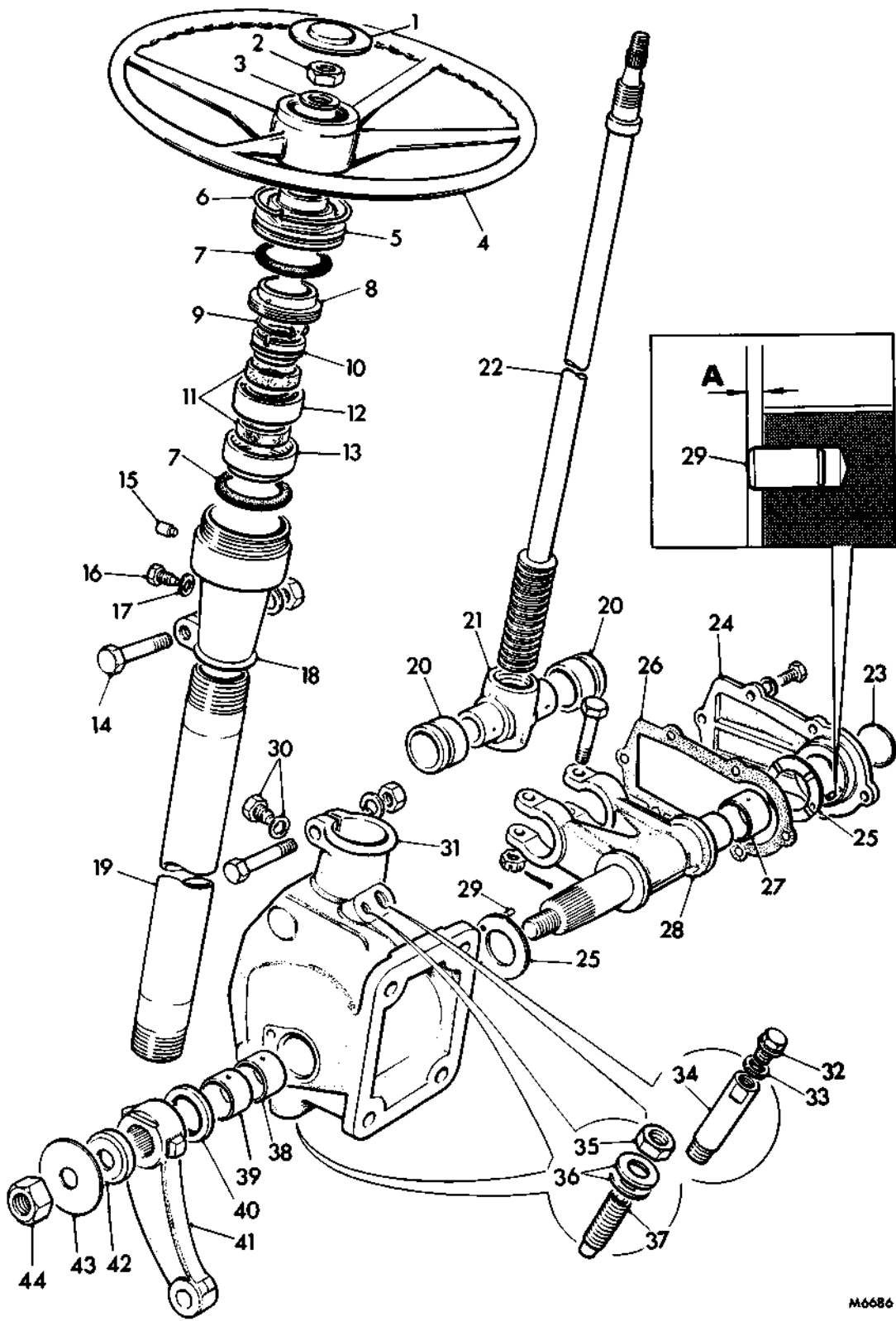


FIG. 1. EXPLODED VIEW OF STEERING GEAR  
 A = Dowel protrusion limit, 1.778 mm (0.070 in)

- 1. Steering wheel cap
- 2. Nut
- 3. Washer
- 4. Steering wheel
- 5. Bearing housing cover
- 6. Circlip
- 7. Rubber buffer
- 8. Bearing cage cover
- 9. Circlip
- 10. Retaining nut
- 11. Oil felt retainer

- 12. Bearing
- 13. Bearing cage
- 14. Bolt
- 15. Dowel
- 16. Location peg
- 17. Washer
- 18. Bearing housing
- 19. Steering column
- 20. Trunnion bush
- 21. Worm nut
- 22. Worm shaft

- 23. Welch washer
- 24. Cover-plate
- 25. Thrust washer
- 26. Joint
- 27. Bush
- 28. Rocker shaft
- 29. Dowel (thrust washer)
- 30. Screw and washer
- 31. Steering box
- 32. Filler plug
- 33. Washer

- 34. Extension tube
- 35. Locknut
- 36. Washer
- 37. Lockstop screw
- 38. Bush (inner)
- 39. Bush (outer)
- 40. Oil seal
- 41. Drop-arm
- 42. Retaining washer
- 43. Tab washer
- 44. Nut

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SECTION 1

Steering Gear

GENERAL INFORMATION

Data

Type SG 278 . . . . .	Daimler worm and nut
Ratio . . . . .	40:1
Steering wheel diameter . . . . .	533 mm (21 in)
Number of steering wheel turns lock to lock . . . . .	6.5
Steering lock-top settings, R.H. and L.H. lock . . . . .	177.8 mm (7.0 in)
<b>Swept turning circle:</b>	
30 ft chassis . . . . .	21.031 m (69 ft)
33 ft chassis . . . . .	21.565 m (70.75 ft)
36 ft chassis . . . . .	21.640 m (71 ft)
<b>Rocker shaft bushes:</b>	
Internal diameter reamed in position . . . . .	44.450 to 44.490 mm (1.7500 to 1.7516 in)
Rocker shaft end-float . . . . .	0.050 mm (0.002 in)
Thrust washers available . . . . .	Five, ranging from 2.33 mm (0.092 in) to 2.59 mm (0.102 in)
Clearance between worm nut and bushes . . . . .	0.050 mm (0.002 in)
<b>Pivot shaft bushes:</b>	
Internal diameter reamed in position . . . . .	44.450 to 44.490 mm (1.7500 to 1.7516 in)
Pivot shaft end-float . . . . .	0.076 to 0.101 mm (0.003 to 0.004 in)
Shims available . . . . .	0.127 mm (0.005 in), 0.180 mm (0.007 in), 0.254 mm (0.010 in)
Ball pin lift . . . . .	0.203 to 0.254 mm $\pm$ 0.050 mm (0.008 to 0.010 in $\pm$ 0.002 in)
Shims available . . . . .	0.127 mm (0.005 in), 0.203 mm (0.008 in) 0.381 mm (0.015 in), 0.635 mm (0.025 in)
<b>Torque tightening figures:</b>	
Socket clamp bolts . . . . .	7.7 kgf m (55 lbf ft)
Ball pin retaining nuts . . . . .	15.4 kgf m (110 lbf ft)
Drop-arm retaining nut . . . . .	33.6 kgf m (240 lbf ft)
Relay lever retaining nut . . . . .	15.4 kgf m (110 lbf ft)
Rocker shaft clamp bolts . . . . .	1.54 kgf m (11 lbf ft)

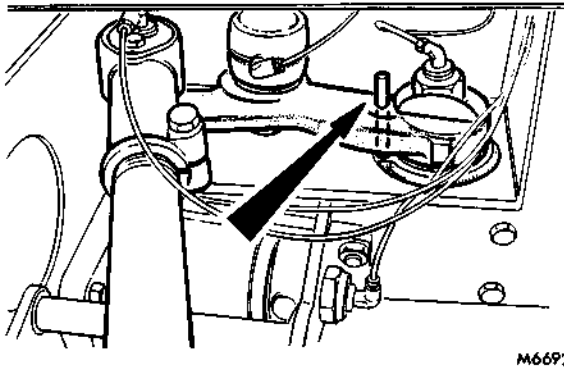


FIG. 3. ALIGNING RELAY LEVER WITH REGISTER ROD

3. Feed the relay lever on the pivot shaft, locating the hole in the relay lever with the register rod in the pivot bracket, see Fig. 3.
4. Fit a new tab washer, nut and tighten to the torque figure quoted in Data.
5. The lever will now be in the straight-ahead position.
6. Re-connect ball pins, tighten to the torque figure quoted in Data, fit split pins.
7. Remove register rod on completion of operation.

## OVERHAUL

### Steering Gear

#### To Dismantle (Fig. 1)

1. Remove the steering box as previously detailed.
2. Remove six setscrews, washers and withdraw side cover and joint; allow oil to drain in a suitable container.
3. Remove bearing housing cover circlip from top of column, unscrew and remove housing cover, note relationship of shaft to nut as it must be refitted in its original position.

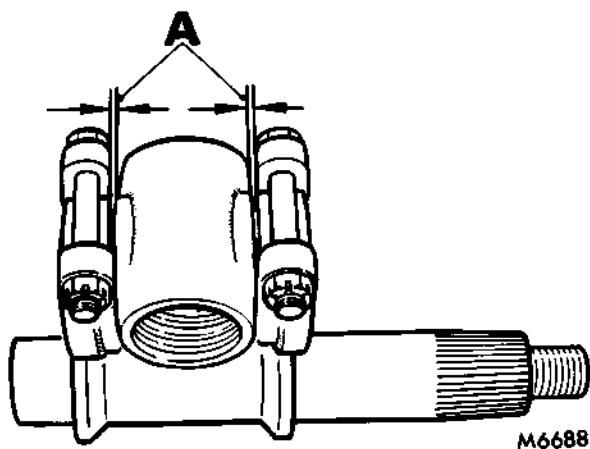


FIG. 4. WORM NUT AND ROCKER SHAFT ASSEMBLY

A = Clearance between worm nut and bushes  
0.050 mm (0.002 in)

4. Unscrew worm shaft from nut, withdraw shaft assembly complete from outer steering column, remove lower rubber buffer.
5. Remove upper rubber buffer, place bearing cage in a vice equipped with soft jaws, withdraw bearing cover.
6. Remove retaining nut circlip, unscrew and remove retaining nut and upper oil felt retainer.
7. Slide bearing cage clear, press bearing from shaft, withdraw lower oil felt retainer and bearing cage.
8. Turn worm nut through 90° to clear edge of cover-plate aperture, withdraw rocker shaft assembly complete, note size and position of inner and outer thrust washers for subsequent reassembly, remove and discard oil seal from steering box.
9. Extract split pins; remove nuts, and withdraw trunnion bush clamp bolts, together with bushes and worm nut.

#### Inspection

1. Wash all parts except seals in a suitable cleaning solvent.
2. Examine rocker shaft trunnion bushes for wear; renew if worn or damaged.
3. Check oil seals; fit new ones as necessary.
4. Check bearings for evidence of roller pitting or wear; renew if this condition is apparent.
5. Examine inner and outer bushes in steering box side cover; renew if worn or damaged, ensuring the oil holes in bushes line up with the holes in the steering box side cover. Ream in position to the internal diameter quoted in Data.

#### To Reassemble (Fig. 1)

Reassembly is a reversal of the dismantling procedure, noting the following points:

1. Fit the trunnion bushes on the worm nut, and insert the worm nut assembly in the rocker shaft.
2. Insert clamp bolts and nuts; do not tighten at this stage.
3. Centralize worm nut assembly by lightly tapping the bushes towards the faces of the worm (Fig. 4), until the recommended clearance is obtained, see Data.
4. Tighten clamp bolts evenly (see Data for torque figure); tighten further if necessary to align nearest split pin hole, fit split pins.  
**NOTE:** The oil holes in the worm nut must be in line with the rocker shaft clamp bolts when refitting.
5. Ensure worm nut is free, DO NOT OVERTIGHTEN clamp bolts; coat the worm nut, trunnion bushes and rocker shaft with Copaslip or Rocol J166 anti-seizure compound.  
**NOTE:** When fitting rocker shaft through oil seal in steering box, suitably tape splines to avoid damage to seal; remove tape after insertion of rocker shaft.

**REMOVAL AND REFITMENT**

**Steering Gear Assembly**

**To Remove**

1. Disconnect batteries or operate isolation cut-off switch.
2. Prise off steering wheel centre motif.
3. Remove nut, washer and withdraw wheel; retain Woodruff key.
4. Remove steering box gaiter, front floor plate retaining screws and remove front plate.
5. Detach clips securing cables to steering column, withdraw instrument panel retaining screws and allow panel to be moved clear.
6. Disconnect automatic lubrication pipe, if fitted.
7. Extract split pin and disconnect front drag-link; renew oil seal as necessary.
8. Suitably support weight of steering box, remove the four setbolts securing the unit to the frame.
9. Lower the unit clear avoid damage to the cables and pipes.

**To Refit**

**NOTE:** For removal and refitment of drop-arm see below.

Refitment is a reversal of the removal procedure, ensuring that no cables or pipes are damaged as the steering box is manoeuvred into position.

**Drop-Arm**

**To Remove**

The drop-arm can be removed from the vehicle without disturbing the steering box.

1. Disconnect lubrication pipe, if fitted.
2. Extract split pin, remove nut, plain washer, cup, oil seal and dust cover, disconnect the front drag-link from the drop-arm.
3. Withdraw drop-arm retaining nut, tab washer and retaining washer.
4. Remove drop-arm from the rocker shaft.

**To Refit**

1. Turn steering wheel until the mark on the rocker shaft aligns with the mark on the steering box.
2. Insert a 12.7 mm (½ in) diameter register rod in the hole drilled in the steering box.
3. Fit drop-arm on splines, align mark on drop-arm with mark on rocker shaft, ensuring that the rod is located with the cut-out in the lug on the drop-arm, see Fig. 2.
4. Refit retaining washer, tab washer, nut and tighten to the torque figure quoted in Data; bend the tab washer over the recess in the drop-arm.

5. Re-connect drag-link, fit dust cover, oil seal, cup, plain washer and nut, tighten nut to the torque figure quoted in Data; tighten further if necessary to align split pin, and fit a new split pin. The drop-arm and steering box should now be in the straight-ahead position.
6. If a new arm or rocker shaft is to be fitted, it is essential that the splines on the shaft do not protrude beyond, or are flush with, the face of the drop-arm. Failure to ensure this will prevent the nut from securely locking the drop-arm to the taper shaft splines.  
**NOTE:** Remove the register rod on completion of drop-arm refitment.

**Relay Lever Pivot Bracket**

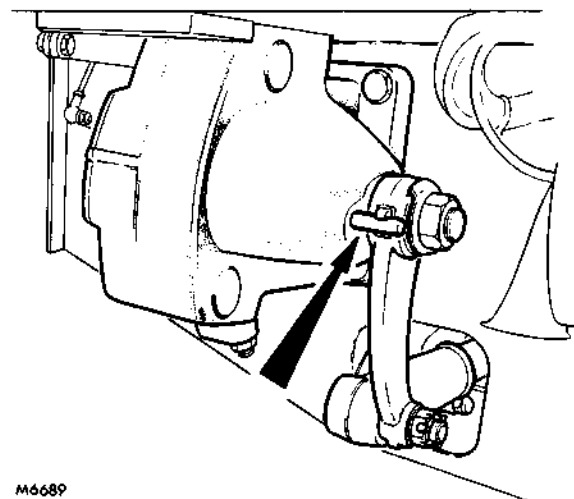
**To Remove**

1. Disconnect lubrication pipes, if fitted, and remove tie-wrap clips from drag-links.
2. Remove split pins and disconnect ball pins from relay lever.
3. Remove nut and tab washer securing the relay lever to the pivot shaft, withdraw lever using suitable extractor.
4. Remove and discard 'O' ring.
5. Remove setbolts, nuts and washers; withdraw unit from the outrigger bracket.

**To Refit**

Refitment is a reversal of the removal procedure, noting the following points:

1. Fit a new 'O' ring between the relay lever and pivot bracket.
2. Insert a 6.4 mm (¼ in) diameter rod in the hole in the top face of the pivot bracket.



M4689

FIG. 2. ALIGNING DROP-ARM WITH REGISTER ROD

# FRONT AXLE AND STEERING

## Steering Ball Joints

### To Dismantle (Figs. 7 and 8)

1. Disconnect lubrication pipe, if fitted.
2. Remove split pin, ball pin retaining nut, and remove ball pin from its respective taper.
3. Slacken clamp bolt, unscrew and remove socket.
4. Remove setscrew and lockplate.
5. Carefully unscrew end cover, remove spring and shims; retain shims for subsequent reassembly.
6. Remove upper ball cup, lift out ball pin and press out lower ball cup.

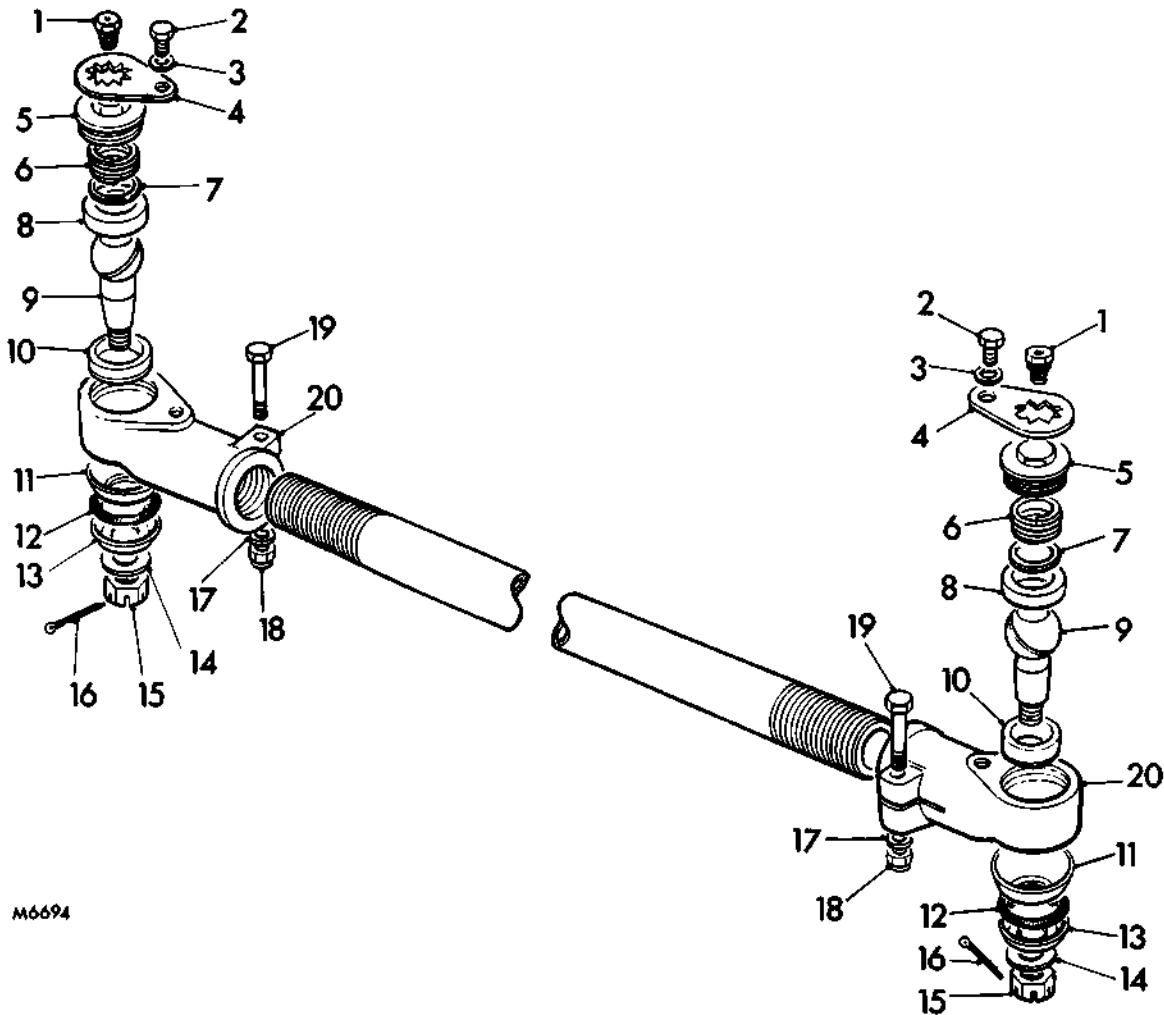
### Inspection

1. Wash all parts in a suitable cleaning solvent.
2. Inspect ball pin for wear or flat spots.
3. Check springs for corrosion or distortion.

### To Reassemble

1. Press in lower ball cup and fit ball pin and upper ball cup.
2. Fit spring, shims, end-cover and tighten; see Data for ball pin lift and shims available.
3. Fit lockplate, washer, setscrew and secure.
4. Ensure that the internal threads of the socket and external threads of drag-link are lightly lubricated.
5. Screw assembled socket to drag-link and/or track-rod; adjust socket to fit through its respective taper. Fit and tighten ball pin retaining nuts to the torque figure quoted in Data; secure with split pins. Tighten clamp bolt to the torque figure quoted in Data, and ensure that the socket will swivel.

**NOTE:** Ensure that the sockets are screwed on the rods by an equal number of threads. If a new clamp bolt is to be fitted, use a high-tensile bolt only.



M6694

FIG. 7. EXPLODED VIEW OF DRAG-LINK

- |               |                      |                |                     |
|---------------|----------------------|----------------|---------------------|
| 1. Lubricator | 6. Spring            | 11. Dust cover | 16. Split pin       |
| 2. Setscrew   | 7. Shim(s)           | 12. Oil seal   | 17. Washer          |
| 3. Washer     | 8. Ball cup (upper)  | 13. Cup        | 18. Nut             |
| 4. Lockplate  | 9. Ball pin          | 14. Washer     | 19. Clamp bolt      |
| 5. End cover  | 10. Ball cup (lower) | 15. Nut        | 20. Ball pin socket |

6. Check rocker shaft end-float, see Data; if clearance is excessive, make adjustment by exchanging thrust washers available, fitted equally on both sides of rocker shaft to ensure correct alignment, see Fig. 5.
7. Ensure the thrust washers are located on their respective dowels in the steering box and the side cover.
8. If the dowels have been removed, see Fig. 1 for dowel protrusion limit.
9. Should a new Welch washer require fitting in the side cover, it should be liberally coated with Loctite 41.
10. Fit a new joint between side cover and steering box. Smear the joint with Hylomar jointing compound.
11. Refit drop-arm, refer to Removal and Refitment of Drop-arm; coat the drop-arm with grease to prevent rust formation.
12. Refit steering box, refill with lubricant of the correct specification and quantity as described in Group 1.

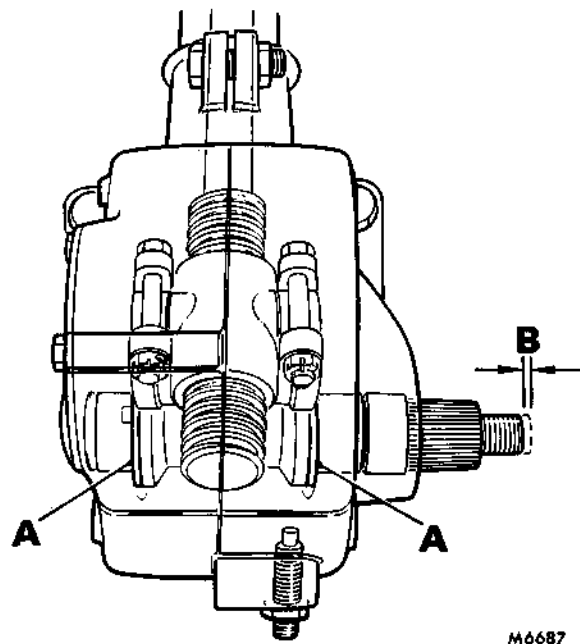


FIG. 5. ROCKER SHAFT IN POSITION

A. Thrust washers    B. End-float = 0.050 mm (0.002 in)

**Relay Lever Pivot Bracket**

**To Dismantle (Fig. 6)**

1. Remove relay lever pivot bracket from chassis, see page 5-1-3.
2. Remove the four setscrews, washers and withdraw the bottom cover and shims; retain shims for subsequent reassembly.
3. Withdraw pivot shaft, together with upper and lower thrust washers.
4. Remove oil seal from the top of the pivot bracket.
5. Press out bushes if worn or damaged.

**Inspection**

1. Clean all parts in a suitable cleaning solvent.
2. Examine oil seal; renew as necessary.
3. Check shaft, bushes and thrust washers for wear or damage; renew as necessary.
4. Ream bushes in position to the internal diameter quoted in Data.

**To Reassemble**

1. Refit bushes if removed, and fit a new oil seal, lips uppermost, lightly smeared with grease.
2. Insert lower thrust washer, ensuring the oil grooves are uppermost and the hole in the thrust washer locates on the dowel; see Fig. 6 for location and dowel protrusion limit.
3. Locate shaft, fit upper thrust washer, oil grooves downwards, locate hole in thrust washer with the dowel in the bottom cover.
4. Fit bottom cover, shims and secure with setscrews; see Data for pivot shaft end-float and shims available.

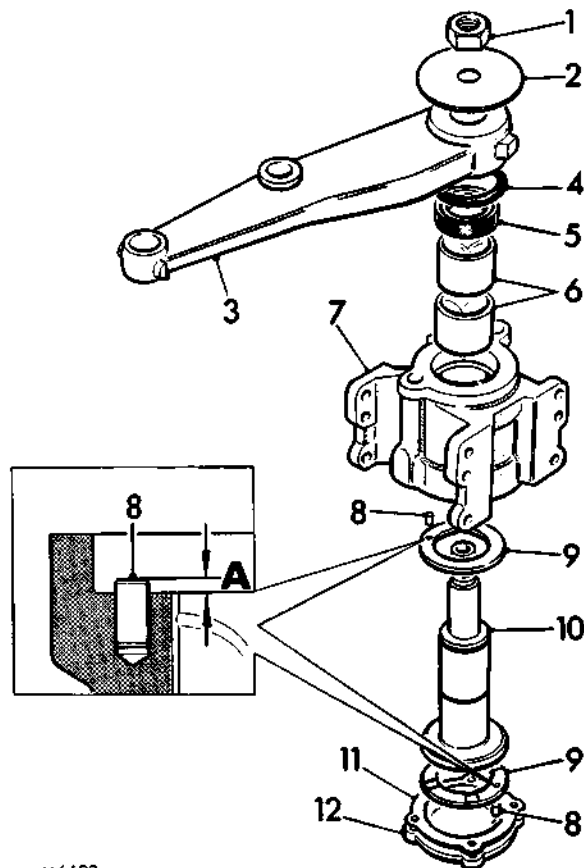


FIG. 6. EXPLODED VIEW OF RELAY LEVER PIVOT BRACKET

A = Dowel protrusion limit, 1.778 mm (0.070 in)

- |                |                  |
|----------------|------------------|
| 1. Nut         | 7. Pivot bracket |
| 2. Tab washer  | 8. Dowel         |
| 3. Relay lever | 9. Thrust washer |
| 4. 'O' ring    | 10. Pivot shaft  |
| 5. Oil seal    | 11. Shims        |
| 6. Bush        | 12. Bottom cover |

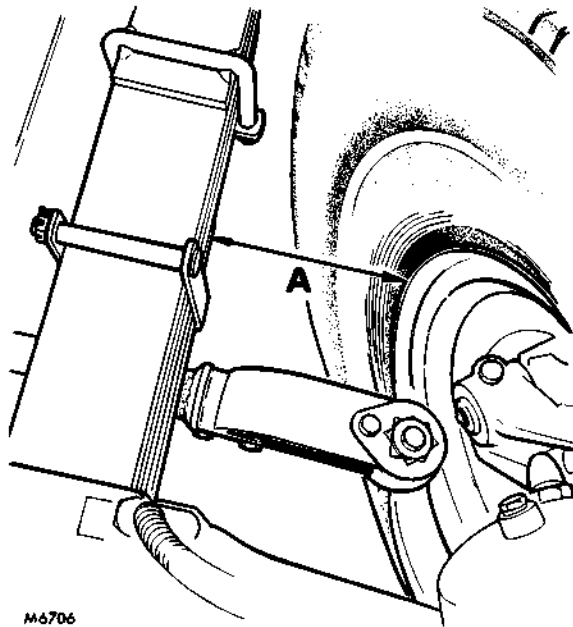
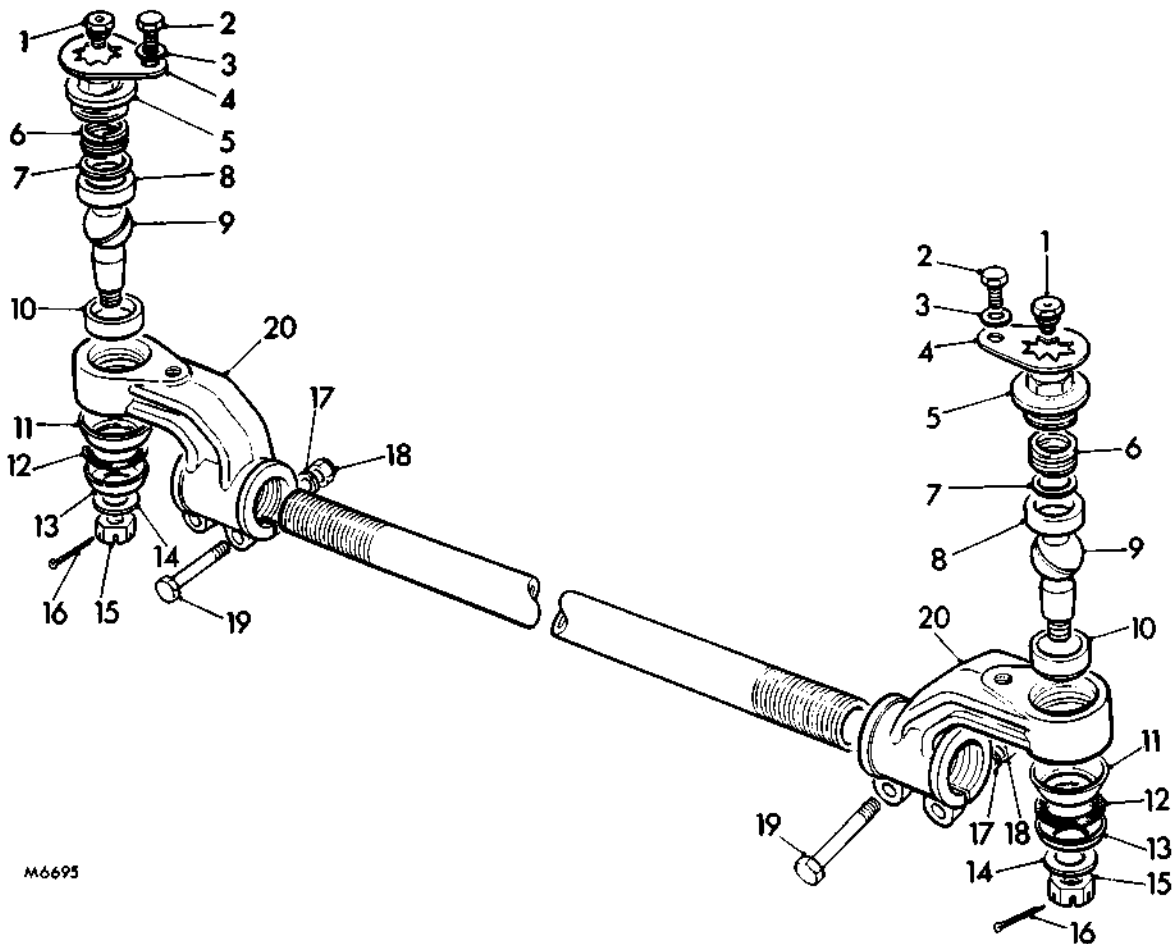


FIG. 9. STEERING LOCK-STOP SETTING

A = 177.8 mm (7.0 in)

9. Tighten socket clamp bolts, see Data for torque figure, ensure all sockets will swivel.
10. Unscrew steering box stops to ensure they are not controlling the achievable lock. Employ the following procedure for power ram setting;
  - a. Turn steering wheel to full right-hand lock, unscrew clamp bolt (33, Fig. 4), page 5-3-6.
  - b. Apply a suitable spanner to the flats on the piston rod (26), unscrew the ram piston rod out of the front socket until the ram bottoms, then back off one turn.
  - c. If the ram bottoms before achieving full lock, screw the ram piston rod into the front socket until full lock is obtained, measured from the road wheel rim to the spring (Fig. 9), then screw in one further turn.
  - d. Check the above procedure for left-hand lock, adjust the relevant steering box and axle stops to give a clearance of 0.254 to 0.381 mm (0.010 to 0.015 in) between axle stops and axle arm swivel faces.
  - e. Tighten all locknuts, lower vehicle to ground, remove jack and supports.





M6695

FIG. 8. EXPLODED VIEW OF TRACK-ROD

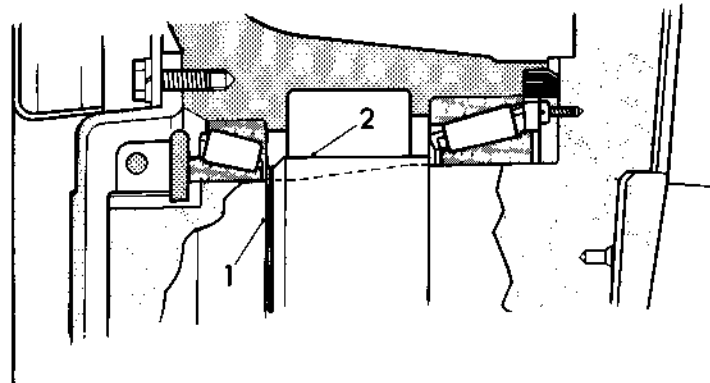
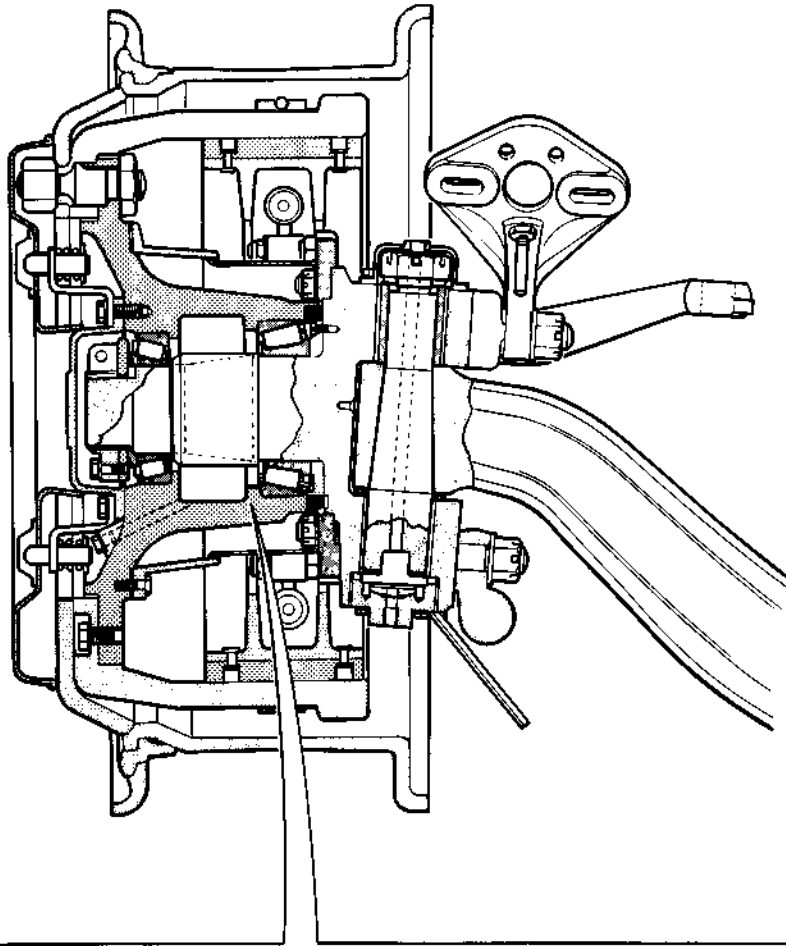
- |               |                      |                |                     |
|---------------|----------------------|----------------|---------------------|
| 1. Lubricator | 6. Spring            | 11. Dust cover | 16. Split pin       |
| 2. Setscrew   | 7. Shim(s)           | 12. Oil seal   | 17. Washer          |
| 3. Washer     | 8. Ball cup (upper)  | 13. Cup        | 18. Nut             |
| 4. Lockplate  | 9. Ball pin          | 14. Washer     | 19. Clamp bolt      |
| 5. End cover  | 10. Ball cup (lower) | 15. Nut        | 20. Ball pin socket |

### ADJUSTMENT

#### To Adjust the Steering Linkage and Axle Stops

If both drag-links have been disconnected, check and adjust steering geometry as follows:

1. Jack up and suitably support front axle.
2. Set front wheels parallel to 1.5 mm ( $\frac{1}{16}$  in) toe-in, using suitable workshop equipment.
3. Centralize the steering box and drop-arm by inserting register rod as described in Removal and Refitment of Drop-Arm.  
**NOTE:** The drop-arm must never vary from this position; any variation could result in under- or over-steering.
4. Set position of relay lever using register rod, see Removal and Refitment of Relay Lever Pivot Bracket.
5. Fit rear drag-link, pre-set to 847.725 mm (33.375 in) between ball pin centres, to steering arm and relay lever.
6. Fit ram, pre-set to 860.425 mm (33.875 in) between ball pillar centres, to relay lever and chassis frame, with four threads showing on the piston rod at the front ball pillar housing.
7. Adjust both sockets of front drag-link equally, connect to ram and the drop-arm.
8. Fit dust covers, oil seals, cups, plain washers and nuts, tighten all ball pin retaining nuts to the torque figure quoted in Data; tighten further if necessary to align split pin holes, fit split pins.



M6746

FIG. 1. SECTIONED VIEW OF FRONT HUB ARRANGEMENT  
Inset shows alternative method of adjusting hub end-float.

- 1. Shim(s)
- 2. Spacer



## SECTION 2

## Front Axle

## GENERAL INFORMATION

## Data

Axle type . . . . .	'I' section steel stamping
Camber . . . . .	2°
Castor . . . . .	1°
Front wheel alignment . . . . .	Set parallel to 1.5 mm ( $\frac{1}{16}$ in) toe-in

## King pins

End-float . . . . .	0.050 to 0.101 mm (0.002 to 0.004 in)
Shims available . . . . .	0.127 mm (0.005 in), 0.203 mm (0.008 in) 0.381 mm (0.015 in), 0.635 mm (0.025 in)

## Hubs

End-float (by split nut adjustment) . . . . .	0.076 to 0.152 mm (0.003 to 0.006 in)
End-float (by spacer and shims) . . . . .	0.101 to 0.152 mm (0.004 to 0.006 in)
Shims available . . . . .	0.076 mm (0.003 in), 0.127 mm (0.005 in) 0.254 mm (0.010 in), 0.381 mm (0.015 in) 0.635 mm (0.025 in), 1.27 mm (0.050 in)
Wheel hub bearings . . . . .	Opposed taper roller
Shims available, lower thrust cap . . . . .	0.127 mm (0.005 in), 0.203 mm (0.008 in) 0.254 mm (0.010 in)

## Torque tightening figures:

Wheel stud retaining nuts . . . . .	34.56 kgf m (250 lbf ft)
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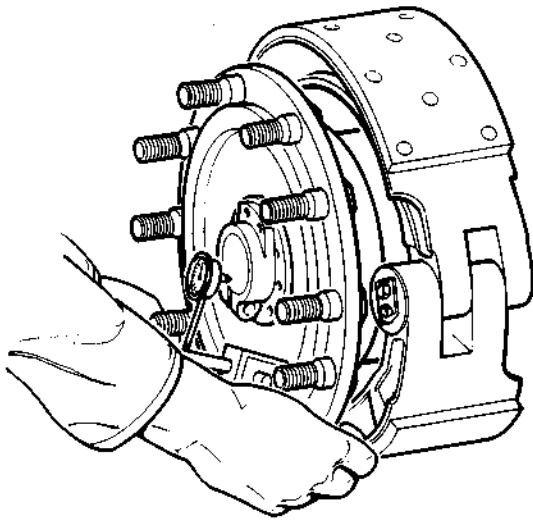


FIG. 4. CHECKING THE HUB END-FLOAT USING A DIAL GAUGE

9. Remove outer bearing, withdraw hub complete with oil seal, withdraw inner bearing.

**NOTE:** On certain types of axle a spacer is fitted between the inner bearing and shims fitted between spacer and outer bearing, see Fig. 1. Refer to Data for end-float and shims available. The hub nut on this type of axle is securely tightened.

### Inspection

1. Wash all parts except oil seals in a suitable cleaning solvent and dry thoroughly. Do not use compressed air.
2. Inspect bearings for evidence of roller pitting wear, overheating or distorted cages. Check outer races for wear or pitting, if either part is found to be defective the complete assembly must be renewed.
3. New outer races should be a press fit in the hub. If this condition is not apparent, wear of the outer race locations in the hub has occurred and the only remedy is to renew the hub.

### Wheel Studs

With the hub removed, examine wheel studs for evidence of wear around tapered shoulder, also thread damage. If these conditions are apparent, renew studs as follows:

- a. Place hub in a vice equipped with soft jaws.
- b. Remove oil deflector and joint if necessary to gain access to locknut; remove nut.
- c. Press or drive out defective stud and locking peg.
- d. Insert a new stud and locking peg, noting that left-hand threaded studs are for left-hand hubs, right-hand threaded studs for right-hand hubs.

- e. Fit and tighten locknut to the torque figure quoted in Data.
- f. Refit oil deflector and joint if removed.
- g. Centre-punch locknut into stud at four diametrically opposed points.

### To Reassemble

1. Press outer bearing races in hub if removed, press in new oil seal.
2. Repack hub and bearings as directed in Group 1. **CAUTION:** Do not pack hub completely; allow for expansion of grease to prevent overheating and premature failure.
3. Refit hub on axle arm, locate inner and outer bearings, avoid damage to oil seal.
4. Fit locking plate, hub adjusting nut and tighten using a suitable bar; back-off one half turn.
5. Using a copper hammer, strike hub to ensure correct bearing location, avoid damaging the wheel studs.
6. Attach a dial gauge base to a convenient point on the hub, arrange the stylus to contact the axle arm, see Fig. 4.
7. Grip hub firmly, push in to take up any clearance, set dial gauge at zero.
8. Lever hub and note dial gauge reading; adjust hub nut until the reading is within the limits quoted in Data.
9. Screw lockplate bolt through hub nut and align through hole(s) in locking plate; securely tighten.
 

**NOTE:** Rotation of the hub nut from one tapped hole to the next hole in the locking plate is equal to 0.127 mm (0.005 in) end-float. Moving the lockplate bolt from the alternate hole in the hub nut to the original tapped hole in the locking plate is equal to 0.0635 mm (0.0025 in) end-float.
10. Fit clamp bolt, nut, secure and fit a new split pin. Do not unscrew nut to facilitate split pin refitment.
11. Re-check hub end-float, since tightening the clamp bolt can alter the pre-set end-float.
12. Fit a new joint, hub cap; secure with setscrews and washers.
13. Fit brake drum; secure with setscrews and washers.
14. Check brake adjustment as described in Group 7.
15. Refit anti-squeak band to brake drum.
16. Refit road wheel and wheel nuts.
17. Lower vehicle to ground, remove jack and supports, tighten road wheel nuts, see Group 1 for torque figure.

REMOVAL AND REFITMENT

Front Axle Assembly

To Remove

1. Slacken road wheel nuts, noting that left-hand threads are used on left-hand side of vehicle and right-hand threads on the right-hand side.
2. Jack and block chassis, support axle by means of a trolley jack, remove wheel nuts and road wheels.
3. Disconnect automatic lubrication pipes, if fitted.
4. Remove split pin, nut, washer and withdraw rear drag-link ball pin from upper steering arm.
5. Disconnect air pipes from front brake chambers, plug pipe ends and chambers to prevent the ingress of foreign matter.
6. Remove nuts, washers, and disconnect shock absorber links from spring plates.
7. Remove spring guard bracket at front shackle pin, right-hand side of chassis.
8. Remove front shackle pin clamp bolts, retaining nuts and drive shackle pins through spring bushes using a suitable drift located through the hole in the chassis frame.
9. Retain thrust washers for subsequent reassembly.  
**NOTE:** The front thrust washers should be kept separate from the rear thrust washers as they are of a different type.
10. Remove upper clamp bolts, retaining nuts, at rear of axle and slacken the lower clamp bolts and retaining nuts.
11. Drive upper shackle pins through spring bush; retain the thrust washers.
12. With the aid of an assistant holding assembly steady, withdraw the axle from the vehicle.

To Refit

Refitment is a reversal of the removal procedure, observing the following points:

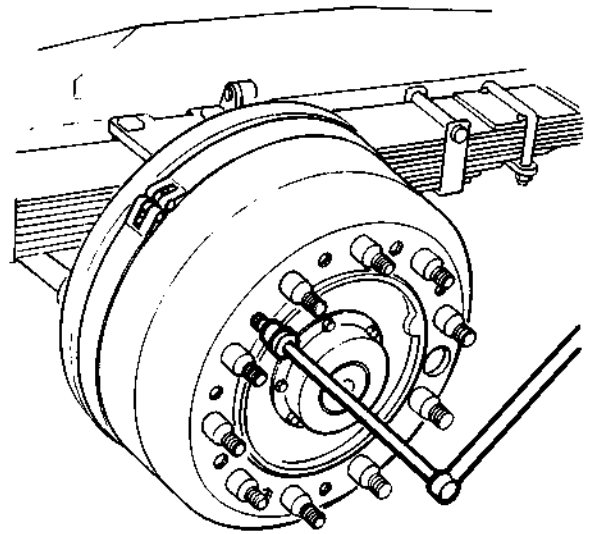
1. Adjust the spring shackles as described in Group 9.
2. Do not tighten the shock absorber links until the full weight of the vehicle rests on the road wheels.
3. When refitting clamp bolts, ensure they line up with the grooves in the shackle pins.
4. Check the steering geometry as described in Section 1.

OVERHAUL

Front Hub

To Dismantle

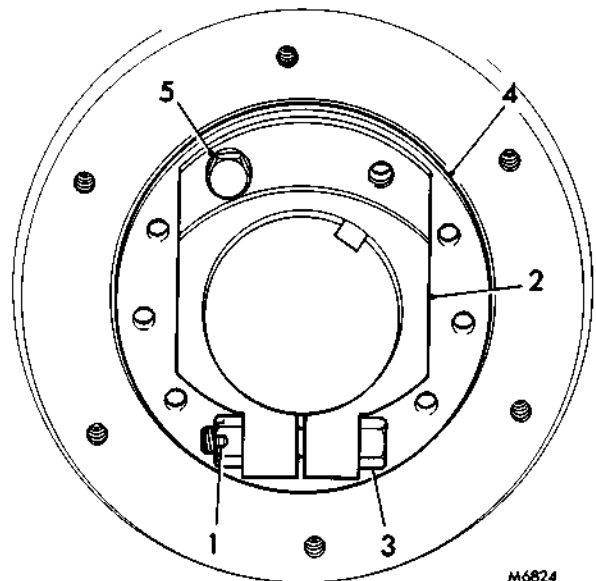
1. Remove wheel nut cover on wheel concerned; slacken wheel nuts.
2. Jack and support axle, remove nuts and road wheel.



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FIG. 2. WITHDRAWING BRAKE DRUM

3. Remove setscrews, washers, withdraw hub cap and joint.
4. Slacken the brake shoe adjusters as described in Group 7.
5. Remove anti-squeak band from brake drum.
6. Remove setscrews, washers and with the aid of three  $\frac{1}{8}$  in U.N.C. setscrews located in the tapped holes provided, jack the drum from the hub, see Fig. 2.
7. Withdraw split pin, remove nut, clamp bolt and lockplate bolt from the hub adjusting nut, see Fig. 3.
8. With the aid of a suitable bar through the clamp bolt hole, unscrew the hub nut and remove, together with the locking plate.



M6824

FIG. 3. HUB SECURITY ARRANGEMENT

- |               |                   |
|---------------|-------------------|
| 1. Split pin  | 4. Lockplate      |
| 2. Hub nut    | 5. Lockplate bolt |
| 3. Clamp bolt |                   |

## FRONT AXLE AND STEERING

### Camber and Castor Angles

The castor and camber angles are an inherent design feature and are not adjustable. They may, however, be checked if it is thought that misalignment may have occurred due to the vehicle being involved in a collision.

### Wheel Alignment, Checking and Adjustment

Before commencing to check wheel alignment ensure that all tyres are inflated to the correct pressure and the vehicle is standing on a level surface. Check and adjust alignment in accordance with instructions given with standard workshop test equipment.

The correct front wheel alignment is:

Wheels parallel to 1.5 mm ( $\frac{1}{16}$  in) toe-in.

This setting is important, and applies to vehicles fitted with either cross-ply or radial-ply tyres.

1. Set the front wheels to the straight-ahead position. Care must be taken to establish this condition and when the vehicle has been brought to a standstill using the vehicle brakes, it should be rolled forward (not reversed), by a distance of at least 180 cm (6 ft). This manoeuvre will ensure that the steering linkage and suspension adopt their normal operating positions.
2. If adjustment is necessary, slacken the track-rod clamp bolts. Rotate the track-rod in the direction necessary to correct the alignment.
3. Repeat the foregoing procedure as a re-check. If the alignment is found to be correct, tighten the clamp bolts securely.

**NOTE:** Under no circumstances must there be any toe-out.

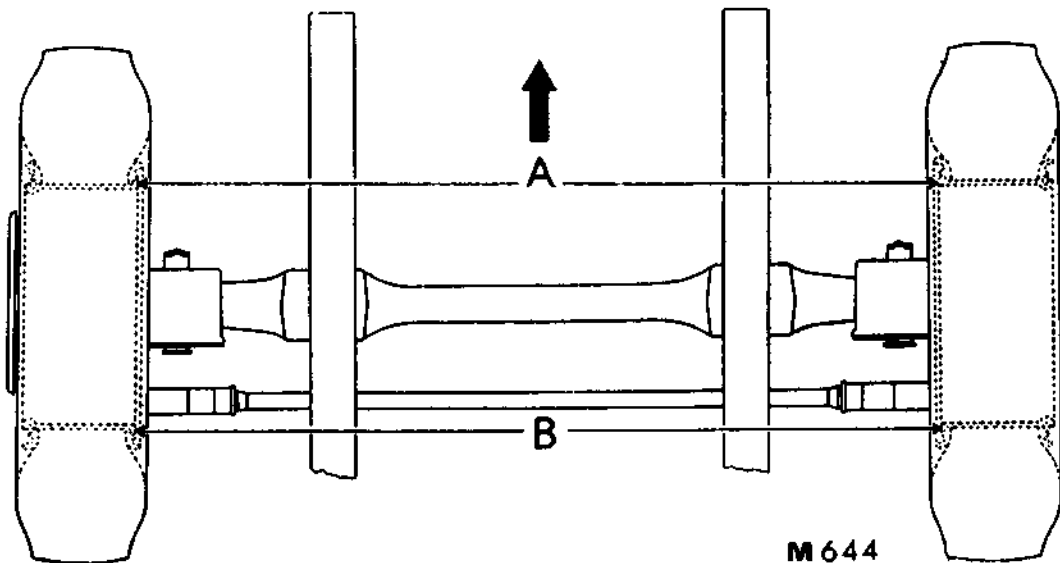


FIG. 5. FRONT WHEEL ALIGNMENT DIAGRAM, ARROW INDICATES FRONT OF VEHICLE

The dimension A taken at the front of the wheels (2nd reading) should be equal to dimension B taken at the rear of the wheels (1st reading) +0 mm (+0 in)  
1.5 mm ( $-\frac{1}{16}$  in)



**Axle Arms**

**To Dismantle**

1. Chock rear wheels, apply handbrake.
2. Release air pressure from system by opening drain taps on the service reservoirs or by repeated application of the brakes.
3. Remove wheel nut cover, slacken road wheel nuts on wheel concerned.
4. Jack and support axle, remove nuts and road wheel.
5. Remove brake drum and hub as described on page 5-2-3.
6. Remove split pin, nut and disconnect push-rod jaw-end from brake lever; remove securing nuts, washers and withdraw brake chamber from mounting bracket complete with springs.
7. Remove split pins, nuts, four setbolts, withdraw oil deflector, joint, brake assembly with backplate; retain four setbolts for subsequent reassembly.
8. Disconnect pipes to air brake chamber, plug pipe and chamber to prevent the ingress of foreign matter.
9. Disconnect automatic lubrication pipes if fitted.
10. Remove split pins, nuts, washers and disconnect track-rod and rear drag-link ball pins on the driving side of the vehicle.
11. Break lock wire, remove nuts, washers and withdraw track-rod, brake chamber bracket, steering-arm from their respective locations.
12. Remove Seelastrip from lower thrust cap, break lock wire, remove setscrews, washers, lockplate and oil deflector.
13. Unscrew lower thrust cap; retain shims and thrust pad.
14. Remove setscrews, washers; withdraw king pin cover and joint.
15. Remove split pin and king pin retaining nut.
16. Using a suitable soft metal drift slightly less in diameter than the upper diameter of the king pin, drive out the pin from the top, retain shims and thrust button.
17. Remove axle arm and the felt washer.
18. Press the distance piece from the upper axle arm bush.
19. Using a suitable spigoted mandrel slightly less in diameter than the outer diameter of the axle arm bushes, press out the worn bushes. If a press is not available, the bushes may be driven out; avoid damage to the axle arm bores.

**Inspection**

1. Wash all components except seals in a suitable cleaning solvent.
2. Examine brake drum for cracks or excessive scoring; renew as necessary.
3. Where facilities are available, the axle, steering-arms and drop-arm should be crack-detected.

4. Check the securing holes in the axle and steering arms for enlargement, also the mounting studs for wear; renew if these conditions are apparent.
5. Examine king pin, axle arm bushes and upper steel bush for wear; renew as necessary.

**To Reassemble**

If new axle arm bushes are to be fitted, proceed as follows:

- a. Press in the new bushes, ensuring the axle arm bores are clean and free from burrs.
- b. Ensure the bushes enter squarely, and the inner faces of the bushes are flush with the axle arm.

**NOTE:** If new king pins and bushes are fitted, the king pin should be lapped in with fine carborundum paste. After lapping, remove all traces of the compound.

1. Fit axle arm to beam, ensuring the felt washer is located on the lower part of the axle arm.
2. Insert king pin through axle arm and beam from lower end, with the thrust button and original shim pack in position.
3. Using a suitable drift located from below, drive the king pin to its limit; fit distance piece located inside the upper axle arm bush.
4. Fit washer and nut to king pin; securely tighten.
5. Fit lower thrust cap, ensure thrust pad and dowels are in position, tighten securely.
6. Select shims, if required, to align locking plate with nut and securing holes; see Data for shims available.
7. Check king pin end-float; adjust shim pack if necessary to produce the required clearance, see Data.
8. Fit split pin to king pin securing nut; fit lockplate, oil deflector to lower cap, secure with setscrews, washers, wire-lock and coat with Seelastrip.
9. Fit joint, top cover secure with setscrews, washers; liberally oil king pin through top cover.
10. Refit track-rod, steering arm, brake chamber bracket, fit nuts, washers, secure and wire-lock.
11. Fit brake assembly, coat joint with Hylomar jointing compound, fit oil deflector on studs.
12. Fit setbolts, tighten nuts and fit split pins.
13. Fit brake chamber to bracket, secure and fit springs, re-connect push-rod jaw-end and fit a new split pin.
14. Refit and adjust hubs as described on page 5-2-4.
15. Remove plugs, re-connect brake chamber hoses.
16. Refit brake drum and centralize brake shoes, see Group 7.
17. Refit track-rod and drag-link ball pins, tighten to the torque figure quoted in Data, fit split pins, seal ends of track-rod and locking plates with Seelastrip.
18. Refit road wheels, nuts and lower vehicle to ground; tighten nuts, refer to Group 1 for torque figure.
19. Remove jack, supports; check and adjust toe-in as necessary, see Data for tolerance.

## FRONT AXLE AND STEERING

Defect	Cause	Remedy
<p><b>Low speed shimmy .</b></p>	<p>Negative castor</p> <p>Worn king pins and bushes</p> <p>Loose steering gear</p> <p>Loose wheel bearings</p> <p>Worn steering ball pillars</p>	<p>Check for worn bushes and damage to front suspension.</p> <p>Renew.</p> <p>See Section 1 of this Group.</p> <p>Inspect for possible damage and adjust.</p> <p>Renew.</p>
<p><b>Wheel tramp . . .</b></p>	<p>Unequal tyre pressure</p> <p>Eccentric tyre wear</p> <p>Inoperative front shock absorbers</p>	<p>Correct.</p> <p>Correct.</p> <p>Renew.</p>
<p><b>Excessive tyre wear .</b></p>	<p>Incorrect camber</p> <p>Incorrect toe-out</p> <p>Incorrect tyre inflation</p> <p>Fast cornering</p> <p>Wheel wobble</p> <p>Worn king pins</p> <p>Harsh or unequal brakes</p> <p>Sustained high speed driving</p>	<p>Check for worn bushes and damage to front suspension.</p> <p>Adjust.</p> <p>Correct.</p> <p>Operator's remedy.</p> <p>Straighten or renew wheel, replace tyre assembly as necessary.</p> <p>Renew king pins and bushes.</p> <p>See 'Brakes', Group 7.</p> <p>Operator's remedy.</p>
<p><b>Front end noisy . .</b></p>	<p>Looseness in front suspension</p> <p>Front shock absorber noisy</p> <p>Worn bushes</p>	<p>Re-tighten all nuts and bolts, check rubber mountings for wear, renew as necessary.</p> <p>Check front wheel alignment.</p> <p>Check the shock absorber fluid level, top up as necessary. Check security of unit to cross-member and links to spring plates.</p> <p>Renew.</p>

FAULT-FINDING CHART

Defect	Cause	Remedy
<p><b>Vehicle pulls to one side . . . . .</b></p>	<p>Incorrect camber</p> <p>Incorrect or unequal castor and king pin inclination</p> <p>Uneven tyre pressures or worn tyres</p> <p>Dragging brake</p> <p>King pin tight in bushes</p> <p>Tight or dry front wheel bearings</p> <p>Incorrect front wheel alignment</p>	<p>Check for worn bushes or damage to front suspension.</p> <p>Check front wheel alignment and angles.</p> <p>Check pressures; renew tyres as necessary. See 'Brakes', Group 7.</p> <p>Free the king pin, if necessary renew the pin and bushes, lubricate.</p> <p>Inspect for damage, readjust and lubricate. Adjust.</p>
<p><b>Vehicle wanders . . .</b></p>	<p>Incorrect castor</p> <p>Incorrect front wheel alignment</p> <p>Worn king pin and bushes</p> <p>Worn front wheel bearings</p> <p>Tight steering assembly</p> <p>Loose rear axle bolts</p> <p>Unequal tyre pressures</p>	<p>Check for worn bushes and damage to front suspension.</p> <p>Adjust.</p> <p>Renew.</p> <p>Renew.</p> <p>See Section 1 of this Group.</p> <p>Tighten.</p> <p>Correct.</p>
<p><b>High speed shimmy .</b></p>	<p>Eccentric wheels and tyres</p> <p>Incorrect adjustment of track-rods</p> <p>Loose steering gear assembly</p> <p>Incorrect setting of steering gear assembly</p> <p>Under-inflation of front tyres</p> <p>Unequal inflation</p> <p>Loose engine mountings</p> <p>Worn propeller shaft joint</p> <p>Faulty shock absorbers</p> <p>Worn or loose front wheel bearings</p>	<p>Check for buckled wheels and damaged outer covers, and renew as necessary.</p> <p>Correct.</p> <p>Correct.</p> <p>Correct.</p> <p>Correct.</p> <p>Correct.</p> <p>Check mounting for damage, renew and tighten as necessary.</p> <p>Renew.</p> <p>Renew.</p> <p>Examine for wear; renew as necessary and adjust.</p>

**E. Steering Chatter**

Steering chatter may be due to:

1. Anchor Ball Pin  
Check that the anchor ball pin is properly secured to the frame member of the vehicle.

**F. Heavy Steering**

Heavy steering over the whole travel of the road wheels, as distinct from local binding, may be due to:

1. Low Pump Output. See Section 4A, page 5-4A-3.
2. Internal Leakage in Hydrosteer Cylinder.

Check the valve spool and the bore of the body for scores or scratches. If in good condition, the trouble is probably due to leakage past the ram piston. In this case the inner tube and piston ring may have to be renewed.

**G. Noisy Operation**

To locate the cause of noise in the system, check the following items:

1. Reservoir Fluid Level.  
Check the fluid level in the reservoir. If the level is low, air is probably being drawn into the system by the pump. Top up with a good quality fluid as specified in Group 1.
2. Pump Parts.  
The pump assembly or certain parts of it may be worn. Dismantle the pump and renew as necessary, See Sections 4A and 4B, page 5-4A-4 and 5-4B-3.
3. Where the pump and reservoir are mounted separately, check that the hose feeding the pump from the reservoir is not blocked. Blockage in this line will cause air to be drawn into the system.

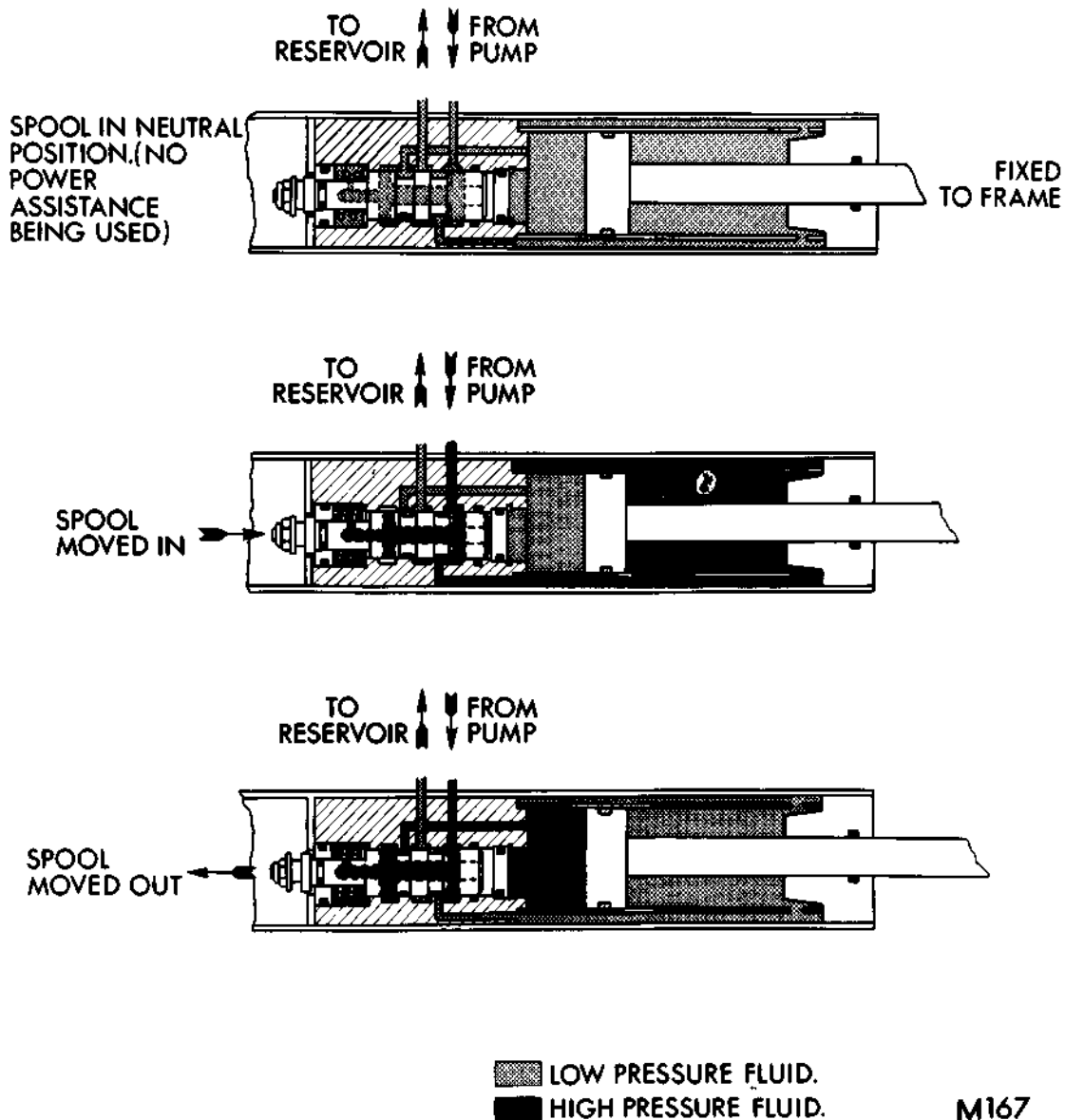


FIG. 1. FLUID CIRCUIT DIAGRAM



SECTION 3

Hydrosteer Power Ram

GENERAL INFORMATION

Data

Make .....	Hydrosteer VC1400358 and 9
Overall length — extended .....	815.34 mm (32.10 in)
Overall length — closed .....	653.29 mm (25.72 in)
Nominal overall length .....	612.14 mm (24.10 in)
Maximum stroke .....	201.68 to 204.47 mm (7.94 to 8.05 in)
Bore .....	57.15 mm (2.25 in)
Reaction spring pre-load .....	86.2 to 95.3 kgf (190 to 210 lbf)
<b>Torque tightening figures:</b>	
Ball pin retaining nuts .....	15.4 kgf m (110 lbf ft)

DIAGNOSTIC TESTING

A. Pump Output Check

Refer to Section 4A, Page 5-4A-3.

B. Power Ram Performance Check

If the pump pressure is satisfactory, 70 kgf/cm<sup>2</sup> (1 000 lbf/in<sup>2</sup>), the fault lies with the ram and therefore it must be removed for overhaul or subsequent replacement. In the event of power steering failure, the vehicle can be steered manually.

C. Binding

If binding or sticking is noticed when the steering wheel is turned, check the following items:

1. Movement of the Input Ball Pin.  
The operating sleeve may be binding in the locating sleeve, probably due to inadequate lubrication. These parts will have to be removed, freed and, if necessary, renewed.
2. Control Valve Spool  
Check the operation of the spool in the valve housing. If it is binding, inspect for burrs or damage and if necessary renew the control valve spool and housing.

D. Excessive Free Play in the Steering

If excessive free play is noticed when steering, check the following items:

1. Manual Ball Pin Cups.  
Check for excessive clearance between the ball pin and ball cups; check for wear or faulty Belleville washers and renew as necessary.
2. Ball Pin Adjustment
  - a. Input Ball Pin  
Remove split pin, and lock ring with tool HY 28, and using a suitable tool remove spring clip. Using tool HY 10 (Fig. 8) tighten input ball cup holder till a metal-to-metal contact is obtained. Wind off to produce a ball pin articulating torque of 0.86 to 1.3 kgf m (6.25 to 10.0 lbf ft). Secure with spring clip.
  - b. Anchor Ball Pin  
Fit ball cup holder, ensuring that the Belleville washers are correctly positioned. Fully tighten ball cup holder with suitable tool, then back off one-eighth of a turn. The maximum end-float of the anchor ball pin must not exceed 0.127 mm (0.005 in). Refit split pin.
  - c. Output Ball Pin  
For overhaul and adjustment refer to page 5-1-6, 'Dismantling Steering Ball Joints'.

# FRONT AXLE AND STEERING

## REMOVAL AND REFITMENT

### Power Ram

#### To Remove

1. Place a suitable container beneath hydraulic pipe connections to ram. Disconnect both pipes, noting their respective connections, and allow fluid to drain.
2. Disconnect automatic lubrication pipe and tie-wrap clips from ram.
3. Remove split pin, nut, plain washer, cup, oil seal, dust cover and disconnect output ball pin from steering relay lever.
4. Remove split pin, nut, washer and disconnect front drag-link from ram.
5. Remove split pin, nut and washer securing anchor ball pin to chassis frame, withdraw ram from its location.

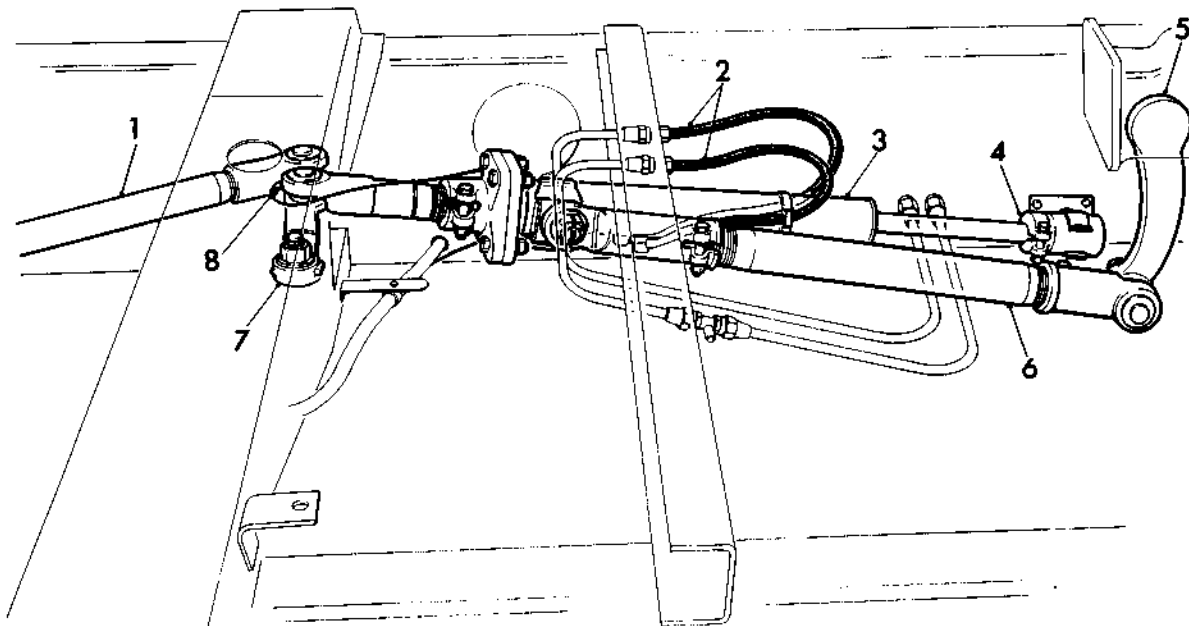
#### To Refit

Refitment is a reversal of the removal procedure. Tighten ball pillar nuts to the torque figure quoted in Data. If the steering geometry is disturbed in any way, refer to Section 1 of this Group.

1. Bleed the system in accordance with the following procedure:
  - a. Jack and block the steering axle.
  - b. Top up the reservoir slightly above the correct level by observing the level indicator and the tube attached to the unit.
  - c. Start the engine, allow to idle and slowly move the steering from lock to lock to ensure complete filling of the power ram and pipe-lines. Re-check the fluid level; if the level has dropped, top up again and repeat the procedure until the level remains correct and constant.

**Do not allow the reservoir to empty.**

2. Finally, lower the vehicle to the ground and while the engine is running at approximately 1500 rev/min, again turn the steering from lock to lock. Re-check the fluid level in the reservoir and check the system for leaks.



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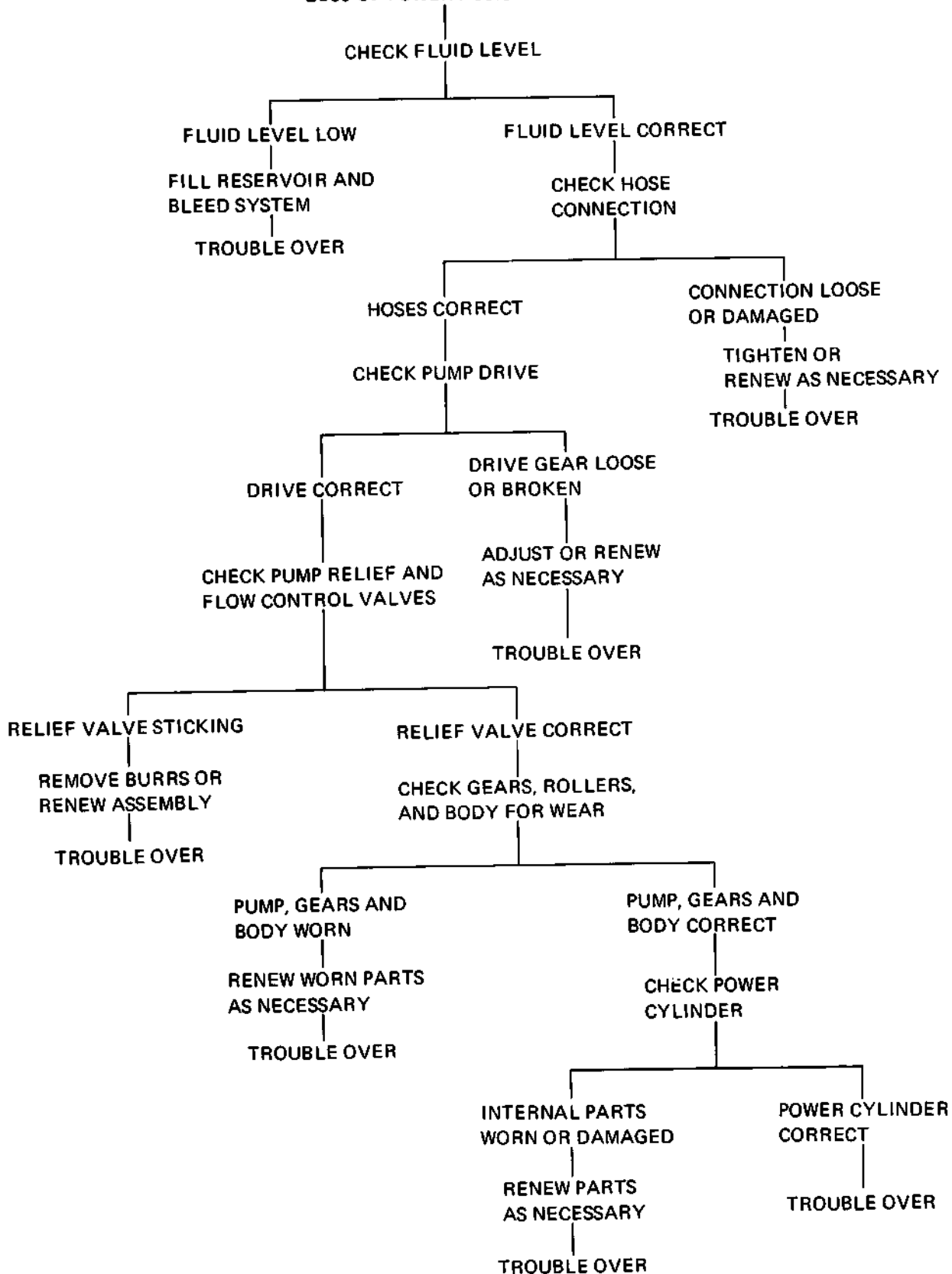
FIG. 2. GENERAL VIEW OF POWER RAM LOCATION

- |                                |                          |
|--------------------------------|--------------------------|
| 1. Drag-link to steering lever | 5. Drop arm              |
| 2. Power steering pipes        | 6. Drag-link to drop arm |
| 3. Power ram                   | 7. Relay lever           |
| 4. Anchor ball joint housing   | 8. Lubrication point     |

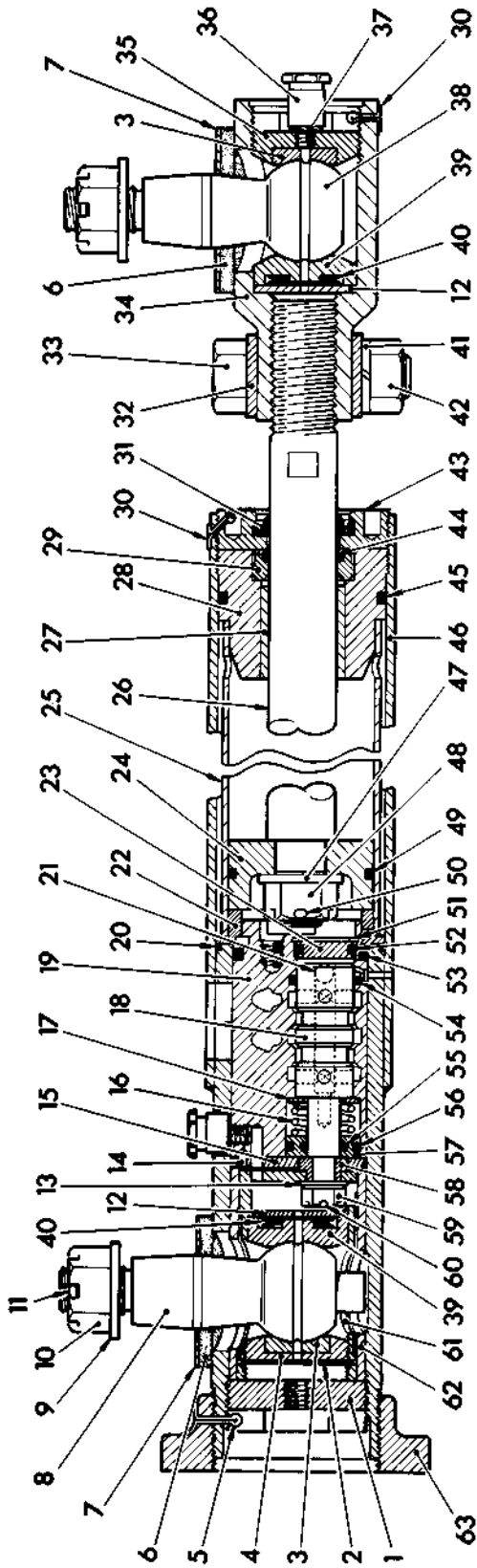
HYDROSTEER DIRECT-COUPLED POWER-ASSISTED STEERING

FAULT-FINDING CHART

LOSS OF POWER ASSISTANCE



Read in conjunction with other notes on diagnostic testing



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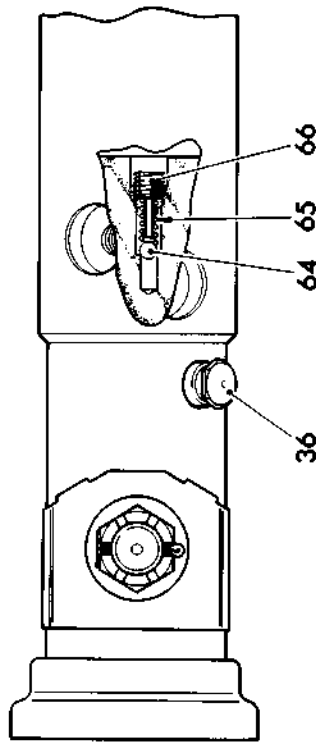


FIG. 4. SECTIONED VIEW OF POWER RAM

KEYS TO FIGS. 4 and 5

- 1. Lock ring
- 2. Spring clip
- 3. Ball cup
- 4. Ball cup holder
- 5. Split pin
- 6. Grease retaining pad
- 7. Spring cover
- 8. Input ball pin
- 9. Washer
- 10. Nut
- 11. Split pin
- 12. Backing washer
- 13. Spool washer
- 14. Locating pin
- 15. Spacer
- 16. Reaction spring
- 17. Reaction washer
- 18. Spool
- 19. Valve body
- 20. O-ring
- 21. Steel ball
- 22. Locating collar
- 23. End cover
- 24. Piston
- 25. Inner tube
- 26. Piston rod
- 27. Bearing bush
- 28. Bearing housing
- 29. Oil seal
- 30. Split pin
- 31. Scraper ring
- 32. Fastening clip
- 33. Bolt
- 34. Anchor ball-joint housing
- 35. Ball cup holder
- 36. Lubrication point
- 37. Fibre washer
- 38. Anchor ball pin
- 39. Inner ball cup
- 40. Belleville washers
- 41. Lock washer
- 42. Nut
- 43. Lock ring
- 44. Backing washer
- 45. O-ring
- 46. Outer tube
- 47. Piston washer
- 48. Piston nut
- 49. Piston ring
- 50. Split pin
- 51. Internal circlip
- 52. O-ring
- 53. O-ring
- 54. O-ring
- 55. O-ring
- 56. O-ring
- 57. Reaction ring
- 58. Collar
- 59. Spool nut
- 60. Split pin
- 61. Operating sleeve
- 62. Locating sleeve
- 63. Flange
- 64. Relief valve ball
- 65. Spring
- 66. Relief plug

OVERHAUL

To Dismantle (Fig. 4)

**NOTE:** It is advisable to obtain a repair kit before dismantling the ram.

After removal of the unit from the vehicle, drain the oil from the cylinder by moving the piston rod in and out several times, from one extreme end of its travel to the other, then proceed as follows:

1. Thoroughly clean the ram in a suitable solvent.
  2. Place the ram in a vice equipped with soft jaws.
  3. Remove four setbolts, self-locking nuts, washers and withdraw output ball pillar assembly from ram, see page 5-1-6, 'Dismantling Steering Ball Joints'.
  4. Remove spring covers (7) and grease retaining pads (6) from the two ball pins (8, 38).
  5. Remove grease nipples or lubrication pipe adaptors (36) and the split pins (5, 30) from each end of the ram and from lock ring (43).
  6. Remove banjo bolts, sealing washers and pipe unions; note their relative positions.
  7. At the anchor ball pin end remove ball cup holder (35) together with outer ball cup (3) and anchor ball pin (38).
  8. Remove inner ball cup (39), Belleville washers (40) and backing washer (12).
  9. Release clamp bolt (33) and unscrew anchor ball joint housing (34) from piston rod (26).
  10. Unscrew lock ring (1), using tool HY 28, Fig. 3.
  11. Remove spring clip (2), unscrew ball cup holder (4) using tool HY 10, withdraw holder (4), outer ball cup (3) and input ball pin (8).
  12. Remove locating sleeve (62), operating sleeve (61) and spool assembly (18) complete, withdraw inner ball cup (39), Belleville washers (40) and backing washer (12). Separate locating sleeve from operating sleeve.
- CAUTION:** The spool and valve body should be handled with extreme care as both are precision parts and are easily damaged. Even the slightest score mark or damage of any description on the mating surfaces of the spool or valve body will render the unit unsatisfactory in operation. The two components are matched and lapped together and are available only as a complete assembly.
13. Remove split pin (60), nut (59) and washer (13) from spool (18), together with operating sleeve (61), spacer (15), collar (58), reaction ring (57), reaction spring (16) and washer (17).
  14. Remove 'O' rings (55, 56) from reaction ring (57).
  15. Unscrew lock ring (43) using tool HY 28, remove backing washer (44), chip scraper ring (31) from lock ring (43) only if worn or damaged. Avoid damage to lock ring.
  16. Withdraw piston rod (26) and inner tube assembly (25) complete from outer tube (46). Using suitable tool remove 'O' ring (20) from outer tube as necessary. Remove outer tube from vice.

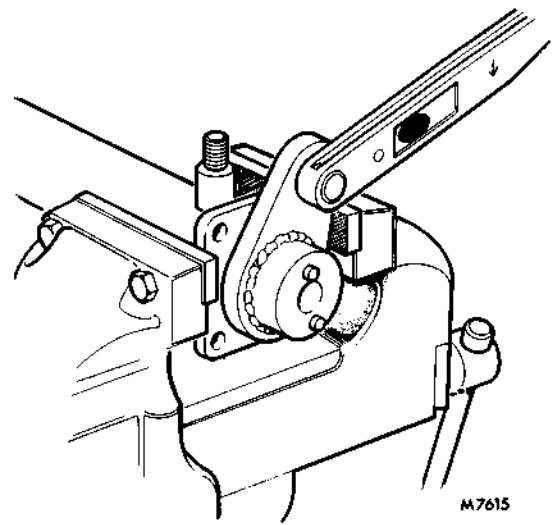
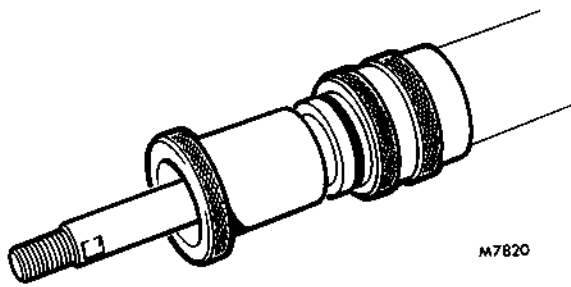


FIG. 3. USING SPECIAL TOOL TO REMOVE LOCK RING

17. Release piston rod (26) and bearing housing (28) by drawing the piston rod rapidly outwards several times to free the bearing housing from the inner tube (25).
18. Place piston rod in vice, remove split pin (50), nut (48), washer (47) and withdraw piston (24) from rod (26), remove piston ring (49) from piston.
19. Remove bearing housing (28) from piston rod (26); withdraw components at the piston end of the rod to eliminate any possibility of damage. Remove piston rod from vice.
20. Using a suitable tool, remove oil seal (29) from bearing housing (28), withdraw 'O' ring (45) from outer recess in bearing housing.
21. Remove inner tube (25) from valve body (19); a few taps with a hardwood drift located down the tube will free the valve body.
22. Release internal circlip (51) from valve body, remove end cover (23), withdraw 'O' ring (52) from end cover and inner 'O' ring (54) from valve body together with 'O' ring (53) on outer diameter of valve body (19).
23. Remove relief plug (66), spring (65) and relief valve ball (64) from valve body (19). Do not remove press-fit locating collar (22) and locating pins (14) from valve body unless worn or damaged.

**NOTE:** On the latest type of power ram the spring (65) has been deleted and the relief plug (66) and relief valve ball (64) modified.



**FIG. 6. FITTING BEARING ASSEMBLY INTO OUTER TUBE**

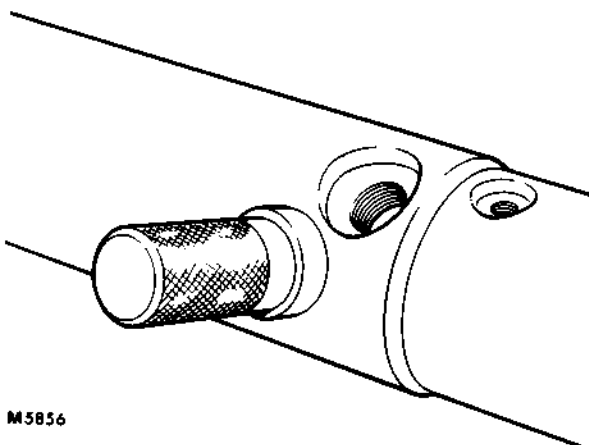
**3. Valve Spool**

- a. Place spool (18) in a vice equipped with soft jaws.
- b. Refit inner 'O' ring (55) and outer 'O' ring (56) to reaction ring (57).
- c. Refit reaction washer (17), spring (16) and reaction ring (57) on the spool, noting both the reaction washer and reaction ring are fitted to the spool chamfer first.
- d. Refit collar (58) on the threaded part of the spool and fit spacer (15) to locate around the collar, ensuring that the holes in the spacer align with the corresponding holes in the valve body and operating sleeve.
- e. Fit operating sleeve (61) on the collar (58); fit washer (13), slotted nut (59) and tighten to a torque of 3.23 to 4.8 kgf m (23.3 to 31.6 lbf ft); align pin hole and secure with split pin (60).
- f. Remove spool assembly from vice, smear operating sleeve with clean hydraulic fluid and slide locating sleeve (62) over it.

**4. Piston Rod**

**NOTE:** To eliminate the possibility of damage to any component, assembly should be carried out from the piston end of the rod.

- a. Using a suitable tool, fit oil seal (29) flat facing outwards into the bearing housing (28).



**FIG. 7. INNER ASSEMBLY CENTRALIZER IN POSITION**

- b. With the chamfered bore of the lock ring (43) upwards, fit scraper ring (31), flat facing downwards into the lock ring (if removed).
  - c. Fit 'O' ring (45) in recess on outer diameter of bearing housing (28).
  - d. Place piston rod (26) in a vice equipped with soft jaws; fit oil seal protection tool HY 20 over piston rod threads and slide bearing housing on piston rod; remove tool.
  - e. Refit piston ring (49) to piston (24); assemble piston on piston rod (26) flat face first; fit washer (47), nut (48) and tighten to a torque of 7.6 to 8.9 kgf m (55 to 65 lbf ft). Do not overtighten as this may cause the piston to swell and bind in the inner tube (25). Align pin-hole and secure with split pin (50).
  - f. Remove piston rod assembly from vice.
5. Compress piston ring (49) and slide the piston rod assembly into the inner tube as far as it will go; locate the recessed end of the bearing housing into the end of the inner tube; carefully tap bearing housing fully home.
  6. Place outer tube (46) in vice, coat 'O' ring (20) with Wellseal and locate in outer tube (if removed).
  7. Slide the valve spool assembly into valve body (19), avoid damage to 'O' rings (53, 54). The assembly must be positioned for the hole in the spacer (15) to fit over the locating pin (14) in the valve body.
  8. Refit the backing washer (12) in the bore of the operating sleeve (61), chamfer first, and ensure it is correctly seated. Place two Belleville washers (40), inner diameters together, in the recess of the inner ball cup (39); a smear of grease will retain them in position. Fit inner ball cup with Belleville washers into the operating sleeve (61) to seat on the backing washer.
  9. Fit outer ball cup (3) into ball cup holder (4); retain in position with a smear of grease. Screw ball cup holder into the operating sleeve (61) a few threads only, using tool HY 10.
  10. Fit tool HY 22 to protect bearing 'O' ring (45) from being damaged by the threads of the outer tube (46), Fig. 6. Slide complete inner assembly into the outer tube from the anchorage end of the unit. Push inner assembly fully home, ensuring that the hose ports in the valve body (19) line up radially with the ports in the outer tube; screw tool HY 17 into one of the hose ports to retain this position, Fig. 7.
- NOTE:** The above operation should be carried out with the power ram horizontal, otherwise the spool assembly could become dislodged from the valve body. Also ensure that the spacer (15) does not become disengaged from the locating pin (14) in the valve body.

**Inspection**

1. Thoroughly clean all components in a suitable solvent and blow dry with compressed air.
2. Examine valve spool and body for burrs or scoring. Remove burrs with a fine emery cloth. **CAUTION:** Do not round off the sharp edges on the valve spool or the operation of the valve will be affected.
3. With all 'O' rings removed, check the fit of the spool in the valve body. Smeard with a light film of oil, it should pass freely through the bore.
4. Inspect mating surfaces of the operating and locating sleeves for wear or damage; they must be free from burrs and scores.
5. Check the fit of the operating sleeve in the locating sleeve. The operating sleeve should slide freely within the locating sleeve when lightly lubricated.
6. Examine inner tube, piston, piston ring, piston rod and bearing for wear or damage; renew as necessary.
7. Ensure that the vent hole in the outer ram casing is clear.

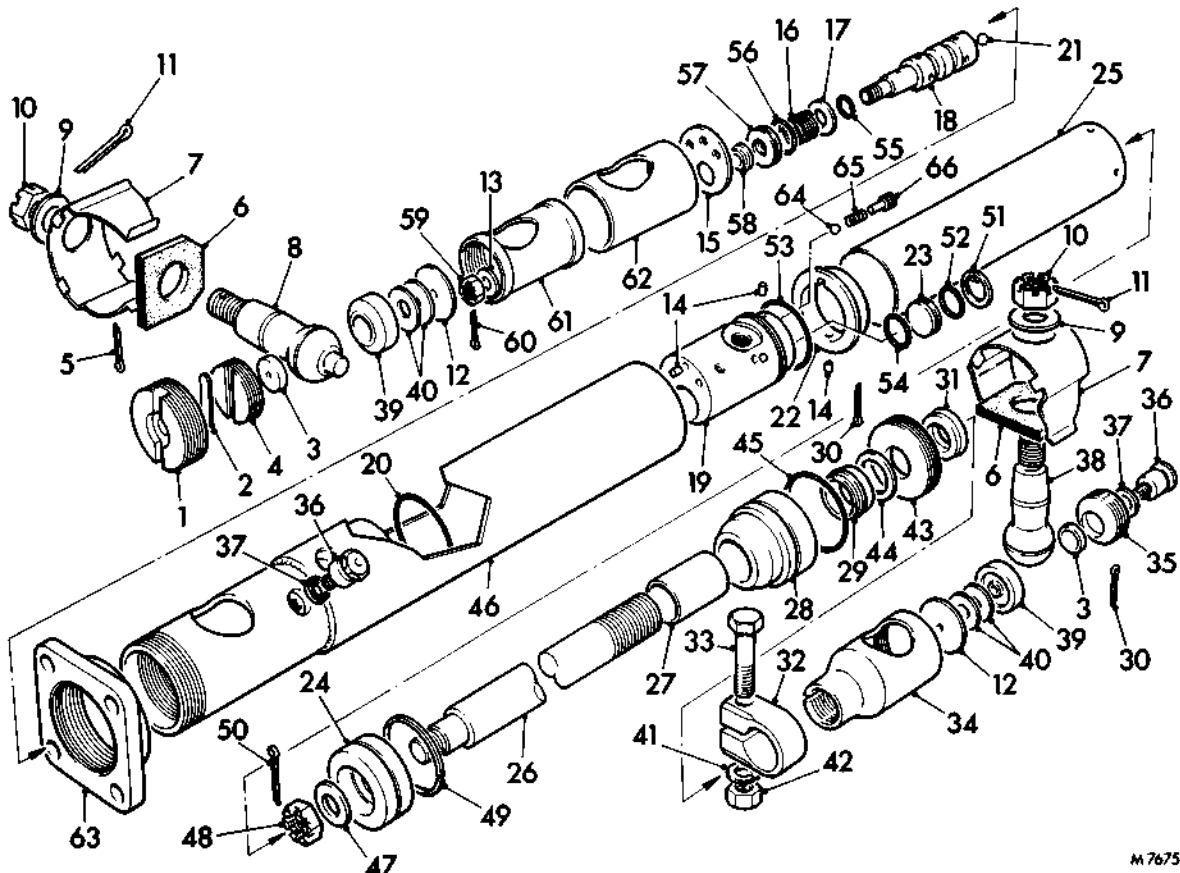
**To Reassemble**

When reassembling it is advisable to renew 'O' rings, split pins, circlips and oil seals. Extreme care must be taken when fitting 'O' rings to avoid damage which would cause subsequent leakage. Lightly lubricate 'O' rings prior to reassembly.

**1. Valve Body**

- a. Insert ball (64), spring (65) in valve body (19), fit relief plug (66) and secure. Check that the ball (64) can lift off its seat by inserting a suitable probe through the valve ports.
- b. If any of the locating pins (14) are loose or damaged, replace with new ones which should be lightly tapped into position.
- c. If the inner tube locating collar required renewal, assemble carefully under a small press, or by a few light taps with a soft-faced hammer, ensuring that the slot in the collar (22) aligns with the locating pin (14) in the outer diameter of the valve body (19).
- d. Refit inner 'O' ring (54) in valve body, fit 'O' ring (52) to end cover (23), slide end cover in valve body and secure with internal circlip (51).
- e. Refit 'O' ring (53) on outer diameter of valve body.

2. Refit the inner tube (25) to the locating collar (22) on the valve body (19), align slot in the tube with the locating pin (14) and tap into position using a soft-faced hammer.



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FIG. 5. EXPLODED VIEW OF RAM ASSEMBLY

# FRONT AXLE AND STEERING

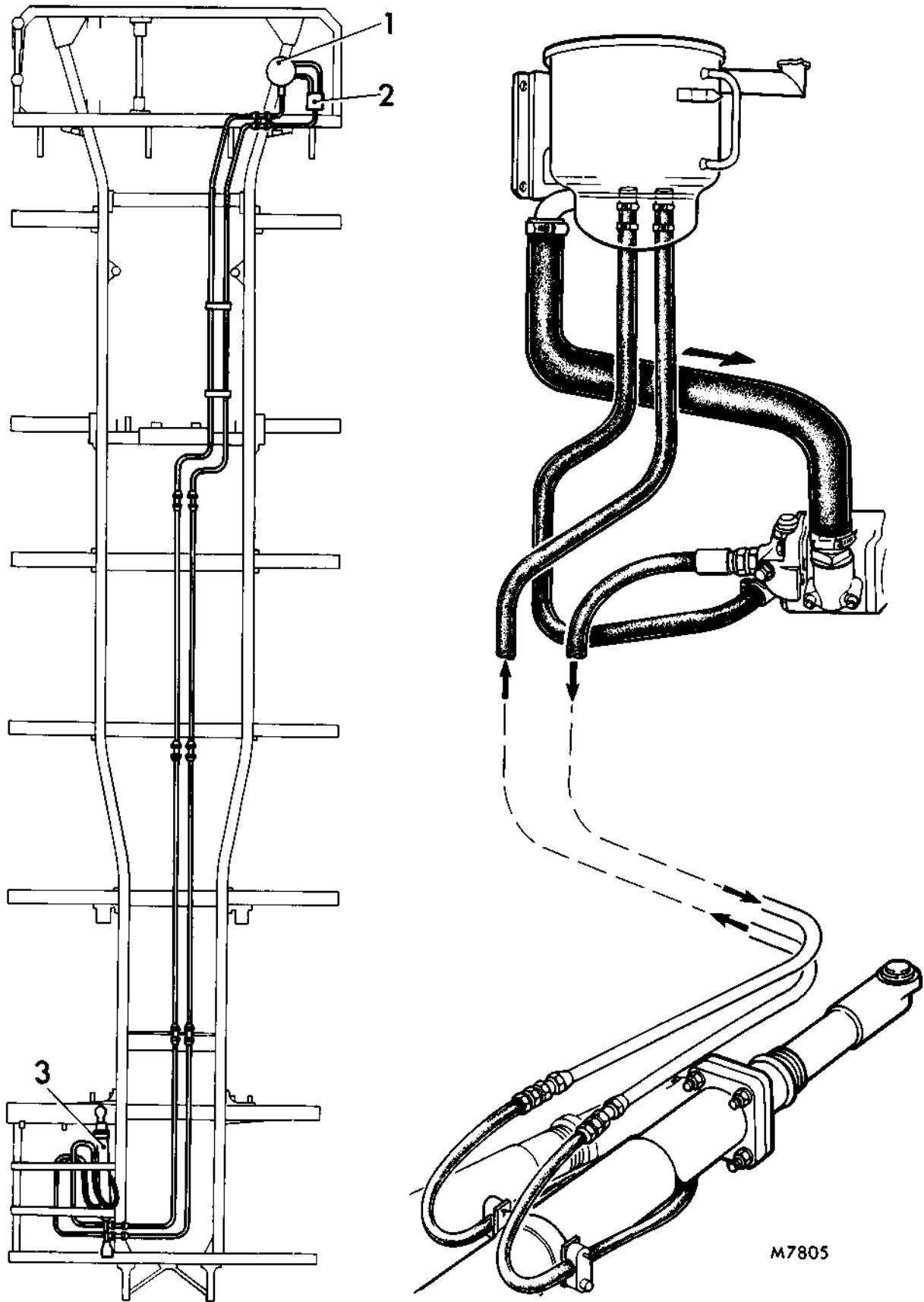


FIG. 9. HYDRAULIC SYSTEM DIAGRAM

Arrows indicate direction of fluid flow

- 1. Reservoir
- 2. Pump
- 3. Power ram



11. Remove tool HY 22, fit backing washer (44) and screw in lock ring (43) into outer tube a few threads only.
  12. Apply a liberal coat of Shell Alvania No. 3 grade grease to spherical surface of input ball pin (8) and assemble through the holes in the outer tube and sleeves, ensuring that the limit peg of the ball pin is correctly located in the two elongated slots provided.
  13. Screw home ball cup holder (4) to its limit, using tool HY 10, (Fig. 8), then back-off to produce a ball pin articulating torque of 0.86 to 1.38 kgf m (6.2 to 10.0 lbf ft); this is achieved by screwing back ball cup holder approximately one-sixth of a turn. Line up slot in ball cup holder to the nearest hole in the operating sleeve (61) and secure with spring clip (2).
  14. Fit lock ring (1); tighten lock ring (43) to a torque of 19.3 kgf m (140 lbf ft) using tool HY 28. Tighten lock ring (1) to a torque of 13.8 kgf m (100 lbf ft), again using tool HY 28. With both lock rings secured and the inner assembly centralized longitudinally and radially in relation to the outer tube, the body centralizing device HY 17 must screw in and out freely. Rectify as necessary if this condition is not apparent. Remove tool HY 17.
- NOTE:** The reassembly of the unit may mean that the split pin holes do not line up with the slots or holes in the lock rings (1, 43). On no account must the lock rings be slackened to facilitate split pin refitment. If necessary, drill additional 3.57 mm ( $\frac{1}{8}$  in) diameter holes in line with lock rings and secure with split pins (5, 30).
15. Screw anchor ball joint housing (34) on piston rod (26).
  16. Refit backing washer (12), Belleville washers (40), inner ball cup (39); grease spherical surface of anchor ball pin (38) with Shell Alvania No. 3 grade grease and locate in housing (34).
  17. Refit outer ball cup (3) and ball cup holder (35); screw in ball cup holder to its limit, then back off approximately one-eighth of a turn; align hole in ball joint housing with slot(s) of ball cup holder and secure with split pin (30).

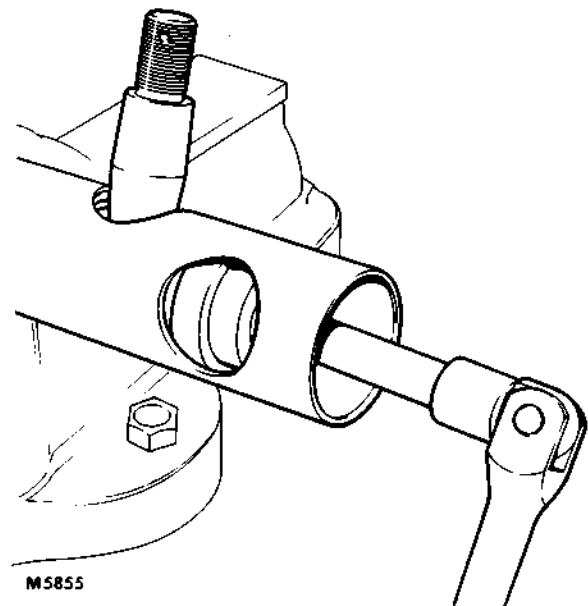


FIG. 8. TIGHTENING INNER BALL CUP HOLDER USING SPECIAL TOOL

**NOTE:** Maximum end-float of anchor ball pin must not exceed 0.127 mm (0.005 in).

18. Refit grease retaining pads (7) and spring covers (6) over both ball pins.
19. Refit banjo bolts, sealing washers and pipe unions in their original positions.
20. Refit grease nipples or lubrication pipe adaptors (36).
21. Refit output ball pin assembly, secure flanges with setbolts, washers and self-locking nuts.
22. With the ram fully compressed, the distance between the outer ball pillars must be set at 860.425 mm (33.875 in), ensuring four threads only are visible on the piston rod (26).
23. Secure clamp bolt (33), ensuring the nut is positioned to the underside of the ram when the unit is refitted to the chassis.
24. Remove ram from vice.

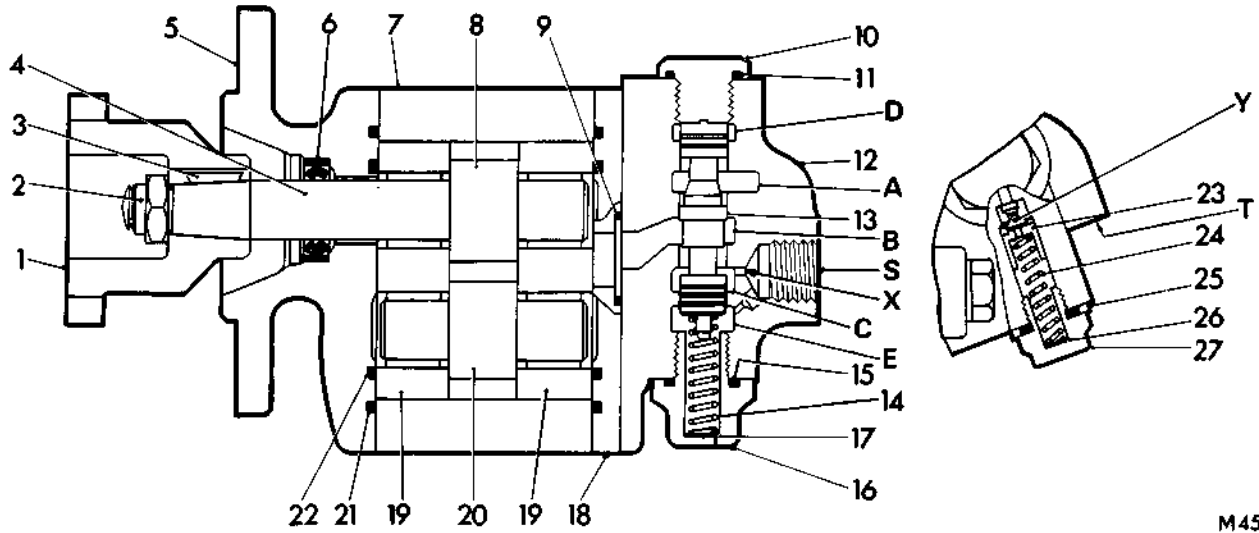


FIG. 1. SECTION VIEW OF PUMP, FLOW VALVE AND RELIEF VALVE

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- |                        |                             |                           |
|------------------------|-----------------------------|---------------------------|
| 1. External drive gear | 10. Valve cap               | 19. Bearing assembly      |
| 2. Self-locking nut    | 11. Sealing ring            | 20. Driven gear           |
| 3. Woodruff key        | 12. Cover and valve housing | 21. Seal                  |
| 4. Drive shaft         | 13. Spool                   | 22. Pressure loading ring |
| 5. Mounting flange     | 14. Flow valve spring       | 23. Relief valve          |
| 6. Seal                | 15. Sealing ring            | 24. Spring                |
| 7. Pump body           | 16. Valve cap               | 25. Bonded seal           |
| 8. Drive gear          | 17. Shims                   | 26. Shims                 |
| 9. 'O' ring            | 18. Sandwich plate          | 27. Valve cap             |

**Flow Control Valve and Pressure Relief Valve Operation (Fig. 1)**

The type of valves used in power steering systems make it necessary to control the flow rate, which, if uncontrolled, is proportional to pump speed; this is the purpose of the flow control valve. The maximum output of the pump is determined by the control orifice 'X' and the position of the spool. Fluid is transferred from the reservoir by the gear elements of the pump, under pressure, to the flow control valve.

The initial path of fluid through the valve is via annulus 'B' and annulus 'C' to the outlet port 'S'. As the pump speed increases, the flow increases until the desired controlled flow is reached, any further increase will result in the spool moving, from the position shown, to allow excess flow to spill past the shallow spool taper to annulus 'A' and from there to reservoir via port 'T'.

The pressure before the control orifice 'X' is transmitted from annulus 'C' to 'D' via drillings in the spool. The lower pressure after the control orifice acts on the spring end of the spool via the drilling connecting port 'S' to annulus 'E'.

Movement of the spool is initiated by higher flow and subsequent increase in pressure drop across the control orifice 'X'. This pressure difference is sensed at the spool ends and the higher pressure at 'D' causes the spool to move against the spring until a balance position, which provides the correct metered flow is reached.

Pressure is controlled by the pilot relief valve so that if service pressure is exceeded, the poppet 'Y' lifts exhausting the pressure at annulus 'E'. The pressure at 'D' then moves the spool completely over allowing a large escape area past the steep spool taper and so via annulus 'A' to the reservoir.

**DIAGNOSTIC TESTING**

**CAUTION:** During the test procedure do not hold the wheels against the lock stops for more than seven seconds, or overheating of the pump may occur and severe damage may result.

**Loss of Power Assistance**

Loss of power assistance may be due to either or several of the following causes:

- a. Fluid level low.
- b. Hose connections loose or damaged.
- c. Flow control and/or pressure relief valve sticking.
- d. Pump components worn or damaged.
- e. Fault in steering gear.

**Remedy**

- a. Top up reservoir and bleed system.
- b. Tighten or renew as necessary.
- c. Remove valve assembly and clean off any burrs or renew assembly.  
**NOTE:** The cover and the spool are matched during manufacture and are not interchangeable.
- d. Remove and dismantle pump, renew parts as necessary.
- e. See Section 1.

## SECTION 4A

## Power Steering Pump

## Plessey Type

## GENERAL INFORMATION

<b>Data</b>	
Make .....	Plessey A33-16793
Type .....	Gear
Drive .....	By gear meshing with engine timing gear
Relief valve setting .....	70 kgf/cm <sup>2</sup> (1 000 lbf/in <sup>2</sup> )
Flow control valve setting .....	11.4 litre (2.5 gal) per min
<b>Torque tightening figures:</b>	
Cover-plate setbolts .....	3.5 to 4.0 kgf m (25 to 30 lbf ft)
Drive gear retaining nut .....	4.0 to 5.6 kgf m (30 to 40 lbf ft)

## DESCRIPTION

The Plessey gear-type hydraulic pump consists essentially of seven main assemblies:

- The main body.
- The cover assembly.
- The sandwich plate.
- The mounting flange.
- The drive shaft and gears assembly.
- The bearings.
- The flow control valve and pressure relief valve.

The main body houses the bearings, which are basically figure-of-eight-shaped blocks, fitted into the body bore. The drive gear and the driven gear are sandwiched between the bearing blocks, with the integral journals of the gears running in the bores of the blocks, the bores being fitted with lubricating scrolls. Fitted externally on the main body is the inlet port adaptor.

The cover assembly houses the flow control valve and relief valve assemblies.

The sandwich plate is trapped between the main body and the cover assembly.

The mounting flange is located on the main body by two diametrically opposed hollow dowels and is held in position by four bolts which pass through the cover assembly, the sandwich plate and the main body. Two of the bolts pass through the hollow dowels and all four screw into the mounting flange.

The threaded and tapered spindle of the drive gear protrudes from one end of the main body and passes through the mounting flange. The helical driving gear fits on the taper of the drive gear spindle and is keyed to it with a Woodruff key. The driving gear is secured to the spindle with a self-locking nut.

## Sealing Arrangements

**1. Mounting Flange to Body**

Two square-section seals, fitted in recesses in the machined face of the mounting flange, form the seals between the body to flange and the bearing block to flange joints.

**2. Pump Shaft**

A conventional duplex seal of double spring-loaded lip form, prevents hydraulic fluid from the pump interior leaking to the exterior via the drive shaft, it also prevents the ingress of foreign matter and engine oil via the mounting aperture.

**3. Sandwich Plate to Body**

Two seals in recesses in the sandwich plate, similar in arrangement to the sealing of the mounting flange to the body.

**4. Sandwich Plate to Cover**

A single square-section ring, fitted in a recess in the sandwich plate around the periphery of the outlet communication port, and a square-section ring fitted in a recess in the sandwich plate around the periphery of the by-pass drilling from the relief valve to the inlet side of the pump, form the seals at these positions.

**5. Flow Control Valve Caps and Relief Valve Plug**

A square-section ring fitted in a recess in each of the two flow control valve caps, and a bonded seal washer fitted beneath the relief valve plug form the seals between these items and the cover.

**6. Inlet Port Adaptor to Main Body**

A square-section ring fitted in a recess in the inlet port adaptor forms the seal between the adaptor and the body.

## REMOVAL AND REFITMENT

### Power Steering Pump

#### To Remove

1. Disconnect batteries or operate isolation cut-off switch.
2. Lift rear engine canopy, open near side panel and inspection panel on bulkhead.
3. Place a suitable container beneath pump to collect hydraulic fluid.
4. Disconnect inlet hose from pump.
5. Disconnect delivery pipe and tank return hose, plug pipes and adaptors to prevent the ingress of foreign matter.
6. Remove mounting bolts and withdraw pump, retain the locking plate which will be dislodged in the process, discard joint.

#### To Refit

Refitment is a reversal of the removal procedure, ensuring a new joint is fitted.

After fitting the pump, bleed the system as directed on page 5-3-4.

## OVERHAUL

### To Dismantle

**NOTE:** Thoroughly clean the exterior of the pump assembly prior to dismantling, taking care to ensure that foreign matter does not enter the inlet and outlet ports. Always work at a clean work bench under conditions of maximum cleanliness.

1. Before dismantling pump, scribe marks on mounting flange, body, sandwich plate and end cover to aid reassembly in their correct relationship.
2. Remove pipe adaptors and sealing washers.
3. Remove self-locking nut securing driving gear and withdraw gear. Extract key from drive gear spindle.
4. Clamp pump body in a vice equipped with soft jaws to ensure that damage cannot result.

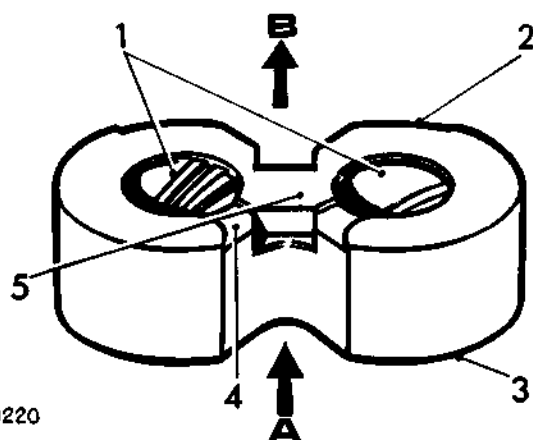


FIG. 3. TYPICAL PUMP BEARING

- |                          |                |
|--------------------------|----------------|
| A Pump Inlet             | B Pump outlet  |
| 1. Lubrication scrolls   | 4. Recess      |
| 2. Relieved radius       | 5. Seal bridge |
| 3. Plain face of bearing |                |

5. Remove four bolts which secure end cover to mounting flange.
6. Carefully remove cover and sandwich plate.
7. Withdraw upper bearing, gear elements and lower bearing. It is suggested that the upper bearing be lightly pencil marked to facilitate correct reassembly.
8. Remove shaft seal from pump mounting flange by careful use of a suitable lever; take care not to damage seal bore.
9. Remove the two flow control valve caps.
10. Gently push out the spring and spool, taking care not to tip the spool and jam it when partially out.
11. Remove the relief valve plug, carefully noting the number and position of the shims.
12. Tap out the valve head and spring.

### Inspection

Clean all parts in a suitable solvent. Air dry or wipe clean with a lint-free cloth. Inspect sealing rings for imperfections. They may be used again if undamaged, but it is advisable to replace them if they have been in service for more than six months.

Pump bodies are itemized on the parts lists for information only and are not available as replacements. Should a pump body be worn beyond the salvageable limits, satisfactory repair becomes uneconomical and it will be necessary to fit a new pump unit.

In the event of components not cleaning up as detailed in the following paragraphs, the advisable course is to clean out the hydraulic system and replace the complete pump unit. Worn components can, in emergency, be replaced but the following points should be noted:

Examine each bearing for wear on the face and in the bores. Pay particular attention to the condition of the lubricating scrolls and the seal bridge, Fig. 3. Score marks or damage across the seal bridge can cause high leakage losses.

Slight abrasions to the side face of the bearings can be erased by placing a sheet of 'O' grade emery paper, lubricated with paraffin, on a truly flat surface. Polish the bearing face using a light rotary action. Outer diameters may be slightly polished to obtain free movement in the pump body.

Inspect the gears for scored or worn side faces of the journals, damaged teeth, centres, thread or keyway and surface cracks.

Slight wear and scoring on the journals can be erased by polishing between lathe centres using 'O' grade emery paper lubricated with paraffin.

**Heavy Steering**

Heavy steering should not be confused with binding. Heavy steering is experienced over the whole travel of the front wheels, whilst binding is normally only experienced over a portion of the front wheel travel.

If the steering is heavy, the pump output pressure should be checked.

If it is suspected that the pump output pressure is low, carry out the following test:

1. Run the engine until normal operating temperature is reached, then stop the engine.
2. Place a suitable container beneath the oil pipe connections at the cross-member aft of the steering gear. Disconnect the outer flexible delivery pipe, and install MS 64 basic test equipment with MS 64-3 adaptors, see Fig. 2. The gauge must be on the pump side of the valve.
3. Fully open the screw-down valve. Top up the reservoir and bleed the system by slowly turning the steering from lock to lock whilst the engine is idling. Continue this procedure until the fluid level in the reservoir remains correct and constant. **Do not allow the reservoir to empty.**

**NOTE:** The steering lock stops must be correctly adjusted to achieve satisfactory bleeding; if any doubt exists on this condition, see page 5-1-7.

Similarly, in order to expel all entrapped air the steering must be turned to full lock in each direction, thus bringing the lock-stops into contact, thereby ensuring that the pressure cut-off holes are uncovered.

**CAUTION:** During the following operation the screw-down valve must not remain closed for more than seven seconds, or overheating of the pump may occur and severe damage may result.

4. With the engine running at idling speed, slowly close the valve and note the gauge reading. If the pressure rises from 65.5 to 70 kgf/cm<sup>2</sup> (950 to 1000 lbf/in<sup>2</sup>), the pump delivery pressure is satisfactory.
5. If the pressure does not rise to within the specified limits, stop the engine and carry out the following check.
6. Remove the reservoir cover retaining bolt and lift off the cover. With the engine idling and the screw-down valve open, engage an assistant to turn the steering wheel from lock to lock whilst observing the fluid flow in the reservoir. If fluid flows through the filter but no appreciable power assistance is apparent, a sticking flow control valve is indicated.

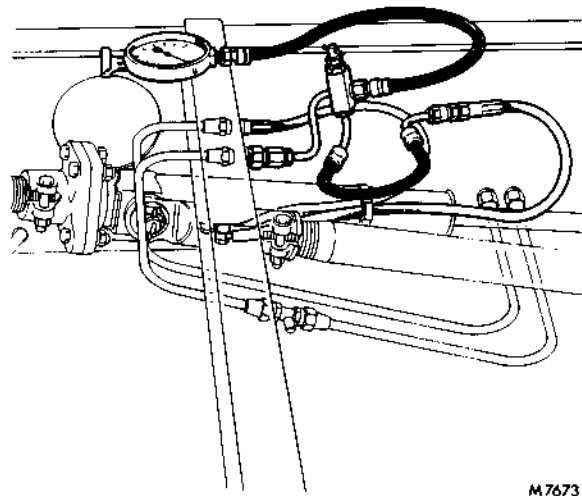


FIG. 2. MS 64 TEST EQUIPMENT INSTALLED

7. Unscrew the hexagon cap and remove the flow control valve assembly from the pump. Clean the valve and bore thoroughly and remove any burrs. Check the compression spring for breakage or weakness; if possible, compare the spring with a new one and renew as necessary. Insert the spring and valve assembly and ensure that the valve moves freely in the bore. Refit the screw-on cap.
8. Re-check the pressure. If the required pressure is not attained, complete the procedures on Fault-finding Chart, page 5-3-3.
9. On completion of the above checks, refit the reservoir cover and, if further work on the pump is not necessary, remove the valve and gauge and re-connect the delivery pipe. Bleed the system and check for leaks.

**Noisy Operation**

- a. Low fluid level in reservoir.
- b. Delivery pipe reservoir to pump obstructed.
- c. Pump internal components worn or damaged.

**Remedy**

- a. Top up to correct level and bleed as necessary.
- b. Remove pipe and clean out; bleed system.
- c. Dismantle the pump and renew parts as necessary (see overleaf).

**Test Equipment**

To do a pressure test on the system a pressure gauge calibrated from 0 to 140 kgf/cm<sup>2</sup> (0 to 2 000 lbf/in<sup>2</sup>) should be used as listed in Group 1.

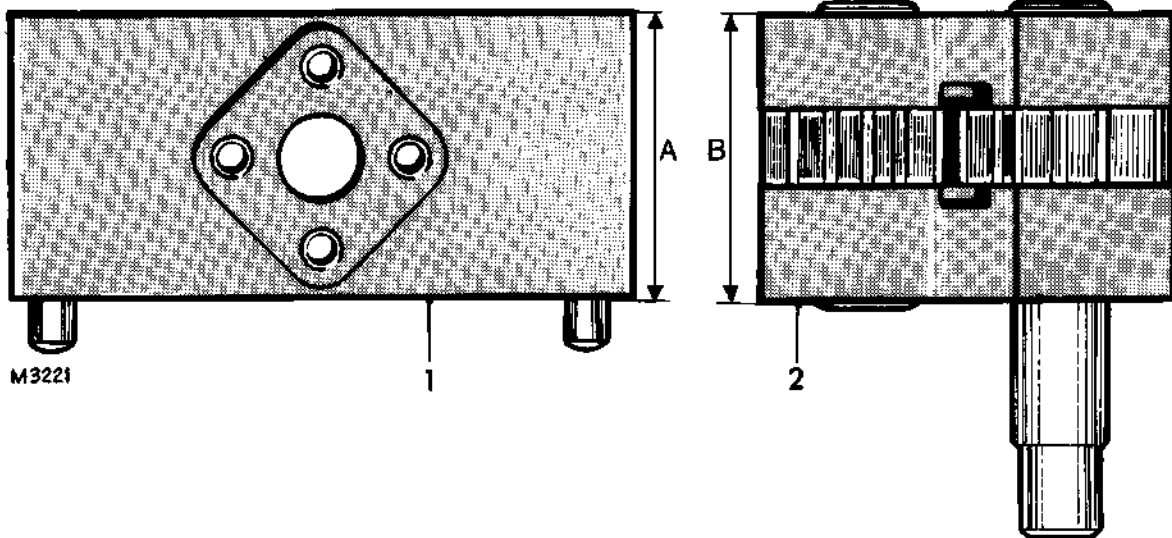


FIG. 6. BEARING CLEARANCE MEASUREMENT  
 1. Body      2. Gears and Bearings assembly  
 Distance B to be 0.10 to 0.20 mm (0.004 to 0.008 in)  
 less than distance A

To ensure correct sealing, check that the overall length of the gear and bearing assembly 'B', Fig. 6, is 0.10 to 0.20 mm (0.004 to 0.008 in) less than the pump body length 'A'.

1. With the cover flat on the bench and the reservoir port facing away, insert the spool, spigoted end first, from the right-hand side. Fit the spring on to the spigoted end of the spool and refit both valve caps and 'O' rings.
2. Refit the relief valve together with its spring, shims, bonded seal and cap.
3. Using a suitable mandrel, which is an accurate fit in the bore of and on the face of the seal, press or drive a new shaft seal into position in the pump body.
4. Fit the inlet and outlet port adaptors to the body.
5. Fit the appropriate sealing rings into the recesses of the mounting flange and sandwich plate.
6. Place the sandwich plate on the end of the pump. Note that the point of the heart-shaped sealing ring is towards the inlet side.
7. Holding the sandwich plate in position, place the pump on the bench, sandwich plate end down, with the inlet side nearest.
8. Lightly lubricate the bores and faces of both bearings.
9. Fit the cover end bearing into the bore with the recessed face uppermost and the relieved radii on the outside diameters towards the outlet side of the pump.
10. Fit the gears into their respective bores.
11. Fit the top bearing over the gear shafts with the recessed face downwards and relieved face towards the outlet side of the pump.
12. Fit a seal guide to the drive shaft, or wrap the drive shaft step with tape to protect the shaft seal. Locate the flange on the body dowels.
13. Place the pump, drive shaft downwards, on two blocks and position the cover assembly on the sandwich plate so that the relief valve cap is towards the inlet side of the pump.
14. Insert the securing bolts complete with spring washers and tighten to the torque figure quoted in Data.
15. Remove the seal guide, or if tape was used, remove tape ensuring that none remains. Fit the drive gear key and drive gear.
16. Fit self-locking nut and tighten to the torque figure quoted in Data.
17. If the pump is not being used immediately, the ports must be sealed with dust caps or adhesive tape to prevent ingress of foreign matter.

Test the unit as described under 'Diagnostic Testing'.

Slightly scored faces may be renovated by sandwiching emery paper between the gear face and a scrap bearing, Fig. 4.

Whilst servicing the drive and driven gears, particular attention should be paid to the following points:

Gear widths of drive and driven gears must be within 0.005 mm (0.0002 in) of each other to ensure satisfactory pump efficiency. Journals must be within 0.013 mm (0.0005 in) of each other. Gear faces must be flat; this feature may be checked by blueing a bearing face and rotating against the gear; this will also reveal any sharp edges on the teeth.

Replacement gears are supplied as matched pairs. Inspect the pump body for external damage and cracks. Examine the bores for wear and damage.

It is normal for the gears to cut a light track on the inlet side of the body bores. If the body is in good condition with no excessive scoring of the track and the depth of the track at the inlet does not exceed 0.10 mm (0.004 in) the body is re-usable; the depth of the track can be determined as follows: Using an internal micrometer, measure the body bore at the bearing location and then at the track position to assess the track depth, Fig. 5.

The only re-working advisable is to remove burrs at the edge of the gear track and this should be carefully effected with fine emery cloth.

Inspect the sandwich plate, mounting flange and cover assembly for damage or cracks. Check the flatness of the sealing faces with a straight-edge.

Inspect the spool valve bore for any signs of scoring and check the relief valve seat for indentations.

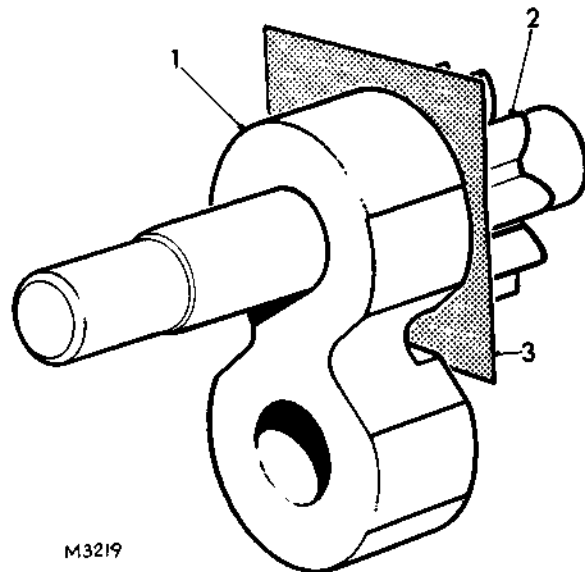
The only re-working advisable is to polish the spool using metal polish to remove fine scratches.

The cover and spool are matched during manufacture and are not interchangeable.

**To Reassemble**

During reassembly all components should be smeared with clean hydraulic fluid.

All machined surfaces should be free from burrs and bruise marks.



M3219

FIG. 4. POLISHING GEAR FACES

- 1. Scrap bearing
- 2. Gear
- 3. Emery paper 'O' grade

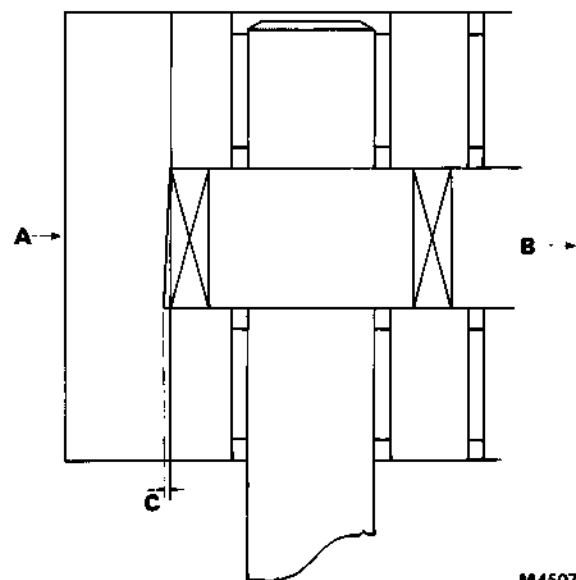
Ensure that the scroll lubricating grooves in the bearing bores are free from damage and foreign matter.

If used bearings are to be refitted, these should be placed in the original positions.

Inspection of the bearings indicates two distinct features which enable the operator to decide the correct location.

- a. A 'Y' shaped recess in the bearing face.
- b. Relieved radii on one side of the bearing.

Assemble bearings with the recesses adjacent to the gear faces and the relieved radii on the outlet side of the pump.



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FIG. 5. GEAR TRACK IN BODY

- A. Inlet
- B. Outlet
- C. Depth of gear track

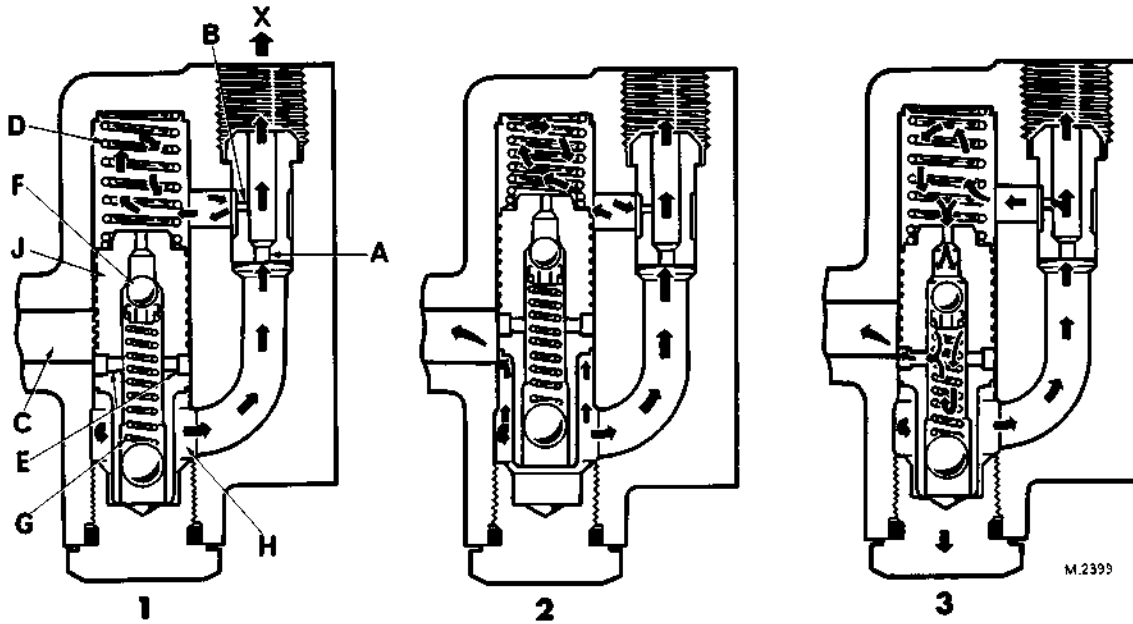


FIG. 1. SECTIONS THROUGH FLOW CONTROL VALVE AND DISCHARGE PASSAGE

Diagram 1  
Flow control valve inoperative

Diagram 2  
Flow control valve operating

Diagram 3  
Pressure relief valve operating

- A. Primary metering orifice
- B. Secondary metering orifice
- C. By-pass orifice
- D. Flow control spring
- E. Radial holes

- F. Pressure relief ball
- G. Pressure relief spring
- H. Annular chamber
- J. Flow control plunger
- X. Discharge to system

**Flow Control Valve and Pressure Relief Valve Operation (Fig. 1)**

The type of valves used in power steering systems make it necessary to control the flow rate, which, if uncontrolled, is proportional to pump speed; this is the purpose of the flow control valve. The maximum output of the pump is determined by the flow control spring 'D' and the size of primary metering orifice 'A' which is formed in the upstream end of an axially drilled plug pressed into the discharge passage. A secondary orifice 'B' in the plug, communicates with the flow control spring chamber.

The relief valve ball 'F' is subject to actual pump delivery pressure, downstream of the primary orifice via an axial drilling in the flow control plunger.

Oil enters the flow control area around the annular chamber 'H' and flows down the curved passage to the discharge connection. A drop in pressure occurs as the oil passes through the primary orifice 'A'. Oil at this lower pressure passes through the secondary orifice 'B' and enters the chamber containing the flow control spring. Diagram 1, Fig. 1.

The pressure difference between oil in annular chamber 'H' and spring chamber increases with oil flow causing the valve plunger 'J' to move against spring 'D'. When the pre-determined maximum flow rate is reached, the plunger uncovers the by-pass port 'C' and oil escapes to the inner intake port in the pump body, thus limiting the flow rate through the primary orifice. Any further increase in flow causes further uncovering of the by-pass port and thus a constant flow is maintained, Diagram 2.

Should the discharge line pressure become greater than the pre-determined maximum, the ball 'F' in the flow control plunger 'J' moves against spring 'G' and oil from the chamber containing spring 'D' escapes through the radial holes 'E' to the by-pass port, Diagram 3. When this condition occurs, a further pressure drop caused by secondary orifice 'B', causes the plunger 'J' to move against spring 'D' to its normal by-pass position, irrespective of the prevailing flow control condition. As soon as the line pressure drops the ball valve closes and the pressure difference is restored allowing the flow control plunger to resume its normal function.

**DIAGNOSTIC TESTING**

Refer to Section 4A, page 5-4A-2.



SECTION 4B

Power Steering Pump

Hobourn Eaton

GENERAL INFORMATION

DATA

Make . . . . .	Hobourn-Eaton 5543-10026-5
Type . . . . .	Roller
Roller length . . . . .	22.86 mm (0.9 in)
Drive . . . . .	By coupling boss on timing cover
Relief valve setting . . . . .	70 kgf/cm <sup>2</sup> (1 000 lbf/in <sup>2</sup> ) nominal
Flow control valve setting . . . . .	11.8 litres (2.6 gals) per min
Flow control spring tension . . . . .	3.6 to 4.0 kgf (8 to 9 lbf) at 20.8 mm (0.82 in) long
Cam and roller clearance . . . . .	0.05 mm (0.002 in)

Torque Tightening Figures

Valve cap . . . . .	4.1 to 4.8 kgf m (30 to 35 lbf ft)
Cover plate socket-headed screws . . . . .	2.4 kgf m (18 lbf ft)

DESCRIPTION

The Hobourn-Eaton roller-type hydraulic pump consists essentially of six main assemblies:

The main body.

The end cover.

The drive shaft.

The roller carrier and rollers.

The cam ring.

The flow control/pressure relief valve.

**REMOVAL AND REFITMENT**

**Power Steering Pump**

**To Remove**

1. Disconnect batteries or operate isolation cut-off switch.
2. Lift rear engine canopy and place a suitable container beneath pump to collect hydraulic fluid.
3. Disconnect air pipe from safety valve to compressor and move clear.
4. Disconnect inlet hose from pump.
5. Disconnect delivery pipe and tank return hose, plug pipes and adaptors to prevent the ingress of foreign matter.
6. Remove nuts, bolts and disconnect drive flange from alternator to pump, slacken cradle securing nut and slide alternator clear.
7. Slacken clamp bolt securing split coupling to driving boss on timing cover.
8. Remove bolts, washers and detach mounting bracket with pump assembly from its dowelled location on the crankcase.

**NOTE:** The pump mounting brackets are not interchangeable, the number stamped on the bracket must coincide with the number stamped on the front left-hand side of the crankcase.

9. Remove nuts, bolts and separate Leyrub and split couplings from pump.
10. Remove locknuts and drive flange securing nuts, detach flanges from each end of the pump, retain Woodruff keys.
11. Remove setscrews, washers and withdraw pump from mounting bracket.

**To Refit**

1. Refit pump to bracket, secure bracket assembly to crankcase.
2. Check and record end-float using dial test indicator.
3. Fit keys in drive shaft, locate pump drive flanges on keys and secure with nuts.

4. Locate split coupling over driving boss, ensure coupling is free on boss; do not secure clamp bolt at this stage.
5. Connect Leyrub coupling to pump drive flange and split coupling.
6. Press shaft forwards and relieve all end-float, place stylus of indicator on rear end of shaft and set at zero.
7. Press shaft rearwards and note gauge reading.
8. With the dial test indicator still in position, halve the original end-float and secure clamp bolt. Re-check and adjust as necessary. Remove indicator.
9. Carefully slide alternator and re-connect drive flange to pump.
10. Tighten alternator cradle securing nut.
11. Remove plugs from pipes and adaptors, re-connect in their original positions.
12. Re-connect air pipe to safety valve.
13. Re-connect batteries, bleed system as described on page 5-3-4.
14. Close engine canopy.

**OVERHAUL**

**To Dismantle**

1. Place pump in a vice equipped with soft jaws.
2. Remove pipe adaptors and sealing washers.
3. Remove socket-headed screws and washers, detach end cover from its dowelled location.
4. Remove 'O' rings from the periphery of the cam ring and from around by-pass port.

**NOTE:** Before removing carrier observe its relative position with regard to direction of rotation and angle of vane faces.

5. Remove drive shaft assembly, release snap-rings and withdraw carrier and drive pin from shaft.
6. Withdraw roller vanes and cam ring from body, remove cam ring lock peg only if worn or damaged.
7. Remove oil seals from end cover and pump body, avoid damage to bores.
8. Remove valve cap, 'O' ring and withdraw valve assembly and flow control spring.



**To Reassemble**

During reassembly all components should be smeared with clean hydraulic fluid. Renew oil seals and 'O' rings as necessary.

1. Using a suitable mandrel, press or drive in new oil seals into end cover and body.
2. Refit cam ring lock peg (if removed) and insert cam ring with slot over peg, ensuring the ring is seated correctly against the bottom face.
3. Refit drive pin to shaft, fit roller carrier in its original position and secure with snap-rings.
4. Insert the shaft from the body joint face using oil seal protection tool LC 172 positioned over drive shaft threads; remove tool after insertion.  
**NOTE:** Ensure that the oil seal journal on the shaft remains in contact with the seal during the remaining reassembly operations.
5. Refit roller vanes; see Fig. 4 for correct installation of rollers and carrier.
6. Refit new 'O' rings around by-pass port and cam ring periphery.
7. Locate end cover on dowels, fit socket-headed screws, washers and tighten to the torque figure quoted in Data. Check pump for freedom of rotation and rectify as necessary.

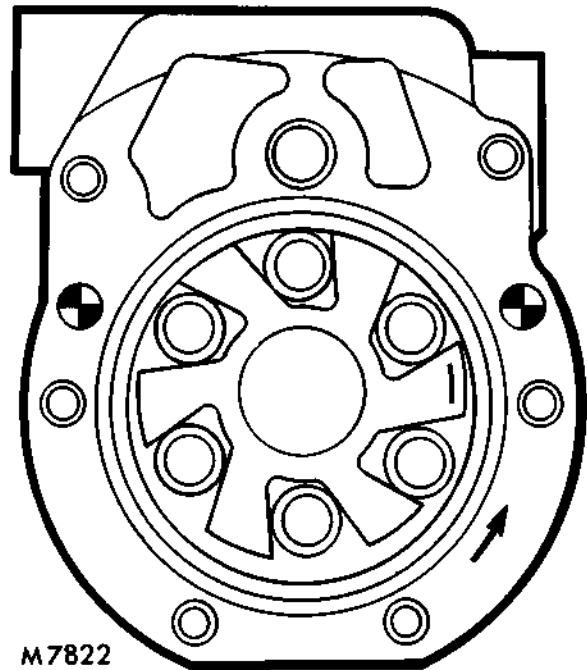


FIG. 4. CORRECT INSTALLATION OF ROLLERS AND CARRIER

Arrow indicates direction of rotation

8. Refit flow control valve spring and valve assembly, check valve for freedom of movement in bore.
9. Fit 'O' ring on valve cap, screw in valve cap and tighten to the torque figure quoted in Data.
10. Refit adaptors and sealing washers.

SECTION 5

Power Steering Reservoir

REMOVAL AND REFITMENT

**To Remove**

1. Disconnect batteries or operate isolation cut-off switch.
2. Lift rear engine canopy.
3. Place a suitable container beneath reservoir to collect hydraulic fluid.
4. Remove filler cap and siphon as much fluid as possible with a suction gun.
5. Disconnect hoses from reservoir and plug the ends to prevent the ingress of foreign matter.
6. Remove setbolts and detach reservoir from mounting bracket.

**To Refit**

Refitment of the reservoir is a reversal of the removal procedure, ensuring that the system is bled as described on page 5-3-4.

**OVERHAUL**

For filter replacement, refer to Group 1.



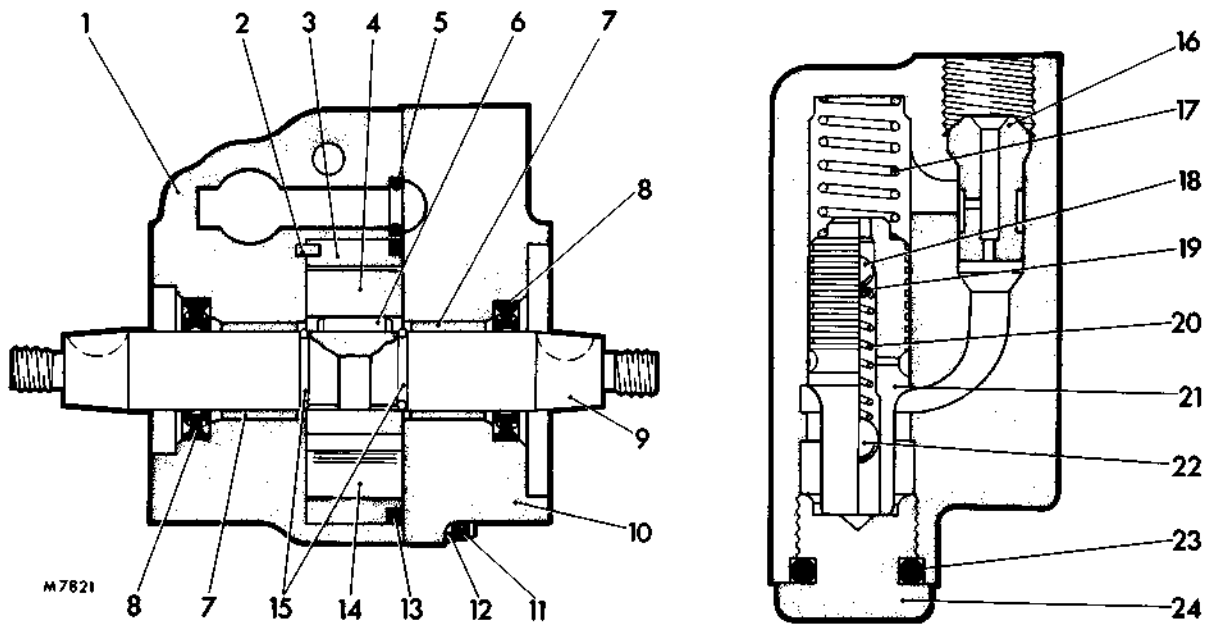


FIG. 2. SECTION THROUGH PUMP AND FLOW CONTROL VALVE

- |                             |                         |
|-----------------------------|-------------------------|
| 1. Pump body                | 13. 'O' ring            |
| 2. Cam ring lock peg        | 14. Roller vane         |
| 3. Cam ring                 | 15. Snap-ring           |
| 4. Roller carrier           | 16. Orifice tube        |
| 5. 'O' ring                 | 17. Flow control spring |
| 6. Roller carrier drive pin | 18. Relief valve ball   |
| 7. Bush                     | 19. Spring guide        |
| 8. Oil seal                 | 20. Relief valve spring |
| 9. Drive shaft              | 21. Flow control valve  |
| 10. End cover               | 22. Valve cap ball      |
| 11. Socket-head screw       | 23. 'O' ring            |
| 12. Washer                  | 24. Valve cap           |

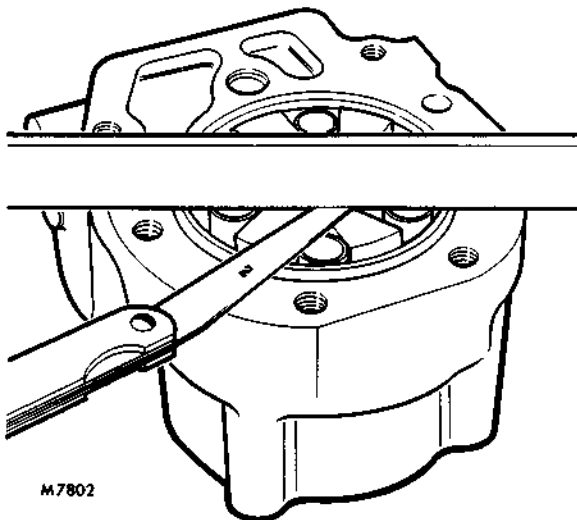


FIG. 3. CHECKING CARRIER AND ROLLER END CLEARANCE

Inspection

1. Clean all components in a suitable solvent, air-dry or wipe clean with a lint-free cloth.
2. Check bushes in pump body and end cover for wear; renew as necessary.
3. Inspect cam ring, roller carrier and its location in pump body. Examine roller vanes for end finish; renew if scored, damaged or eccentric.
4. Check with feeler gauge the clearance between cam surface, carrier and roller vanes, see Data and Fig. 3.
5. Examine shaft; if scored or damaged on any of the journals it must be renewed.
6. Check the surface finish of the flow control valve and its respective bore in the pump body; renew as necessary.
7. Check the flow control spring tension, see Data.

**GROUP 6**  
**REAR AXLE**

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Overhaul . . . . .	6-1-3

SECTION 1

Rear Axle Unit

DATA

Type . . . . . Daimler fully-floating, two-stage reduction, spiral bevel  
dropped centre

Ratio . . . . . 5.3: 1

Oil capacity . . . . . 12.5 litres (22 pints)

**Spiral Bevel Gear and Differential Assembly**

Bearing pre-load . . . . . 0.127 mm (0.005 in)

Adjustment . . . . . Adjusting nuts

**Pinion Assembly**

Bearing pre-load . . . . . 0.196 kgf m (17 lbf in)

Adjustment spacers . . . . .	12.45 mm (0.49 in)	12.7 mm (0.5 in)
	12.96 mm (0.51 in)	13.20 mm (0.52 in)
	13.46 mm (0.53 in)	13.74 mm (0.54 in)
	7.62 mm (0.3 in)	7.67 mm (0.302 in)
	7.72 mm (0.304 in)	7.77 mm (0.306 in)
	7.82 mm (0.308 in)	

Pinion housing adjustment shims . . . . .	0.076 mm (0.003 in)	0.127 mm (0.005 in)
	0.203 mm (0.008 in)	

**Intermediate Shaft**

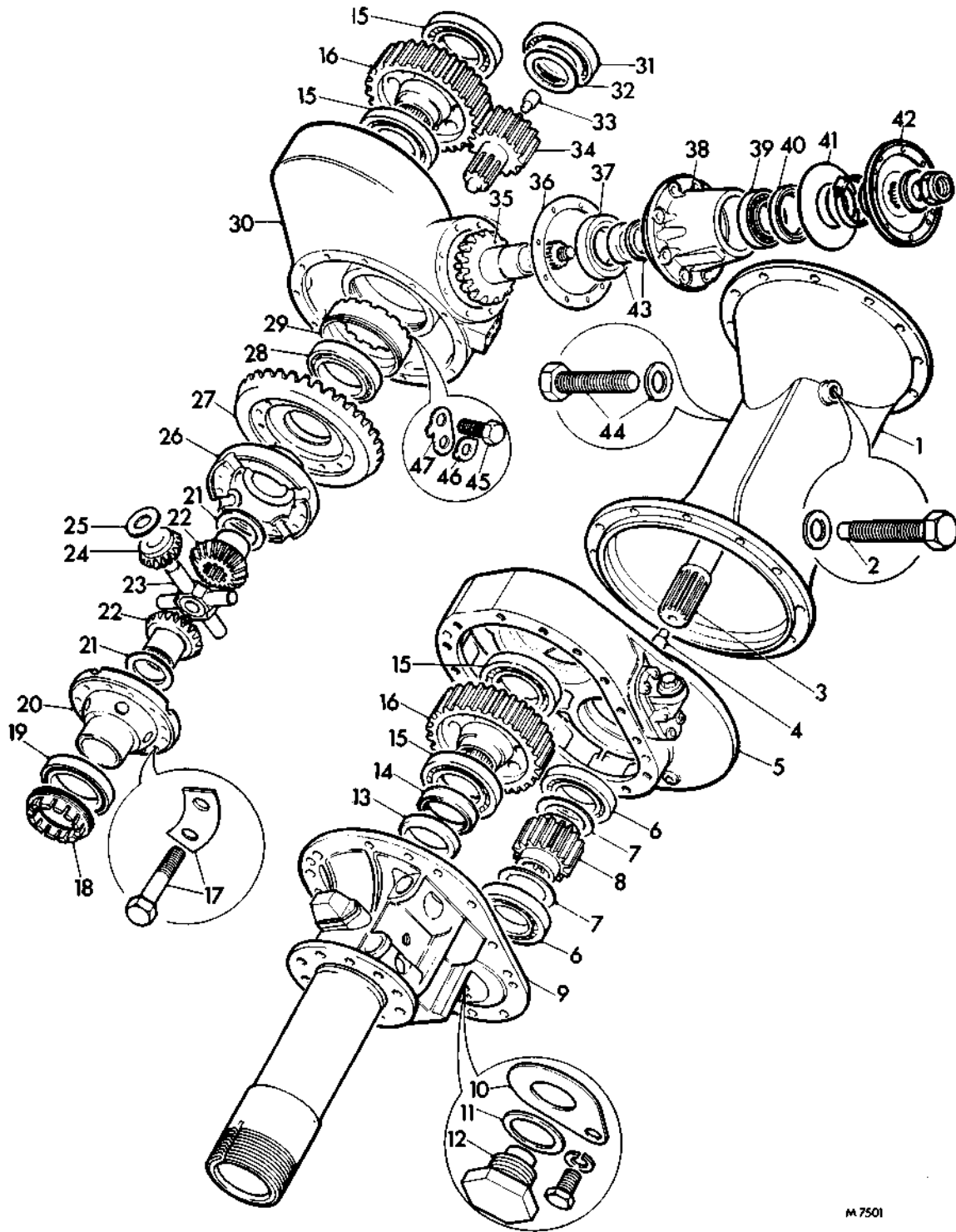
End-float . . . . . 1.78 mm (0.070 in)

Adjustment shims . . . . .	0.56 mm (0.022 in)	1.22 mm (0.048 in)
	2.03 mm (0.080 in)	

**Hubs**

End-float . . . . . 0.203 to 0.254 mm (0.008 to 0.010 in)





M.7501

FIG. 1. EXPLODED VIEW OF REAR AXLE

- |                        |                         |                          |                          |
|------------------------|-------------------------|--------------------------|--------------------------|
| 1. Centre casing       | 13. Shield              | 25. Washer               | 37. Bearing              |
| 2. Adjuster lock screw | 14. Oil seal            | 26. Differential casing  | 38. Bevel pinion housing |
| 3. Intermediate shaft  | 15. Bearing             | 27. Crown wheel          | 39. Bearing              |
| 4. Thrust button       | 16. Spur gear           | 28. Bearing              | 40. Oil seal             |
| 5. Casing              | 17. Bolt and lockplate  | 29. Adjuster             | 41. Shield               |
| 6. Bearing             | 18. Adjuster            | 30. Differential housing | 42. Coupling flange      |
| 7. Shield              | 19. Bearing             | 31. Bearing              | 43. Shims                |
| 8. Pinion gear         | 20. Differential casing | 32. Shield               | 44. Setscrew             |
| 9. Outer axle casing   | 21. Thrust washer       | 33. Thrust button        | 45. Setscrew             |
| 10. Lockplate          | 22. Gear wheel          | 34. Pinion               | 46. Tab washer           |
| 11. Shims              | 23. Trunnion            | 35. Bevel pinion         | 47. Lockplate            |
| 12. Thrust plug        | 24. Pinion              | 36. Shims                |                          |

**AXLE SHAFTS**

**To Remove and Refit**

1. Remove the nuts and washers securing the axle shaft flanges to the hubs.
2. Using three ½ in U.N.F. withdrawal bolts, remove the axle shafts.

**To Refit**

1. Refit the axle shaft, ensuring that a new joint is fitted between the hub and axle shaft flange.
2. Refit the spring washers and nuts and tighten securely.

**TO REMOVE AND REFIT THE REAR AXLE**

**To Remove**

1. Drain the oil from the axle casing.
2. Chock the front road wheels.
3. Release the road wheel nuts. Jack and suitably support the rear end of the chassis. Remove the road wheel nuts and wheels.
4. Remove the shield from the propeller shaft.
5. Disconnect propeller shaft at the axle driving flange.
6. Disconnect shock absorbers at the spring clamp bracket.
7. Release the hand brake lever or hand control valve when fitted, disconnect the pull-off springs and the brake-rods at the brake levers.
8. Disconnect air pipes at brake chambers.
9. Remove the automatic lubrication pipes from the spring shackles if fitted.
10. Support the axle with a suitable lifting trolley, remove the pinch-bolts and drift out the shackle pins, retain the distance pieces.
11. Withdraw the axle from the vehicle.

**To Refit**

Refitment is a reversal of the removal procedure. Adjust the shackle pins as follows.

1. Offer the ends of the springs to the spring brackets and insert the distance pieces between the springs and spring brackets. Fit the shackle pins and pinch-bolts.
2. Tighten the pinch-bolts at the opposite end to the shackle pin adjusting nuts; do not tighten the pinch-bolts adjacent to the adjusting nuts at this stage.
3. Tighten the adjusting nut until an equal load is applied to the distance pieces. Release the adjusting nut until a clearance of 0.127 mm (0.005 in) to 0.508 mm (0.020 in) is obtained between the distance piece and spring bracket. Tighten the remaining pinch-bolt.

**OVERHAUL**

**HUBS**

**To Dismantle**

1. Chock the front road wheels.
2. Release rear road wheel nuts.
3. Jack and support rear axle, remove road wheels.
4. Remove axle shaft.
5. Release brakes as described in Group 7.
6. Remove setscrews securing brake drum to hub. Using three ¾ in U.N.C. withdrawal bolts, remove the brake drum.
7. Remove setscrew and pinch-bolt from hub nut.
8. Insert a suitable bar into the pinch-bolt hole and remove the hub nut. Withdraw locking plate.
9. Withdraw hub complete with bearings, oil seals, distance piece, and shims if fitted.
10. Remove setscrews securing oil seal housing to the hub, remove oil seal housing.
11. Remove oil seals from oil seal housing.
12. Remove rear bearing inner race from hub.
13. Drift bearing outer races from hub.

**To Reassemble**

1. Fit bearing outer races into the hub.
2. Fit rear bearing inner race into the hub and pack with grease.
3. Fit oil seals into oil seal housing.
4. Position joint and oil seal housing onto the hub and retain with setscrews.
5. Locate hub onto the axle tube taking care not to damage the oil seals. Grease and refit inner race of the front bearing.
6. Fit the locking plate and hub nut; check end-float as follows:  
Tighten the hub nut until there is no perceptible end-float, release the hub nut until correct end-float is obtained, see DATA. If shims are fitted use originals as a guide, tighten the hub nut and check end-float. Add or subtract shims accordingly.
7. Refit setscrew and pinch-bolt.
8. Refit brake drums and re-adjust brakes as described in Group 7.
9. Refit axle shafts, ensuring a new joint is fitted between the hub and axle shaft flange.
10. Refit road wheels.

**REAR AXLE**

1. Remove axle shafts.
2. Remove brake-drums and hubs.
3. Remove self-locking nuts and withdraw brake carrier complete with brake shoes.
4. Remove setscrews, nuts and washers and withdraw axle outer casings.

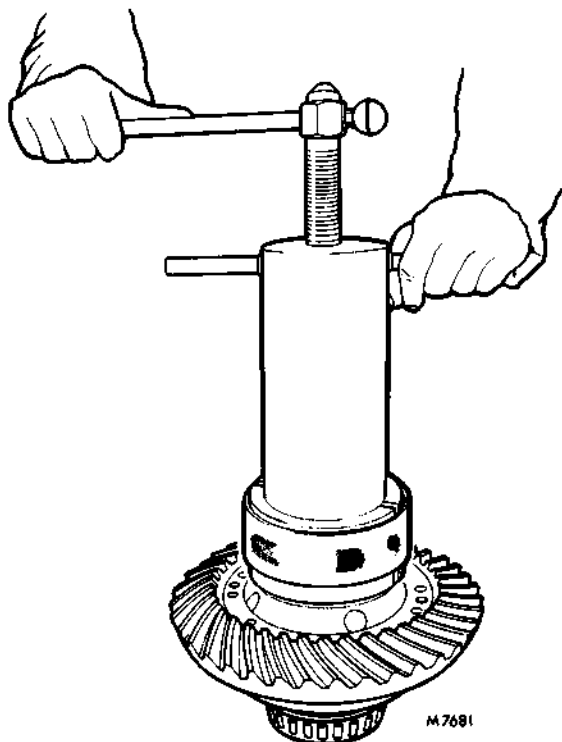


FIG. 2. WITHDRAWING DIFFERENTIAL BEARINGS

5. Remove thrust buttons, shims and lock plates from outer casings.
6. Remove spur gears and pinions complete with bearing races from left- and right-hand casings. **Note:** Left-hand pinion gear is splined to the intermediate shaft.
7. Withdraw the intermediate axle shaft.
8. Remove the bevel pinion assembly from the right-hand casing. **Note:** Retain shims for use when reassembling.
9. Remove nuts, washers and setscrews and separate the left-hand casing from the centre casing.
10. Stand the axle on the right-hand casing, remove nuts, washers and setscrews and withdraw centre casing.
11. Withdraw the differential unit.

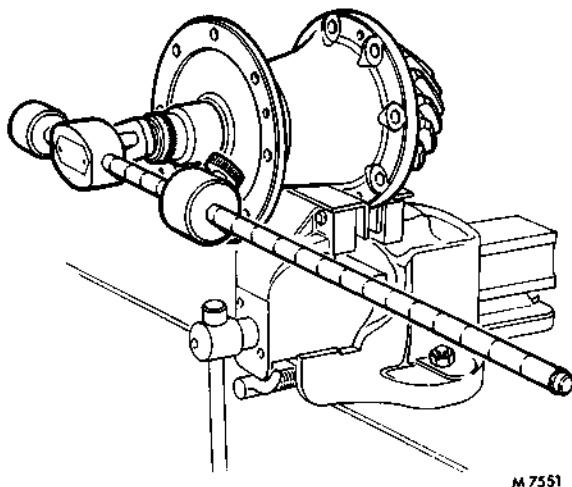


FIG. 3. CHECKING PINION BEARING PRE-LOAD

12. Remove the two setscrews from the centre casing and remove adjuster nut and bearing race.
13. Remove setscrews lockplate adjuster nut and bearing race from right-hand casing.
14. Remove bearing shells from axle outer casings.

**TO DISMANTLE PINION ASSEMBLY**

1. Fit flange holding tool LC 113 A and support assembly in vice. Release flange nut.
2. Remove assembly from vice, remove nut, washer and withdraw coupling flange.
3. Press pinion shaft from pinion housing, retain distance pieces.
4. Remove oil seal and bearing race from pinion housing.
5. Remove bearing shells from pinion housing.
6. Drift bearing race from pinion shaft.

**TO DISMANTLE DIFFERENTIAL UNIT**

1. Using tool D 707 with adaptor sets D 707-4 and D 707-5, Fig. 2, remove the bearing races from the differential casing.
2. Release tab washers and remove the bolts securing the crown wheel to the differential casings. Withdraw the crown wheel.
3. Separate differential casings and withdraw gear wheels, pinions, thrust washers and trunnion.

**Inspection**

1. Thoroughly clean all components.
2. Examine all components for wear, damage or distortion; renew as necessary.
3. Lubricate all relevant parts during assembly procedure to prevent initial oil starvation.

**REASSEMBLY**

**DIFFERENTIAL UNIT**

1. Assemble bevel wheels, pinions, thrust washers and trunnion into the differential casing. **Note:** The differential casings are reference-marked; these marks must correspond when the casings are fitted together.
2. Fit crown wheel to differential casing and secure with bolts and tab washers.
3. Press bearing inner races onto differential casing.

**PINION ASSEMBLY**

1. Press bearing shells into pinion housing.
2. Press bearing inner race onto pinion shaft.
3. Locate pinion shaft into pinion housing, fit original shims and inner race of front bearing.
4. Fit coupling flange, refit washer, nut and tighten securely.

5. Using tool 18G 207, check the bearing pre-load, see Data. Add or subtract shims accordingly.  
**Note:** If original bearings are to be used, halve the figure quoted in Data.
6. Remove nut, washer and withdraw coupling flange.
7. Using tool D 702 with 550, fit new oil seal into the pinion housing.
8. Refit coupling flange and secure with nut and washer.

**REAR AXLE UNIT**

1. Locate adjuster nuts into the centre and differential casings.
2. Using tool D 704, drift bearing shells into the centre and differential casings.
3. Stand the differential casing on the outer case mounting face, locate differential unit into the differential casing.
4. Coat mating faces of the centre and differential casings with a suitable jointing compound.
5. Position centre casing onto the differential casing and secure with two nuts and opposite bolts.
6. Fit and secure pinion assembly complete with original shims to the differential casing.
7. Using tool D 705, screw the inner adjuster nut until the crown wheel is fully into mesh with the pinion gear. Release the adjuster nut approximately two castellations and lock by inserting a bar through either of the holes in the centre casing.

**Note:** Difference between the two holes is half a castellation.

8. Support the axle in the horizontal position.
9. Using tool D 703, screw the outer adjuster nut until all bearing end-float is eliminated.
10. Using a dial test indicator, Fig. 6, check the backlash. See Data.
11. If adjustment is necessary, screw the adjuster nuts an equal amount of turns until correct backlash is obtained.
12. Check tooth markings; adjust if necessary by adding or subtracting shims between pinion and bevel gear housing.
13. When correct backlash and tooth markings are obtained release the two nuts and opposite bolts and using tool D 703, screw the outer adjuster nut inwards one castellation to give a bearing pre-load of 0.127 mm (0.005 in).
14. Fit the remaining nuts, bolts, washers and tighten securely.
15. Fit the outer adjuster nut locking piece, locking strip and setscrews. Knock over corners of locking strip.
16. Remove the lock bar from the centre casing, fit locking screw and setscrew to centre casing.
17. Paint the mating faces of the axle left-hand and centre casings with a suitable jointing compound.

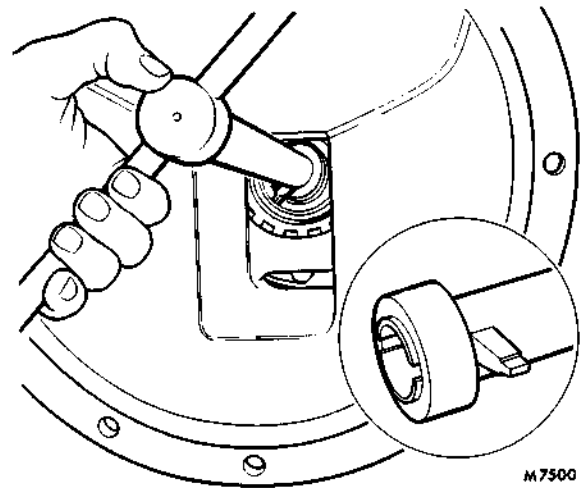


FIG. 4. SERVICE TOOL D705

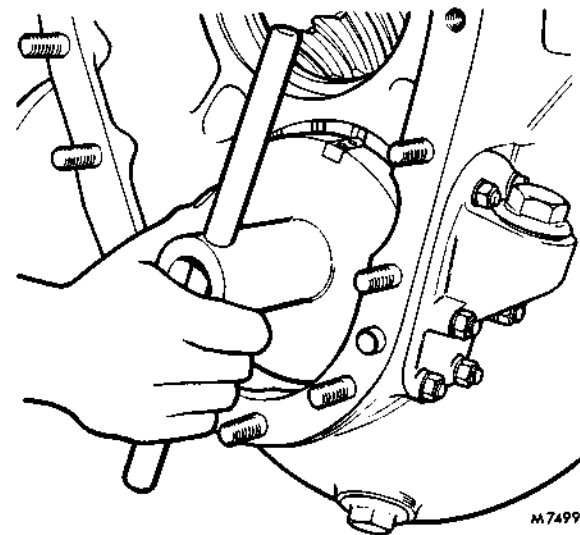


FIG. 5. SERVICE TOOL D703

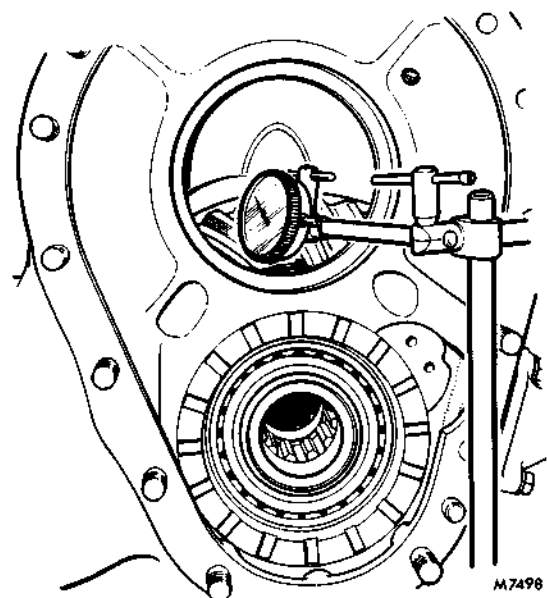


FIG. 6. CHECKING CROWN WHEEL/PINION BACKLASH

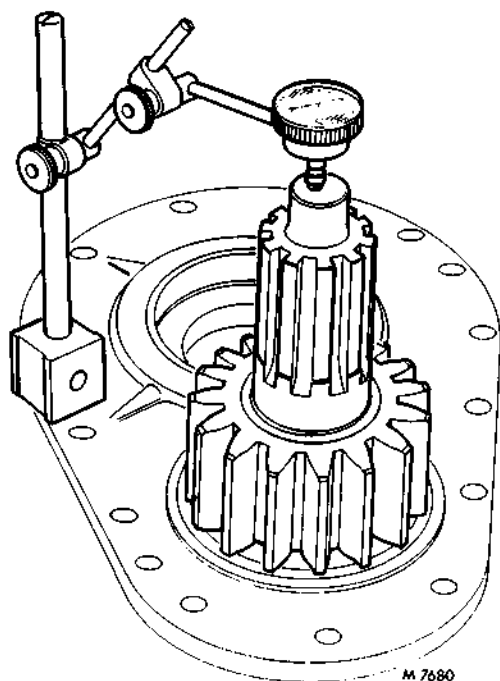


FIG. 7. PINION HEIGHT CHECK

18. Fit the left-hand casing to the centre casing and secure with nuts, bolts and washers.
19. Fit bearing races into the bevel gear and left-hand axle casings.
20. Fit the intermediate drive shaft.
21. Fit the spur gear and pinion gear complete with bearing inner races into the left-hand axle casing. Ensure chip shields are fitted to the pinion gear.
22. Locate the differential drive pinion gear complete with thrust button into axle outer casing.

23. Apply a dial test indicator to the pinion gear shaft, Fig. 7. Fit thrust plug and lockplate, fully tighten and note the reading.

Example: Reading obtained	0.075 in
Reading required	<u>0.040 in</u>
Shims required	<u>0.035 in</u>

See Data for size of shims available.

24. Fit thrust plug, lockplate and shims to outer casing. Fit locating screw, tighten thrust plug and knock over tab to retain.
25. Remove pinion gear from axle outer casing.
26. Fit pinion gear and spur gear into the bevel gear casing.
27. Fit axle outer casings.
28. Fit thrust plug without lockplate to the left-hand axle outer casing. Screw the thrust plug inwards until it butts against the intermediate shaft thrust button.
29. Measure the distance between axle case face and thrust plug hexagon head. Calculate shims required to give correct shaft end-float, see Data.  
 Note: Include thickness of lockplate when selecting shims.
30. Fit thrust plug, lockplate and shims to outer casing. Fit locating screw, tighten thrust plug and knock over tab to retain.
31. Refit brake assemblies.
32. Refit hubs and brake drums.
33. Refit axle shafts.



GROUP 7

BRAKES

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## SECTION 1U

## General Information

## DUAL AIR BRAKING SYSTEM

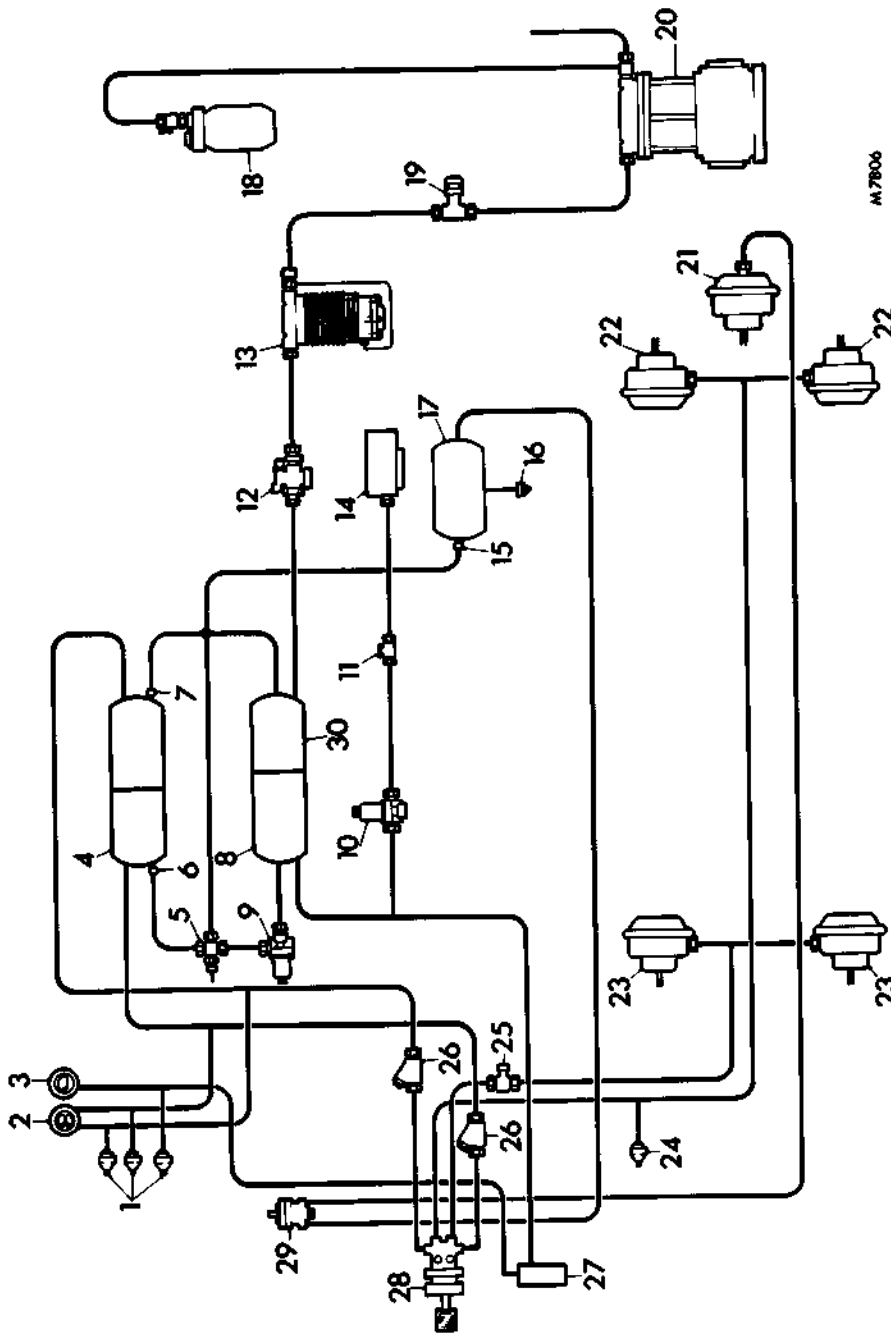
The dual air braking system comprises two separate service brake circuits, one operating the front brakes and the other the rear brakes.

Each circuit is operated simultaneously from the dual footbrake valve.

In the event of one circuit failing, the other circuit will function in the normal way, thus preventing total brake failure.

## DATA

Braking system . . . . .	Air pressure operated with Bendix Westinghouse or Clayton-Dewandre equipment
Unloader valve	
Cut-out pressure . . . . .	8.4 kgf/cm <sup>2</sup> (120 lbf/in <sup>2</sup> )
Cut-in pressure . . . . .	7.4 kgf/cm <sup>2</sup> (106 lbf/in <sup>2</sup> )
Spring brake control valve	
Maximum delivery pressure . . . . .	6.3 kgf/cm <sup>2</sup> (90 lbf/in <sup>2</sup> )
Pressure regulator valve	
Opening pressure . . . . .	5.0 kgf/cm <sup>2</sup> (72 lbf/in <sup>2</sup> )
Limiting valve (Gearbox supply)	
Pressure limited to . . . . .	6.3 kgf/cm <sup>2</sup> (90 lbf/in <sup>2</sup> )
Stop-light switch . . . . .	Operates above 0.35 kgf/cm <sup>2</sup> (5 lbf/in <sup>2</sup> )
Reverse light switch . . . . .	As above
Low-pressure indicators	
Spring brake warning light	
Operating pressure . . . . .	3.8 to 4.6 kgf/cm <sup>2</sup> (54 to 66 lbf/in <sup>2</sup> )
Service brake supply	
Operating pressure . . . . .	3.8 to 4.6 kgf/cm <sup>2</sup> (54 to 66 lbf/in <sup>2</sup> )
Secondary brake supply	
Operating pressure . . . . .	3.1 to 3.8 kgf/cm <sup>2</sup> (45 to 55 lbf/in <sup>2</sup> )
Auxiliary supply	
Operating pressure . . . . .	5.5 kgf/cm <sup>2</sup> (78 lbf/in <sup>2</sup> )



M7806

FIG. 2. DIAGRAMMATIC LAYOUT OF BRAKE SYSTEM - WITH POWER ASSISTED HANDBRAKE

- |                                    |   |                                     |
|------------------------------------|---|-------------------------------------|
| 1. Low pressure indicators         | 21. Diaphragm brake chamber, handbrake system     | 25. Auto-lube take-off, alternative |
| 2. Dual air gauge                  | 22. Diaphragm brake chamber, rear service brakes  | 26. Air line strainers              |
| 3. Auxiliary air gauge             | 23. Diaphragm brake chamber, front service brakes | 27. Junction block                  |
| 4. Service brake reservoirs        | 24. Stop-light switch                             | 28. Footbrake valve                 |
| 5. Check valve                     |   | 29. Handbrake push valve            |
| 6. Non-return valve                |   | 30. Sensing reservoir               |
| 7. Non-return valve                |   |                                     |
| 8. Auxiliary reservoir             |   |                                     |
| 9. Pressure regulator valve        |   |                                     |
| 10. Limiting valve, gearbox supply |   |                                     |
| 11. Auto-lube take-off point       |   |                                     |
| 12. Unloader valve                 |   |                                     |
| 13. Condenser/drain valve          |   |                                     |
| 14. Electro-pneumatic valve block  |   |                                     |
| 15. Non-return valve               |   |                                     |
| 16. Low-pressure indicator         |   |                                     |
| 17. Spring brake reservoir         |   |                                     |
| 18. Alcohol evaporator             |   |                                     |
| 19. Safety valve                   |   |                                     |
| 20. Compressor                     |   |                                     |

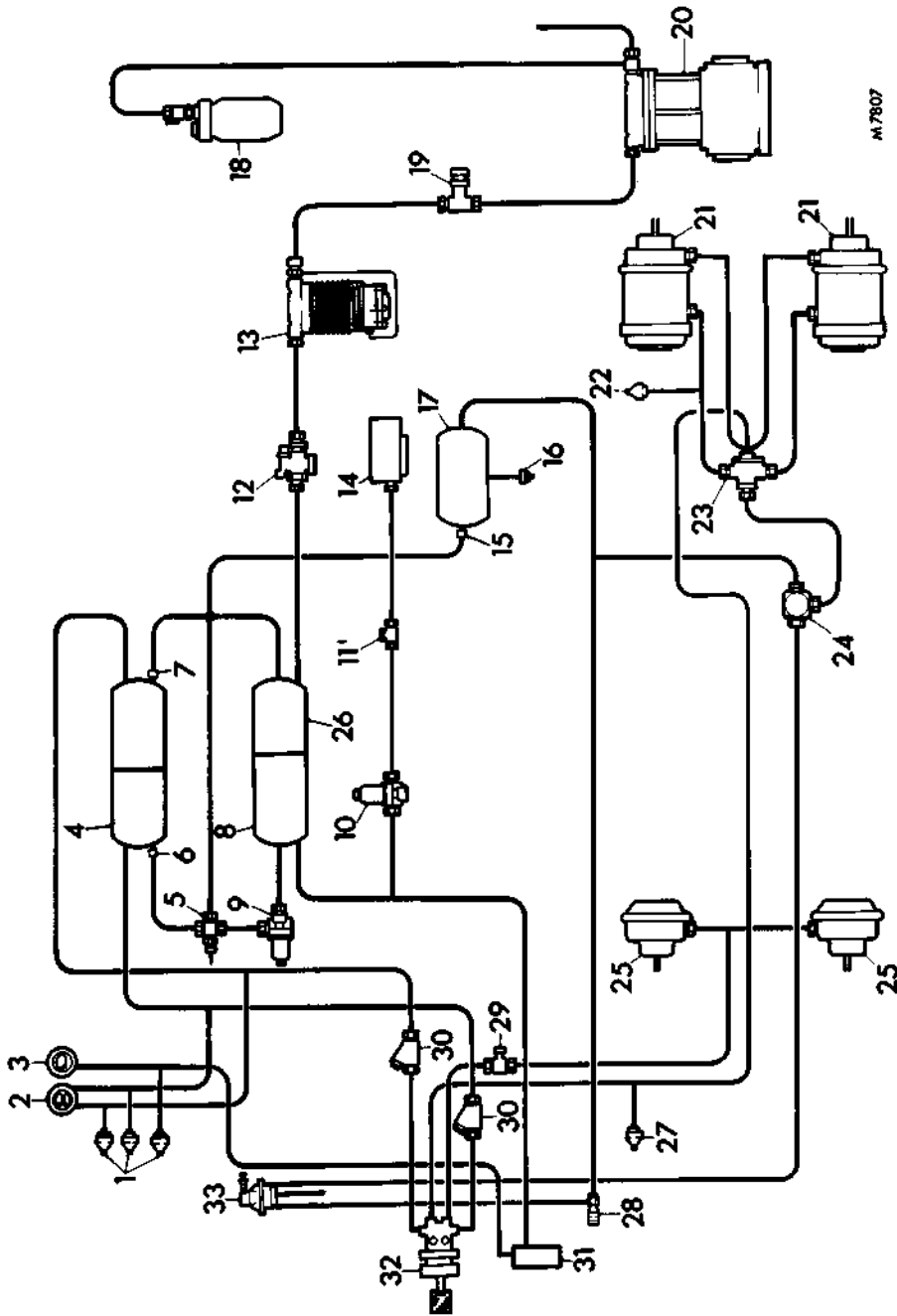


FIG. 1. DIAGRAMMATIC LAYOUT OF BRAKE SYSTEM - WITH SPRING BRAKE ACTUATORS

- |  |
|--|
| <ul style="list-style-type: none"> <li>1. Low-pressure indicators</li> <li>2. Dual air gauge</li> <li>3. Auxiliary air gauge</li> <li>4. Service brake reservoirs</li> <li>5. Check valve</li> <li>6. Non-return valve</li> <li>7. Non-return valve</li> <li>8. Auxiliary reservoir</li> <li>9. Pressure regulator valve</li> <li>10. Limiting valve, gearbox supply</li> <li>11. Auto-lube take-off point</li> <li>12. Uni/over valve</li> <li>13. Condenser/drain valve</li> <li>14. Electro-pneumatic valve block</li> <li>15. Non-return valve</li> <li>16. Low-pressure indicator</li> <li>17. Spring brake reservoir</li> <li>18. Alcohol evaporator</li> <li>19. Safety valve</li> <li>20. Compressor</li> <li>21. Spring brake actuators</li> <li>22. Low-pressure indicator</li> <li>23. Differential protection valve</li> <li>24. Relay valve</li> <li>25. Single diaphragm brake chambers</li> <li>26. Sensing reservoir</li> <li>27. Stop-light switch</li> <li>28. Towing connection</li> <li>29. Auto-lube take-off, alternative</li> <li>30. Air line strainer</li> <li>31. Junction box</li> <li>32. Footbrake valve</li> <li>33. Hand control valve</li> </ul> |
|--|

## SECTION 3E

## Brake Assemblies

OPERATION OF THE AUTOMATIC ADJUSTERS  
(Fig. 1)

If the running clearance between the brake shoe linings and brake drum is too great, the clearance is taken up by the increased movement of the camshaft lever (6) acting on the pawl ratchet assembly (9) via the connecting link (5). Movement of the pawl ratchet assembly rotates the wormshaft (8) which in turn rotates the upper adjuster sleeve, the connector and lower adjuster sleeve, see Fig. 3. This action screws the brake adjusters outwards, moving the brake shoes nearer the brake drum.

The above adjustment continues until the correct brake liner clearance is obtained, and further adjustment is prevented by the limited movement of the brake camshaft lever, the movement being insufficient to operate the ratchet pawl assembly.

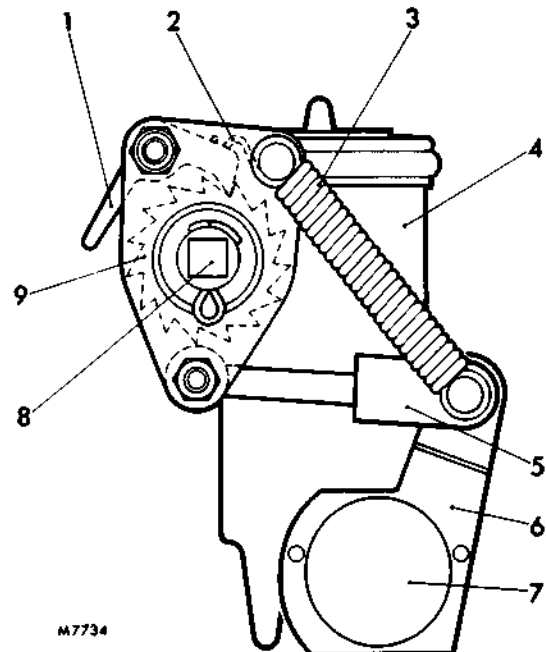


FIG. 1. THE PAWL RATCHET ASSEMBLY

- |                 |                    |
|-----------------|--------------------|
| 1. Pawl         | 5. Connecting link |
| 2. Pawl spring  | 6. Camshaft lever  |
| 3. Spring       | 7. Brake camshaft  |
| 4. Driving body | 8. Wormshaft       |
|                 | 9. Ratchet         |

## REMOVAL AND REFITMENT

## FRONT BRAKE ASSEMBLY

## To Remove (Fig. 1)

1. Apply parking brake and chock the rear road wheels.
2. Jack up and suitably support the front axle. Remove the road wheels.
3. Slacken off each brake adjuster by depressing the pawl release lever (1) and rotating the squared end of the ratchet wheel shaft anti-clockwise.
4. Remove the ten setscrews and withdraw the brake drum with the aid of three  $\frac{3}{8}$ in-16 U.N.C. bolts, located in the tapped holes provided.
5. Detach the connecting link (5) from the brake camshaft lever (6) by removing split pin and withdrawing the clevis pin.

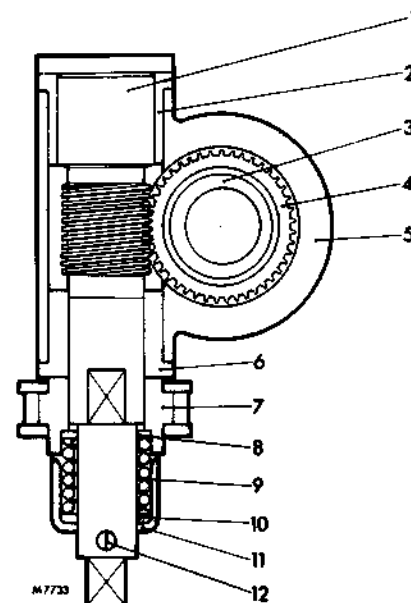


FIG. 2. SECTION THROUGH WORMSHAFT ASSEMBLY

- |                    |                          |
|--------------------|--------------------------|
| 1. Wormshaft       | 7. Pawl ratchet assembly |
| 2. Bush            | 8. Washer                |
| 3. Adjuster screw  | 9. Spring                |
| 4. Adjuster sleeve | 10. Washer               |
| 5. Driving body    | 11. Spring retainer      |
| 6. Bush            | 12. Split pin            |

## BRAKES

---

### To Reassemble

1. Fit bearings to handbrake bearing brackets.
2. Fit felt oil seals to brackets and covers.
3. Fit covers to brackets.
4. Fit trigger to handbrake lever.
5. Fit pawl release rod and pin to trigger.
6. Fit washer, spring, locknut and end piece to bottom end of pawl release rod.
7. Fit bush in top end of handbrake inner lever.
8. Fit bushes in handbrake lever side plates.
9. Fit buffer to handbrake lever.
10. Fit handbrake inner lever to handbrake lever.
11. Pass handbrake shaft outer end piece through handbrake lever side plate and inner lever.
12. Fit inner lever clamp bolt and buffer stop plate.
13. Slide quadrant support plate on handbrake shaft outer end piece and fit quadrants, buffers and distance pieces to support plate.
14. Fit bush to pawl.
15. Fit pawl to handbrake lever and release rod.
16. Adjust position of pawl release rod end piece, if necessary, to give clearance over full range of quadrants when trigger is against the stop.
17. Lock pawl release rod with locknuts.

**To Refit**

1. Refitment is a reversal of the removal procedure, noting the following points:
  - a. Care must be taken when assembling the brake shoe pivots. Each pin should be lightly smeared with Rocol anti-seize compound, J.166 and the 'O' ring oil seals carefully fitted.
  - b. Re-lubricate brake camshafts with grease; see Group 1 for correct specification.
  - c. Set the return spring tension by rotating the adjuster screws (6), Fig. 3, until a dimension of 9.5 mm (0.375 in) is obtained between the spring lever and the face of the spring, shown at 'A'.
  - d. Position the brake operating lever on splines of brake camshaft, using the alignment marks for correct location. Secure the lever with pinch bolt and nut.
  - e. Before carrying out adjustment of the brake lining clearance, insert a 6.35 mm ( $\frac{1}{4}$  in) diameter register rod in the hole drilled in the brake operating lever, and move the lever slightly until the rod can also be located in the brake carrier, see Fig. 4. With the register rod located, adjust the lever stop rod by slackening the locknut and unscrew rod until it just touches the brake lever. Secure locknut and remove register rod.
  - f. Set brake lining initial clearances as described under ADJUSTMENT.

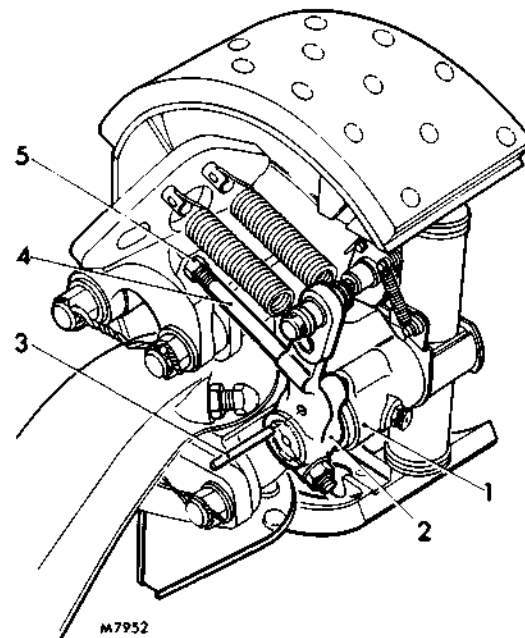


FIG. 4. ADJUSTMENT OF LEVER STOP ROD

- |                  |                   |
|------------------|-------------------|
| 1. Brake carrier | 4. Lever stop rod |
| 2. Brake lever   | 5. Locknut        |
| 3. Register rod  |                   |

2. Check the lining clearance by inserting a feeler gauge between the brake drum and each shoe lining at a point mid-way along their surface. The correct clearance should be 0.381 mm (0.015 in). Record the difference between the two readings obtained.

**Note:** If the brakes are checked with the weight of the vehicle off the road wheels, the clearance at the bottom shoe will normally be greater than the upper shoe by approximately 0.127 mm (0.005 in). This is due to float in the hub bearings.

3. If the lining clearance requires adjustment, remove the brake drum and detach the lower adjuster assembly. The clearances can be centralized by adjusting the lower adjuster. Grip the end of adjuster screw in a vice and hold the adjuster body while rotating the drive-end of adjuster sleeve with a square-ended tool. A quarter-turn of the tool will increase or decrease the clearance by 0.254 mm (0.010 in).
4. Refit components and brake drum. It may be necessary to wind off the brake shoes by depressing the pawl release lever and turning the squared end of the ratchet wheel shaft anti-clockwise before refitting the brake drum.

Repeat adjustment until the correct clearance is obtained.

**REAR BRAKE SHOES**

The removal and refitment of the rear brake shoes is identical to the procedure described for the front brake shoes.

**WARNING:** Chock the front road wheels before commencing work on the rear brake assemblies.

**ADJUSTMENT****Balancing the automatic adjusters**

1. With the air system fully charged, apply the brakes with repeated applications of the brake pedal. This action will allow the automatic adjusters to take up any excessive clearance between linings and brake drum.





## SECTION 5

## Air Assisted Handbrake

## REMOVAL AND REFITMENT

## Handbrake lever and cross-shaft

## To Remove

1. Chock vehicle wheels.
2. Remove bolts securing handbrake lever gaiter to floor of cab.
3. Remove handbrake air control valve from support bracket.
4. Remove bolts securing handbrake cross-shaft outer end piece to handbrake tube.
5. Disconnect automatic lubrication pipes from both cross-shaft bearing brackets.
6. Remove three bolts securing quadrant support plate to frame and remove handbrake lever assembly together with bearing bracket and outer plate.
7. Remove bolts securing inner end piece to cross-shaft tube and remove tube.
8. Remove clamp bolt and disconnect inner lever from linkage.
9. Remove inner lever and bush from handbrake cross-shaft inner end piece.
10. Remove inner end piece from inner bearing bracket.
11. Remove bolts and distance piece securing inner bearing bracket to sub-frame and remove bearing bracket.

## To Refit

Refitment is a reversal of the removal procedure.

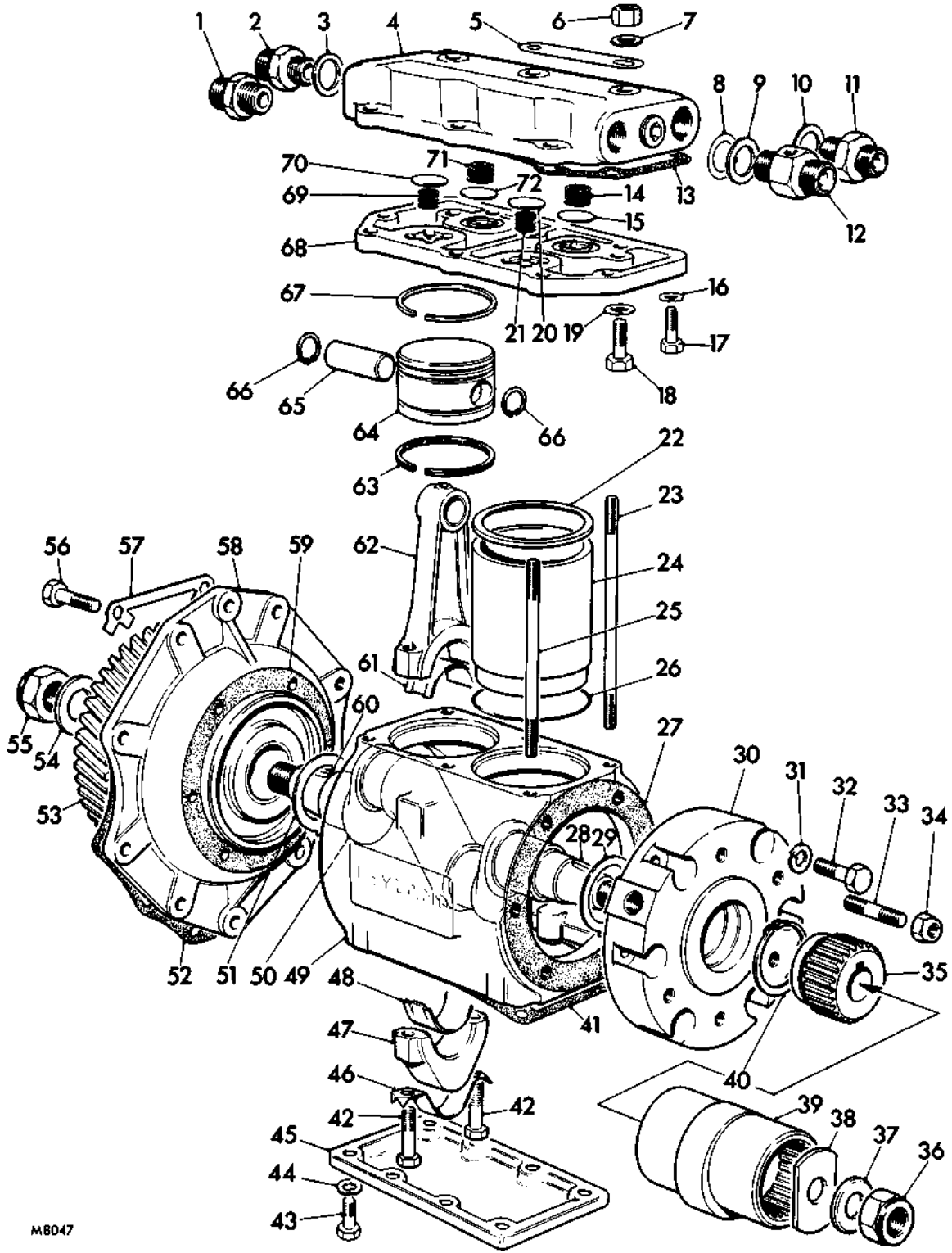
**Note:** When re-connecting the handbrake shaft outer end piece and handbrake tube ensure that the linkage and lever are in the released position.

## OVERHAUL

## To Dismantle

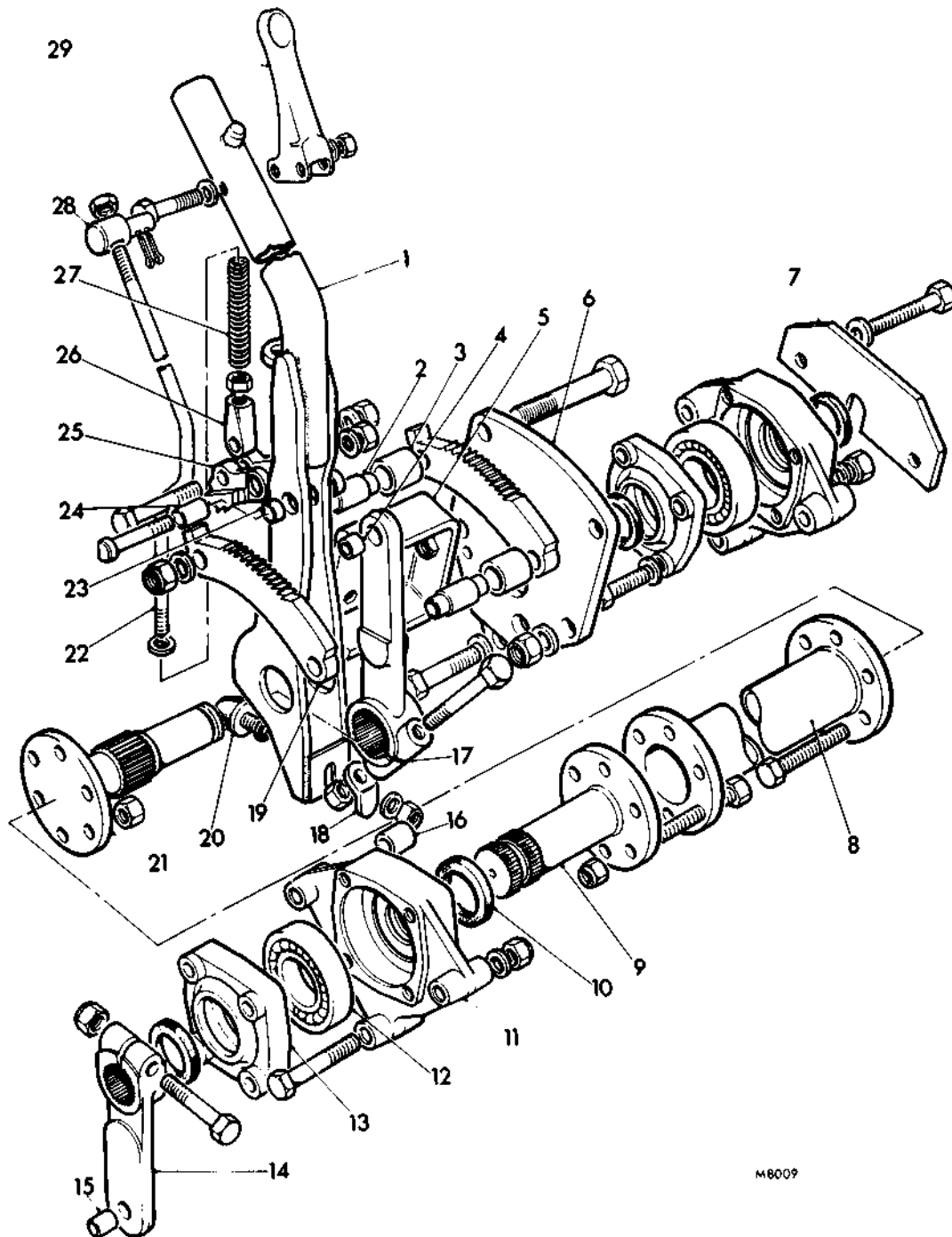
1. Remove clamp bolt and buffer stop plate from inner handbrake lever.
2. Remove handbrake cross-shaft outer end piece from inner handbrake lever.
3. Remove buffer from bottom end of handbrake lever.
4. Remove pawl pivot pin together with pawl and bush.
5. Remove bushes from handbrake lever side plates.
6. Remove bush from upper end of handbrake inner lever.
7. Remove bolts securing quadrants and buffers to quadrant support plate and quadrants, distance pieces and buffers.
8. Remove bolt securing pawl to pawl release rod end piece and remove pawl.
9. Unlock both pawl release rod locknuts.
10. Remove pawl release rod end piece, locknut spring and washer from pawl release rod.
11. Remove pawl release rod pin from trigger.
12. Unscrew pin from rod and remove rod from guide.
13. Remove trigger fulcrum bolt and remove trigger from handbrake lever.
14. Remove covers from handbrake bearing brackets.
15. Remove felt oil seals from brackets and covers.
16. Remove bearings from brackets.
17. Examine all parts for wear, damage or severe corrosion and renew where necessary.





M8047

FIG. 2. EXPLODED VIEW OF WATER COOLED AIR COMPRESSOR



M6009

FIG. 1. EXPLODED VIEW OF AIR ASSISTED HANDBRAKE

- |  |                                 |   |
|--|---------------------------------|---|
| 1. Handbrake lever                       | 11. Cross-shaft bearing bracket | 21. Handbrake cross-shaft outer end piece |
| 2. Quadrant distance piece               | 12. Bearing                     | 22. Pawl release rod                      |
| 3. Buffer                                | 13. Cover                       | 23. Handbrake outer lever bush            |
| 4. Handbrake inner lever bush            | 14. Inner lever                 | 24. Pawl pivot pin bush                   |
| 5. Air control valve support bracket     | 15. Inner lever bush            | 25. Pawl                                  |
| 6. Quadrant support plate                | 16. Distance piece              | 26. Pawl release rod end piece            |
| 7. Outer plate                           | 17. Inner handbrake lever       | 27. Spring                                |
| 8. Handbrake tube                        | 18. Buffer stop plate           | 28. Pawl release rod pin                  |
| 9. Handbrake cross-shaft inner end piece | 19. Quadrant                    | 29. Trigger                               |
| 10. Felt oil seal                        | 20. Buffer                      |   |

## OVERHAUL

The manufacturer's recommended overhaul period for the cylinder head is every year or 80 000 km (50 000 miles) and the complete compressor, every two years or 240 000 km (150 000 miles).

Before overhaul, a major repair kit, new cylinders and piston rings should be obtained.

### To Dismantle (Fig. 2)

1. Mark a line on the cylinder head, cylinders, end-cover and crankcase for reassembly purposes.
2. Progressively slacken and remove the six cylinder head retaining nuts and spring washers. Lift off the cylinder head and remove and discard the sealing joints.
3. Separate the cylinder head by removing the four retaining screws and remove the valve assemblies. Reface the valve seats if showing signs of pitting.
4. Withdraw the cylinders from the crankcase and remove and discard the 'O' ring seals.
5. Remove the sump cover-plate and joint.
6. Mark the big-end bearing caps to ensure correct reassembly. Release tabs of locking straps and remove connecting rod bolts and caps. Withdraw connecting rod and piston assemblies from the crankcase.
7. Remove the crankcase end cover and withdraw the crankshaft.
8. Remove piston rings from pistons. Remove one circlip from each piston and press out the gudgeon pins.
4. Examine pistons for excessive wear, scores, cracks or damage of any kind. Renew if necessary.
5. Test gudgeon pin clearance in small-end bush, limit 0.038 mm (0.0015 in).
6. Inspect connecting rods for cracks and damage; renew where necessary.
7. Check crankshaft journals for excessive wear. If badly scored or more than 0.038 mm (0.0015 in) oval, the crankshaft should be replaced.
8. It is recommended that new shell bearings be fitted to ensure complete serviceability.
9. If an oil leak has been observed, a new seal must be fitted. Care should be taken to ensure that the new seal is correctly fitted.
10. Examine the crankcase, base plate and end cover for cracks or damage.

### Inspection

1. Remove completely all traces of old jointing from mating faces, loosen any carbon or other foreign matter present on any of the component parts.
2. Check oilways in the crankshaft and end cover to ensure that they are free from obstruction.
3. Thoroughly wash all parts and flush all oilways in cleaning solvent, then dry with compressed air.
1. If a new small-end bush has to be fitted, mark the piston and connecting rod for reassembly purposes. Drill the oil hole through the bush from the top of the connecting rod before reaming.
2. Place the lower half of the cylinder head on a flat surface and fit a new joint. Position the valve discs and springs and carefully place the upper half of the cylinder head over the valve assemblies and press down until both halves of the head are correctly located. Ensure the valves are not trapped between the mating faces of the cylinder head. Insert the four securing screws from the underside of the head and tighten to a torque of 0.96 kgf m (7 lbf ft).
3. Refit thrust washer (29) to crankshaft with white metal face towards the crankshaft. Insert crankshaft into crankcase and refit end cover, ensuring a new joint is fitted. Check crankshaft end-float is within 0.076 to 0.558 mm (0.003 to 0.022 in). Renew thrust washer if necessary.
4. Fit each gudgeon pin to its piston and connecting rod assembly and secure with circlips.

## SECTION 5A

## Handbrake Air Control Valve

## DESCRIPTION

The handbrake air control valve, Fig. 1, working in conjunction with the handbrake, controls the supply of air to the handbrake chamber.

When the handbrake is applied, force is exerted on the adjusting screw (1), moving the plungers against the pressure of the spring (2).

The hollow plunger (3) seats on the inlet-exhaust valve (4), closing the exhaust port, and then unseats the inlet valve, allowing compressed air to flow through the valve to the brake chamber which assists the brake application.

Whilst the brakes are being applied, the effort provided by the brake chamber tends to reduce the manual effort on the plunger so that, when no further effort is applied, the spring loaded inlet-exhaust valve reseats and stops the air supply to the brake chamber.

As soon as the brakes are held applied by the pawl and ratchet, the effort on the control valve plungers is relaxed and the plunger return spring moves the hollow plunger away from the inlet-exhaust valve, allowing air from the brake chamber to vent to atmosphere through the exhaust port and check valve (6).

When the handbrake is moved to disengage the pawl, from the ratchet prior to releasing the handbrake, force is again applied to the plungers in the body and the valve passes compressed air to the brake chamber, so that the braking effort is transferred from the pawl to the brake chamber.

This enables the pawl to be easily disengaged from the ratchet and the brakes to be released.

When the handbrake is moved to the released position the control valve exhausts air from the brake chamber.

## REMOVAL AND REFITMENT

## To Remove

1. Release air from the system.
2. Disconnect air lines from valve.
3. Blank off unions and pipes.
4. Remove valve from vehicle frame.

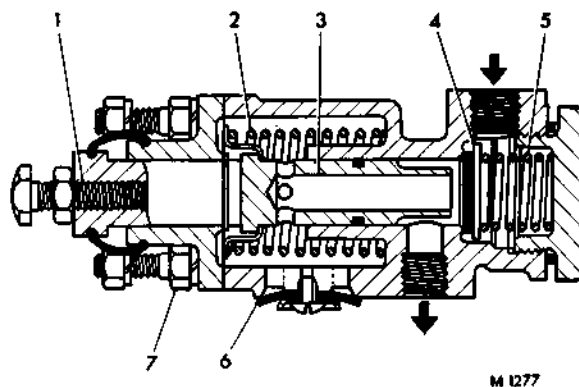


FIG. 1. SECTIONED VIEW OF HANDBRAKE PUSH VALVE

- |                        |                        |
|------------------------|------------------------|
| 1. Adjuster screw      | 5. Valve spring        |
| 2. Control spring      | 6. Exhaust check valve |
| 3. Valve plunger       | 7. Retaining studs     |
| 4. Inlet/Exhaust valve |                        |

## To Refit

Refitting is the reverse of the removal procedure.

**Note:** The adjusting screw may require readjustment so that the head of the screw just touches the cam of the handbrake lever when the lever is in the released position against the stop.

## OVERHAUL

## To Dismantle

1. Mark end cover in relation to valve body to ensure correct reassembly.
2. Remove adjusting screw and locknut.
3. Lightly clamp end cover and valve body together, then remove studs securing end cover to valve body.
4. Release clamping slowly and allow end cover to separate from valve body.
5. Remove end cover, valve plunger and spring from body.
6. Remove 'O' ring from valve plunger.
7. Remove end cap from valve body.

**Note:** Some valves have a screwed cap and some have a plain cap with a circlip.



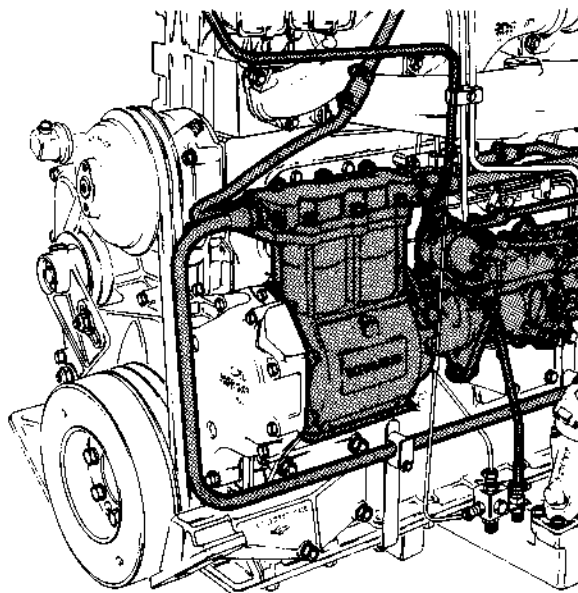
## SECTION 6M

## Air Compressor

## DIAGNOSTIC TESTING

If the compressor fails to maintain adequate pressure in the air system, certain tests can be carried out to ascertain which part of the compressor is malfunctioning. Possible causes are as follows:

1. Engine air filter needs cleaning.
2. Excessive carbon in the compressor cylinder head or delivery line.
3. Excessive wear in cylinders or piston rings.
4. Worn inlet or delivery valve and seats.
5. Broken or weak valve springs.
6. Air leakage in system.
7. Defective unloader valve.



M 7909

FIG. 1. COMPRESSOR IN POSITION ON VEHICLE

## Operating Tests

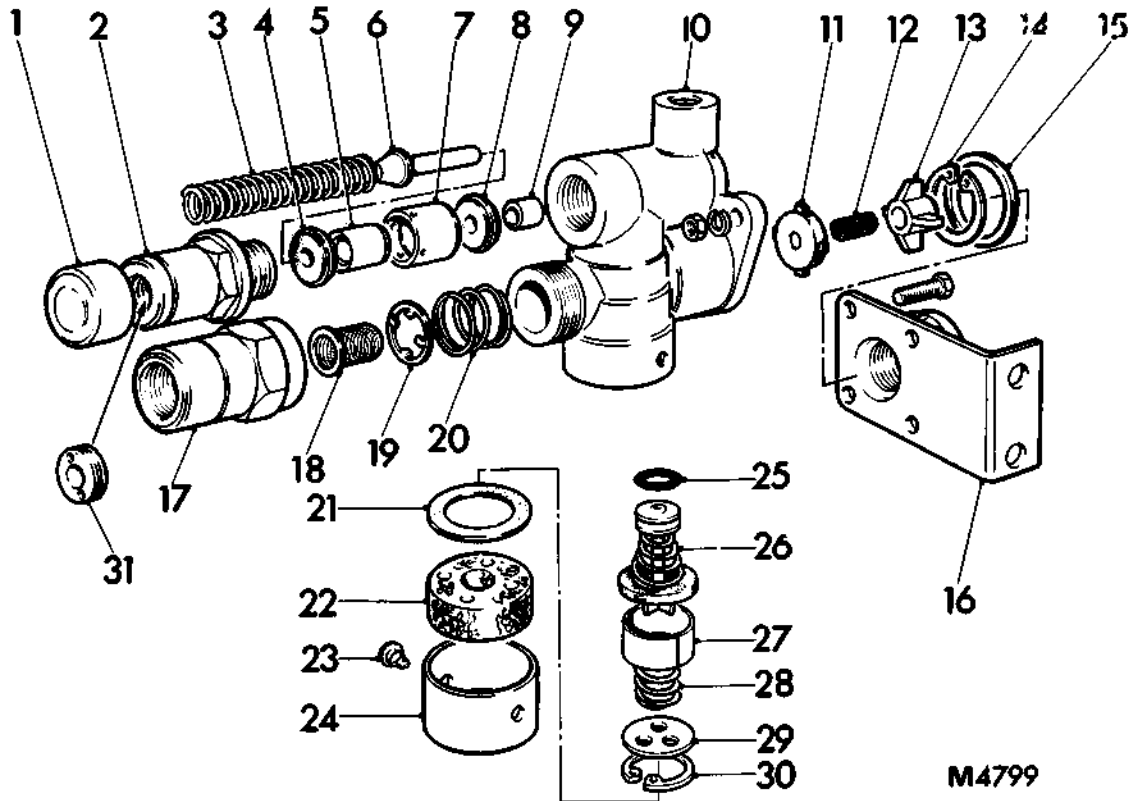
1. Release all air pressure from the system and remove the delivery port pipe connection.
2. Run the engine for a short time to warm the compressor up and clear any collected oil.
3. Hold a sheet of white card 50 mm (2 inches) from the delivery port for 10 seconds. A light mist of oil should be apparent, indicating correct lubrication is taking place. The formation of a large patch of oil will indicate wear in the cylinder bores or piston assemblies.
4. Reconnect the delivery port connection.
5. If the oil carry-over test proves negative, remove the compressor cylinder head and connect a separate air line of 7.03 kgf/cm<sup>2</sup> (100 lbf/in<sup>2</sup>) to the delivery port. An excessive amount of escaping air indicates a defective delivery valve, spring or valve seat.

## REMOVAL AND REFITMENT

## To Remove the Compressor Cylinder Head

1. Fully release air pressure from system and drain the engine cooling system.
2. Disconnect air inlet and outlet pipes.
3. Disconnect and remove water inlet pipe, engine cylinder head to compressor.
4. Disconnect water outlet pipe and secure clear of compressor.
5. Remove cylinder head retaining nuts and washers. Tap cylinder head to break joint and lift cylinder head from compressor.

**Note:** The cylinder liners should be held in place whilst removing the cylinder head to avoid breaking the crankcase seal.



**M4799**

**FIG. 2. EXPLODED VIEW OF UNLOADER VALVE**

- |                           |                            |
|---------------------------|----------------------------|
| 1. Cap                    | 17. Pipe connection, inlet |
| 2. Control spring housing | 18. Strainer               |
| 3. Control spring         | 19. Guide, strainer        |
| 4. Valve                  | 20. Spring, strainer       |
| 5. Pilot valve piston     | 21. Felt washer            |
| 6. Push-rod               | 22. Silencer               |
| 7. Pilot valve bush       | 23. Self-tapping screw     |
| 8. Valve                  | 24. Cover, silencer        |
| 9. Filter                 | 25. 'O' ring seal          |
| 10. Body                  | 26. Exhaust valve assembly |
| 11. Check valve           | 27. Sleeve                 |
| 12. Spring, check valve   | 28. Spring, exhaust valve  |
| 13. Spring guide          | 29. Perforated plate       |
| 14. Circlip               | 30. Circlip                |
| 15. Gasket                | 31. Adjusting bush         |
| 16. Bracket               |                            |





## KEY TO FIG. 2.

1. Air inlet adaptor	25. Cylinder head studs	49. Cylinder block
2. Cooling water adaptor	26. O-ring	50. Crankshaft
3. Joint	27. Joint	51. Thrust washer
4. Cylinder head	28. Key	52. Joint
5. Name plate	29. Thrust washer	53. Drive gear
6. Cylinder head retaining nuts	30. Crankcase end cover	54. Washer
7. Spring washer	31. Spring washer	55. Locknut
8. Joint	32. Bolts	56. Bolt
9. Joint	33. Stud	57. Locking strip
10. Joint	34. Locknut	58. Cover
11. Water adaptor	35. Output drive gear	59. Joint
12. Air inlet adaptor	36. Locknut	60. Key
13. Joint	37. Washer	61. Top half shell
14. Delivery valve spring	38. Plate	62. Connecting rod
15. Delivery valve	39. Fuel pump drive coupling	63. Scraper ring
16. Spring washer	40. Circlip	64. Piston
17. Retaining screws	41. Joint	65. Gudgeon pin
18. Retaining screws	42. Connecting rod bolts	66. Circlips
19. Spring washer	43. Sump cover plate bolts	67. Compression ring
20. Inlet valve	44. Spring washer	68. Cylinder head base plate
21. Inlet valve spring	45. Sump cover plate	69. Inlet valve spring
22. Joint	46. Locking strip	70. Inlet valve
23. Cylinder head studs	47. Bearing cap	71. Delivery valve spring
24. Cylinder liner	48. Bottom half shell	72. Delivery valve

**To Refit the Compressor Cylinder Head**

1. Refitment of the compressor cylinder head is a reversal of the removal procedure, noting:
  - a. Re-tighten cylinder head retaining nuts to a torque of 2.2 kgf m (16 lbf ft).
  - b. Refill the engine cooling system, see Group 1.

**To Remove the Compressor**

1. Fully release air pressure from system and drain water cooling system until level is below compressor.
2. Disconnect and remove air inlet and outlet pipes.
3. Disconnect and remove water inlet pipe at compressor to cylinder head.
4. Uncouple water outlet pipe at compressor, and secure clear of unit.
5. Disconnect oil feed pipe compressor to fuel pump.

6. Disconnect oil feed pipe compressor to oil pressure switch.
7. Disconnect oil feed pipe compressor to engine block.
8. Remove fuel pump and coupling, see Group 2.
9. Remove compressor securing nuts and bolts.
10. Withdraw compressor clear of front timing gear case.

**To Refit the Compressor**

1. Locate compressor in front timing gear case and secure with bolts and self-locking nuts.
2. Fit fuel pump and coupling, see Group 2.
3. Fit oil feed pipes.
4. Fit and reconnect water inlet and outlet pipes.
5. Fit air inlet and outlet pipes.
6. Refill water cooling system to correct level.

## OVERHAUL

### To Dismantle (Fig. 2)

1. Mark a line on mounting bracket and body to ensure correct alignment on assembly.
2. Remove the three nuts, spring washers and bolts and withdraw mounting bracket assembly (1). Remove operating plunger (2) and link assembly (3) and (4).
3. Remove valve plungers (5) and withdraw the two piston assemblies (6) complete with 'O' rings (7). Remove the piston return springs, obturating washers (9) and spring retainers (10).

4. Remove circlips (12) and withdraw inlet valve guides (13), complete with 'O' rings (14), springs (15) and inlet/exhaust valve assemblies (16).
5. Remove circlip (17) and withdraw filter screen (18).

### Cleaning and Inspection

1. Thoroughly clean all parts in solvent and dry with compressed air.
2. Check all threads and carefully examine all working surfaces for wear or damage; renew as necessary.
3. Check springs for corrosion or distorting; renew as necessary.

**Note:** The piston assemblies are specially pre-loaded and issued as matched pairs. They should not be dismantled. If the pistons are damaged, they should be renewed as a matched pair.

### To Reassemble

1. Reassembly is a reversal of the dismantling procedure, ensuring that springs, 'O' rings and working surfaces are lubricated with Air Brake Grease, Grade A (Bendix Westinghouse recommendation).

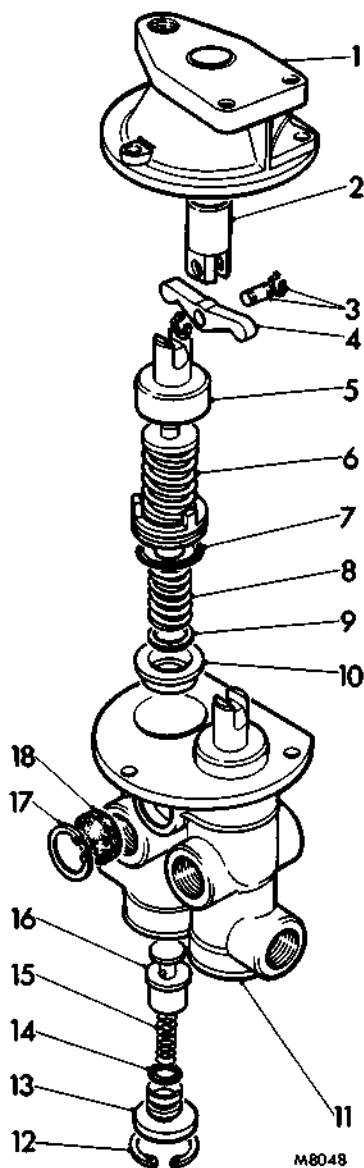


FIG. 2. DUAL FOOTBRAKE VALVE

- |                      |                                  |
|----------------------|----------------------------------|
| 1. Mounting bracket  | 11. Valve body                   |
| 2. Operating plunger | 12. Circlip                      |
| 3. Pin and circlips  | 13. Inlet valve guide            |
| 4. Link              | 14. O-ring                       |
| 5. Valve plunger     | 15. Spring                       |
| 6. Piston assemblies | 16. Inlet exhaust valve assembly |
| 7. O-rings           | 17. Circlip                      |
| 8. Spring            | 18. Filter screen                |
| 9. Obturating washer |                                  |
| 10. Spring retainers |                                  |

## TESTING

### Operating and Leakage tests

1. Place vehicle over an inspection pit, and chock the road wheels.
2. Start engine and fully charge the air system. Coat exterior of valve with a soap solution and inspect for air leakage.
3. Insert air pressure gauges at some suitable point in the two delivery lines and progressively apply the brakes, increasing the pressure in 1.4 kgf/cm<sup>2</sup> (20 lbf/in<sup>2</sup>) increments. Check that the two gauge readings do not differ by more than 0.35 kgf/cm<sup>2</sup> (5 lbf/in<sup>2</sup>) throughout the test.



5. Refit the piston rings, ensuring that the compression rings are fitted with the word 'TOP' facing upward to the piston crown.
6. With the big-end bearing shells located correctly in their respective rod and cap housings, assemble connecting rods on crankshaft journals as originally fitted.
7. Using new locking straps, replace and tighten evenly the connecting rod bolts to a torque reading of 1.40 to 1.66 kgf m (10 to 12 lbf ft). Bend up tabs of locking straps.
8. Space piston ring gaps and position new sealing rings on cylinders.
9. Pass cylinders carefully over pistons, then insert the ends into top of the crankcase, aligning any positioning marks which may have been made during dismantling.
10. Place new joints on cylinders and correctly position cylinder head on the studs.
11. Fit plain and spring washers followed by securing nuts, and tighten nuts progressively to a torque spanner setting of 2.2 kgf m (16 lbf ft).
12. Invert compressor and apply clean engine oil over crankshaft and cylinder walls.
13. Refit base cover plate using a new joint. Tighten setscrews to a torque of 1.4 kgf m (10 lbf ft).



## SECTION 7E

### Unloader Valve (Westinghouse Type)

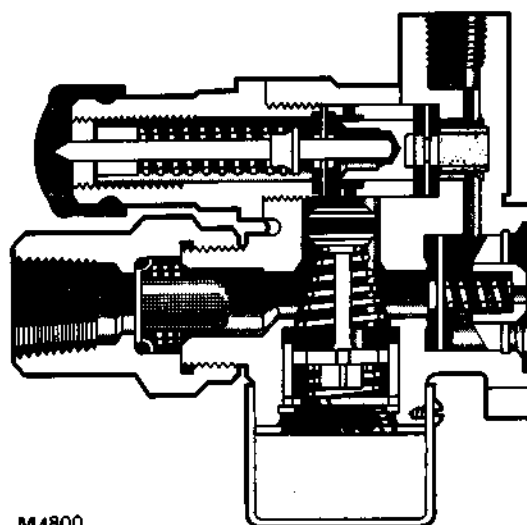
#### REMOVAL AND REFITMENT

##### To Remove

1. Release all air pressure from system, disconnect air pipes at the valve and remove the mounting nuts and bolts.

##### To Refit

1. Refitment is a reversal of the removal procedure.
2. Carry out the Operating and Leakage Tests.



M4800

FIG. 1. SECTION THROUGH UNLOADER VALVE

#### OVERHAUL

The manufacturer's recommended overhaul period is every year or 80 000 km (50 000 miles).

##### To Dismantle (Fig. 2)

Before dismantling the valve, ensure a repair kit is obtained.

1. Unscrew the control spring housing (2) and withdraw the control spring, push-rod, pilot valves, piston, bush and filter (items 3 to 9).
2. Remove self-tapping screws (23), cover (24) and exhaust silencer (22). Remove the exposed circlip (30) and withdraw the exhaust valve assembly (items 25 to 29).
3. Unscrew inlet adaptor (17) and withdraw strainer, guide and spring (18), (19) and (20).
4. Remove nuts and setscrews retaining the mounting bracket (16) to the valve. Remove circlip (14) retaining the check valve assembly and withdraw spring guide, spring and check valve (13), (12) and (11).

##### Inspection

1. Thoroughly clean all the components.
2. Discard all components which are to be replaced by the repair kit.
3. Examine all springs and metal seats. If the check valve seat in the body is damaged, use a new body or fit a new unloader valve complete.

##### To Reassemble

Reassembly is a reversal of the dismantling procedure noting the following points:

- a. Lightly grease all moving parts with Bendix Westinghouse Air Brake Grease – Grade A.
- b. When refitting the pilot valve bush ensure that the holes in the bush are towards the relay piston.
- c. After assembly carry out the Operating and Leakage tests.

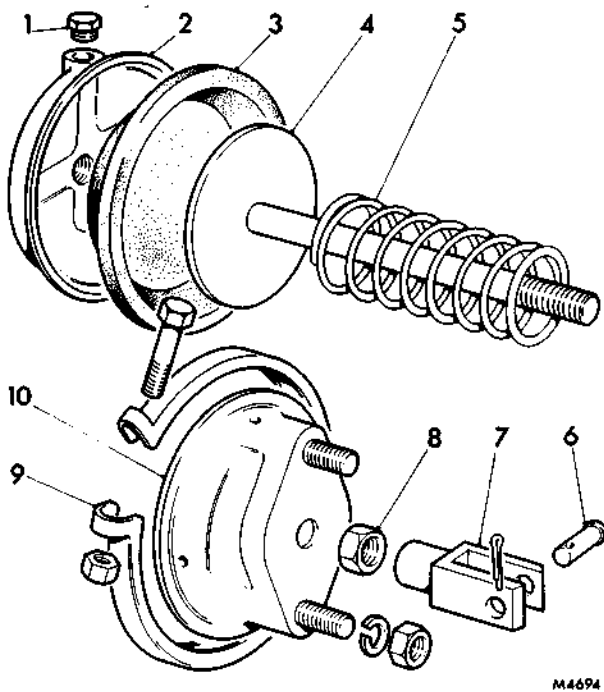
#### TESTING

##### Operating Test and Adjustment

1. Charge the reservoirs and check the cut-out pressure of the unloader valve. This should be as shown in Section 1 of this Group. If incorrect, turn screwed bush, Fig. 2 (31), clockwise to increase and anti-clockwise to decrease the cut-out pressure.
2. Reduce the pressure in the reservoirs and note the cut-in pressure. This should be as shown in Section 1 of the Group.

##### Leakage Test

1. Charge the system to just below cut-out pressure and with a soap solution check for leaks at the exhaust port and at the ends of the control spring housing. No leakage is permissible.



**FIG. 2. EXPLODED VIEW OF DIAPHRAGM BRAKE CHAMBER**

- |                   |                        |
|-------------------|------------------------|
| 1. Plug           | 7. Jaw-end             |
| 2. Pressure plate | 8. Locknut             |
| 3. Diaphragm      | 9. Clamp ring          |
| 4. Push-rod       | 10. Non-pressure plate |
| 5. Spring         |                        |
| 6. Pin            |                        |

**OVERHAUL**

**Note:** New diaphragms must be ordered before dismantling the units.

**To Dismantle**

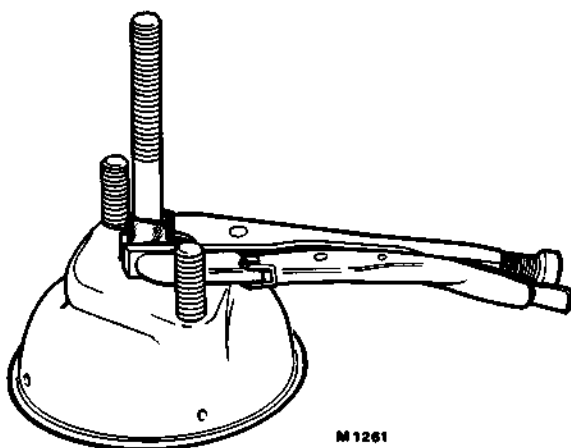
1. Clean all dirt and grease from the outside of the chamber and inspect for external damage.
2. Mark both halves of the body in relation to the clamping ring, so that the two halves and the clamping ring will be in the same location when the unit is reassembled.
3. Pull push-rod against the pressure of spring and, taking precautions to avoid damaging the push-rod, clamp it lightly at the non-pressure plate with vicegrip pliers, or a similar tool. This will relieve the tension of the spring on the pressure plate.
4. Extract clamp ring nuts and bolts, and remove clamping ring from the body halves.
5. Separate pressure plate, non-pressure plate and the diaphragm.
6. Carefully release the vicegrip pliers from the push-rod and withdraw the push-rod and return spring.

**Inspection**

1. Inspect all metal parts for damage, and renew any defective parts.
2. Check the return spring and renew if any sign of distortion or corrosion is apparent.
3. Ensure that the breather holes are not obstructed before reassembly.
4. It is important to note that, if either the diaphragm or the return spring is renewed, the corresponding diaphragm or return spring in the brake chamber on the other side of the vehicle should also be renewed, otherwise uneven braking may occur.

**To Reassemble**

1. Place push-rod on flat surface and fit return spring over push-rod.
2. Position non-pressure plate on push-rod and force it down until it rests on the flat surface. Clamp push-rod at the non-pressure plate with vicegrip pliers, taking precautions to avoid damaging the push-rod.



**FIG. 3. METHOD OF CLAMPING THE PUSH-ROD PRIOR TO REASSEMBLY**

## SECTION 8G

**Footbrake Valve  
(Westinghouse Type KY672/1)**

**REMOVAL AND REFITMENT****To Remove**

1. Chock the road wheels and apply the hand brake.
2. Release all air pressure from the system.
3. Brush dirt from footbrake valve.
4. Mark position of valve relative to the mounting plate and tag the pipe connections for identification.
5. Disconnect pipe connections and protect the ends from ingress of foreign matter.
6. Remove the three nuts and washers securing the footbrake valve to the chassis and withdraw the valve.

**To Refit**

1. Refitment of the footbrake valve is a reversal of the removal procedure ensuring that a clearance of  $\frac{1}{32}$  to  $\frac{1}{16}$  in exists between the end of the push-rod and the footbrake valve plunger, as shown at 'A' Fig. 1.

2. If the clearance is not within the limits quoted above, the push-rod should be adjusted as follows:

- a. Remove the clamp bolt and withdraw brake pedal and extension from brake pedal lever.
- b. Remove the three nuts and the bolt retaining the pivot bracket assembly to the chassis and withdraw the bracket assembly complete with brake pedal lever and push-rod.
- c. With the spring removed from push-rod, refit the assembly and set correct clearance between push-rod and brake valve plunger by slackening the small locknut and rotating the adjuster screw at the end of the plunger.
- d. When clearance is correct, secure the small locknut. Remove the bracket assembly, refit spring over push-rod and refit the bracket assembly.

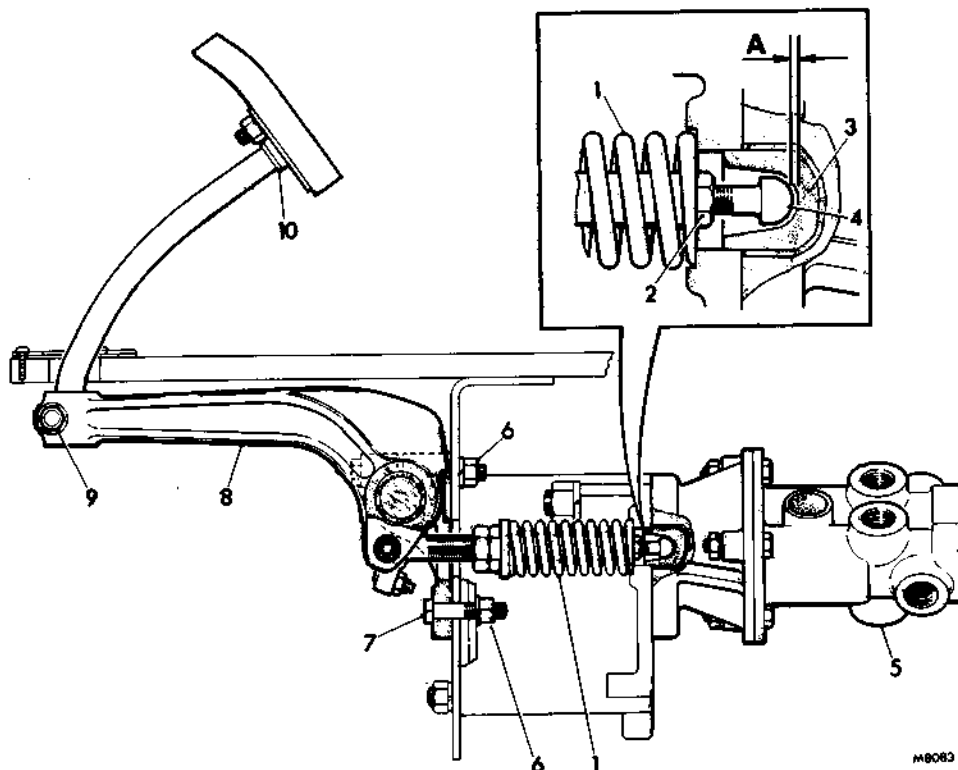


FIG. 1. FOOTBRAKE ASSEMBLY

- |                        |                    |
|------------------------|--------------------|
| 1. Return spring       | 6. Nut             |
| 2. Locknut             | 7. Bolt            |
| 3. Brake valve plunger | 8. Pedal lever     |
| 4. Push rod            | 9. Clamp bolt      |
| 5. Brake valve         | 10. Pedal assembly |





## SECTION 10H

Pressure Regulator Valve  
(Westinghouse Type)

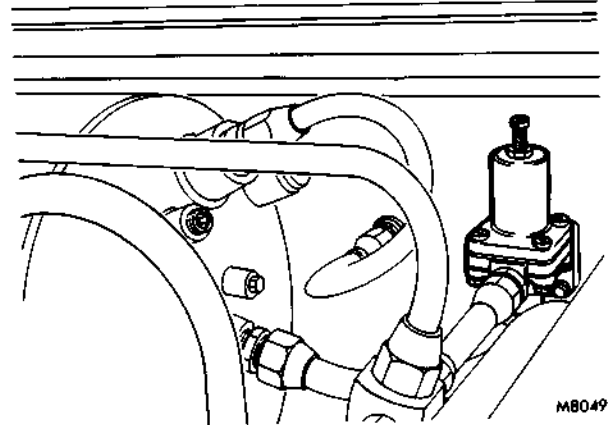
## REMOVAL AND REFITMENT

## To Remove

1. Release all air pressure from system.
2. Disconnect the two air lines and remove the valve.

## To Refit

1. Refit pressure regulator as originally fitted and secure the air line connections.
2. Carry out operating and leakage tests.

FIG. 1. PRESSURE REGULATOR VALVE  
IN POSITION

## OVERHAUL

A repair kit is not available for the pressure regulator valve, as it is considered uneconomic to repair. Inspect and test the unit at vehicle overhaul periods and if wear or damage is apparent, replace the unit complete.

## TESTING

## Operating Test

1. Connect an air supply line, fitted with an accurate air gauge, to the inlet port of the valve. Slowly increase the air supply pressure and note the opening pressure of the valve. The correct opening pressure is shown in DATA, Section 1. If the valve requires adjustment, slacken the locknut on the top cover and turn the adjusting screw clockwise or anti-clockwise to increase or decrease the opening pressure respectively.

**Note:** With the valve mounted on the vehicle, the pressure setting of the valve can be checked by noting that the auxiliary reservoir pressure remains at zero until all other reservoir gauges show a pressure reading equal to the correct opening pressure of the pressure regulator valve shown in DATA. Thereafter all reservoirs will be charged up to the unloader valve cut-out pressure.

## Leakage Tests

1. Charge the air system and check valve body and the pipe connections for leakage, using a soap solution. No leakage is permissible.

## To Refit

1. Remount the actuator on the vehicle. Tighten mounting stud nuts to a torque of 9.7 kgf m (70 lbf ft). Reconnect jaw-end to slack adjuster or brake lever.
2. Refit release bolt and screw down fully to 4.83 kgf m (35 lbf ft) torque. See Special Note.
3. Fit end breather cap, ensuring that the slot is facing downwards, indicated by arrow.
4. Reconnect air pressure pipes and charge system to unloader valve cut-out pressure.
5. Check and adjust brakes.

### Special Note

When fitting a new or reconditioned spring brake actuator the breather end-cap should be removed and the release bolt should be screwed down and tightened to the above torque after fitting the unit to the vehicle, as these units are despatched with the release bolt unscrewed to assist fitting.

Failure to carry out this instruction will result in the release bolt breaking the end-cap as soon as air is applied to the spring brake chamber.

Do not screw the release bolt fully home before remounting the chamber on the vehicle as this will make fitting extremely difficult.

## OVERHAUL

The manufacturer recommends that the actuator is removed from the vehicle and overhauled every year or 80 000 km (50 000 miles).

### To Dismantle

**DANGER:** It is essential that the powerful coiled spring is carefully released from tension with service tool MS 61 and adaptor set WH 61-5, see Fig. 2.

**Note:** A field maintenance kit should be obtained before dismantling the actuator.

1. Thoroughly clean the exterior of the brake chamber and scribe a line across the full length of the actuator to ensure correct assembly alignment.
2. Before removing the clamp ring, fit a tube over the push-rod and secure with a nut, or protect the push-rod with felt or other protective material and clamp with vice-grips. This will relieve the pressure of the spring on the diaphragm and the non-pressure plate.
3. Remove the clamp ring from the actuator.
4. Unscrew the nut from the end of the push-rod, or release vice-grips, and remove the push-rod, non-pressure plate, return spring and diaphragm.
5. Hold the spring chamber push-rod with vice-grips, after first wrapping the rod with felt or other protective material and unscrew the setscrew retaining the push-plate and push-rod.

**WARNING:** The following procedures, paragraphs 6, 7, 8, 9, 10, and 11 should only be undertaken using the service tool MS 61 and adaptor set WH 61-5.

6. Using the two pinned socket (2) of the adaptor set, unscrew the anti-explosion washer from inside the actuator head. This may be tight for the first thread as it could be holding the piston just clear of the bottom of the cylinder.
7. Place the actuator in the basic tool and centralize. Locate the thrust pad (1) of the tool set, well-lubricated in its bore, on the end of the central screw and wind down until the pad locates in the actuator head. Remove the sealing compound from around the circlip. Depress the head into the cylinder approximately 0.8 mm ( $\frac{1}{32}$  inch) to relieve the load from the circlip.

**CAUTION:** Only the smallest amount of movement of the spring housing is necessary to remove the spring thrust from the circlip; excessive force will break the spring housing.

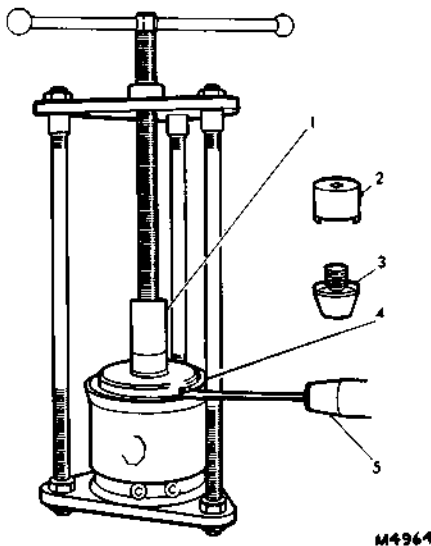


FIG. 2. TYPICAL SPRING BRAKE ACTUATOR HELD IN BASIC TOOL MS 61 SHOWING CIRCLIP REMOVAL

- |                          |            |
|--------------------------|------------|
| 1. } Adaptor set WH 61-5 | 4. Circlip |
| 2. }                     | 5. Lever   |
| 3. }                     |            |

## SECTION 11

## Single Diaphragm Brake Chambers

## REMOVAL AND REFITMENT

## FRONT SERVICE BRAKES

## To Remove

1. Prevent the vehicle from moving by applying the parking brake.
2. Carefully note the positions of the air line relative to the brake chamber, and the brake chamber relative to its mounting bracket, to ensure correct replacement.
3. Disconnect air line and take care to prevent dirt from entering the brake chamber or air line.
4. Remove push-rod, fork-end pin and gaiter, slacken the locknut and unscrew the fork-end.
5. Unscrew nuts on mounting studs and remove the brake chamber.

## To Refit

1. Before refitting the brake chamber smear the push-rod with grease. See Group 1 for details of grade.
2. Position brake chamber on its mounting bracket, fit spring washers and nuts, and tighten securely.
3. Re-connect air line to the units as originally fitted.
4. Turn wheels to the full right- and left-hand lock, and check that air lines are clear of the tyres.
5. Refit gaiter, screw jaw-end onto the push-rod until the first thread protrudes, and tighten locknut.
6. Before connecting jaw-end to slack adjuster the brake chamber should be tested, together with the corresponding brake chamber on the other side of the vehicle, to ensure simultaneous operation.
7. Disconnect jaw-end pin from the other slack adjuster and charge braking system.
8. Apply footbrake valve sufficiently to move push-rods, and check that they begin to move simultaneously.

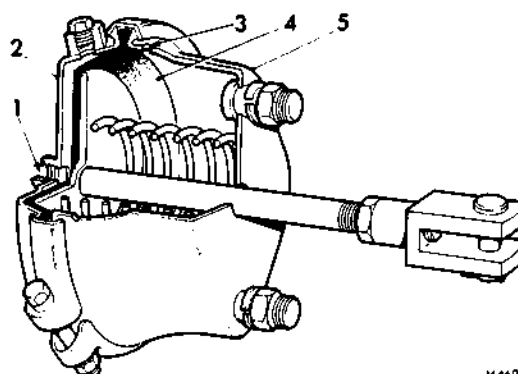


FIG. 1. CUT-AWAY VIEW OF DIAPHRAGM BRAKE CHAMBER

- |                   |                       |
|-------------------|-----------------------|
| 1. Air inlet port | 4. Diaphragm          |
| 2. Pressure plate | 5. Non-pressure plate |
| 3. Breather hole  |                       |
9. Unbalanced operation may be caused by unmatched diaphragms or incorrect springs.
  10. After testing, smear fork-end pins with grease and connect each fork-end to brake levers or slack adjusters when fitted.
  11. Ensure that brakes are correctly adjusted and that linkage does not bind.
  12. Carry out operating and leakage tests, then road-test the vehicle.

## POWER-ASSISTED HANDBRAKE

## To Remove

1. Disconnect the air pressure line from the brake chamber.
2. Blank off the union connection and pipe line.
3. Remove the clevis pin from the cross-shaft linkage.
4. Remove two nuts and washers and detach the chamber from the mounting bracket.

## To Refit

Refitting is the reverse of the removal procedure.

**Note:** Ensure that the handbrake lever is in the fully 'OFF' position and the brake chamber rod is in the fully released position before connecting the brake chamber rod to the cross-shaft lever. If necessary, adjust the position of the brake-rod fork-end so that clevis pin passes through the fork-end and cross-shaft lever in the above position.



5. Refit the push-rod into the piston shank. Fit the new circlip and screw the small guide bullet (3) of the adaptor set into the end of the push-rod finger tight (or a suitable protection plug into the end of the spring chamber push-rod). Lubricate the tip of the push-rod to assist insertion through the rod seal in the bottom of the chamber.
  6. Refit the piston in the spring chamber. This is best achieved by holding the piston at an angle and entering the piston seal gradually so that it is not damaged.
  7. Push down the piston, ensuring that the push-rod tip enters the seal in the bottom of the chamber. Remove the protective plug from the push-rod.
  8. Lubricate the thrust washers and place one of the washers on the piston. Fit the new main spring on the piston, locate the other washer over the spigot in the chamber head and position the head over the spring. Align the marks on the spring chamber and chamber head.
  9. Position the unit in the basic tool and centralize by measuring from the spring chamber to the three side-rods.
  10. Wind down the central screw of the tool until the thrust pad, as before, locates in the chamber head bore.
  11. Ensure the thrust washers and spring are locating correctly and continue turning the central screw until the chamber head is compressed into the spring chamber bore and the circlip groove is visible; refit the circlip.
- Note:** Due to slight out-of-squareness of some springs there may be some slight misalignment of the chamber head as it enters the spring chamber. This can usually be corrected by using a bar against one of the side-rods to lever the head into position.
- DANGER:** Ensure that the circlip is fitted correctly before removing the service tool.
12. Lightly lubricate the bore in the head and fit the new anti-explosion washer; tighten securely.
  13. Apply approximately 25 mm (1 inch) of Prestik 5913 sealing compound, 3 mm ( $\frac{1}{8}$  inch) diameter, to the circlip gap and then cover head retaining circlip and surrounding area with sealant (Bostik 772) allowing it to dry in a vertical position for not less than 45 minutes.
  14. Grip the push-rod with vice-grips and take precautions to avoid damaging the surface; refit the push-plate and securely tighten the retaining setscrew.
  15. Fit a new diaphragm, push-rod, return spring and non-pressure plate. Compress the return spring and refit the clamp ring.
  16. Torque tighten the clamp ring bolts to 2.1 kgf m (15 lbf ft). This figure must be re-checked after one hour.
  17. Refit the warning tags and locknuts. Fit the actuator to the vehicle, see page 7-11E-1.

### TESTING

#### Operating Test

Operate the spring brakes by means of the hand control valve and observe that the release bolt moves forward promptly without binding. Release the brakes and observe that the release bolt retracts fully without binding.

#### Leakage Test

Operate the spring brakes by means of the hand control valve and carry out the following tests:

Coat the brake chamber around the clamping ring with soap suds to check for leakage. Check for leakage past piston seal by applying soap suds to the exhaust vent in the end-cap.

Slight frothing is permissible.



3. Position new diaphragm centrally on pressure plate and centre non-pressure plate and push-rod on diaphragm. Loosely install the clamp ring and align components using a hide-faced hammer.
  4. Tighten the clamp ring and release the vice-grip pliers.
2. Apply and release the brakes and note that the push-rods move smoothly and promptly without binding.

**Note:** Due to the rubber bead on the diaphragm having a tendency to 'bed-in', the clamp ring should be retightened after a few hours to prevent bead movement causing leakage and fretting.

## TESTING

### Operating Test

1. Check the travel of the push-rod and adjust brakes if necessary. Push-rod travel should be kept at a minimum without the brakes binding, since excessive travel shortens the life of the brake diaphragms and also results in slow braking response.

### Leakage Test

1. Apply the parking brake.
2. Seal up three of the four breather holes in the non-pressure plate with suitable plugs or tape and coat the open hole with a soap solution.
3. Charge the system to the normal operating pressure and apply the brakes. Leakage at the open hole indicates a faulty diaphragm; renew diaphragm.



## SECTION 11E

Spring Brake Actuator  
(Westinghouse Type)

**DANGER:** Spring Brake Actuators contain an extremely powerful coil spring. There is a risk of **SERIOUS PERSONAL INJURY** if the actuator is dismantled without the use of special service tools described in the dismantling instructions.

## REMOVAL AND REFITMENT

## To Remove

**DANGER:** Before starting work on the spring brake actuators, release all air from the system and remove the release bolt (located under the end-cap). See paragraphs 1 and 2, and Fig. 1 below.

1. With the vehicle standing on level ground and the wheels chocked, set the hand control lever to the 'ON' position. This will release air from the spring brake chambers. Disconnect the air lines from spring and service ports of the actuator.
2. Remove breather end-cap; unscrew and remove release bolt.
3. Disconnect the jaw-end from the slack adjuster or brake lever, unscrew the nuts from the mounting studs and remove the spring brake actuator from the vehicle.

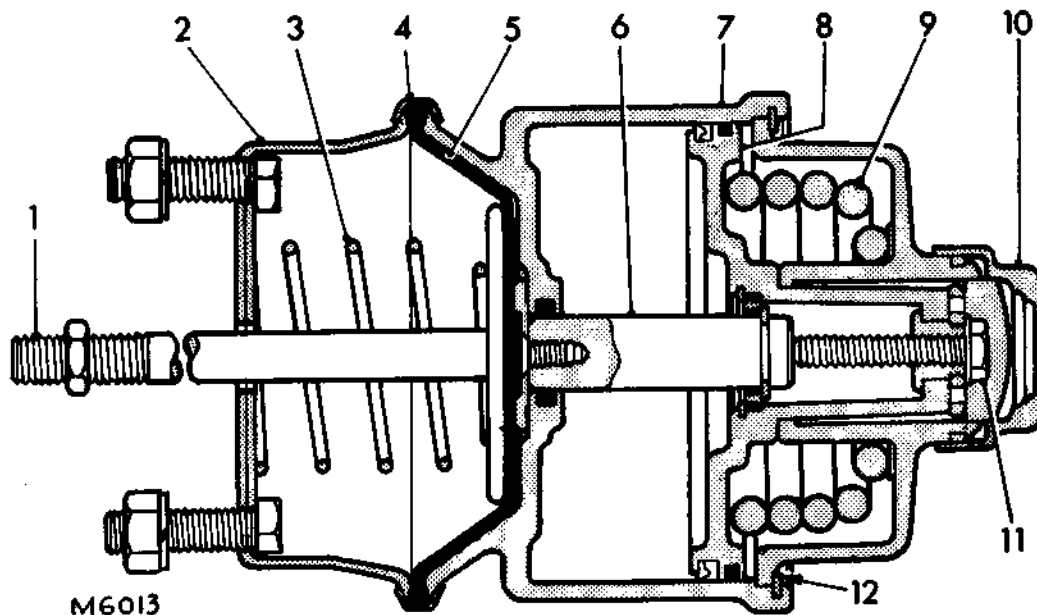


FIG. 1. TYPICAL SPRING BRAKE ACTUATOR

(In normal driving position—showing service footbrake and handbrake in the 'OFF' or released position)

- |                           |                       |                          |
|---------------------------|-----------------------|--------------------------|
| 1. Service brake push-rod | 5. Diaphragm          | 9. Handbrake spring      |
| 2. Service brake chamber  | 6. Handbrake push-rod | 10. End-cap, with filter |
| 3. Service brake spring   | 7. Handbrake chamber  | 11. Release bolt         |
| 4. Clamp ring             | 8. Handbrake piston   | 12. Circlip              |





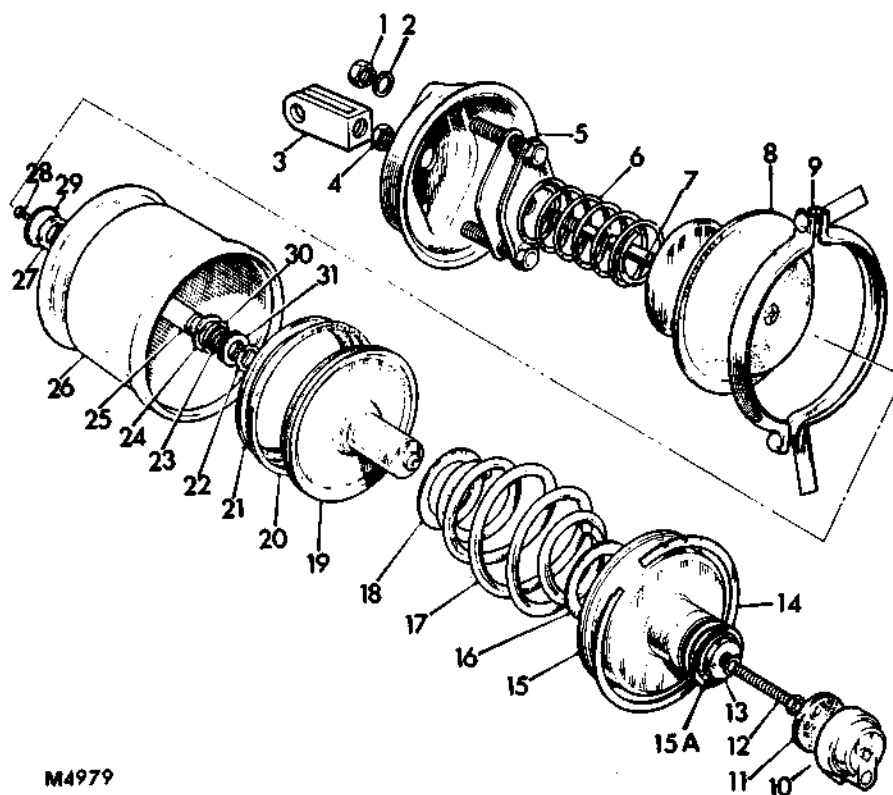
8. Remove the circlip (the circlip is located in a safety groove in the head and should be removed with care) and then turn the screw slowly anti-clockwise allowing the spring to expand in a controlled manner.
9. When the head and spring are completely free, release the tool and remove the head and spring.
10. Grip the piston shank firmly and pull it straight out of the chamber.
11. Remove the push-rod from the piston shank by removing the circlip and pulling out the push-rod and collar complete.

**Note:** Wash seals and diaphragm in soap and water. Wash all metal parts in cleaning solvent and carefully examine the spring brake unit, body, piston and head castings for any signs of surface imperfections due to damage or excessive wear. If there are any such signs the part should be renewed. Particular attention should be given to the body bore, for the piston, and the bore of the head which forms the rear guide bore. Wear which shows a visible step in excess of 0.25 mm (0.010 inch) indicates the desirability of head renewal.

**To Reassemble**

Before reassembling the unit lubricate all seals and mating surfaces with Bendix Westinghouse Grade A air brake grease. (In earlier kits, a felt wiper was used instead of nylon, and this felt should be soaked in oil to Bendix Westinghouse specification K4-757-01.)

1. Lubricate the seal groove on the piston and fit the new seal.
2. Place nylon wiper in groove of piston and apply more grease. (If a felt wiper is used, place the lubricated felt in the groove.)
3. Fit the two new 'O' rings on the collar and assemble the collar to the push-rod. Fit the new circlip, ensuring that it seats correctly in its groove.
4. Fit the new push-rod seal into the chamber by bending and feeding into position from one side.

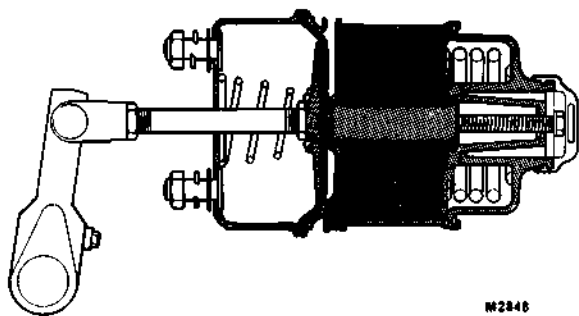


M4979

FIG. 3. EXPLODED VIEW OF TYPICAL SPRING BRAKE ACTUATOR

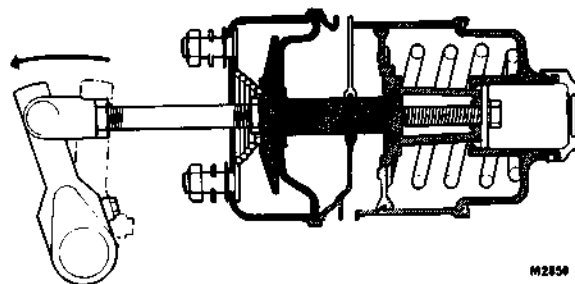
- |                       |                           |                   |                        |
|-----------------------|---------------------------|-------------------|------------------------|
| 1. Nut                | 9. Clamp ring             | 16. Thrust washer | 24. Circlip            |
| 2. Washer, spring     | 10. Breather cap          | 17. Spring        | 25. Push-rod           |
| 3. Jaw-end            | 11. Filter element        | 18. Thrust washer | 26. Chamber            |
| 4. Locknut            | 12. Release bolt          | 19. Piston        | 27. Push-rod seal      |
| 5. Non-pressure plate | 13. Anti-explosion washer | 20. Wiper         | 28. Screw, socket head |
| 6. Spring             | 14. Circlip               | 21. Piston seal   | 29. Push-plate         |
| 7. Push-rod           | 15. Chamber head          | 22. Snap-ring     | 30. 'O' ring seal      |
| 8. Diaphragm          | 15a. 'O' ring seal        | 23. 'O' ring seal | 31. Collar             |





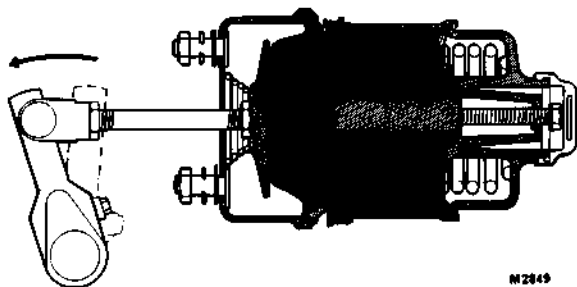
M2846

FIG. 4. NORMAL DRIVING—SERVICE AND SPRING BRAKES RELEASED



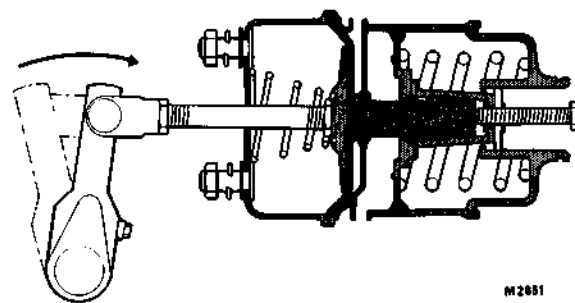
M2850

FIG. 6. EMERGENCY OR PARK POSITION—SPRING BRAKES APPLIED



M2849

FIG. 5. SERVICE BRAKES APPLIED



M2851

FIG. 7. SPRING BRAKES MANUALLY RELEASED

## To Reassemble

1. Renew all parts found to be defective during 'Inspection'.

Lubricate the parts, where necessary, with C.D.S. 156 grease (Clayton recommendation). Screw the spring retainer on to the adjusting screw and adjust it to the position noted when dismantling.

2. Lightly smear the sliding surfaces of the adjusting screw and body with grease. Insert the 'O' ring diaphragm, beaded side first, into the body. Re-lubricate the adjusting screw bore in the body and insert the adjusting screw. Lightly smear the seal with grease and fit it on to the switch assembly with the lips facing towards the shoulder.

Lightly smear the sliding surfaces of the spring retainer and switch assembly with grease.

3. Place the spring in the spring retainer and, ensuring that both ends of the spring are correctly seated, fit the switch assembly to the body. Fit the shakeproof washers and screws and tighten.

Refit the unit in the braking system, and then carry out the operating and leakage tests.

## TESTING

### Operating Tests

1. Charge the system to the governor or unloader valve cut-out pressure and stop the engine. Slowly reduce the air pressure and check that the switch operates the low pressure warning device when the reservoir air pressure has fallen to  $4.218 \pm 000.492 \text{ kgf/cm}^2$  ( $60 \pm 7 \text{ lbf/in}^2$ ).
2. Release all air pressure from the system, start the engine and observe the pressure gauge. The difference between the switch off and switch on pressure must not exceed  $0.703 \text{ kgf/cm}^2$  ( $10 \text{ lbf/in}^2$ ).

3. If the switch requires adjusting, chock the wheels and release all air pressure from the system. Disconnect the wires from the switch. Remove the screws from the unit, and holding the switch assembly against the body, turn the switch assembly clockwise, viewed from the terminal end of the unit, to lower the pressure setting, or anti-clockwise to raise the setting. Place the shakeproof washers on the screws. Ensuring that the screw threads are clean and dry, smear the threads with Loctite and refit the shakeproof washers and screws.
4. Reconnect the wires. Repeat the tests and, if necessary, re-adjust the switch to obtain the correct pressure setting.
5. After adjusting, tighten the clamping screws to a torque loading of 17.25 to 23 kgf cm (15 to 20 lbf in).

### Air Leakage Test

1. Chock the wheels. Charge the vehicle braking system to the governor or unloader valve cut-out pressure and stop the engine.
2. Apply soap solution to the body and the joint between the body and switch assembly. Bubbles indicate leakage which is not permissible. Leakage from the joint indicates that the 'O' ring diaphragm is defective.
3. If the test indicates defective parts, or that the unit is insecurely mounted, these must be rectified.



## SECTION 12D

### Stop-Light Switch (Westinghouse Type SL4)

#### DESCRIPTION

The switch is fitted in the front and rear brake delivery lines. When the brake pedal is depressed, air pressure acting on the diaphragm closes the electrical contacts to complete the brake stop-light circuit.

As the air is exhausted from each delivery line when the brake pedal is released, the spring forces the contacts apart and breaks the lighting circuit.

#### REMOVAL AND REFITMENT

##### To Remove

1. Isolate the electrical supply before starting work on the switch.
2. Disconnect the terminal connections.
3. Carefully unscrew the switch from its location.

##### To Refit

1. Refit the switch to the vehicle, reconnect the wiring and carry out the Operating and Leakage Tests.

#### OVERHAUL

This unit is not a repairable item. If the switch does not function correctly, replace with a new unit.

#### TESTING

##### Operating Test

1. Ensure the air system is charged, then apply the footbrake and check that the stop-lights operate as soon as the brakes operate.
2. Release the footbrake pedal and check that the stop-lights are extinguished.

##### Leakage Test

1. Charge the air system and, with the aid of an assistant depressing the footbrake, coat the entire switch with a soap solution. Leakage is not permissible. Any leakage at the cover is an indication that the diaphragm is faulty.

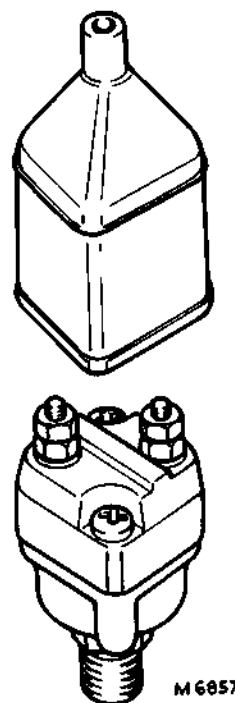
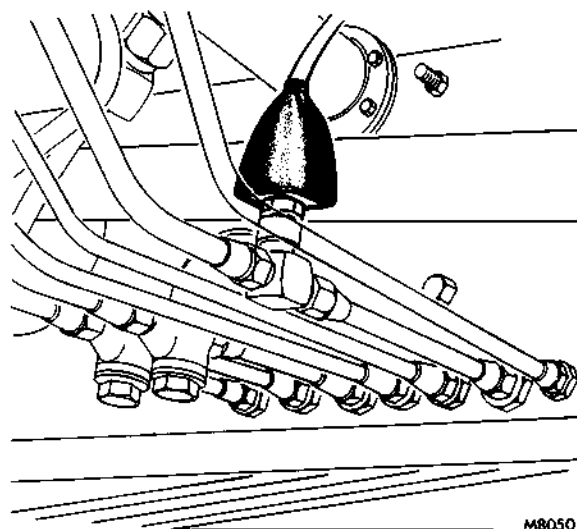


FIG. 1. STOP LIGHT SWITCH WITH RUBBER BOOT



M8050



## SECTION 13

### Low Pressure Indicator (Westinghouse Type LP2)

#### DESCRIPTION

The indicator is a safety device designed to give audible warning when the air pressure is insufficient to hold off the parking brakes during normal running. It is basically an electro-pneumatic switch which operates a buzzer in the driver's compartment when the air pressure falls below a pre-determined pressure and consists of a die-cast body and an insulated cover, between which is clamped a spring-loaded rubber diaphragm.

A fixed electrical contact is secured in the base of the valve body, the moving contact being a part of the diaphragm assembly.

When the air pressure below the diaphragm exceeds the spring pressure, the contacts are forced open and the electrical circuit is broken.

If at any time the air pressure falls below the pre-set figure shown in DATA, the spring re-asserts itself, closing the contacts and operating the buzzer.

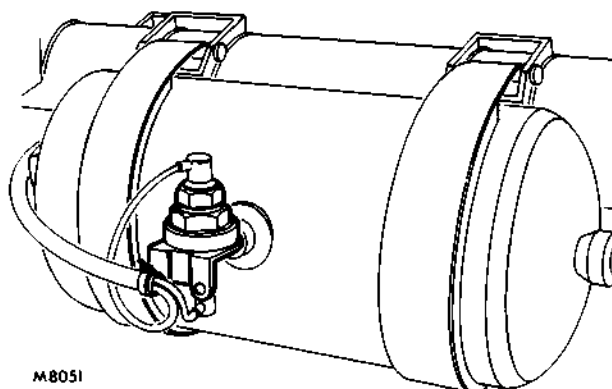


FIG. 1. LOW PRESSURE INDICATOR LOCATED IN SPRING BRAKE RESERVOIR

#### REMOVAL AND REFITMENT

##### To Remove

1. Apply the parking brake, and release all pressure from the air system.
2. Isolate the electrical supply.
3. Uncouple the air line and disconnect the electrical connections; tap for identification purposes.
4. Remove the switch.

##### To Refit

1. Refit the switch to the vehicle, and carry out the Operating and Leakage Tests.

#### TESTING

##### Operating Test

1. Connect an Avometer across the low-pressure switch terminals. Start the engine and re-charge the air system, noting that a reading should be obtained on the Avometer when the correct cut-out pressure at the switch is attained.  
**Note:** The service brake reservoir air gauges can be used to determine the switch cut-out pressure.
2. If the switch does not operate at the correct cut-out pressure, or if wear or damage is apparent, replace the switch complete.

##### Leakage Test

##### Low-pressure switch

1. With the air system fully charged, place the travel control valve in the 'OFF' position and coat the switch with a soap solution. Leakage is not permissible.





## SECTION 13A

Low-Pressure Indicator  
(Clayton Type)

## REMOVAL AND REFITMENT

## To Remove

1. Chock the wheels and release all air pressure from the braking system. Disconnect the wires from the low pressure switch.
2. Brush away dirt from the switch and unscrew it from its mounting. Take precautions to prevent dirt from entering the switch and its mounting port in the system.

## To Refit

1. Screw the unit into position and tighten only sufficiently to prevent air leakage.
2. Re-connect the wires to the switch.
3. Carry out the operating and leakage tests.

## OVERHAUL

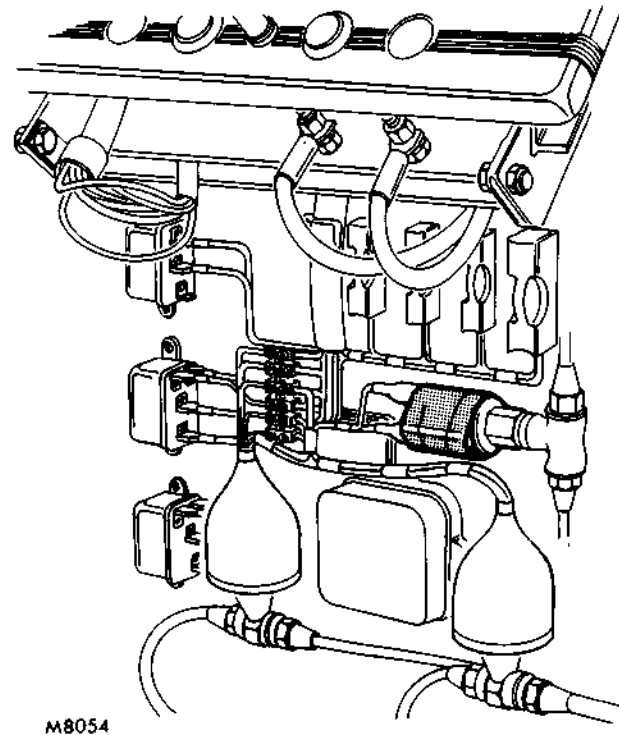
The manufacturer's recommended overhaul period is every two years or 160 000 km (100 000 miles).

## To Dismantle

1. A new switch assembly, seal, spring and 'O' ring diaphragm should be ordered before removing the unit from the vehicle.
2. Remove grease and dirt from the exterior of the unit.
3. Remove the screws and separate the parts of the unit. Withdraw the 'O' ring diaphragm and seal from the body. Note the position of the spring retainer on the adjusting screw to facilitate re-assembly and then unscrew the spring retainer. Discard the switch assembly, seal, spring and 'O' ring diaphragm.

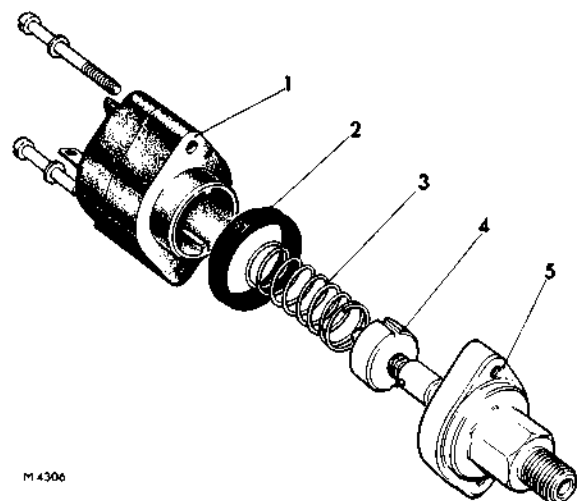
## Inspection

1. Wash metallic parts in cleaning solvent and blow dry with compressed air. Wipe the spring retainer and the adjusting screw with a clean cloth.
2. Examine the body for cracks and damage. Examine the sliding surfaces of the spring retainer, adjusting screw and body for scores and excessive wear. Examine all threads for damage.



M8054

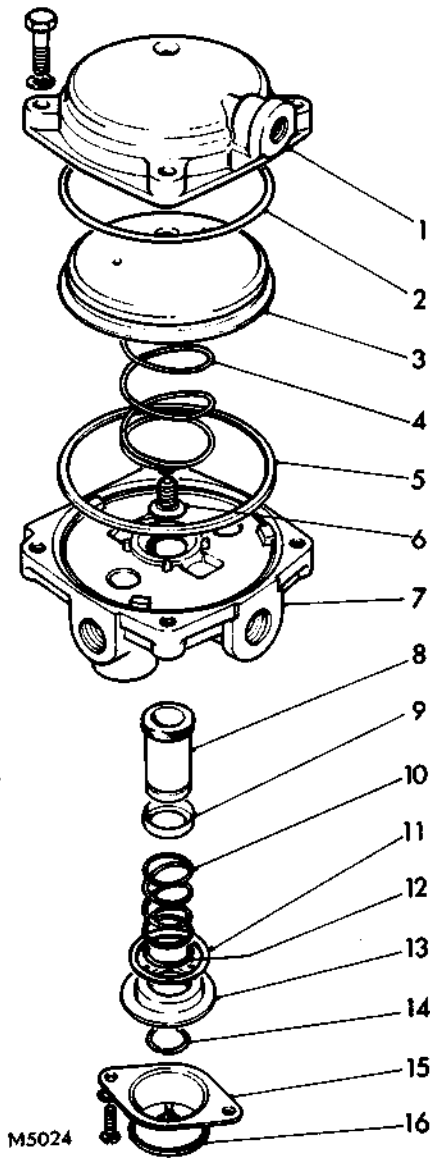
FIG. 1. LOW-PRESSURE INDICATOR IN POSITION



M4306

FIG. 2. EXPLODED VIEW OF LOW-PRESSURE INDICATOR

- |                    |  |
|--------------------|--|
| 1. Switch assembly | 4. Spring retainer and adjusting screw |
| 2. Seal            | 5. Body, with 'O' ring diaphragm       |
| 3. Spring          |  |



**FIG. 2. EXPLODED VIEW OF RELAY VALVE**

- |                         |                         |
|-------------------------|-------------------------|
| 1. Cover                | 9. Valve retainer       |
| 2. Piston sealing ring  | 10. Valve spring        |
| 3. Piston               | 11. Sealing ring        |
| 4. Piston return spring | 12. Sealing ring        |
| 5. Sealing ring         | 13. Valve guide         |
| 6. Exhaust valve seat   | 14. Circlip             |
| 7. Body                 | 15. Check valve seat    |
| 8. Inlet/exhaust valve  | 16. Exhaust check valve |

**TESTING**

**Operating Test**

Start the engine and fully charge the air system to test valve as follows:

1. Operate the handbrake and check that the brakes are applied and released promptly through the relay valve.

**Leakage Test**

1. Coat the top cover joint and pipe connections with a soap-and-water solution.
2. Operate the brakes to test the cover joint and pipe connections for leakage. Leakage in excess of a one-inch soap bubble in three seconds is not permissible.
3. Move the handbrake control lever to the 'ON' position and coat the exhaust check valve and seat items (15) and (16) with a soap-and-water solution to check the valve and seat for leakage. Leakage in excess of a one-inch soap bubble in three seconds is not permissible.

## SECTION 13D

**Low Pressure Indicator  
(Westinghouse Type LP3)**

**REMOVAL AND REFITMENT****To Remove**

1. Pull back the rubber boot and disconnect the electrical connections from the indicator.
2. Unscrew the indicator from its location.

**To Refit**

1. Refitment is a reversal of the removal procedure. Carry out Leakage and Operating Tests.

**OVERHAUL**

At overhaul periods, dismantle and clean the components in a suitable solvent. The life of the contacts can be extended by turning the contact disc and contact plate over, thereby bringing fresh contacts into operation.

**TESTING****Leakage Test**

1. Fully charge the air system.
2. Test the indicator for air leakage, using a soap solution. No leakage is permissible.

**Operating Test**

1. Ensure that the electrical circuit between the indicator terminals is broken when air pressure behind the indicator diaphragm exceeds the setting pressure, as shown in DATA, Section 1.
2. If the indicator does not function correctly, replace the indicator unit complete.

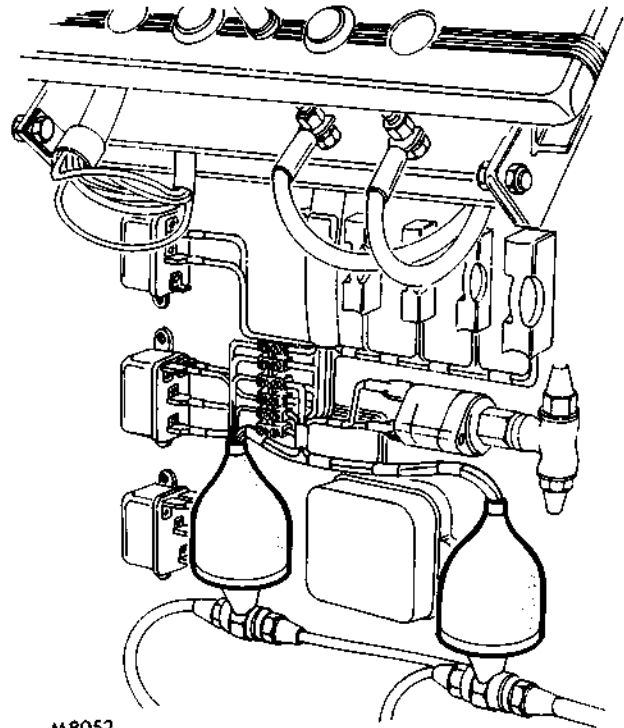


FIG. 1. LOW-PRESSURE INDICATORS (SERVICE BRAKES) IN POSITION

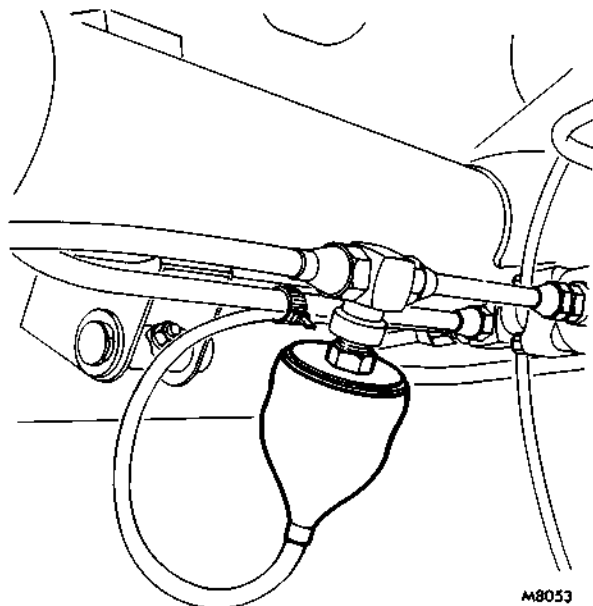


FIG. 2. LOW-PRESSURE INDICATOR (SPRING BRAKE WARNING LIGHT) IN POSITION



## SECTION 14

## Air Line (Strainer)

## DESCRIPTION

The purpose of the air line strainer is to ensure that no foreign matter enters the brake valves, causing damage to the valves or seats.

One air line strainer is fitted to each of the supply lines for the dual concentric brake valve.

The strainer consists of a housing which contains a fine wire-mesh element. The element is spring loaded, so if at any time a blockage occurs, the element is lifted off its seat, permitting a continual flow of air.

## OVERHAUL

The manufacturer's recommended overhaul period for the air line strainer is every 40 000 km (25 000 miles).

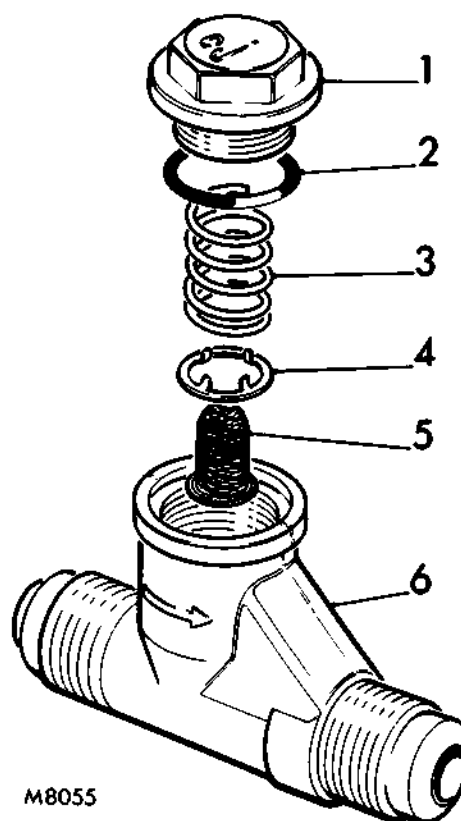
## To Dismantle

1. Remove the screw cap complete with rubber sealing ring, and withdraw spring and strainer element.
2. Wash the element thoroughly in a suitable solvent and fit a new sealing ring if necessary.

## To Reassemble

Reassembly is a reversal of the dismantling procedure, noting the following:

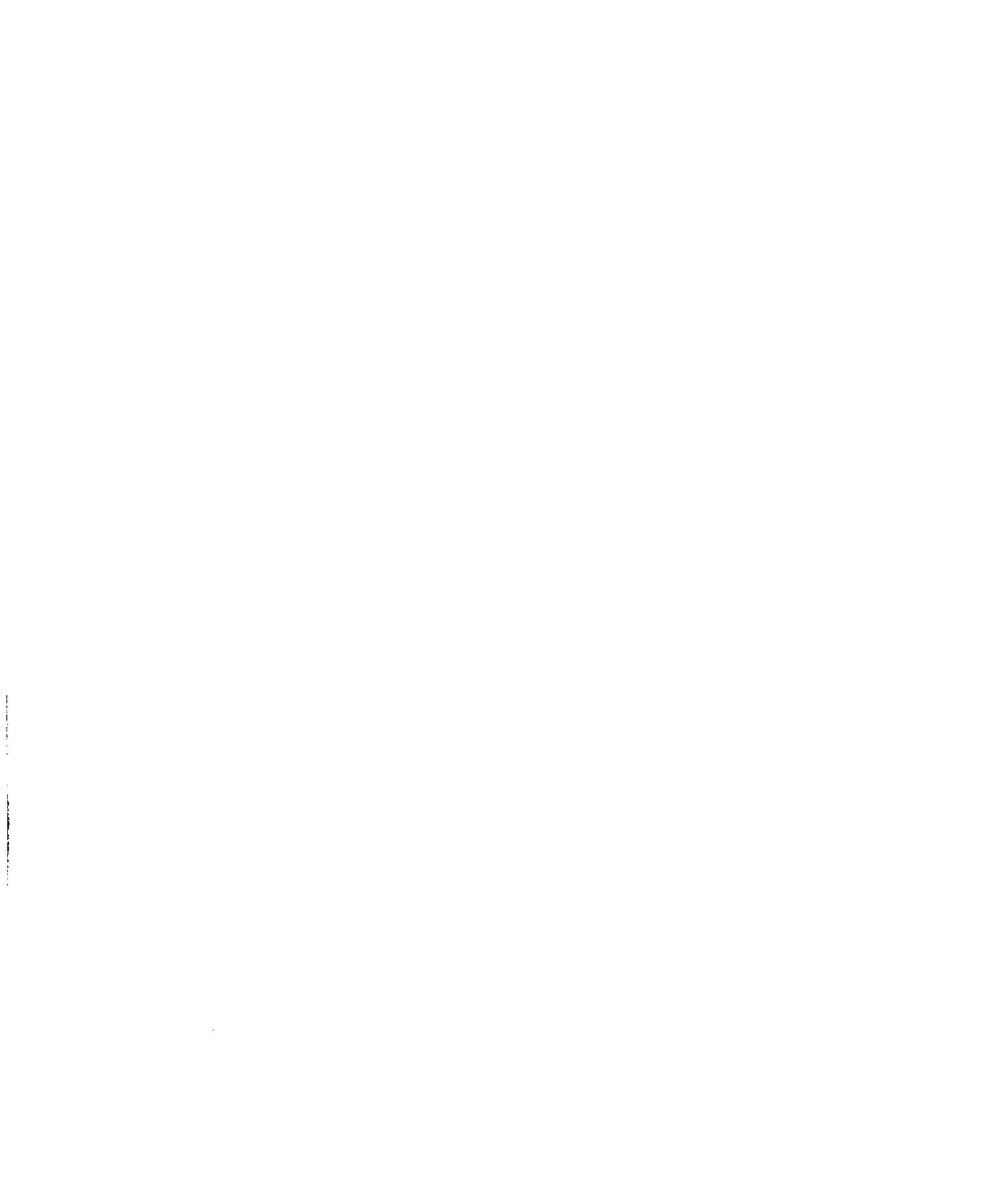
1. Check the air line strainer connections for leakage after the air system has been recharged.



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FIG. 1. EXPLODED VIEW OF AIR LINE STRAINER

- |                        |                  |
|------------------------|------------------|
| 1. Screw cap           | 4. Spring plate  |
| 2. Rubber sealing ring | 5. Strainer      |
| 3. Spring              | 6. Strainer body |



## SECTION 15D

## Relay Valve

## REMOVAL AND REFITMENT

## To Remove

1. Apply handbrake control in 'ON' position and chock road wheels.
2. Fully release pressure from air brake system.
3. Disconnect air inlet and outlet pipes.
4. Remove securing nuts and washers at mounting bracket. Remove relay valve clear of chassis.

## To Refit

1. Secure relay valve to mounting bracket and re-connect air inlet and outlet pipes.
2. Recharge air system and carry out the Operating and Leakage Tests.
3. Remove chocks and road test vehicle.

## OVERHAUL

The manufacturer's recommended overhaul period is every year or 160 000 km (100 000 miles).

**Note:** A service exchange unit or a repair kit should be obtained before overhaul.

## To Dismantle (Fig. 1)

1. Mark a line across valve to aid re-assembly.
2. Grip valve body lightly in soft-vice jaws and remove top cover (1), sealing ring (5), piston (3), complete with sealing ring (2) and return spring (4).
3. Remove setscrews securing inlet/exhaust check valve (9) to the body; lift off valve.
4. Remove and dismantle the inlet/exhaust valve (8).

## Inspection

1. Inspect valve and replace all items by those contained in the repair kit.
2. Check piston return spring (4), and renew if distorted or damaged.

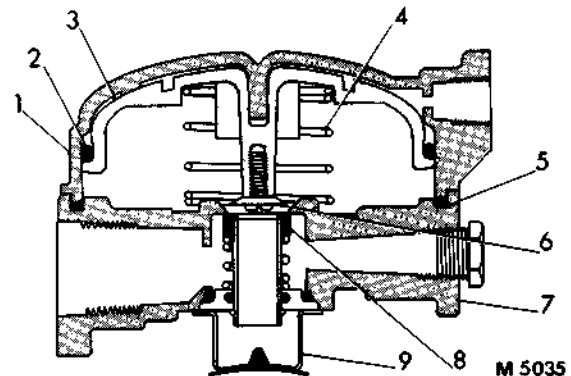


FIG. 1. SECTIONED VIEW OF RELAY VALVE

- |                         |                        |
|-------------------------|------------------------|
| 1. Top cover            | 6. Exhaust valve seat  |
| 2. Piston seating ring  | 7. Valve body          |
| 3. Piston               | 8. Inlet/exhaust valve |
| 4. Piston return spring | 9. Exhaust check valve |
| 5. Sealing ring         |                        |

3. Check and clean exhaust valve seat (6), valve body (7) and inlet/exhaust valve (8). Remove burrs and renew items 6, 7 and 8 as necessary.

## To Reassemble (Fig. 2)

1. Smear all seals, sealing rings, springs and sliding surfaces with Bendix Westinghouse 'Grade A' grease or Clayton CDS 156 grease according to maker of valve.
2. Re-assemble the inlet/exhaust valve (8), valve retainer (9), valve spring (10), sealing rings (11) and (12), and valve guide (13); secure with circlip (14). Fit assembly to valve body (7).
3. Fit exhaust check valve and seat (16) and (15) to body (7).
4. Ensure exhaust valve seat (6) is secured to piston (3). If valve seat is loose, secure with Loctite Screwlock compound.
5. Refit sealing ring (2) to piston (3), and fit piston to top cover (1).
6. Refit sealing ring (5) to body (7).
7. Assemble spring (4) to body (7) and fit top cover (1).

Secure with bolts and spring washers.





SECTION 16E

Non-return Valve  
(Single Check Valve)

DESCRIPTION

The valve is fitted to the inlet side of each service brake reservoir and is designed to allow air to pass in one direction only. This ensures that the service brake circuits remain unaffected by a pressure loss in any other part of the air system.

On certain vehicles, a non-return valve is also fitted to the inlet side of the handbrake reservoir.

The manufacturer recommends that the non-return valves are renewed every 160 000 km (100 000 miles).

REMOVAL AND REFITMENT

To Remove

1. Release all air pressure from the system and disconnect the air piping from the inlet side of each service reservoir and remove the non-return valves.

To Refit

1. Refitment is a reversal of the removal procedure. After refitment, carry out the Operating and Leakage Tests.

TESTING

Operating Test

1. Fully charge the air system.
2. Deplete the auxiliary reservoir by opening the reservoir drain taps and check for a drop in pressure on the service brake air gauges in the driving compartment.

If a drop in pressure is evident, the non-return valves should be renewed.

Leakage Test

1. With the air system fully charged, check for external leakage at the non-return valve connections. Leakage is not permissible.

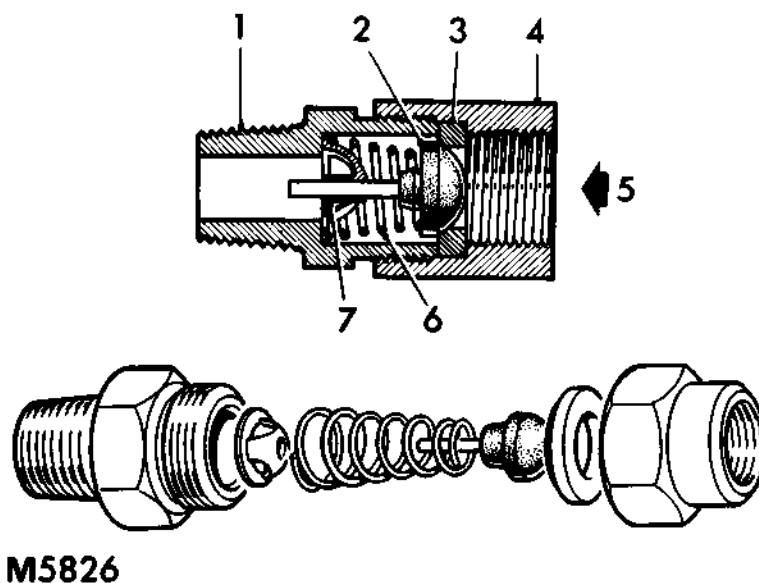


FIG. 1. NON-RETURN VALVE

- |               |                          |
|---------------|--------------------------|
| 1. Body       | 5. Direction of air flow |
| 2. Valve      | 6. Spring                |
| 3. Valve seat | 7. Spring guide          |
| 4. Screw cap  |                          |



## Section 18

## Condenser and Drain Valve

## DESCRIPTION

The condenser unit is used in the vehicle air pressure system to filter and dry the air delivered from the compressor. The unit is mounted in the air line between the compressor and the unloader valve. The integral bridge pipe operates the drain valve assembly by the pressure drop in the condenser cylinder, whenever the unloader valve cuts out allowing condensate to exhaust from the lower drain port.

## REMOVAL AND REFITMENT

## To Remove

1. Place the vehicle over an inspection pit and apply the hand control valve to the 'ON' position.
2. Discharge all air from the system.
3. Disconnect the air line connections, noting their relevant positions and take care to prevent dirt entering the pipes.
4. Remove the three setscrews and washers from the mounting plate and withdraw the unit from the vehicle.

## To Refit

Refitment is a reversal of the removal procedure.

## OVERHAUL

## To Dismantle

**Note:** A repair kit must be obtained before dismantling.

1. Remove dirt from the exterior of the unit.
2. Mark the cylinder, base plate and the drain valve body prior to dismantling to show their correct relationship.
3. Remove the bridge pipe from the unit; make sure that no dirt enters the pipe.
4. Remove the four nuts and washers securing the drain valve to the cylinder, taking care because of the tension on the filter retaining spring.

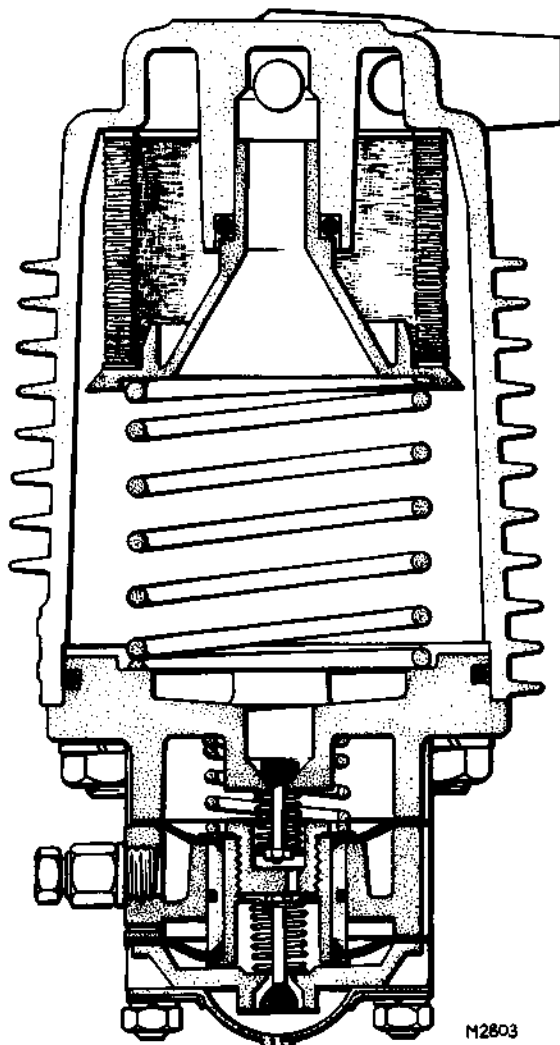


FIG. 1. SECTIONED VIEW OF CONDENSER AND DRAIN VALVE

5. Remove the spring, the filter retainer and the filter, and take off the sealing rings, one from the filter retainer and the other from the cylinder base plate.
6. Remove six nuts and washers from the base of the unit and remove the bottom cover and drain valve assemblies.
7. Unscrew the valve centre guide from the diaphragm retainer and remove the diaphragm washer. The upper and lower diaphragms can now be removed from the drain valve body.
8. Withdraw the piston from the drain valve body and remove the sealing ring.
9. Unscrew the nuts off the valve stems and take off the valves, springs and spring retainers.
10. Discard all items which will be renewed from the repair kit.



15. Place the filter on the retainer and insert into the bore in the cylinder, fit the retainer spring on the cylinder baseplate.
16. Locate the marks made before dismantling, fit the baseplate over the studs and press into the cylinder.
17. Fit the nuts and washers and tighten to a torque of 2.22 kgf m (16 lbf ft).
18. Reconnect the bridge pipe to the unit.

## TESTING

### Operating Test

1. Place the vehicle over an inspection pit with the hand control valve in the 'ON' position.
2. Stop the engine and reduce the pressure in the system by applying and releasing the brakes.
3. Start the engine and charge the system to the unloader valve 'cut-out' pressure, see DATA, and note when the unloader valve 'cuts-out' the drain valve exhausts a small quantity of air/water/oil.

### Air Leakage Test

**Note:** The unit must be drained of all condensate before testing.

1. Place the vehicle over an inspection pit and apply the hand control valve to the 'ON' position.
2. Release all air pressure from the system.
3. Remove the bridge pipe from the cylinder and fit a closure plug.
4. Charge the system to the unloader valve cut-out pressure, see DATA, and stop the engine.
5. Operate the brake valve to discharge air until the unloader valve 'cuts-in', see DATA, and coat the drain port with a soap solution.
6. Leakage in excess of a 0.5 cm bubble in five seconds indicates a faulty inlet valve or seat.
7. Charge the system to the unloader valve 'cut-out' pressure, stop the engine, remove the closure plug and reconnect the bridge pipe.
8. Operate the brake valve to discharge air until the unloader valve 'cuts-in' and coat the breather hole and the drain port with a soap solution.
9. Slight leakage from the breather hole indicates a defective piston sealing ring, excessive leakage indicates a ruptured diaphragm.
10. Leakage from the drain hole in excess of a 1 cm soap bubble in five seconds is not permissible.

## SECTION 19

## Alcohol Evaporator

## DESCRIPTION

The alcohol evaporator is incorporated into the air system to prevent possible failure of the braking system when the vehicle is operating in temperatures below freezing point.

The vaporized alcohol drawn into the system acts as an anti-freeze and prevents the freezing of any moisture which may be present in the air lines.

The correct operation of the alcohol evaporator is indicated by the presence of bubbles in the alcohol when the compressor is pumping air into the system.

## OVERHAUL

A repair kit is not available for the alcohol evaporator as it is considered uneconomic to repair. Inspect the unit at vehicle overhaul periods, and if wear or damage is apparent, replace the unit complete.

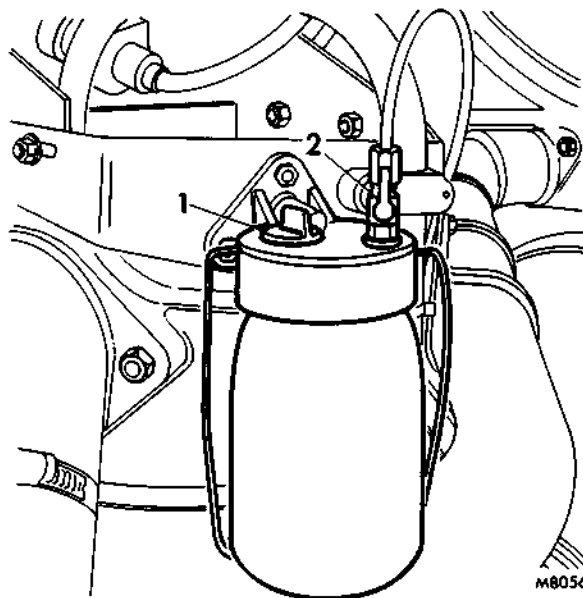


FIG. 1. ALCOHOL EVAPORATOR UNIT

1. Filler plug
2. Control tap

## SECTION 20H

Limiting Valve  
(Westinghouse Type)**DESCRIPTION**

The limiting valve, bolted to the inside of the chassis frame, is fitted in the auxiliary air line to limit the air pressure supplied to the semi-automatic (pneumocyclic) gearbox. Excess or insufficient air pressure could damage the gearbox mechanism.

The limiting valve operating pressure is set by the adjuster screw on top of the valve.

For the correct operating pressure setting see Data, Section 1 in this group.

**REMOVAL AND REFITMENT****To Remove**

1. Fully release pressure from the air system.
2. Disconnect and remove valve from the vehicle.
3. Protect pipes and connections from dirt or grime.

**To Refit**

1. Refit valve to vehicle with the embossed arrow pointing in the direction of the air flow.

**OVERHAUL**

A repair kit is not available for the limiting valve as it is considered uneconomic to repair.

Carry out the operating and leakage tests at the vehicle overhaul periods, and if the valve is malfunctioning, fit a replacement valve complete.

**TESTING****Operating Tests**

1. Connect a calibrated air pressure gauge, fitted with a flexible hose, to the delivery side of the valve to test the output pressure.

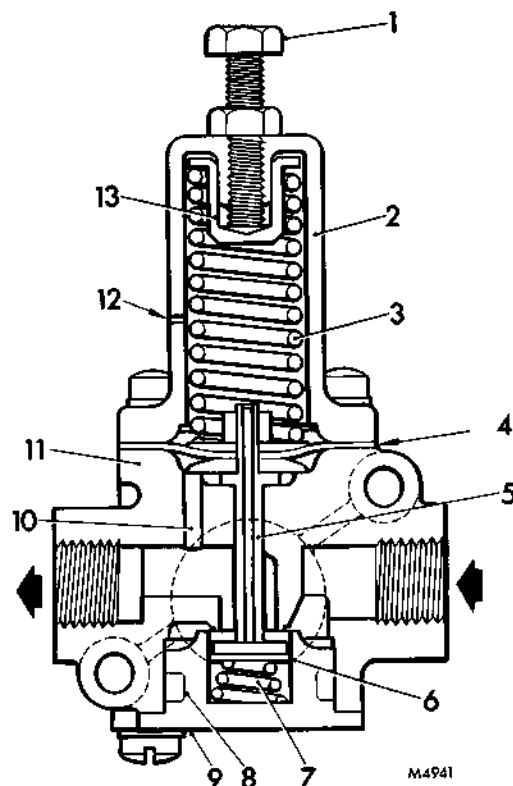


FIG. 1. SECTIONED VIEW OF LIMITING VALVE

Arrows showing direction of the air flow

- |                           |                   |
|---------------------------|-------------------|
| 1. Adjuster screw         | 8. O-ring         |
| 2. Top cover              | 9. End cover      |
| 3. Setting control spring | 10. Choke passage |
| 4. Diaphragm assembly     | 11. Valve body    |
| 5. Hollow stem            | 12. Breather hole |
| 6. Inlet valve            | 13. Spring seat   |
| 7. Valve spring           |                   |

2. Start the engine and fully charge the air system until the unloader valve cuts out.
3. Test that the gauge reading is equal to the limiting valve operating pressure (see Data, Section 1 in this group).
4. Turn adjuster screw (1) clockwise to increase or anti-clockwise to decrease the air pressure. Tighten locknut.

**Leakage Tests**

1. Charge the air system and check valve body and pipe connections for leakage, using a soap solution. No leakage is permissible.

## SECTION 22A

Differential Protection Valve  
(Westinghouse Type)

## REMOVAL AND REFITMENT

## To Remove

1. Thoroughly clean the exterior of the valve.
2. Release all air pressure from the system.
3. Disconnect air lines from the valve.

## To Refit

1. Fit the valve on the chassis and reconnect the air lines as originally fitted.
2. Fully charge the air system, coat the entire valve with soap solution and test for leakage with spring brakes and service brakes applied in turn. Leakage from the valve or connections is not permissible.

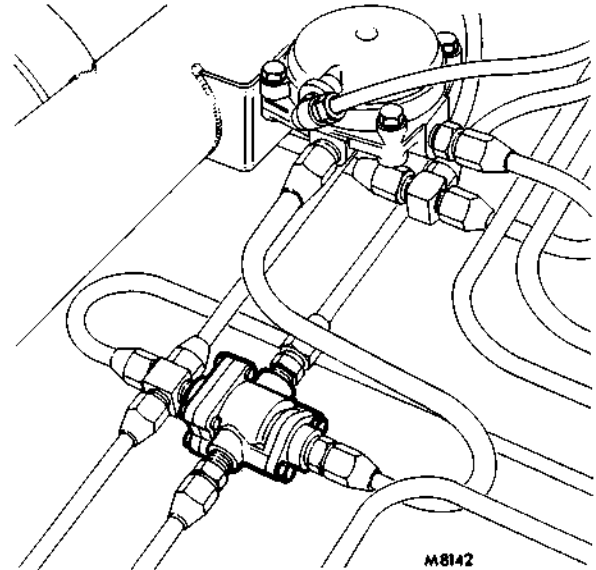


FIG. 1. DIFFERENTIAL PROTECTION VALVE

## OVERHAUL

A repair kit is not available for the differential protection valve as it is considered uneconomic to repair. Inspect the valve at vehicle overhaul periods, and if wear or damage is apparent, replace the valve complete.



## SECTION 29

## Safety Valve

## DESCRIPTION

The safety valve is incorporated in the air system to prevent excessive air pressure 'build-up' should the compressor or unloader valve devices become inoperative. Excessive pressure will lift the ball valve off its seating, and allow air to pass through the exhaust port to atmosphere.

The pressure setting of the safety valve is shown in DATA, Section 1.

## OVERHAUL

At vehicle overhaul periods, it is recommended that the safety valve is checked for leakage. If leakage is in excess of a one inch soap bubble in one second, the valve should be replaced.

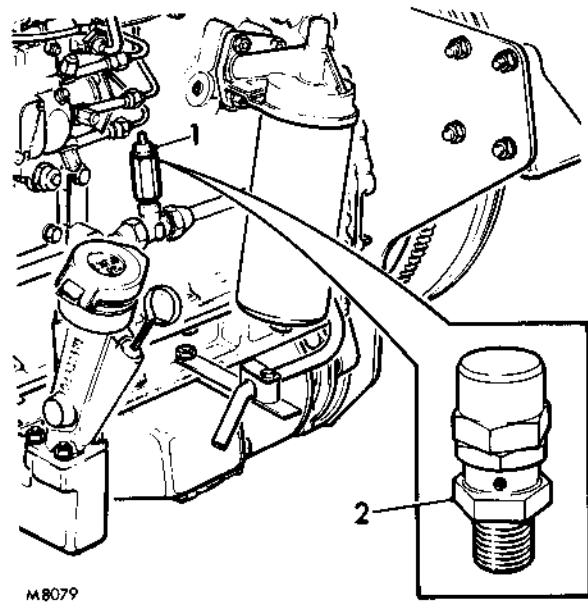


FIG. 1. SAFETY VALVE IN POSITION

1. Safety valve      2. Safety valve, alternative type



**GROUP 8**  
**ELECTRICAL**

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**WIRING DIAGRAM . . . . . End of Group**

## SECTION 1

## Electrical System

**GENERAL INFORMATION**

This group details electrical equipment fitted on these passenger chassis.

**Wiring**

A 24-volt insulated return system is used throughout, the harnesses being protected by PVC sleeving. The wiring diagram covering the standard chassis appears at the end of the group.

**Protective Treatment**

The electrical equipment and connections are sprayed before leaving the factory, with a protective coating of Tectyl 506. If the connections have to be disturbed at any time, the sealant can be removed by the application of white spirit or a proprietary solvent. To reseal the equipment the use of Tectyl is recommended and it may be sprayed over any external fitting to give a completely resistant seal. It should not, however be applied inside components such as relays, since this may deposit a non-conducting film between the points.

**Alternating Current Charging System**

CAV alternating current generating equipment is fitted as standard which should give little trouble providing the precautions detailed in Section 3 are observed.

The following cautionary notes are for the benefit of coachbuilders and others who may have to break into the wiring in order to connect up equipment installed when the body is fitted.

1. Should it be necessary at any time to disconnect a lead from the system, it is essential that the engine be stopped to avoid arcing or accidental short circuits.
2. Whenever a lead is disconnected it should be identified in relation to its terminal to facilitate reconnection. This applies particularly to regulator connections as shorting or reverse polarity no matter how brief will cause immediate irreparable damage to transistors and diodes.
3. The batteries must never be disconnected whilst the alternator is running, nor should the batteries be connected into the system before checking the polarity and voltage.
4. If welding or soldering is necessary in the vicinity of the alternator or regulator, precautions must be taken to ensure that heat is not transmitted to the diodes otherwise irreparable damage will be caused.

**Switchboard (Fig. 1)**

The CAV switchboard contains all driving lamp switches, push buttons and lamps for the charging circuit, lubricating oil pressure and low air warning. The only attention likely to be needed is the replacement of defective bulbs or fuses. Access for this purpose can be gained by unscrewing the two knurled nuts at either side of the panel which is hinged at its lower edge. A spare fuse bobbin is to be found below the panel.

**Isolation Switch**

The isolation switch item 2, Fig. 2, is normally mounted on a bracket on the right-hand side of the forward face of the engine bulkhead.

**The Fast Fuse**

Connecting the batteries incorrectly (reverse polarity) will result in irreparable damage being done to parts of the system. The fast fuse item 9, Fig. 2, when wired correctly into the system, will protect the rectifying diodes and the solid state devices in the regulator against this condition. It consists of a precision made, high purity silver strip, surrounded by a fine quartz sand enclosed within a cylindrical ceramic body.

The design of the fuse ensures that the current restricting section of the link ruptures at high speed and at precisely the pre-determined current level. This fault will occur at the beginning of the fault current rise and thus the current will be prevented from reaching a damaging level. A spare fuse is carried within the unit. Replacement fuses must be as originals.

**Relay—Starter Motor Isolation**

The starter motor isolation relay item 4, Fig. 2, is fitted so that the starter motor operation may be inhibited whilst the engine is running.

When the alternator output attains 19V the coil is energised to break line between C1 and C2 therefore inhibiting any further operation of the starter motor. On engine shut down the alternator voltage diminishes, thereby remaking C1 and C2 to complete the starter motor circuit.



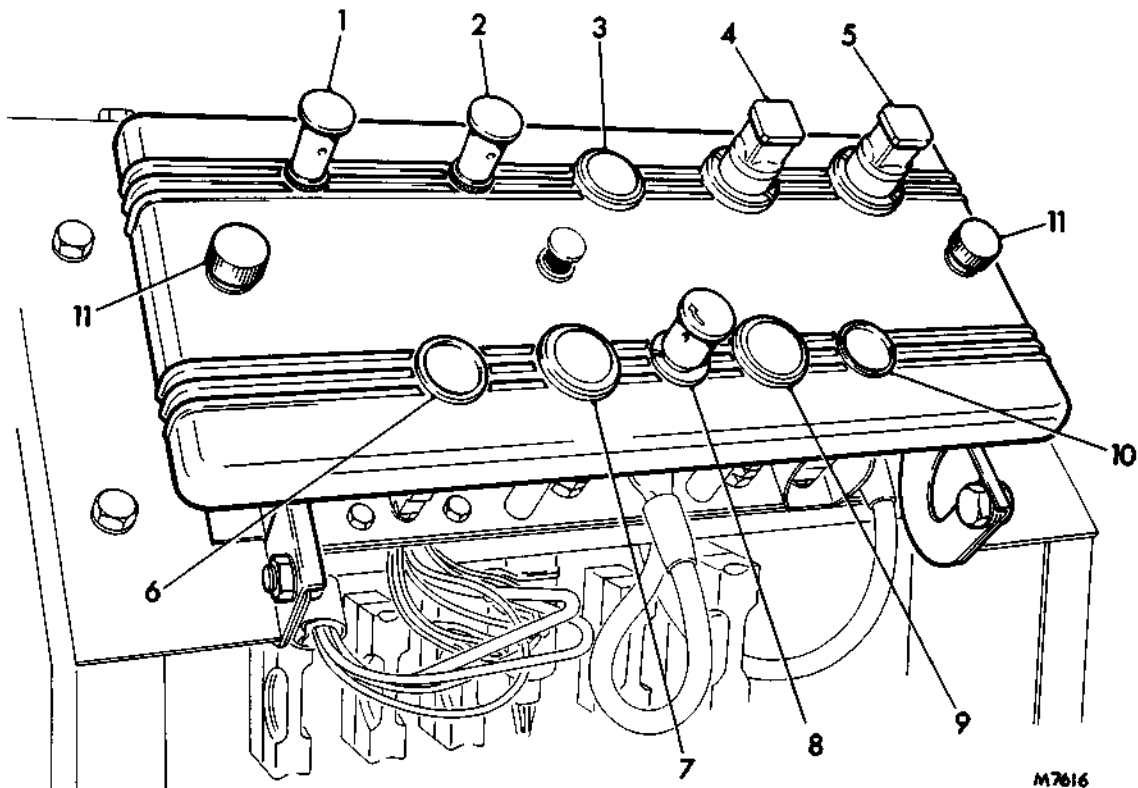


FIG. 1. THE CAV SWITCHBOARD

- |                                  |                                  |
|----------------------------------|----------------------------------|
| 1. Switch start                  | 7. Warning lamp—low oil pressure |
| 2. Switch foglamps               | 8. Switch, panel lamps           |
| 3. Warning—low air pressure lamp | 9. No charge warning lamp        |
| 4. Switch, side and tail lamps   | 10. Push button, engine stop     |
| 5. Switch headlamps              | 11. Panel securing studs         |
| 6. Push button, starter motor    |                                  |

M7616

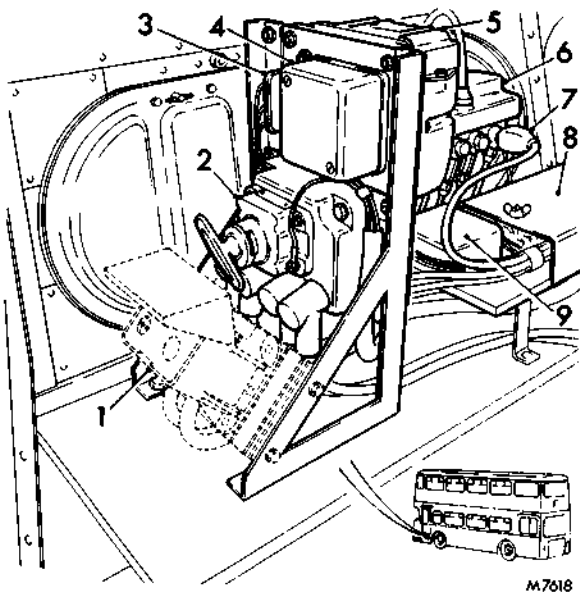


FIG. 2. VIEW OF COMPONENT LOCATION

- |                                      |                                  |
|--------------------------------------|----------------------------------|
| 1. Boost charge socket (when fitted) | 5. Control board CAV             |
| 2. Isolation switch                  | 6. Electro-pneumatic valve 4-way |
| 3. Relay—engine stop                 | 7. Reverse light switch          |
| 4. Relay—starter motor isolation     | 8. Rear junction box             |
|                                      | 9. Fast fuse CAV                 |

M7618

**Boost Charge Socket (when fitted)**

**Charging**

Located adjacent to the isolation switch item 1, Fig. 2. The boost charge socket is provided to enable a boost or trickle-charge of the vehicle batteries. Before connecting to the charging source always ensure that the battery isolation switch is isolated i.e. open condition. Failure to do this will result in a permanent supply being fed to the electrical installation.

**Starting**

Should it be necessary to start the engine from a power source other than the vehicle batteries, booster batteries may be connected to the charging socket. The isolation switch must be closed and all unnecessary vehicle electrical equipment switched off.

Starting power must not be supplied from a vehicle with engine running or from a charging machine.

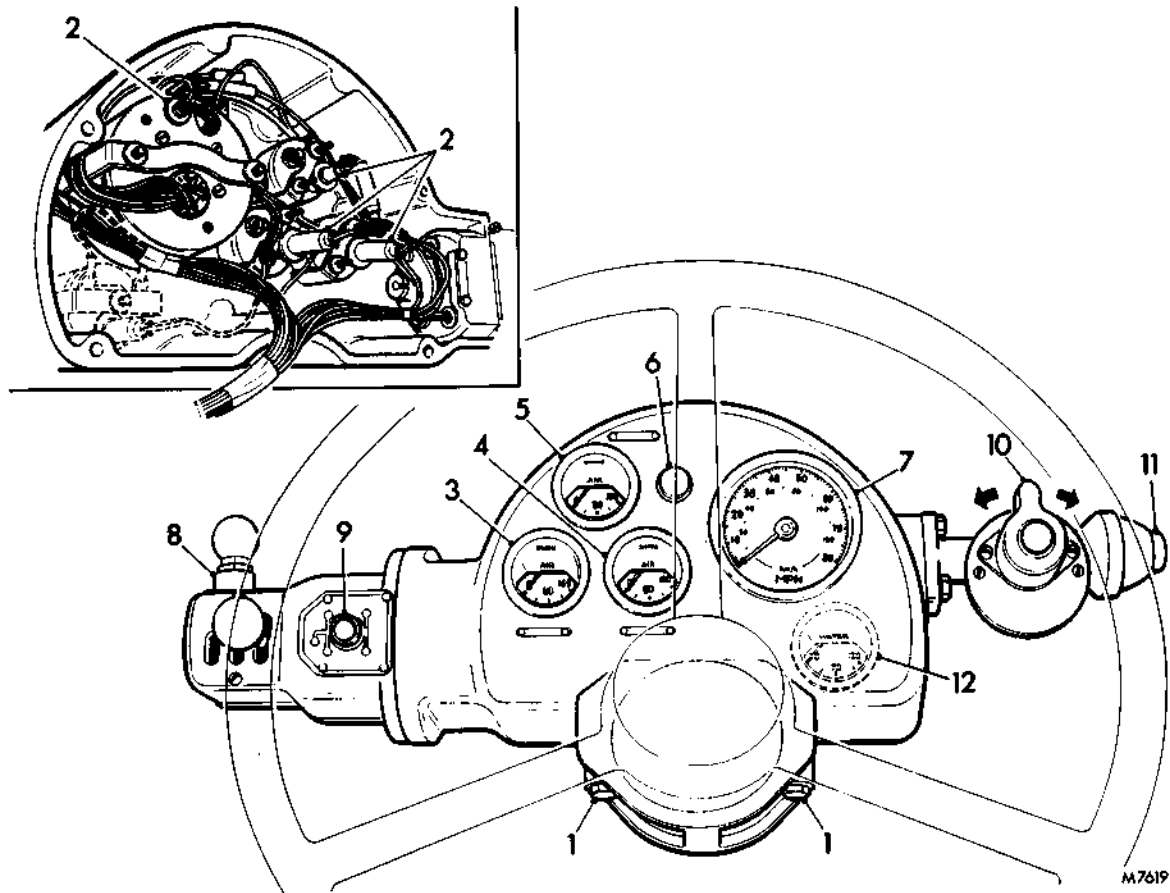


FIG. 3. INSTRUMENT PANEL

- |   |   |
|---|---|
| 1. Clamp studs                              | 7. Speedometer                            |
| 2. Lamps speedometer and air gauges         | 8. Gear selector                          |
| 3. Air gauge—front brake                    | 9. Gear selector neutral warning light    |
| 4. Air gauge—rear brake                     | 10. Switch direction indicator            |
| 5. Air gauge—auxiliary                      | 11. Horn button                           |
| 6. Spring brake warning light (when fitted) | 12. Water temperature gauge (when fitted) |

#### Instrument Panel, Fig. 3

The instrument panel, mounted on the steering column tube carries the speedometer, air gauges and spring brake warning light. The gear selector switch—with the exception of direct air shift models—is mounted on the left of the panel; an extension on the right carries the horn button and direction indicator.

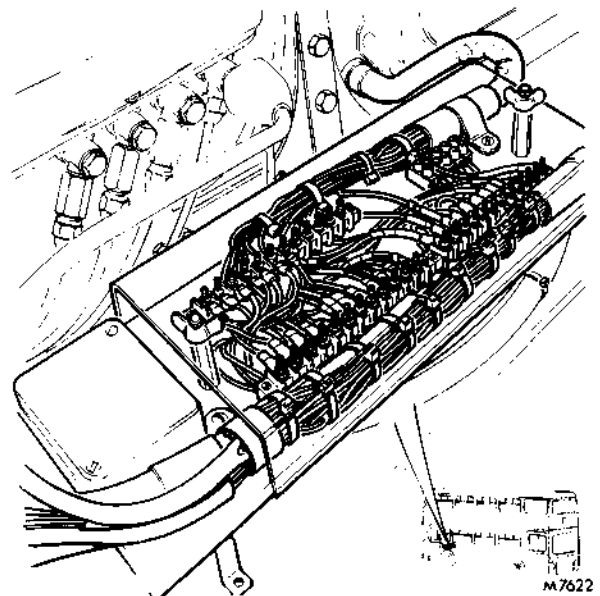


FIG. 4. REAR JUNCTION BOX

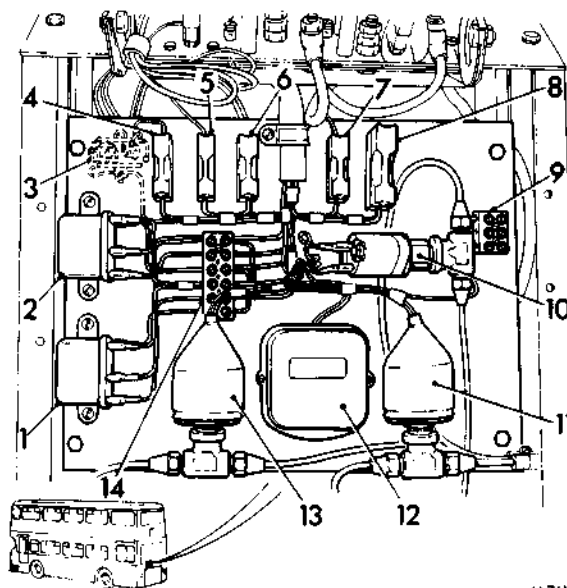
**Rear Junction Box, Fig. 4**

The rear junction box is fitted to the front face on the right hand side of the engine compartment and contains four terminal strips to which are connected the following components as listed under:

Terminal	Colour	Circuit
1.	Spare	
2.	Spare	
3.	Spare	
4.	Black (2)	Reverse lights
5.	Brown	Reverse switch
6.	Red/Brown	Engine temperature +
	Green/Blue	Engine temperature
7.	Green/Blue	C2 Engine stop relay
8.	Blue	'3' starter solenoid relay
9.	White/Red	'1' starter solenoid relay
10.	White	Plunger switch
11.	White	Oil switch +
12.	Grey	Oil switch
13.	Grey	W1 engine stop relay
14.	Light Green/White	W2 engine stop relay
15.	Black	Engine stop solenoid
16.	Black	Engine stop solenoid
17.	Black/White	- VE
18.	Black	Tail lights
19.	Red/Black (2)	- VE
20.	Black	Charge warning light
21.	Brown/Yellow	- VE rear lamps
22.	Black (3)	Generator -
23.	Black	Generator +
24.	Red	- VE
25.	Black	E P valve
26.	Yellow/Orange A	E P valve
27.	Yellow/Slate B	E P valve
28.	Yellow /Pink C	E P valve
29.	Yellow/Black D	E P valve
30.	Yellow/White R	E P valve
31-36	Spare	
37.	Green (3)	Stop lights
38.	Light Green/White (2)	Flasher O/S
39.	Green/red (2)	Flasher N/S
40.	White/Brown	Side and tail light
41.	Red/Yellow	Fog (when fitted)

**Relay Panel, Fig. 5**

The relay panel is fitted to the left of the steering wheel, underneath the switchboard, and comprises the items listed under Fig. 5.



**FIG. 5. RELAY PANEL**

- |                                 |  |
|---------------------------------|--|
| 1. Low air pressure relay       | 10. Switch low air pressure-auxiliary reservoir                  |
| 2. High water temperature relay | 11. Switch low air pressure-front brakes                         |
| 3. Voltage stabiliser           | 12. Warning buzzer-low air pressure and high coolant temperature |
| 4. Fuse-voltage stabiliser      | 13. Switch low air pressure-rear brakes                          |
| 5. Fuse-speedo                  | 14. Terminal strip 6-way   |
| 6. Fuse-reverse light           |  |
| 7. Fuse-relays                  |  |
| 8. Fuse-gear selector           |  |
| 9. Terminal strip 3-way         |  |

**Start Inhibitor Circuit (Electro-pneumatic)**

Perusal of the start inhibitor circuit Fig. 6 will show the conditions which must be satisfied before the engine can be started from the driving compartment are:

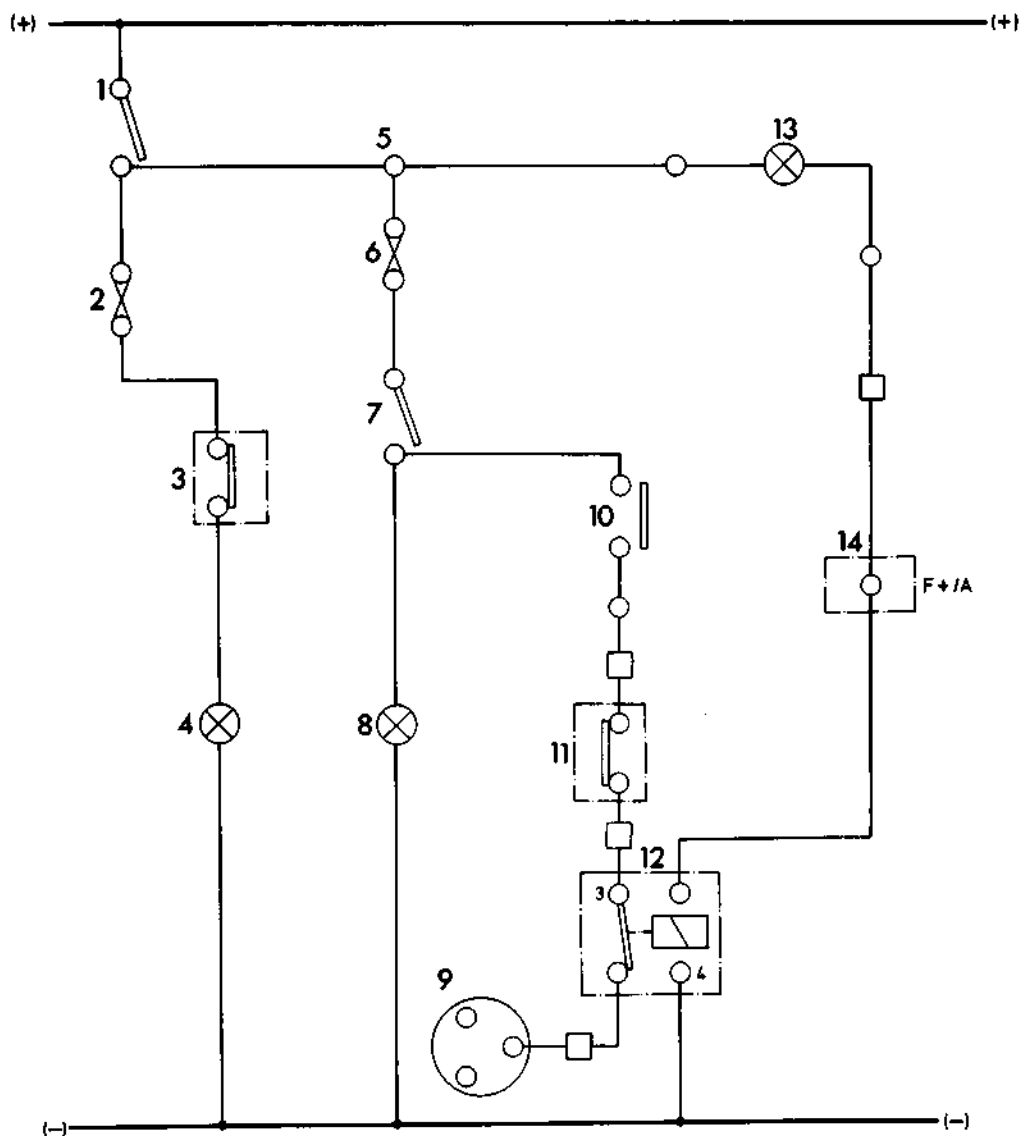
1. When a semi or fully automatic Leyland gearbox is fitted the gear selector switch must be at position 'S' or 'N' for fully automatic.
2. The engine canopy must be closed.

**OPERATION**

With the start switch (1) closed, current is fed via start switch positive (5), the gear selector switch neutral position (7), through the engine canopy micro-switch (11) via the normally closed contacts C1 and C2 (12) of the starter motor isolation relay to the starter solenoid (9). On closing of the starter push button the circuit is completed.

Once the engine has started the alternator voltage rises and when it reaches 19 volts the starter motor isolation relay coil is energised, breaking contacts C1 and C2, thereby isolating the starter motor from further operation.





M7620

FIG. 6. CIRCUIT DIAGRAM—START INHIBIT—  
ELECTRO-PNEUMATIC

- |  |                                      |
|--|--------------------------------------|
| 1. Start switch                              | 8. Warning lamp—gear selector switch |
| 2. Auxiliary fuse                            | 9. Starter solenoid                  |
| 3. Oil pressure switch                       | 10. Push-button start                |
| 4. Oil pressure warning lamp                 | 11. Canopy micro-switch              |
| 5. Start switch positive switch              | 12. Relay—starter motor isolation    |
| 6. Fuse—gear selector switch                 | 13. Charge warning lamp              |
| 7. Neutral position 'S'—gear selector switch | 14. Regulator F+/A                   |



## SECTION 2

## Batteries

The range of batteries is extended — i.e., wet charged, dry charged, dry uncharged, sealed charge and alkaline.

## Lead Acid

## Filled

## Data

Make and Type . . . . .	Lucas MXF13	Exide 712	Oldham TX6-IMH
Capacity at 20 hour rate . . . . .	198Ah	198Ah	198Ah
Initial charge current . . . . .	11.5 Amperes	11.5 Amperes	11.5 Amperes
Minimum initial charge time . . . . .	48 hours	48 hours	48 hours
Re-charge current . . . . .	20.0 A	20.0 A	20.0 A
Approximate level of electrolyte . . . . .	Level with separator guards	¼ inch above plates	Electrolyte level with separator guards

## General

Tops of batteries should be kept clean and dry. Check the electrolyte level — replenish as necessary — at regular intervals. Ensure vent plugs are clear. Terminals and connections should be kept smeared with petroleum jelly.

## Unfilled

## Preparation for service

## Specific gravity of electrolyte for filling batteries:

1. Climates with shade temperatures normally below 25°C (77°F) — specific gravity should be 1.260 at 15°C (60°F).
2. Climates with shade temperatures frequently exceeding 25°C (77°F) — specific gravity should be 1.210 at 15°C (60°F).

## Filling of Batteries

There are various types of batteries and the relevant instructions are:

## 1. Dry Uncharged Batteries

- (a) Batteries, electrolyte and ambient temperature should be between 15°C — 40°C.
- (b) Remove vent plugs or manifolds.

(c) Fill each cell with electrolyte to the level of the separator guards or marker line. Stand for one hour then add electrolyte as necessary to restore to the required level, replace plugs or manifold.

(d) Carry out the initial charge as prescribed.

## 2. Dry Charged Batteries

- (a) Batteries, electrolyte and ambient temperatures should be between 15°C — 40°C.
- (b) Remove dry charge tape, vent plugs or manifold.
- (c) Fill each cell with electrolyte to level of separator guards or marker line. Note temperature and specific gravity of electrolyte.
- (d) Allow to stand for twenty minutes, recheck temperatures and specific gravity of electrolyte. Correct level in each cell if necessary — refit plugs or manifold.

A short first charge should now be given at the applicable rate for at least four hours.

In emergency conditions, provided the temperature rise is less than 10°C and the specific gravity fall is less than 0.10 — the battery may be placed in service — on condition it is given a four hour charge within the next forty eight hours. If the specific gravity fall or temperature rise exceeds the limits given above, the battery must be given an initial charge prior to being put into service.



**Table 1. Specific gravities of electrolyte for initial filling of dry uncharged batteries.**

Temperature of Filling-in-Acid			5°C (41°F)	10°C (50°F)	15°C (60°F)	20°C (68°F)	25°C (77°F)	30°C (86°F)	35°C (95°F)
Sp. Gr. of Filling-in-Acid	Normal – Temperate Climates	Lucas Exide	1.267	1.264	1.260	1.257	1.253	1.250	1.246
		Lucas	1.217	1.214	1.210	1.207	1.203	1.200	1.196
	Tropical Climates	Exide	1.237	1.234	1.230	1.227	1.223	1.220	1.216

**After charge adjust S.G. to:**

Temperate climates	<b>Lucas</b> Below 27°C (80°F) 1.270-1.290	<b>Exide</b> Below 32°C (90°F) 1.270-1.285
Tropical climates	Above 27°C (80°F) 1.210-1.230	Above 32°C (90°F) 1.240-1.255

**Note:** Any figures on manufacturer's labels attached to batteries, which may be at variance with those quoted should always be accepted as the over-riding authority.

**3. Sealed Charge Batteries**

- (a) Remove and discard the red and black terminal caps to expose live terminals.
- (b) Use a precision suppressed zero voltmeter to measure the open circuit voltage.
- (c) Remove vent plugs or manifold.
- (d) Remove and discard the cell sealing plugs.
- (e) Fill each cell with electrolyte to the level of separator guards or level mark (Ambient, batteries and electrolyte temperatures between 15°C – 40°C).
- (f) If a voltage reading was not taken at (b) above, check cell specific gravities after a five minute stand.
- (g) If the voltage is above 11.8 volts (or 5.9 volts for a six volt unit) or alternatively the specific gravity is greater than 0.020 less than the filling gravity, it must be given an initial charge at the recommended recharge rate until all the cells gas freely and the specific gravities cease to rise.

**Mixing the Electrolyte**

Electrolyte is usually available at the required specific gravity, but if this is not so – sulphuric acid of a higher specific gravity must be diluted with distilled or chemically approved water to the required grade.

When mixing, always add the acid to the water, **never water into acid**, and carry out the operation slowly. Whilst pouring the acid, stir continuously with a clean new wood stick which should be destroyed after use.

Considerable heat is generated when acid is mixed with water so the final adjustment of specific gravity must be made after the electrolyte has been allowed to cool to room temperature.

Vessels used for mixing or storing electrolyte must be of glazed, glass, earthenware, hard rubber or lead. Care must be exercised if using glass containers as the heat of mixing may crack them.

Specific gravity readings at electrolyte temperatures other than 15.0°C (60°F) can be corrected by use of the above conversion table.

**WARNING:**

Concentrated acid must be handled with great care as it will blister the skin and damage clothing. It is not advisable to use acid with a specific gravity exceeding 1.350 for the preparation of electrolyte.

If acid is splashed in the eyes wash out immediately with plenty of clean water and then seek medical advice if discomfort continues.



### Bench Charging

Precautions to be observed during charging:

1. Always break the charging circuit at the main switch. Never remove batteries from a live circuit because of the risk of sparks and explosion.
2. Ensure that all connections between batteries and supply leads are securely fixed and make good electrical contact. Arrange cables in such a way that accidental shorting or sparking will be avoided.
3. Keep the charging point, batteries and connections as clean and dry as possible.
4. Protect the batteries from direct sun-rays. Maintain a clear space of at least one inch around each battery.
5. All wood benches should be treated with acid resisting paint. Batteries should stand only on clean dry, impregnated wood, glass, porcelain, glazed earthenware or slate.
6. Floors must be insulated. Concrete floors which are difficult to keep dry are not considered absolutely non-conducting.

Direct current only must be used for charging. Connect the positive lead of the charging source to the positive terminal of the battery and the negative lead to the battery negative terminal.

### Initial Charge

This charge should be carried out at a current equal to 0.1 times the rated capacity.

During which the electrolyte level must be maintained above the separator guards or at the minimum level indication by the addition of distilled water as necessary.

Whilst charging, the electrolyte temperature must not exceed 40°C for temperate climates or 48°C for tropical climates. If these temperatures are reached then the charge can either be interrupted or reduced to one third the normal rate for a suitable period.

Charging should continue until voltage and specific gravity show no increase over five successive hourly readings and each cell is gassing freely.

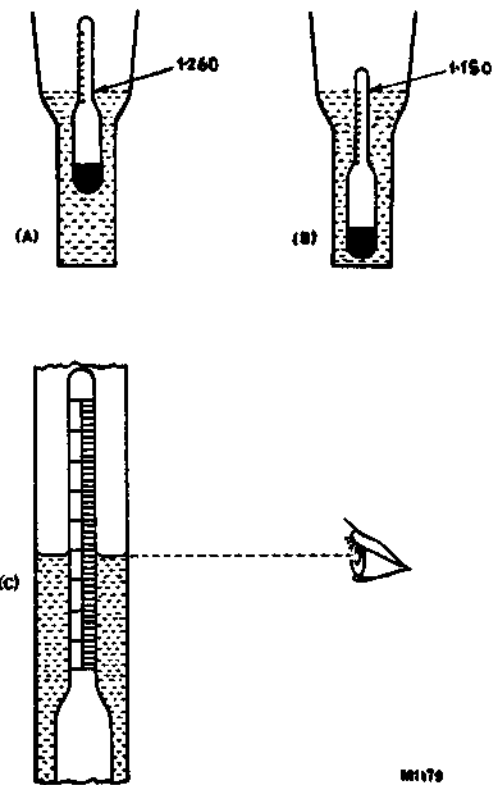


FIG. 1. USING THE HYDROMETER

High float (a) indicates high specific gravity.  
Low float (b) shows low specific gravity.

Correct method of reading hydrometer is shown at (c). Eye is level with liquid surface disregarding curvature of liquid against glass.

### Care of Batteries in Service

If the batteries require topping-up more frequently than once per fortnight in temperate climates or once per week in tropical regions, the charging rate is suspect and should be corrected if necessary.

**Caution:** It is of vital importance on vehicles fitted with A.C. systems, that the electrolyte be maintained at the correct level. Frequent high topping, to overcome the effects of excessive charging, will result in high evaporation and reduced specific gravity causing incorrect back voltage (E.M.F.) and a consequent reduction in battery life.

### Purity of Water

Water used for topping-up should be distilled or chemically approved. It should be stored in a clean glass or earthenware receptacle. A suitable rubber syringe should be used for transferring the liquid to the cells. The use of impure water will affect the battery resulting in inferior performance and short life.

### Battery 'Dopes'

The use of proprietary battery additives is not recommended and will render the battery maker's guarantee void.



# ELECTRICAL

## Testing

If trouble is encountered certain tests can be carried out to ascertain whether it is just out of condition or reaching the end of its useful life. Assuming the other electrical equipment is in order the following may be taken as possible danger signs of a failing battery.

1. Sluggish operation of the starter.
2. Failing lights after a short period of parking.
3. Continuously high rate of charge when the vehicle is running with no electrical load switched on.

## High-rate Discharge Test

The high-rate discharge test is a timed on-load voltage check applied to individual cells. A good cell will maintain a constant reading for ten seconds when the prongs of a suitably rated test meter are pressed on to adjacent intercell connectors or terminals. A weak cell will show a falling voltage.

If all readings are similar but low it can be assumed that the battery is in a healthy condition although partially discharged, and hydrometer readings will determine the exact state of charge. If a cell gives a

reading appreciably lower than the remainder or shows a rapid fall-off in voltage during a 5-second period, a failing cell is indicated.

Erratic readings with several cells showing a falling voltage indicate that the battery has just reached about the end of its life, and this will be confirmed if these cells have specific gravities very much lower than the remainder.

Before testing, each cell must be at least 70% charged, but if the test is conducted immediately after the vehicle has completed a journey, it is advisable to slightly discharge the battery by operating the starter motor or leaving the headlights on for a few minutes. Failure to remove the surface charge may lead to falsely high readings on the high-rate discharge test.

## Hydrometer Test

The hydrometer measures the state of charge of a battery by determining the specific gravity of the acid. This varies with temperature and whatever the reference temperature used, the correction is always 7 points (.007) of specific gravity for each 10°C variation.

**TABLE 2. Hydrometer Readings – Temperate Climates**

Condition of Cells	Actual hydrometer readings at temperatures of:						
	5°C (41°F)	10°C (50°F)	15°C (60°F)	20°C (68°F)	25°C (77°F)	30°C (86°F)	35°C (95°F)
Fully Charged	1.287	1.284	1.280	1.277	1.273	1.270	1.266
Half Discharged	1.207	1.204	1.200	1.197	1.193	1.190	1.186
Fully Discharged	1.117	1.114	1.110	1.107	1.103	1.100	1.096

**TABLE 3. Hydrometer Readings – Tropical Climates**

Condition of Cells	Actual hydrometer readings at temperature of:						
	10°C (50°F)	15°C (60°F)	25°C (77°F)	30°C (86°F)	35°C (95°F)	40°C (104°F)	52°C (125°F)
Fully Charged	1.254	1.250	1.243	1.240	1.236	1.233	1.224
Half Discharged	1.184	1.180	1.173	1.170	1.166	1.163	1.154
Fully Discharged	1.104	1.100	1.093	1.090	1.086	1.083	1.074



If it becomes necessary to re-charge the batteries the precautions listed under the heading 'Preparation for Service' should be strictly observed and care taken not to exceed the specified re-charge current given in Data.

**Fast Charging**

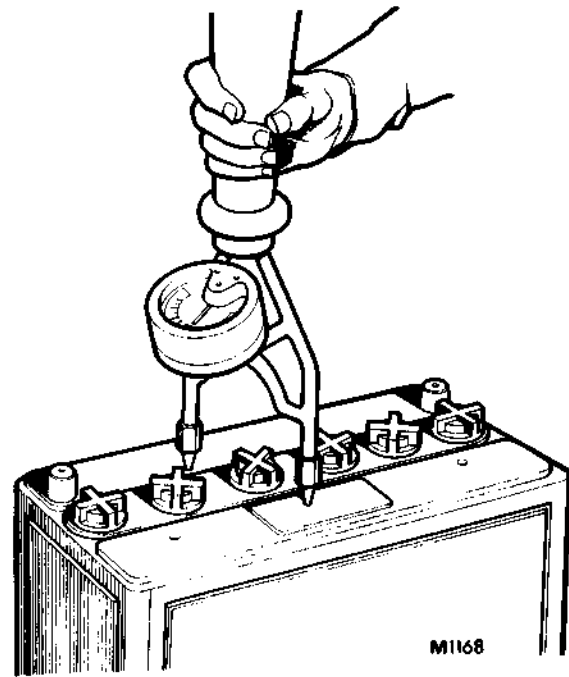
Fast charging equipment should be used with discretion and only regarded as an emergency measure for a discharged but otherwise healthy battery.

A normal low-rate charge is always preferable. Frequent need for fast charging indicates a failure in the vehicle charging equipment which should be investigated without delay.

When using this type of charger the instructions issued by the maker should be closely followed and the temperature of the electrolyte kept below 43.3°C (110°F). This method must never be used for initial charging.

**Low-Rate Chargers**

Low-rate chargers may be used to keep a stand-by battery in a healthy state of charge. They should have a minimum output current of quarter the normal charging current recommended for the battery.



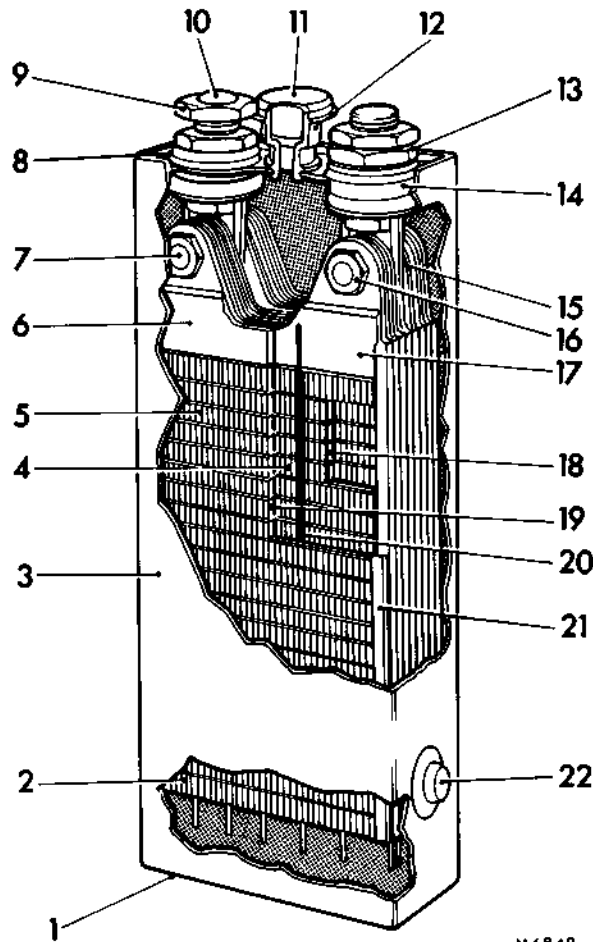
**FIG. 2. THE HEAVY DISCHARGE TEST**

Batteries should be disconnected from the charger when fully charged as continuous charging will cause premature failure of the plates.

**Alkaline**

**Data**

Make and Type . . . . .	Lucas LCV 12
Capacity at 20 hour rate . . . . .	120 ampere hours
Normal Charge Current . . . . .	24 amperes
Approximate Electrolyte Level . . . . .	2 inches above plates
Quantity of Liquid Electrolyte type 'R' per cell . . . . .	2.0 litres (0.45 gallon)
Weight of Solid Electrolyte type 'R' per cell . . . . .	0.6 kg (1.34 lb)
Normal Discharge Current . . . . .	12 amperes



M6848

FIG. 3. NICKEL CADMIUM CELL - SECTIONED

- |                          |                         |                               |
|--------------------------|-------------------------|-------------------------------|
| 1. Welded joint.         | 9. Terminal nut.        | 16. Group nut.                |
| 2. Perforated pocket.    | 10. Terminal pillar.    | 17. Negative plate frame.     |
| 3. Container.            | 11. Vent. cap assembly. | 18. Negative active material. |
| 4. Negative plate.       | 12. Filler cap.         | 19. Positive active material. |
| 5. Positive plate.       | 13. Gland nut.          | 20. Insulating rods.          |
| 6. Positive plate frame. | 14. Gland.              | 21. Edge Insulators.          |
| 7. Group bolt.           | 15. Spacing washer.     | 22. Suspension boss.          |
| 8. Cell cover.           |                         |                               |

**Routine Precautions**

1. Never permit metallic objects to rest on batteries or fall across terminals. All tools should be insulated.
2. Do not top-up batteries whilst they are on high rate charge and never examine them with a naked light or do anything likely to cause a spark.
3. Take care not to spill electrolyte on the skin and always wear safety goggles and protective clothing when handling electrolyte.
4. In the event of an accident wash skin with plenty of clean cold water, then cover immediately with boric ointment or a saturated solution of boric acid crystals.

Wash out eyes with clean cold water followed immediately by a cold solution of boric acid crystals, (prepared by dissolving one ounce of crystals to one pint of boiling water). In an emergency a copious application of water will give relief.

In all cases of eye injury call for professional attention.

**Care of Batteries in Service**

1. Maintain electrolyte at the correct level by the addition of pure distilled water only.
2. Keep the cells and cradles clean and dry.
3. Keep vent caps closed except when topping up.
4. Change the electrolyte when necessary.
5. Smear the terminals, connectors and cell tops with pure petroleum jelly.
6. **NEVER** put lead battery acid in a nickel cadmium alkaline battery **NOR** use utensils which have been used for lead acid batteries.

Electrolyte is corrosive - handle batteries with care. Wear goggles, rubber gloves and protective clothing when preparing electrolyte and filling cells.





### Operation

Batteries will normally be filled and in a partially charged condition.

Check the electrolyte level and top-up if necessary. If the vehicle is required to operate a city type schedule immediately, the batteries should be given a charge for 4 hours at the normal charging current shown in data before going into service.

Repeated deep discharges will harm the cells and excessive loads particularly on parked vehicles should therefore be avoided.

In the event of batteries becoming discharged due to extreme conditions, they should be charged from an external source.

The frequency of topping-up is governed by the nature of the duty cycle and may only be determined by experience.

A reasonable consumption of distilled water is the best indication that the batteries are being operated correctly.

Excessive consumption is indicative of overcharging or operation at too high a temperature, negligible consumption indicates undercharging.

Specialised topping-up equipment is obtainable from Lucas Electrical Industries, consisting of:

- Pressure pump, tubing and 2 gallon plastic container.
- Pistol complete with bush for topping up steel cells.
- Buzzer unit (powered by 4½ volt dry cell – not supplied) complete with cable.

### Operating Instructions

1. Fill container with distilled water.
2. Pressurise container by operation of pump.
3. Place filling nozzle in cell, operation of trigger will allow water to flow into cell until electrolyte reaches nozzle tip – then buzzer will sound warning operator to release trigger and cut off flow of water. Cells should now be at correct level.

### Specific Gravity

The normal specific gravity of the electrolyte is approximately 1.190, irrespective of the state of charge. Whilst this figure is not critical, cells should not be used if their gravity is higher than 1.250 or lower than 1.160.

The specific gravity should be checked every 6 months to ensure that it is within these limits.

Batteries should be topped-up correctly and the solution in the cells allowed to mix thoroughly by 8 hours charging from the vehicle alternator during normal operation. They should then be allowed to stand for some hours to permit gas bubbles to disperse before taking specific gravity readings.

The figures given are related to an ambient temperature of 20°C (68°F) with the electrolyte at the correct level above the tops of the plates. At other temperatures, use the nearest given temperature.

9°C (48°F)	20°C (68°F)	31°C (88°F)	42°C (108°F)
1.205	1.200	1.195	1.190
1.195	1.190	1.185	1.180
1.185	1.180	1.175	1.170
1.175	1.170	1.165	1.160
1.165	1.160	1.155	1.150

### Vent Caps

Cells are fitted with vent caps having an improved hinge and modified form of diaphragm seal. This seal gives additional protection against absorption of impurities from the atmosphere.

Examine diaphragm occasionally and if necessary it can easily be renewed. Stretch the new one, after wetting with water, across the holding stud.

### Changing Electrolyte

The electrolyte in cells will gradually deteriorate in service due to absorption of impurities present in the atmosphere or introduced in topping up water.

This deterioration is normally a slow process and is accompanied by a gradual fall in specific gravity.

The electrolyte should therefore be changed every three years, or before the specific gravity has fallen to 1.160 whichever is the earlier.

For operators in the UK, replacement electrolyte is available in liquid form – and has a specific gravity of 1.190 in order to balance the percentage of old and therefore weak electrolyte which invariably remains absorbed in the plates.

For overseas operators, electrolyte is supplied in solid form and must be dissolved in pure distilled water prior to use.

The quantity of electrolyte (liquid or solid) is shown in data.



## ELECTRICAL

Do not start electrolyte change until the required amount of fresh solution is available, then proceed as follows:

1. Discharge the battery at approximate normal discharge current — either on an external load to an average of 0.80 volts per cell, or by switching on the vehicle lighting until they are almost extinguished.
2. Disconnect and remove from vehicle. If the steel cells and wood crates are dirty or require separating, disconnect all intercell connections, dismantle one side of each crate and remove cells. If cells and crates are clean, they can be handled without dismantling and this will apply to plastic cells.
3. Invert cells and pour away all old electrolyte, then allow to drain in the inverted position for no longer than 30 minutes.  
Do not shake cells during emptying nor wash out with water.  
Electrolyte should NOT be discharged into a public drainage system but should be handed to the local authority who will arrange for its disposal.
4. Refill cells immediately after draining period with fresh electrolyte to correct level.
5. Any encrustation is best removed with warm water only. Clean and dry the cells and crates. Where necessary repaint the cell sides and crates with 'Celvar' obtainable from Lucas Electrical Industries.  
Reassemble cells in crates.  
Lightly smear connectors and terminals with petroleum jelly.
6. The cases and lids of plastic cells require no special treatment except wiping dry to remove moisture or electrolyte.  
Do not use solvent for cleaning and do not remove from crates unless very dirty.  
Lightly smear connectors and terminals with petroleum jelly.
7. Recharge the battery at normal charge current — see data — for 12 hours. Check electrolyte level and top-up if necessary.

### Repairs

Replacement of external parts such as vent caps, terminal nuts, connectors, etc. should be made as necessary to maintain the battery in an efficient condition.

Only absolutely clean plain iron glazed earthenware, vitreous enamelled iron or ebonite vessels should be used for preparing electrolyte or filling cells.

Under no circumstances should galvanised, painted, copper or aluminium vessels, or vessels having soldered joints be used.

When the vessel is ready, pour in pure distilled water in the proportion of 4.5 litres (1.0 gallon) of water to each 1.9 kg (4.25 lb) of solid electrolyte to be dissolved and then carefully add the whole contents of the drums. Stir thoroughly until thoroughly dissolved, cover to keep out as much air as possible and adjust specific gravity carefully by adding small quantities of distilled water and thoroughly stirring until this is at the correct values as follows:

For first filling of new cells . . . 1.190 at 20°C (68°F)  
Those whose electrolyte is . . . 1.185 at 31°C (88°F)  
to be changed . . . 1.180 at 42°C (108°F)

### Preparing Electrolyte

Great care should be taken in the preparation of electrolyte. Use only electrolyte type 'R'. Its purity must be preserved by using materials from newly opened drums and dissolving same in pure distilled water, keeping air from it as much as possible during its preparation and until the cells are filled and ensuring there is no contamination with acid or other impurities.

Since acid or even slightly acidulated water will impair the performance of cells and possibly destroy them, great care should be exercised to ensure that mixing vessels, hydrometers and other articles which have been used with lead acid cells are NOT employed.

Use only pure distilled water for dissolving solid electrolyte. Distilled water for accumulators is sometimes supplied in carboys that have contained acid; this is quite unsuitable and will cause permanent damage to cells.

Do NOT use tap, rain or condensed boiler water.

Distilled water should be stored in clean glass or glazed earthenware containers.



**Filling and Charging of New Cells**

Carefully remove and discard the solid plugs one at a time as each cell is to be filled and fill the cells to the correct level.

Do not spill electrolyte on crates or between cells. Thoroughly clean and dry all external parts and close the vent caps.

Allow battery to stand for at least 24 hours after filling and then top-up to the correct level with liquid electrolyte.

Charge at normal charge current – see data – for 12 hours.

Check electrolyte level and top-up if necessary with pure distilled water.

Close vent caps.

Battery is now ready for duty.

**External Charging or Bench Charging**

Should it be necessary to charge the batteries from an external source this should preferably be done at the normal charge current, but somewhat higher or lower values of current can be used, if more convenient, provided the time on charge is accordingly adjusted.

Overcharging does not damage a nickel cadmium alkaline cell – so if in doubt charge generously.





## SECTION 3

## The CAV Charging System

## DATA

**Alternator**

Type . . . . .	AC203-060-5
Maximum rated output . . . . .	60A at 27.5V
Maximum continuous operating speed . . . . .	8,000 rev/min
Cooling . . . . .	Surface cooled (built-in fan)
Rectification . . . . .	Built-in silicon diodes
Stator phase resistance . . . . .	0.095 ohms
Weight (without pulley) . . . . .	21,8 kg (48 lb)

**Regulator**

Type . . . . .	460C-3 control board
----------------	----------------------

## SERVICE PRECAUTIONS

**WARNING:** Diodes and transistors are sensitive to voltage changes and high temperatures. It is essential, therefore, that precautions are taken to avoid damage to the system, when carrying out maintenance or diagnostic testing.

1. Should it be necessary at any time to disconnect a lead from the system, it is essential that the engine be stopped to avoid arcing or accidental short circuiting.
2. Whenever a lead is disconnected it should be identified in relation to its terminal to facilitate reconnection. This particularly applies to regulator connections as short circuiting or reverse polarity no matter how brief, will cause immediate and permanent damage to transistors and diodes.
3. The batteries must never be disconnected whilst the alternator is running nor should the batteries be connected into the system without checking for polarity and voltage.
4. If arc welding is to be carried out on the vehicle, the alternator and battery must be disconnected. When welding, brazing or soldering ensure that any heat source is kept away from the alternator.

CHARGING SYSTEM – FAULT DIAGNOSIS

Warning light does not illuminate when warning light switch is closed

Check warning light bulb – Renew if faulty

No fault discovered

Check all regulator, alternator and battery connections

No fault discovered

Open warning light switch. Disconnect 'F' lead at regulator and clip lead to regulator negative (-) terminal. Close warning light switch. If warning light illuminates, regulator is faulty. If warning light does not illuminate, alternator is faulty.

Warning light does not extinguish and ammeter shows no output when engine is running

Check all regulator, alternator and battery connections

No fault discovered

Open warning light switch. Disconnect 'F' lead at terminal and clip lead to regulator negative (-) terminal. Close warning light switch and run engine at fast idle.

If no output appears

Alternator faulty

If output appears

Regulator faulty

Warning light does not extinguish when engine is running and ammeter shows reduced output with full output only available at maximum speed

Warning light extinguishes but alternator delivers reduced output and will only provide full output at maximum speed

Alternator faulty

Warning light flashes intermittently and ammeter needle oscillates when battery is fully charged and no loads are switched in

Check for excessive resistance in regulator negative (-) sensing lead

If no fault

Regulator faulty

Batteries overcharging and ammeter indicates high or full output all the time

Check regulator positive (+) lead and its connection at regulator

If no fault



## REMOVAL AND REFITMENT

## Alternator

## To Remove

1. Rotate the isolator switch to the 'OFF' position.
2. Open the engine access panels. Note the positions and disconnect the electrical cables.
3. Remove the nuts and bolts securing the coupling flange.
4. Release the strap securing the alternator to the cradle and detach the alternator from the engine.

## To Refit

5. Reverse the procedure 1 to 4, ensuring all electrical cables are connected in their original positions.

## OVERHAUL

## To Dismantle, Fig. 1

1. Reference mark the drive end shield (1), stator (4) and slip ring end shield (6) to facilitate correct assembly.
2. Remove the fan cowl (9) from the slip ring end shield. Remove the fan securing nut and washers and withdraw the fan (10).

3. Remove the nut from the drive end of the shaft and extract the pulley using a suitable extractor.
4. Remove the cover (14) and gland plate (15) from the terminal box.
5. Disconnect the 'A' lead (7) from terminal post.
6. Remove the brush box assembly (18).
7. Remove the bearing clamp plate (11) and spacer (12) from the slip ring end. Remove the grease nipple from the end of the rotor shaft.
8. Remove the drive end clamp plate screws.
9. Remove the drive end shield (6) using a suitable extractor.
10. Withdraw the rotor (3) from the slip ring shield using a tool manufactured to the specifications given in Group 1, reference 1-4-4
11. Disconnect the three screws and washers securing the three phase stator leads to the heat sinks (8).
12. Remove the screws from the slip ring end shield and detach the end shield.
13. Remove the circlips (5) and oil seal (16) from the slip ring end shield. Remove the slip ring bearing (13) from the end shield. Remove the oil seal from the slip ring bearing clamp plate.

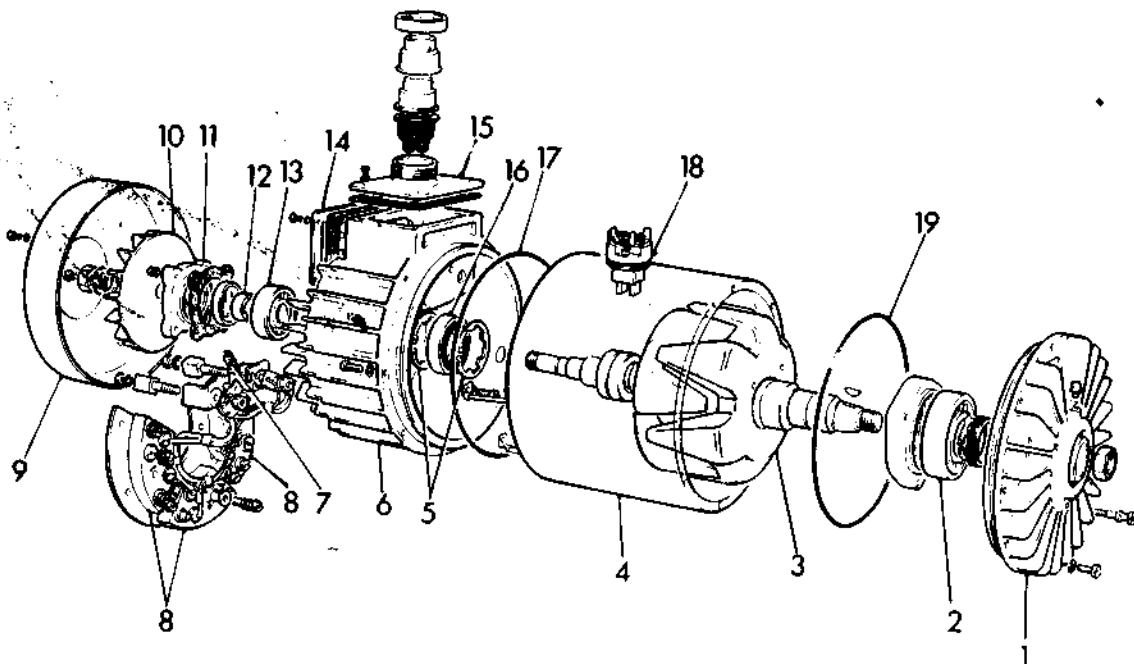


FIG. 1. EXPLODED VIEW OF ALTERNATOR

- |                     |                         |                         |                        |
|---------------------|-------------------------|-------------------------|------------------------|
| 1. Drive end shield | 6. Slip ring end shield | 11. Bearing clamp plate | 16. Oil seal           |
| 2. Oil seal         | 7. 'A' lead             | 12. Spacer              | 17. O-ring             |
| 3. Rotor            | 8. Heat sink            | 13. Bearing             | 18. Brush box assembly |
| 4. Stator           | 9. Fan cowl             | 14. Cover               | 19. O-ring             |
| 5. Circlip          | 10. Fan                 | 15. Gland plate         |                        |

M 6471

14. Remove the O-ring (17) from the flange on the slip ring end shield.
15. Remove the oil seal (2) from the drive end shield. Remove the O-ring (19) from the flange on the drive end shield.
16. Remove the O-ring from the slip ring end of rotor shaft.

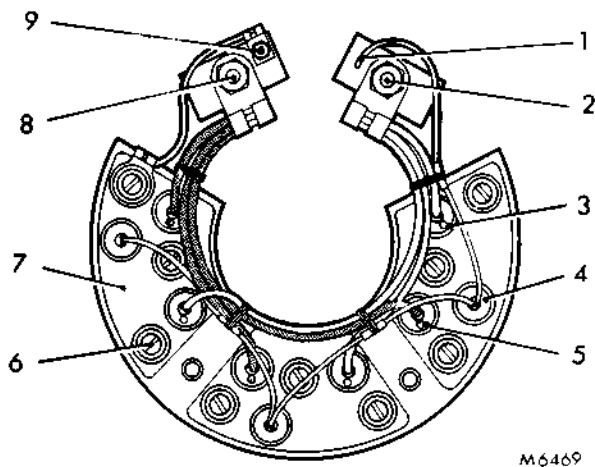
**Inspection**

1. Examine all components for wear, damage or corrosion; renew as necessary.
2. Examine the insulation on the windings and leads for deterioration; renew as necessary.
3. Examine the bearings and renew if they are defective.
4. Check that the slip rings are concentric to within 0,05 mm (0.002 in) and are free from damage. If necessary, the slip rings can be skimmed in a lathe to a minimum diameter of 40,7 mm (1.602 in).  
**Note:** When skimming slip rings the rotor must be mounted on its bearing or bearing journals in the lathe.
5. Check that the brushes are in good condition and not worn below the minimum length of 7,9 mm (0.312 in). On older type brush boxes renew the brushes, if necessary, as follows:
  - a. Remove the securing nuts from the terminal posts and detach the washer, Lucar blade and plain washer.
  - b. Depress the terminal post into the brush box. The brush, spring and post are integral and are renewed as a complete assembly.

- c. Renew the O-ring on the terminal post aperture.
- d. Fit the brush assembly and assemble the plain washer, Lucar blade, washer and secure in position with the nut.

**Note:** On the latest type brush box a new brush box assembly (complete with bushes) must be fitted.

6. Check the stator insulation resistance by connecting a 100V megger type tester to one of the leads and to the frame. The resistance must not be less than 3 megohms.
7. Check the stator winding and continuity by connecting a 24V supply in series with a variable resistor and ammeter to any two of the three phase leads on the stator. Pass a current of 40A through the windings and measure the volts at the leads. Repeat the test on each pair of leads. An indicated voltage reading of 2V to 3V should be obtained from each pair of leads. If a variable reading is obtained in each test, renew the stator.
8. Check the rotor insulation resistance by connecting a 100V megger type tester between the shaft and slip ring. The resistance must not be less than 3 megohms.
9. Check the rotor winding resistance and continuity by connecting a suitable meter across the slip rings. The resistance should be 10 to 10,5 ohms.
10. Check each diode in the assembled heat sinks (see Fig. 2) using a 44 or 48W test light connected in series with a probe in the positive line of a 24V supply and a second probe connected to the negative line of the supply. The following diagnostic testing chart will indicate defective diodes:



**FIG. 2. HEAT SINK RENEWAL**

- |                          |                        |
|--------------------------|------------------------|
| 1. 'A' lead              | 6. Fixing screws       |
| 2. Output terminal (+)   | 7. Heat sink           |
| 3. Red spot main diode   | 8. Output terminal (-) |
| 4. Auxiliary diode       | 9. 'R' terminal        |
| 5. Black spot main diode |                        |

Test No.	Probe (+) connection	Probe (-) connection	Polarity of diode under test	Serviceable indication
1	Each heat sink in sequence	D +	Positive	Lamp illuminated
2	D +	Each heat sink in sequence	Positive	No illumination
3	D -	Each heat sink in sequence	Negative	Lamp illuminated
4	Each heat sink in sequence	D -	Negative	No illumination



5	Each heat sink in sequence	'A' terminal	Auxiliary	Lamp illuminated
6	'A' terminal	Each heat sink in sequence	Auxiliary	No illumination

If a defective diode is diagnosed the complete assembly (consisting of three diodes and heat sink) must be renewed. Renew the heat sink, if necessary, as follows:

**NOTE:** The main diodes are identified by coloured spots; diodes with a red spot must be connected to the main output terminal and diodes with a black spot must be connected to the negative main output terminal (see Fig. 2).

- a. Unsolder the leads from the connecting tags. Cut the leads from the auxiliary diode approximately 19 to 25 mm (0.75 to 1.0 in) from the diode.
- b. Remove the screws, washers and insulating bushes and detach the heat sink. Ensure that the insulator between the base of the heat sink and the end shield is undamaged.  
**NOTE:** The connections on the middle heat sink of production alternators differ from that illustrated and must not be altered unless a new service replacement heat sink is fitted.
- c. Position the new heat sink on the insulator and fit the insulating bushes, washers and screw. Torque tighten the screws to 4,15 kgf m (30 lbf ft).  
**NOTE:** If all three heat sinks are renewed, the fixing posts (positioned between the heat sinks) are not required and should be removed.
- d. Solder the leads from the main diodes to the appropriate tags.
- e. To connect the auxiliary diode lead(s) to the severed connecting leads, slide a small length of glass sleeving of suitable diameter over the lead to be joined. Cut the diode lead, allowing sufficient for overlap. Twist the two exposed ends together and solder the joint. Paint the joint with VA276 varnish paint and, when the varnish is tacky, slide the glass sleeving over the joint. Paint the covered joint with VA276 varnish paint.
- f. Bind the leads with ties and test the heat sink.

#### To Reassemble, Fig. 1

1. Renew all seals, O-rings and gaskets and, prior to assembly, lightly smear with Shell Alvania 2 grease.
2. Insert the oil seal between the two circlips in the bore of the slip ring end shield. Fit the O-ring on the flange lip of the slip ring end shield. Fit the oil seal in the slip ring bearing clamp plate.
3. Insert the oil seal into the bore of the drive end shield and fit the O-ring on the flange lip.
4. Fit the O-ring on the slip ring end of the rotor shaft.
5. Align the reference marks on the slip ring end shield and the stator. Fit the end shield screws and torque tighten to 4,15 kgf m (30 lbf ft).
6. Connect the three-phase leads to the heat sinks and torque tighten the screws to 4,15 kgf m (30 lbf ft).
7. Insert the spacer into the bore of the clamp plate (with the slotted end of the spacer towards the bearing).
8. Insert the rotor with the attached drive end shield assembly into the stator, aligning the reference marks on the end shield and stator. Ensure that the rotor shaft is correctly aligned with the bore of the slip ring end shield.
9. Tighten the drive end shield screws evenly half a turn at a time.
10. Fit the slip ring bearing onto the rotor shaft and press it into the housing using the clamp plate and tightening the securing screws evenly.
11. Fit the fan and torque tighten the securing nut to 2,75 kgf m (20 lbf ft).
12. Fit the brush box assembly, ensuring that the gasket and dowel locate correctly.
13. Connect the flying lead to the 'A' terminal. Ensure that the tag is correctly located and positioned on the Lucar blade and terminal blade. Fit the terminal box cover and gland plate.
14. Fit the cowl to the slip ring end shield.
15. Fit the drive pulley.

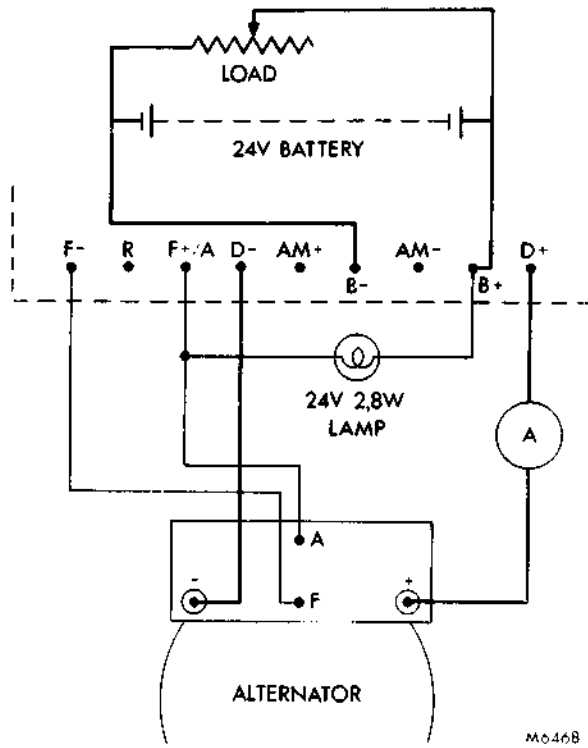


FIG. 3. TEST BENCH CIRCUIT

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TESTING

**NOTE:** Before connecting the alternator on a test bench, check the insulation resistance of the alternator windings using a 100V 'megger' type test equipment. Connect one side of the 'megger' to the alternator frame and connect the other side to the 'D+', 'D-' and 'A' terminals in sequence; the resistance between any of these terminals must not be less than 3 megohms.

1. Mount the alternator on a suitable test machine and connect the drive.
2. Connect the alternator as shown in Fig. 3  
**Caution:** Do not disconnect or alter any electrical connections while the alternator is running.
3. Start the drive and increase speed until the ammeter indicates that the alternator is charging.
4. Connect a voltmeter across terminals 'A' and 'F' on the control board and reduce the alternator speed to its cutting-in speed of 650 rev/min (cold) or 700 rev/min (hot). The voltmeter should indicate not less than 24V.
5. Connect the voltmeter across terminals 'B+' and 'B-'.
6. Apply the various loads at the appropriate speeds and check the performance against the following chart:

HOT		COLD	
A	Rev/min	A	Rev/min
20	830	20	750
30	900	30	830
40	970	40	880
50	1070	50	940

A tolerance of  $\pm 5\%$  of the output figures at the indicated speeds is permissible.

**NOTE:** Do not continue with the test if a fault in the alternator is indicated. Remove the alternator from the test bench and rectify.

## SECTION 4

## Starter Motor – CAV

## DATA

Type . . . . . U6/24B/3  
 Weight . . . . . 27,2 kg (60 lb)

Test (with 116AH battery)	Battery Voltage	Current (Amps)	Speed (Rev/min)	Torque	
				kgf m	lbf ft
Lock torque	24	1000	–	8.5	62
Running torque	24	450	1170	3.6	26
Light running torque	24	70	3500	–	–

## DIAGNOSTIC TESTING

Fault	Rectification
Starter fails to operate	Check: State of charge of batteries. All cables and connections are clean and secure. Solenoid switch.
Solenoid operates activating drive pinion into mesh, but starter does not operate	Check: Starter for seizure. Brushes for wear. Condition of bearings. Main contacts on solenoid switch.
Pinion does not fully engage in flywheel ring gear	Check: Pinion for wear. Flywheel ring gear for wear. Catch plate and trigger for wear.

## REMOVAL AND REFITMENT

## To Remove

1. Rotate the isolator switch to the 'OFF' position.
2. Remove the rear seats and any ancillary equipment that obstructs the access panel. Detach the access panel.
3. Note the positions and disconnect the electrical connections from the starter motor.
4. With starter motor adequately supported remove the securing strap and withdraw the starter motor from the engine.
5. Retain the tapered split collar.

## To Refit

1. Reverse the procedure 1 to 4, ensuring that all electrical connections are in their original positions.
2. On refitting split collar ensure that the taper is facing the starter motor.

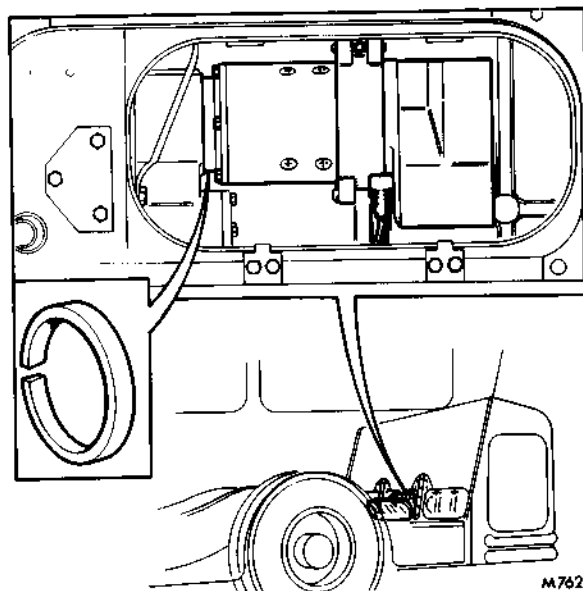


FIG. 1. STARTER MOTOR AND SPLIT COLLAR LOCATION

6. Insert the pinion into the drive-end shield bearing and the commutator end of armature into the bearing pin in the commutator-end shield. Check both bearings for excessive side-play. If excessive side-play is evident both commutator-end and drive-end shields must be renewed.
7. Using test probes connected to a supply (not exceeding 110V) and in series with a 15W bulb, check the brushgear insulation between:
  - a. The positive and negative brush holders (Fig. 5).
  - b. The positive brush holder and the frame (Fig. 6).
  - c. The negative brush holder and the frame (Fig. 7).

Illumination of the bulb indicates defective insulation.

8. Remove all burrs and sharp edges from the clutch plates with an abrasive stone. If the clutch plates are worn, distorted or discoloured the complete assembly must be renewed.
9. Examine the pinion teeth for wear or damage; renew as necessary, ensuring that the new pinion has the same number of teeth and is made of the same material as the previous pinion.

**To Reassemble, Fig. 2**

1. Secure the armature in a suitable clamping device or a vice fitted with soft jaw clamps.
2. Liberally smear the spring and thrust washer on the armature plunger (32) with grease. Insert the plunger into the bore of the armature and tighten the plunger retaining nut (33).
3. Insert the pressure plates (13), back plate (12) and shim washers (11) into the clutch outer race.
4. Lightly smear the clutch springs (9) with grease and insert them, (largest diameter first), into the holes in the clutch inner race (8).
5. Lightly grease the clutch plates (10) with grease and position them on the splines of the clutch inner race.  
**NOTE:** The bronze and steel clutch plates must be fitted alternately, fitting a steel clutch plate first.
6. Assemble the clutch inner race complete with clutch plates and spring ring (see Fig. 8).
7. Grease the pinion spring (7) and slide it onto the armature shaft.

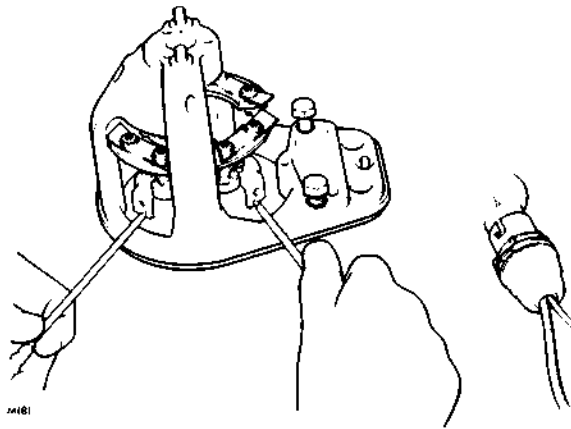


FIG. 5. CHECKING THE BRUSH GEAR (a)

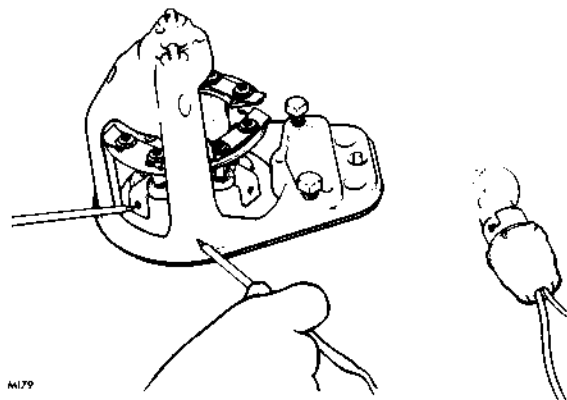


FIG. 6. CHECKING THE BRUSH GEAR (b)

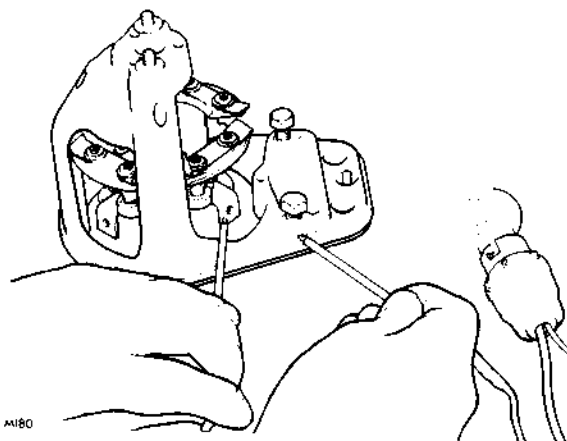
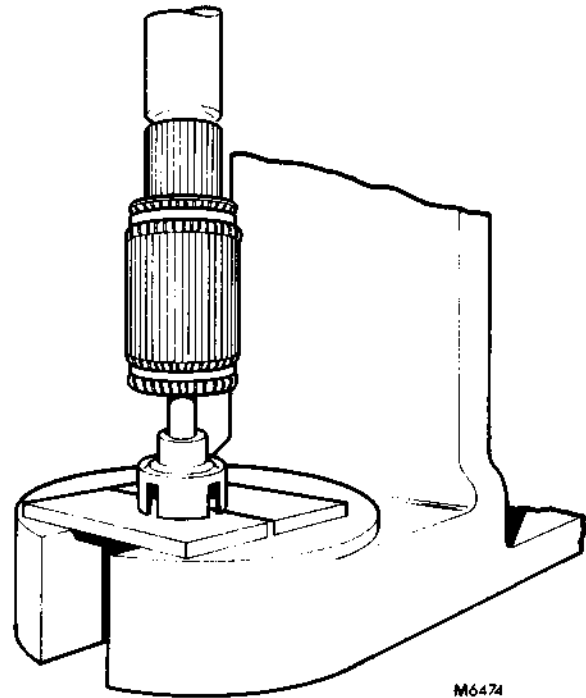


FIG. 7. CHECKING THE BRUSH GEAR (c)

14. Note the positions and disconnect the solenoid coil leads.
15. Remove the negative terminal nut (16) and screw (21) securing the negative connector to the brush gear. Detach the negative connector.
16. Remove the screws (17) and detach the solenoid switch.

#### Inspection

1. Inspect the surface of the commutator. A satisfactory condition is indicated by an even highly burnished dark copper colour. If the contact surface is rough, pitted, scored, burned or coated with hard carbon or oil, the commutator must be re-surfaced using a fine grade of glass paper. If the surface condition is severe the commutator should be skimmed in a lathe.
2. Using a 'growler' armature tester, check the armature windings for continuity and short circuits. If suitable test equipment is not available the armature should be tested by substitution. Should the armature be faulty, the clutch outer race (36) should be pressed off the defective shaft and, using a suitable tool, pressed onto the shaft of a new armature (see Fig. 3).
3. Using test probes connected to a supply (not exceeding 110V) and in series with a 15W bulb, check the field coils for short circuits to the yoke and poles (see Fig. 4). Illumination of the bulb indicates defective insulation.
4. Using an ohmmeter check the field coils for open circuits. The ohmmeter should be connected across each of the coils in turn. If infinity or maximum ohms are obtained, an open circuit is indicated.
5. Using a low reading ohmmeter, check the field coils for internal short circuits. If a suitable instrument is not available, the coils should be tested by substitution. Field coils should be renewed as follows:
  - a. Remove the screws (14) and withdraw the poles and coils, noting the position of the coils to facilitate assembly. Each pole has a 'step' machined on its surface and is marked with a number which corresponds with a number stamped on the end of the yoke. When refitting the poles, the 'steps' must all be positioned towards the commutator-end of the yoke and all the numbers must correspond.
  - b. Fit new coils to the poles and insert into the yoke. Fit the screws (14).

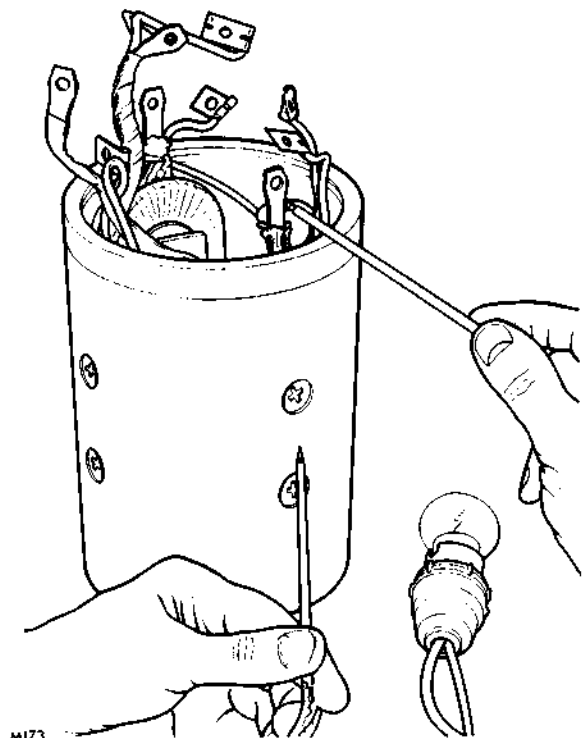


M6474

FIG. 3. PRESSING ON THE CLUTCH OUTER RACE

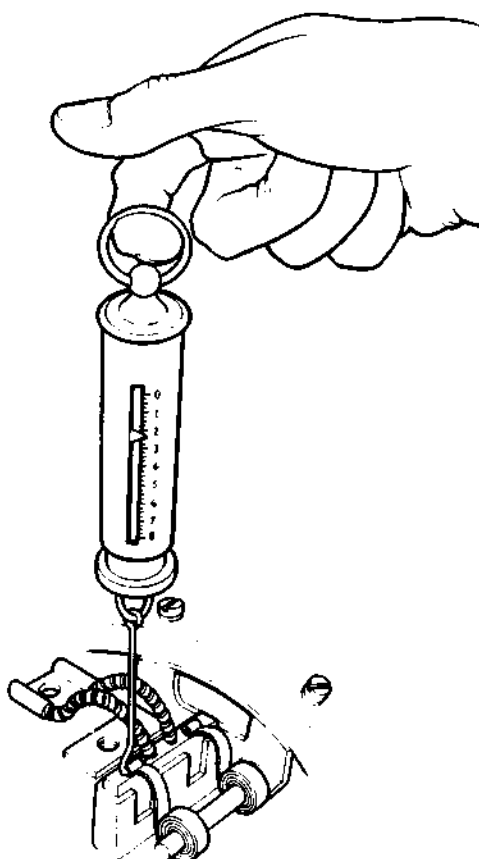
- c. Apply 'Duralac' sealing compound to the pole screws (14). The screws should be tightened firmly to exclude any clearance between the mating surfaces of the poles and the yoke.

**NOTE:** The field coils will 'bed-down' more easily if the yoke coils and poles are heated gently in an oven before the pole screws are tightened. If the coils are loose on the pole shoes they must be tightened by either using a leatheroid spacer or taping the coils.



M173

FIG. 4. CHECKING THE FIELD WINDINGS FOR SHORT CIRCUITS



M164

FIG. 10. CHECKING SPRING BRUSH PRESSURE

21. Fit the fixing bolts (37) and washers and torque tighten to 0,83 to 1,1 kgf m (6 to 8 lbf ft). Ensure the armature is not binding and is free to rotate.
22. Fit the washers and nut (20) to the armature plunger.
23. Refit the brushes into their original position.
24. Check the brush spring pressure using a spring balance hooked under the spring (see Fig. 10). The pressure of each spring should be 51,0 to 68,0 kgf (18 to 24 ozf).  
**NOTE:** If new brushes are fitted they must be well 'bedded', that is, worn to the periphery of the commutator over a minimum of 80% of their contact area.
25. Connect the brush and field leads to the brush gear to their original connections.
26. Pull the armature forward until the trigger (19) is raised to its highest extent by the tripping disc (30) (see Fig. 11). The dimension 'A' between the shoulder on the trigger and the bottom of the slot should be  $2 \pm 0,1$  mm ( $0,078 \pm 0,004$  in).
27. Carry out the Mechanical and Performance Tests as described in this section.

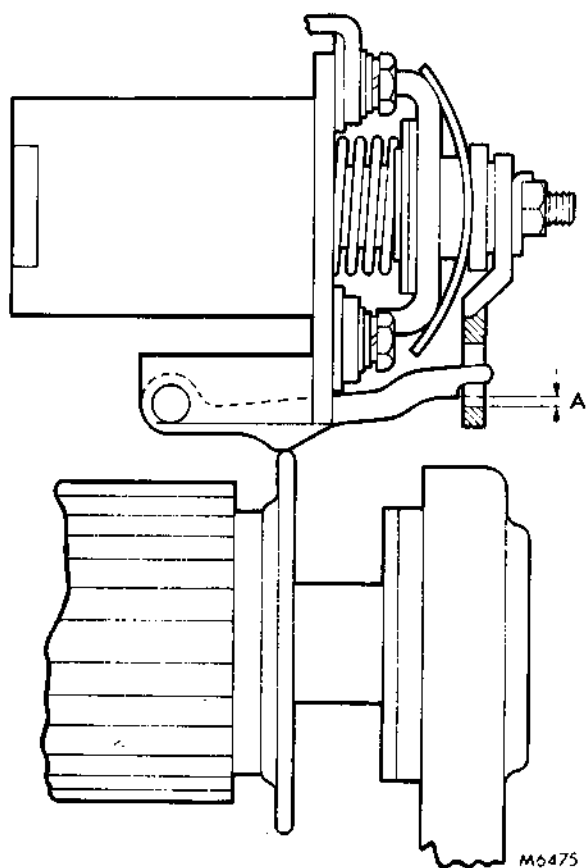
## TESTING

## Mechanical Test

1. Connect the starter motor to a battery of suitable voltage.
2. Insert a strip of insulating material between the moving contact and the second stage contact of the solenoid switch, thus preventing the second stage contacts from closing.
3. Activate the starter motor. The solenoid switch first stage contacts should close and the pinion should revolve in its normal direction of rotation and, simultaneously, move forward approximately 25,4 mm (1 in).  
**CAUTION:** Do not activate the starter motor for long periods as the auxiliary windings may be damaged by over heating.
4. Remove the insulating strip from the second stage contacts.

## Performance Test

1. Fit the starter motor to a starter test fixture and connect a suitable power supply. The gap between the starter pinion and the test rig flywheel must be set at 3,175 mm (0,125 in).
2. Check the lock torque, running torque and light running torque against the figures given in DATA.

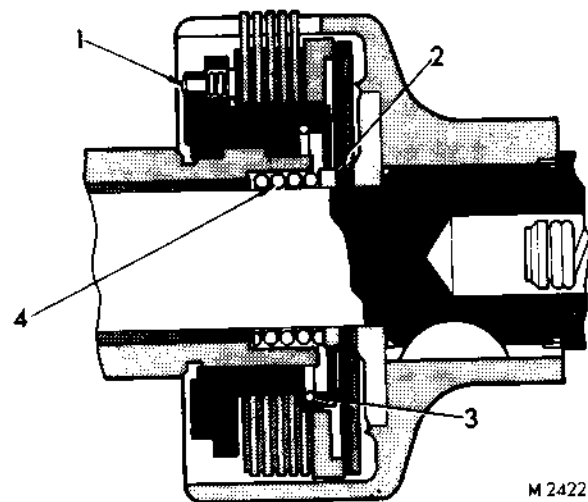


M6475

FIG. 11. RELATIONSHIP BETWEEN TRIGGER AND TRIPPING DISC



8. Grease the bore of the pinion (39) and insert the rubber sealing ring (when fitted) and shims (6).
9. Insert the pinion into the drive-end shield (38) using a rotary motion in the same direction as the pinion thread spiral, whilst the lubricating pad is lifted from inside the casting.
10. Slide the pinion and drive-end shield onto the armature shaft. Push the pinion forward and rotate until it engages the clutch inner race. With the pinion held in this position, fit the shim (3), washer (2) and nut (1). Ensure the shim locates over the shoulder of the shaft and then tighten the nut securely.
11. Adjust the clutch slip torque as follows:
  - a. Clamp the armature in a suitable clamping fixture or a vice fitted with soft jaw clamps.
  - b. Fit special socket 6244-5 on the pinion teeth and use in conjunction with a standard torque spanner calibrated to 20,7 kgf m (150 lbf ft) and fitted with a ½ in square drive shaft (see Fig. 8).  
**NOTE:** The torque spanner must be fitted so the torque load is applied in an anti-clockwise direction to the pinion.
  - c. Adjust the clutch to slip at 13,8 to 16,6 kgf m (100 to 120 lbf ft). Adjustment is achieved by fitting or removing shims (11) between the clutch plates (10) and back plate (12), until the clutch will support, at the end of the torque spanner, a torque of not less than 13,8 kgf m (100 lbf ft) and not more than 16,6 kgf m (120 lbf ft). The shims (11) are available in 0,1 mm and 0,5 mm thicknesses.
  - d. Slip the clutch ten times and, if necessary, re-adjust to 13,8 to 16,6 kgf m (100 to 120 lbf ft).
12. Fit the nut (40) and tighten securely. Insert split pin.
13. Pour approximately 12 cc of oil into the oil filler holes in the drive-end shield. Allow sufficient time for the lubrication pad to absorb the oil. Fit the spring (4) and lubrication plug (5). Wipe all surplus oil from the drive-end shield.
14. Fit the commutator-end shield to the yoke (15), using 'Duralac' sealing compound. Ensure that the dowel in the yoke is correctly located.
15. Fit the solenoid switch (18) to the commutator-end shield (34) and secure in position with the fixing screws (17), after apply 'Duralac' sealing compound to the screw threads.



M 2422

FIG. 8. SECTION THROUGH CLUTCH ASSEMBLY

- |                 |                  |
|-----------------|------------------|
| 1. Guide pin    | 3. Spring ring   |
| 2. Spacing ring | 4. Pinion spring |

16. Assemble the negative connector (23) to the commutator-end shield and fit the nuts (16) and screw (21).
17. Connect the solenoid winding leads to their original positions.
18. Secure the main field coils, positive terminal connector and auxiliary field connections to the solenoid switch.
19. Fit the screws and insulating pieces (31) securing the main field connections to the connector at the base of the commutator-end shield.
20. Assemble the armature and drive-end shield to the yoke and apply 'Duralac' sealing compound to the spigots and register between the yoke and end-shields.

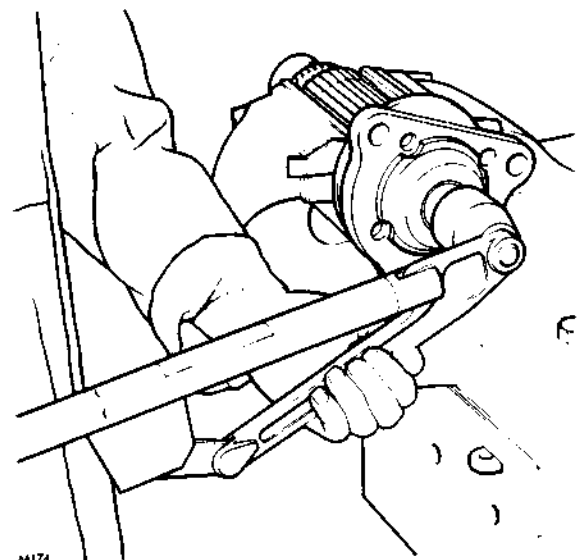


FIG. 9. ADJUSTING CLUTCH SLIP TORQUE

5. Locate the end of the trigger in the slot in the catch plate, fit the lock washer (2) and nut (1). Tighten the nut securely.
6. Check that gap 'A' between the catch plate and the shoulder on the trigger and the gaps between contacts 'B' and 'C' are within the limits detailed below:

Dimension	mm	inches
'A'	$2,0 \pm 0,1$	$0.079 \pm 0.004$
'B'	$3,8 \pm 0,3$	$0.15 \pm 0.012$
'C'	$1,0 \pm 0,1$	$0.39 \pm 0.004$

Adjusting washers (5) must be added or removed until the correct contact gap is obtained. The washer (6) must not be removed as it acts as a locating spigot for the return spring.

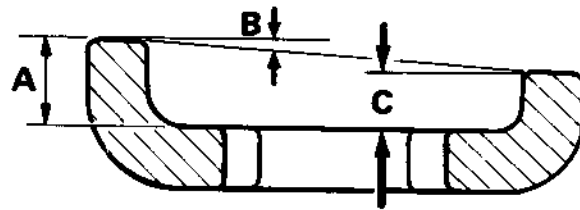
**NOTE:** Adjusting washers are available in four thicknesses: 0,1 mm, 0,2 mm, 0,3 mm, and 1,0 mm.

7. After the adjustments have been completed, secure the nut (1) with the lock washer (2).

**TESTING**

**Mechanical Tests**

Ensure that the spring pressures are as follows:



**FIG. 14. MOVING CONTACT**

A = 8,1 mm (0,319 in) B = 4° 6.5'  
C = 5,3 mm (0,209 in)

1. The force required to overcome both the return spring and contact spring, applied at the tip of plunger, is 11,35 to 13,15 kgf (25 to 29 lbf).
2. The force required to overcome the trigger spring, applied at the peak of the tripping face while the switch is in the OFF position, is 20,0 to 30,0 kgf (7,5 to 10,5 ozf).

**Electrical Tests**

1. Ensure that both contacts close when a 15V supply is applied to the solenoid winding.
2. Subject the switch to twice the normal voltage for a duration of a few seconds and ensure that the trigger operation is satisfactory. Any defective assembly or 'rounding off' on the trigger or catch plate will cause the catch to trip.



- When the performance tests have been completed fit the sealing ring and commutator end cover and carry out the Insulation Test.

#### Insulation Test, Fig. 12

- Using test probes connected to a mains supply (not exceeding 110V) and in series with a 15 W bulb between the following:
  - The positive terminal and frame.
  - The negative terminal and frame.

If the bulb illuminates during any of the tests the insulation is faulty.

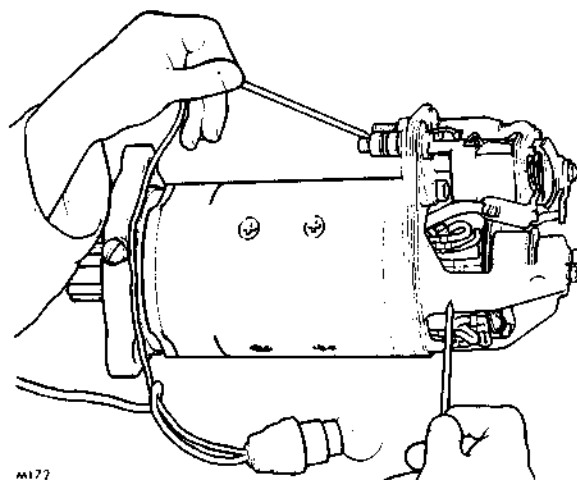


FIG. 12. INSULATION TEST

## OVERHAUL

### Solenoid Switch

#### To Dismantle, Fig. 13

- Release the lock washer (2) and remove the nut (1).
- Withdraw the catch plate (9), contact guide (8), contact leaf spring (3), moving contact (4), adjusting washers (5), insulating washer (6) and return spring (7).
- Remove the trigger spring (12).

#### Inspection

- Clean all components in a suitable solvent and dry thoroughly.
- Examine the moving contacts for excessive pitting or discolouration. The moving contacts can be refaced upon a lathe. It is important that the angular dimensions of the moving contacts (see Fig. 14) are maintained when the contact is refaced and that contact surfaces are smooth, flat and on the same plane. A maximum of 0,5 mm (0.020 in) can be removed from the contact faces, but if this is insufficient the moving contact must be renewed.
- Examine the fixed contacts for excessive pitting or discolouration. The contacts can be refaced upon a lathe. A maximum 0,5 mm (0.20 in) can be removed; renew as necessary.  
**NOTE:** New contacts are supplied in an unmachined state and must be assembled to the switch and faced on a lathe before being placed in service.

- Examine the solenoid winding for breakages or damage; renew as necessary.
- Examine the catch plate and trigger for excessive wear; renew as necessary.

#### To Reassemble, Fig. 13

- Lightly smear the solenoid plunger (at the point of entry into the switch body) and leaf spring (3) (at the point of contact with the moving contact) with petroleum jelly. Ensure that the contact faces are clean and free from any surplus petroleum jelly.
- Fit the return spring (7), ensuring that it locates over the lip on the periphery of the switch bore.
- Fit the trigger spring (12).
- Assemble the insulating washer (6), adjusting washers (5), moving contact (4), contact spring (17), contact guide (8) and catch plate (9).

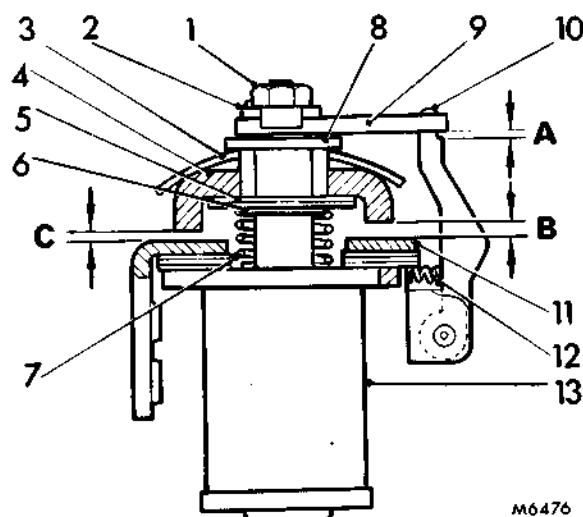
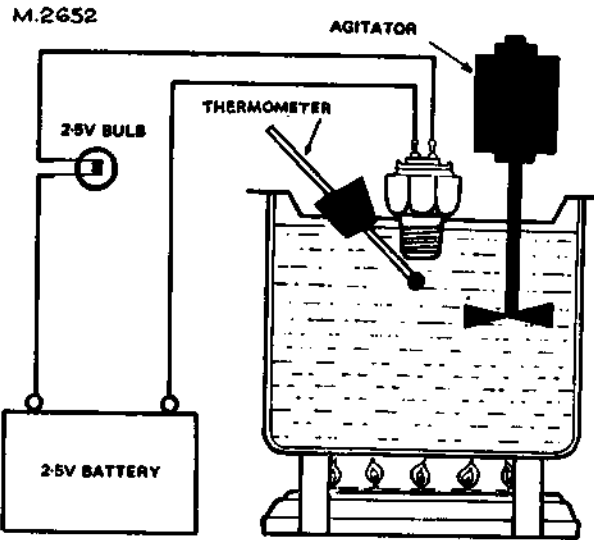


FIG. 13. SOLENOID SWITCH

- |                      |                    |
|----------------------|--------------------|
| 1. Nut               | 8. Contact guide   |
| 2. Lockwasher        | 9. Catch plate     |
| 3. Leaf spring       | 10. Trigger        |
| 4. Moving contact    | 11. Fixed contacts |
| 5. Washers           | 12. Trigger spring |
| 6. Insulating washer | 13. Coil           |
| 7. Return spring     |                    |



**FIG. 2. METHOD OF TESTING COOLANT TEMPERATURE SWITCH**

**OIL PRESSURE SWITCH**

The oil pressure switch Fig. 1, is fitted in the engine lubricating system and is connected to a warning lamp on the switchboard. The lamp lights when the lubricating oil pressure falls to a minimum safe working level.

**Maintenance**

Maintenance, other than ensuring that the terminal connections are clean and secure, and that the rubber shroud is in place, is not required.

The switches are non-repairable, and should they fail, must be renewed.

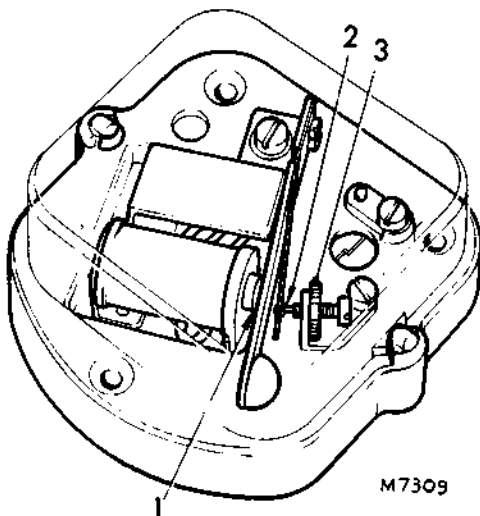
**Note:** For access to both switches lift the engine canopy.

**WARNING BUZZER**

The buzzer is mounted on the relay panel for warning of low air pressure and high coolant temperature. It consists of a solenoid and contact breaker assembly, mounted on a moulded plastic base with removable cover.

**DATA**

Coil . . . . .	Moulded cellulose acetate bobbin
Magnet . . . . .	Solid pole
Armature/contact spring . . . . .	Phosphor bronze
Contacts . . . . .	Silver
Voltage . . . . .	24
Current consumption . . . . .	0.12 amperes



**FIG. 3. WARNING BUZZER WITH COVER REMOVED**  
 1. Air gap  
 2. Contact points  
 3. Locknut

**Test and Adjust**

If the operation of the buzzer is unsatisfactory, the electrical supply and security of connections should first be checked.

1. Ensure that there is a suitable air gap (1) between the solid magnet pole and the moving arm.
2. Should the contact points (2) be burnt or pitted, clean with a thin strip of glasspaper.
3. If the frequency is too low or too high, adjust by slackening the locknut (3) and turning the screw in or out as required.
4. If the operation is still unsatisfactory the unit should be replaced by a new one.

## SECTION 5

## Miscellaneous Equipment

**COOLANT TEMPERATURE SWITCH**

The coolant temperature switch is fitted in the engine cooling system and connected to a warning buzzer. The buzzer operates when the coolant temperature reaches the cut-in temperature. See Data table below.

**Testing****Coolant Temperature Switch**

If the switch is suspected of being faulty, remove the rubber shroud and with the start switch ON, short across the thermal switch terminals. If the warning light and buzzer do not operate the fault is elsewhere in the system.

**Tightening torques**

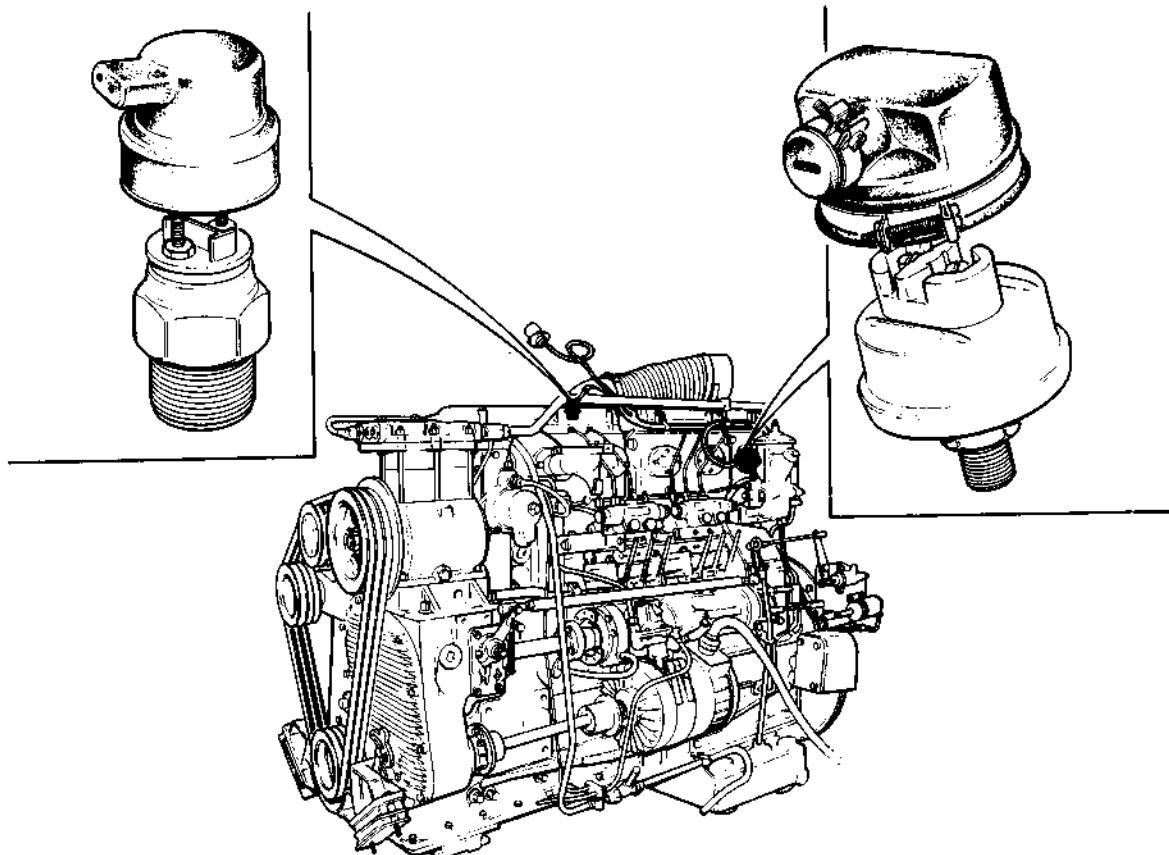
Coolant temperature switch – 4.6 kgf/m (36 lbf/ft).  
Oil pressure switch – 2.7 kgf/m (20 lbf/ft).

If the switch is still suspect test follows:

1. Drain the vehicle cooling system to below the level of the switch.
2. Remove the switch and connect it in series with a 2.5 volt battery and bulb as shown in diagram.
3. Heat the water, restraining the temperature rise to a maximum of 1°C per minute; use of an agitator is necessary to prevent hot spots occurring.  
Note: If the temperature is allowed to rise faster than 1°C per minute a false reading may result.
4. Check the temperature at which the bulb lights against the figure in the table.
5. Slowly cool the water and check the cut-out point against the figures given.
6. Repeat the tests twice to eliminate the possibility of an intermittent fault.

Discard any switch operating outside the specified limits.

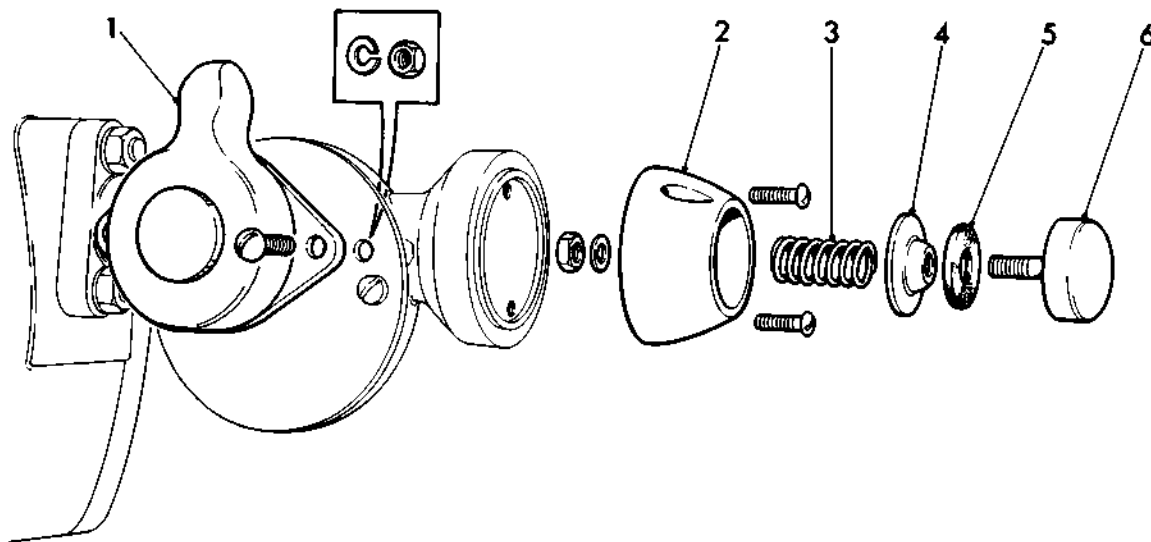
Coolant Temp. Switch Smiths' Ref. SJC1002/04	Cut-in Temp. 71.5–69.0°C	Cut-out Temp. 63.0–59.5°C	Max. Operating Temp. 120°C	Contact Load 100W
Oil Pressure Switch Smiths' Ref. PS3261/06	Operating Pressure Range 0.42 kgf/cm <sup>2</sup> ± 0.07 kgf/cm <sup>2</sup> (6 lbf/in <sup>2</sup> ± 1 lbf/in <sup>2</sup> )			



M7625

FIG. 1. SWITCHES—ENGINE COOLANT AND OIL PRESSURE

1. Engine coolant temperature
2. Engine oil pressure



M7628

**FIG. 7. TRAFFICATOR AND HORN PUSH**

- |                       |                |
|-----------------------|----------------|
| 1. Trafficator switch | 4. Contact     |
| 2. Horn push body     | 5. Felt washer |
| 3. Spring             | 6. Knob        |

**SWITCHES – GENERAL**

**Trafficator Switch and Horn Push, Fig. 7**

To remove the trafficator switch, release the two nuts securing the blanking plate to the bracket, lift off, disconnect and label the wiring connections, release the two nuts securing switch to blanking plate. The horn push may be removed by releasing the two recessed set screws.

**Switchboard**

The switchboard mounted units are of conventional type. All, with the exception of starter-push and engine stop controls, are retained by locking rings. Before these can be unscrewed the switch knob must be removed; this is done by inserting a suitable tool, such as a drill shank, in a hole in the knob and pressing gently inwards to release a spring catch. This will allow the knob to be withdrawn from the spindle.

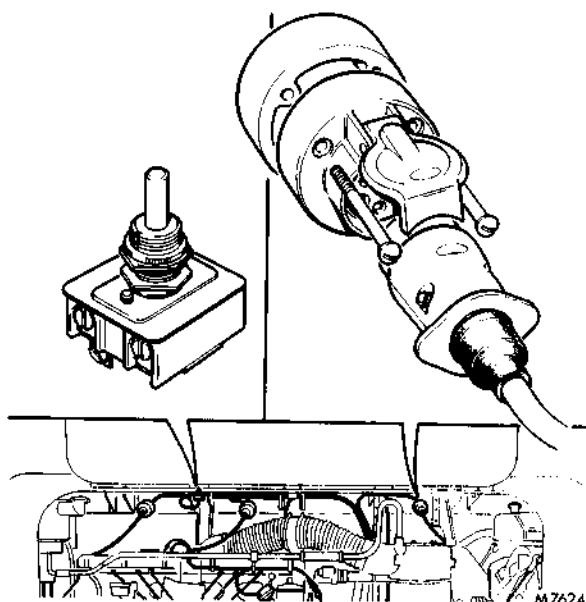
The starter and engine stop push switches are each retained by two screws inserted from below the panel.

**Plug and Socket 5- and 7-pin, Fig. 8**

Three such units are fitted to the rear engine bulkhead. The two outside 5-pin plugs connect the left- and right-hand rear lamp clusters to the main loom and the centre 7-pin plug connects the engine coolant temperature switch, oil pressure switch and the engine stop solenoid to the main loom. Care should be taken when separating the plug from the socket to prevent ingress of dirt or moisture. Do not separate plug from sockets without first releasing the spring retaining clip.

**Micro-switch—Start Inhibit, Fig. 8**

Located on the rear engine bulkhead and operated by plunger movement caused by the opening or closing of the engine canopy, with the canopy open the start circuit is inhibited. The switch is wired in the normally closed mode.

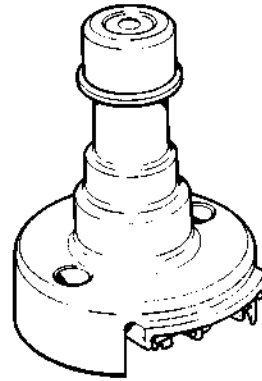


**FIG. 8. LOCATION OF PLUGS AND SOCKETS AND MICRO SWITCH**



**Foot Dip Switch, Fig. 4**

The headlamp dip switch is a rotary action foot operated switch, mounted on the driver's compartment floor left of the steering column. To remove release the two retaining screws and identify the three cables before disconnecting. The unit is non-repairable.



M7627

FIG. 4. FOOT DIP SWITCH

**Fast Fuse, Fig. 5**

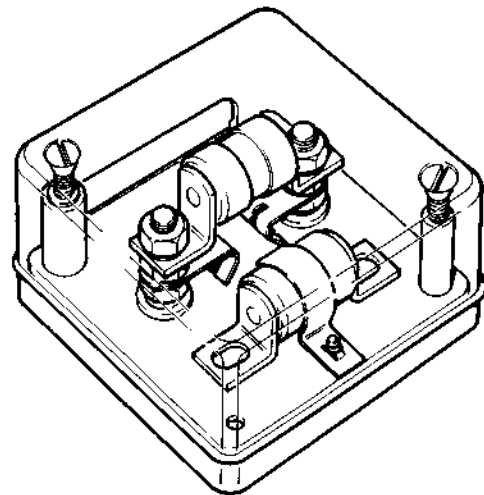
Mounted adjacent to the rear junction box the fast fuse unit consists of a metal and moulded plastic box containing a special fuse made with high accuracy. The fuse rating being specially chosen to protect the alternator rectifier diodes from damage caused by reverse polarity battery connections. When replacing fuses, always ensure that they are of the correct rating.

**DATA**

For AC203 (60 ampere) Alternators

Maximum ambient temperature is . . . . . 60°C

Spare fuse provided

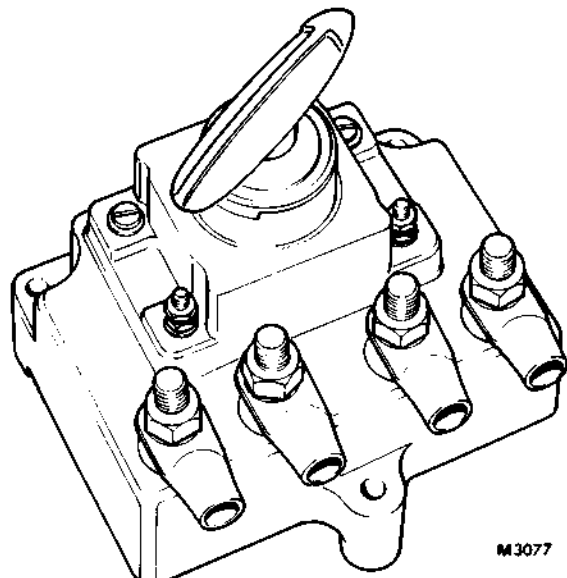


M7630

FIG. 5. FAST FUSE

**Isolation Switch, Fig. 6**

The CAV 444 switch is a rotary action model fitted with heavy duty self-aligning main contacts. It is provided with auxiliary contacts which open first to break the alternator field circuit. This is to prevent damage due to voltage surge which could arise if the load were removed from a running alternator by opening the master contacts.



M3077

FIG. 6. ISOLATION SWITCH





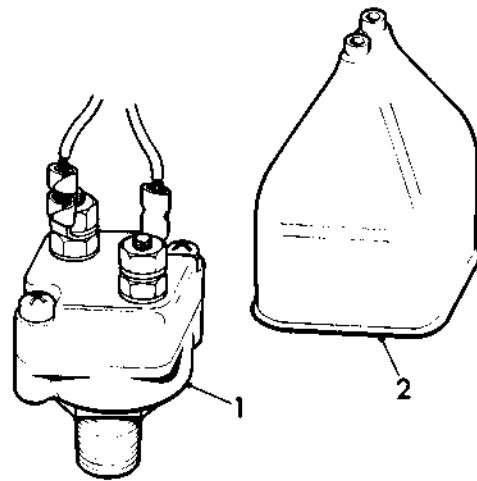
**Reverse Gear Light Switch, Fig. 9**

Located on the electro-pneumatic valve, the reverse light switch is operated when the driver selects reverse gear. Should there be malfunction within the switch, it must be replaced, the switches are non-repairable.

**Stop Light Switch**

A stop light switch is fitted into the footbrake line so that the stop lights operate whenever the footbrake pedal is operated.

The low air indicator switches, and stop light switches are non-repairable.



M7631

FIG. 9. REVERSE GEAR LIGHT SWITCH  
1. Switch      2. Boot

### GENERAL DESCRIPTION

A variety of lamps may be fitted to cater for the requirements of individual operators, the instructions in this Section are, however intended to cover only the types in general use.

All headlamps are similar in design and differ only as regards the light unit and bulb.

Auxiliary driving lamps include foglamps, long range driving lamps and special purpose spot lamps.

Foglamps have 'block' pattern or fluted lenses in clear or amber glass and are stem-mounted.

Long range driving lamps have plain convex lenses in clear or amber glass and are stem mounted in a similar fashion to the foglamps.

#### The Light Unit

The 'block' pattern lens surface is divided into small flutes and prisms which in conjunction with double filament bulbs produce a predetermined spread of light according to whether the beams are designed for dipping to the left, right or vertically.

The letters LHD (Left Hand Drive), RHD (Right Hand Drive) or VERT (Vertical Dip), are moulded into the glass to facilitate identification of Light Units. While dip filaments are positioned above the main filaments, they are also displaced to the left in bulbs for LHD Light Units and to the right for RHD Light Units. It is thus important always to fit the correct replacement bulb.

#### Bulbs

The 'prefocus' bulb eliminates the need for any focusing device in the lamp. 'Prefocus' bulbs are

normally cylindrical in shape to reduce the overall diameter to a minimum, an important feature where the bulb is fitted through an aperture in the rear of the reflector. High wattage (60-watt) bulbs are made spherical because of the greater heat generated. French 3-pin Duplo bulbs and Unified European bulbs are also spherical.

Bulbs for headlamps and foglamps have transverse filaments to give wide spread beams, while bulbs for long range driving lamps and spot lamps have axial filaments to give narrow beams.

'Prefocus' bulb caps are carried on flanges accurately positioned in relation to the filaments. To ensure correct fitting of the bulbs in the Light Unit, a slot in the flange engages with a projection on the inside of the bulb sleeve at the rear of the reflector. Some earlier bulbs have two slots in the flange marked 'TOP' and care must be taken to fit them accordingly.

Bayonet-fitting bulbholders with spring-loaded supply contacts secure the bulbs firmly in position.

The French Duplo bulb has three pressed-metal tags on the cap for bayonet-fitting in the bulbholder, the adaptor plate carrying the bulbholder being secured to the Light Unit reflector by two spring clips.

The Unified European bulb is secured in the rear of the Light Unit reflector by a simple wire clip.

#### Regulations

Lamps must be set to comply with local lighting regulations.

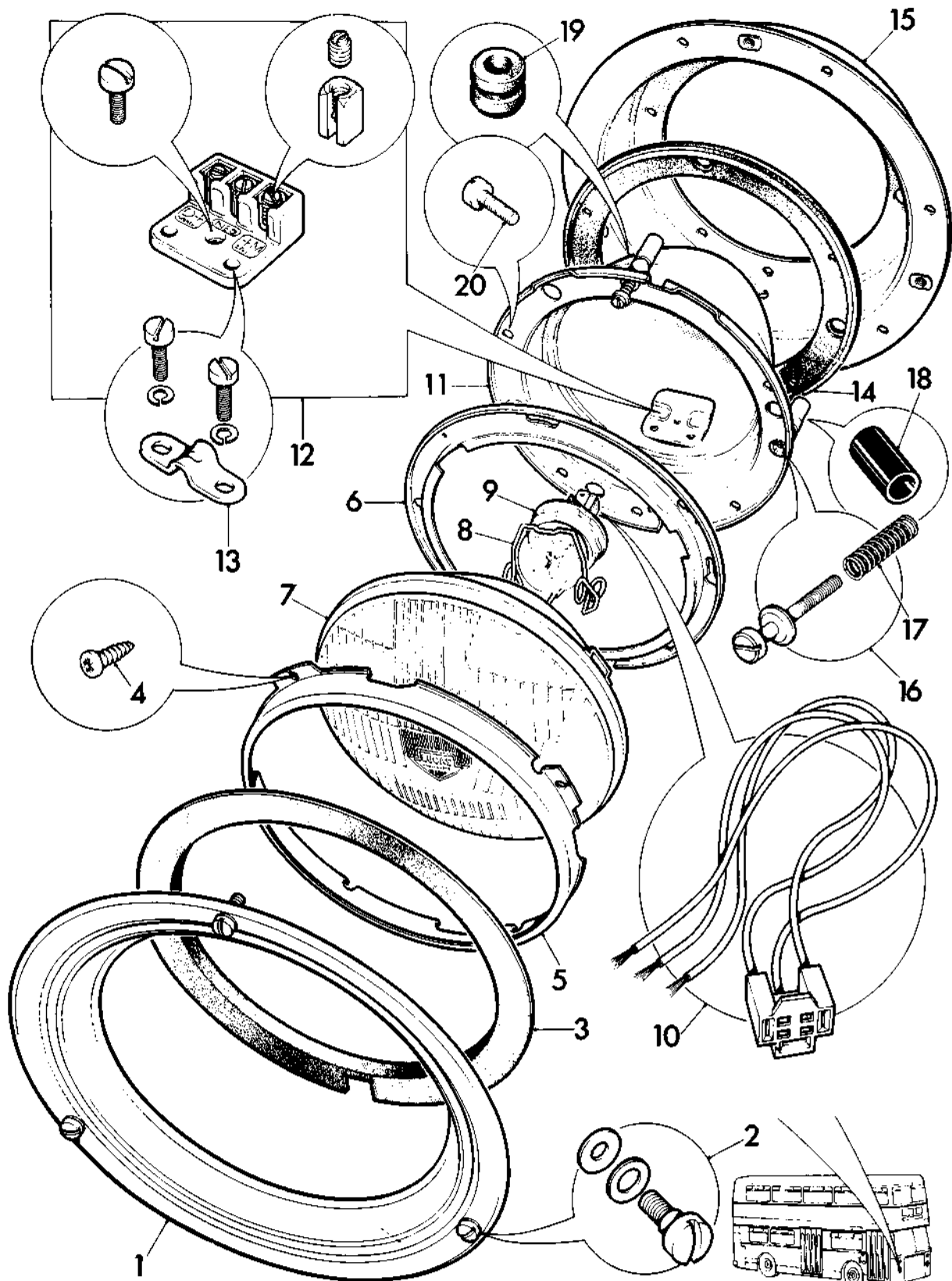
Accurate and rapid checking of lamp setting is most easily effected by using a Beam Setter. When such facilities are not available, the lamps can be set by marking off a smooth wall or screen and shining the lamp on it from a distance of twenty-five feet.





## SECTION 6

## Lamps



M 5898

FIG. 1. TYPICAL HEADLAMP ASSEMBLY

- |                      |                       |                        |                            |
|----------------------|-----------------------|------------------------|----------------------------|
| 1. Rim.              | 6. Retaining plate.   | 11. Body, outer shell. | 16. Trim screw and washer. |
| 2. Screw, fixing.    | 7. Light unit.        | 12. Junction box.      | 17. Spring, trimmer.       |
| 3. Dust excluder.    | 8. Retaining clip.    | 13. Clip, cable.       | 18. Sleeve, sealing.       |
| 4. Screw, fixing.    | 9. Bulb, 24V, 50/55W. | 14. Gasket, body.      | 19. Grommet, cable.        |
| 5. Rim seating unit. | 10. Connector.        | 15. Body, assembly.    | 20. Screw, fixing.         |

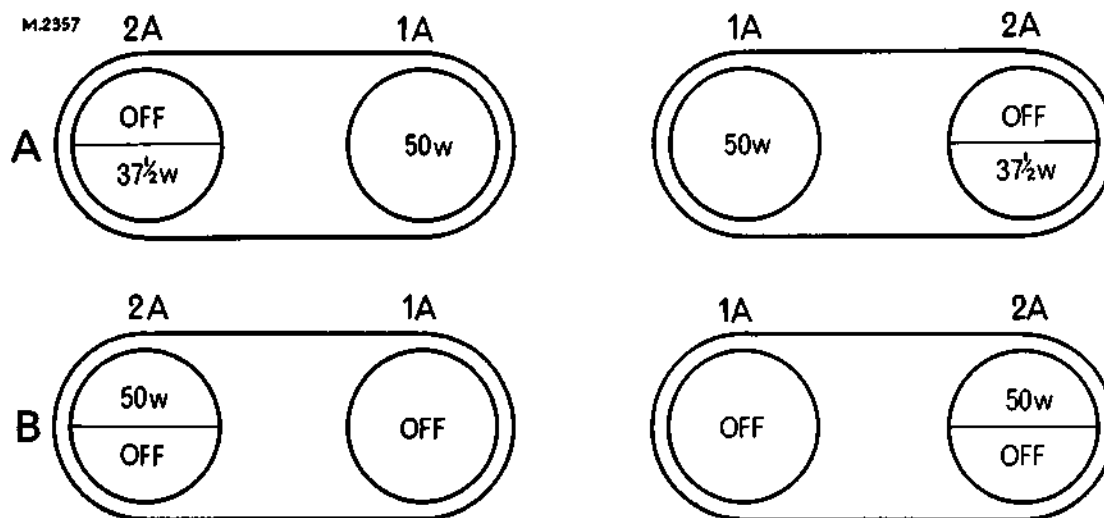


FIG. 2. DUAL HEADLAMP SYSTEM OPERATION

A. Full beam

B. Meeting beam

### DUAL-HEADLAMP SYSTEM

The dual headlamp system consists of two separate light units positioned on each side of the vehicle, the particular layout depending upon the styling of the vehicle.

Each pair consists of one main beam unit and one meeting beam unit, known respectively as 1A and 2A units. The main beam units are placed inboard in the side by side arrangement. A total of 175 W is available when main beams are in use, and 100 W on dipped beam, Fig. 2.

#### Light Units

The sealed beam light units are 146.0 mm (5.75 in), metal backed with non-detachable bulbs. Each is carried in a seating rim which is attached by a three point mounting to the lamp body pressing. Two of the mounting points are adjustable loaded assemblies whilst the third is a hard rubber pivot. Independent movement of the unit in a horizontal or vertical plane is achieved by the adjustment of two screws only, Fig. 3.

#### Adjustment

Setting of the lamps is accomplished by one of two methods:

1. Mechanical Aiming.
2. Visual Aiming.

Failure to ensure accurate aiming of these headlamps will result in a light source which gives poor road illumination and glare causing great annoyance to oncoming traffic.

Mechanical setting equipment should, therefore, be used wherever possible, and the visual method used only when the correct equipment is not available. Before attempting either method the following points must be observed:

1. Tyres must be inflated to the correct pressure.
2. A check must be made for imperfect filaments or faulty beam switching.
3. Headlamp lenses must be cleaned with a damp cloth.
4. Examination of the locating pads should be made if the mechanical aimer is used.
5. The vehicle should, if possible, be rocked to equalise the road springs.
6. The vehicle should be unladen.

#### Mechanical Aiming

The use of mechanical beam aiming equipment, obtainable from J. Lucas Ltd., of Birmingham, is recommended for setting these headlamps, and the lenses are provided with moulded projections for this purpose.

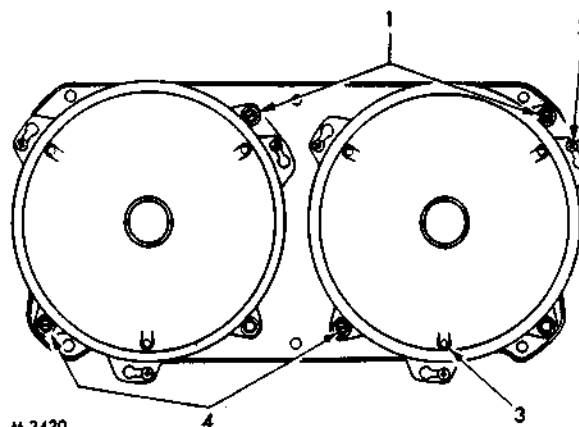


FIG. 3. TYPICAL HEADLAMP INSTALLATION

1. Vertical adjustment screws
2. Rim securing screws
3. Moulded projections for mechanical setting
4. Horizontal adjustment screws



**HEADLAMPS -- SINGLE PATTERN**

**Adjustment**

Remove the front rim and rubber dust excluder. Adjust the vertical and horizontal setting by turning the three spring-loaded adjustment screws to which the Light Unit is mounted.

the bulb sleeve, press on and secure by twisting the bulbholder clockwise. If a pilot bulbholder is attached to the main bulbholder, it is so arranged that when the pilot bulb is fitted it is adjacent to the window in the lamp reflector.

French three-pin Duplo bulbholders are secured in position on the rear of the reflector by two spring clips. Release these clips to remove the bulbholder.

**SERVICING**

**Removal of Light Unit**

Unscrew the rim securing screw and lift off the rim and rubber dust excluder. Press the Light Unit against the tension of the adjustment screws and turn it in an anti-clockwise direction until the heads of the screws can be disengaged through the slotted holes in the Light Unit seating rim. Do not disturb the screws when removing the Light Unit or the lamp setting will be altered.

**Lamps with Bulb Retaining Clip and no Bulbholder**

This arrangement is found in certain auxiliary lamps and in the Unified European Light Unit.

Release the bulb by squeezing together the two ends of the retaining clip and lifting it clear of the bulb sleeve.

**Bulb Renewal**

Replacement bulbs should be wiped before fitting and must never be handled by greasy fingers, otherwise the grease will evaporate in service and cause discoloration of the reflector.

The bulb can now be withdrawn from the bulb sleeve and the new bulb fitted.

**Lamps with Bayonet-Fitting Bulbholder**

Remove the Light Unit as described previously and turn the bulbholder in an anti-clockwise direction until spring pressure disengages the holder locating pegs in the bulbholder. The bulb can now be removed and the new bulb fitted.

**Light Unit Renewal**

In the event of damage to either the front lens or reflector, a replacement Light Unit should be fitted as described below.

Remove the Light Unit assembly and bulb. Withdraw the three self-tapping screws from the unit rim and remove the seating rim and unit rim from the Light Unit. Position the replacement Light Unit on the seating rim, taking care to see that the diecast projection or locating tabs at the edge of the Light Unit fit into the slot(s) in the rim. Ensure that the unit rim is correctly positioned and finally secure in position by means of the three self-tapping screws.

To refit the bulbholder engage the projections on the inside of the bulbholder with the slots or flanges in

Replace the bulbholders, Light unit and front rim.



The vertical centre line of the vehicle must coincide with that of the screen, and the lamps must be exactly at the 7.6 m (25 ft) setting distance.

Large, suitably marked, aiming boards or screens as shown in Fig. 4 can be used but it is important to observe that 2A units must be aimed on the meeting beam, and not on the main beam portion which only provides supplementary light to that of the 1A units. Further, 2A units must be set using the top and right hand edges of the high intensity portion of the meeting beam and not the centre or 'hot spot'.

The actual setting limits for 1A and 2A units at 7.62 m (25 ft) are as follows:

Vertical limits – see Fig. 4.

1A units: Centre of high intensity zone 50.8 mm (2 in) below horizontal centre line of lamps with a tolerance of 50.8 mm (2 in) either way.

2A units: Top edge of high intensity zone of meeting beam on horizontal centre line of lamps with a tolerance of 50.8 mm (2 in) either way.

### Horizontal Limits

1A units: Centre of high intensity zone on vertical centre line of lamps with a tolerance of 152 mm (6 in) either way.

2A units: Right hand edge of high intensity zone of meeting beam 50.8 mm (2 in) to left of vertical centre line of lamps with a tolerance of 50.8 mm (2 in) to the right or 102 mm (4 in) to the left.

**Note:** The adjusting screws are shown in Fig. 3. It is important, when setting lamps, to use a suitable narrow bladed screwdriver in the screw slots, and use a spanner to hold, but not to turn, the locknut.

### Light Unit Renewal

1. Remove the screws securing the front rim, Fig. 1.
2. Remove from each lamp the three Philips head screws, Fig. 3 (2). The unit can now be separated from the seating rim, allowing removal of the light unit after its terminal adaptor has been withdrawn.

After replacement it is important that the beams be checked and reset if necessary.



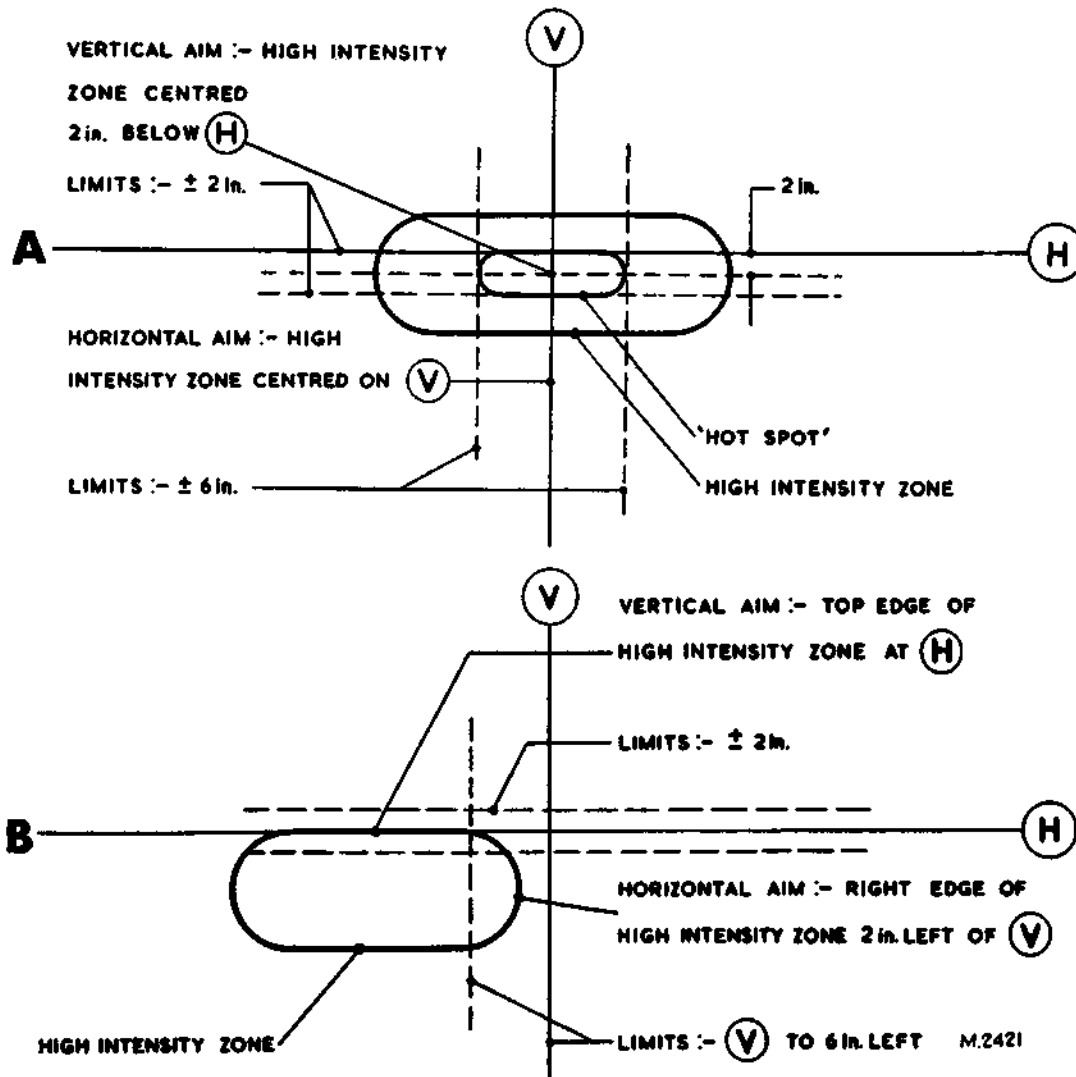


FIG. 4. BEAM SETTING DIAGRAM—FOUR HEADLAMP SYSTEM

A. Type 1A units  
 B. Type 2A units  
 Vertical centre-line 'V' straight ahead of lamp  
 Horizontal centre-line 'H' same height as lamp centre

Full details of the method of beam setting, using this equipment, is obtainable from the manufacturers. A feature of the system is that, unlike the visual method, setting may be carried out in normal light.

#### Visual Aiming

Visual aiming can only be carried out in at least semi-darkness, and before commencing the site must be prepared as follows:

1. The test area should be large enough to allow the front of the vehicle to be placed 7.6 m (25 ft) from the screen or wall.

2. The floor on which the vehicle is to stand must be flat and the screen mounted perpendicular to it.

3. A reference line should be marked on the floor parallel to the screen and exactly 7.6 m (25 ft) away.

4. The screen, which may be a painted wall or movable screen, should be approximately 1.8 m (6 ft) high by 3 m (10 ft). Its surface should be painted with a washable, non-gloss white or light grey paint, and be provided with adjustable bars or tapes for marking vertical and horizontal lines.

With the test site prepared, the vehicle should be positioned so that it faces, and is square to the screen.



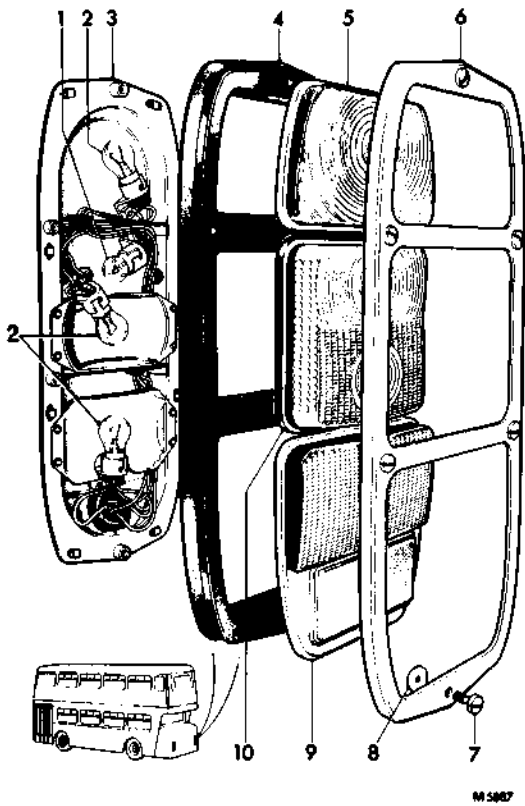


FIG. 5. REAR LAMP ASSEMBLY

- |  |                                     |
|--|-------------------------------------|
| 1. Bulb, 24 Volt, 5 Watt                       | 6. Bezel                            |
| 2. Bulb, 24 Volt, 21 Watt                      | 7. Screw                            |
| 3. Base assembly                               | 8. Washer                           |
| 4. Gasket                                      | 9. Lens, reflector and reverse lamp |
| 5. Lens, turn direction indicator flasher lamp | 10. Lens, tail and stop lamp        |

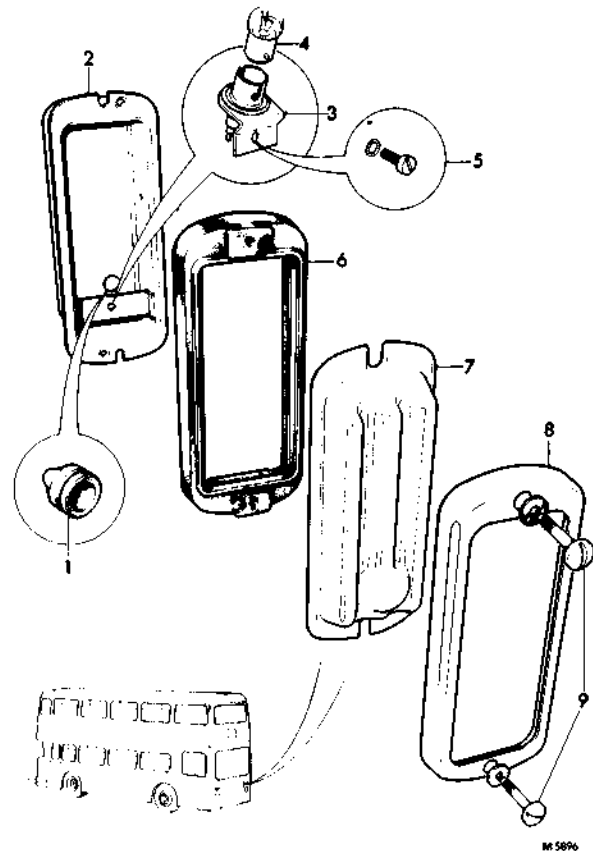


FIG. 7. SIDELAMP

- |                         |                              |
|-------------------------|------------------------------|
| 1. Grommet              | 5. Fixing screw and washer   |
| 2. Bulbholder           | 6. Gasket                    |
| 3. Bulbholder, interior | 7. Glass                     |
| 4. Bulb 24 Volt, 5 Watt | 8. Rim                       |
|                         | 9. Fixing screws and washers |

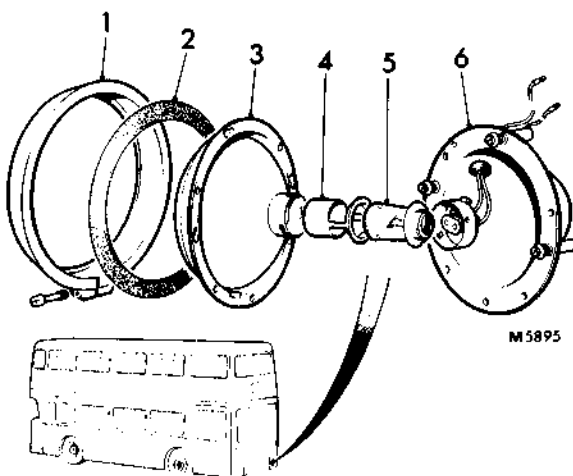


FIG. 6. EXPLODED VIEW—FOG LAMP

- |                 |                           |
|-----------------|---------------------------|
| 1. Lamp bezel   | 4. Shield—bulb            |
| 2. Sealing ring | 5. Bulb, 24 Volt, 44 Watt |
| 3. Light unit   | 6. Lamp shell             |

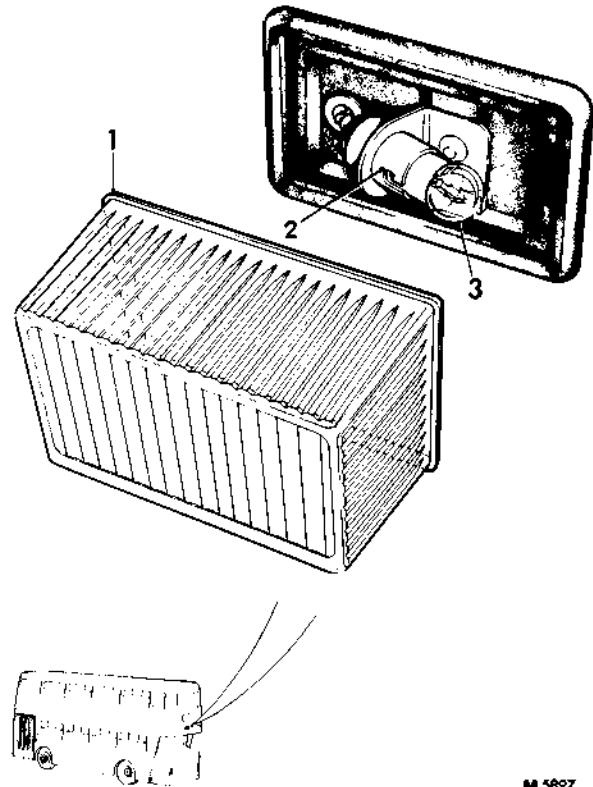
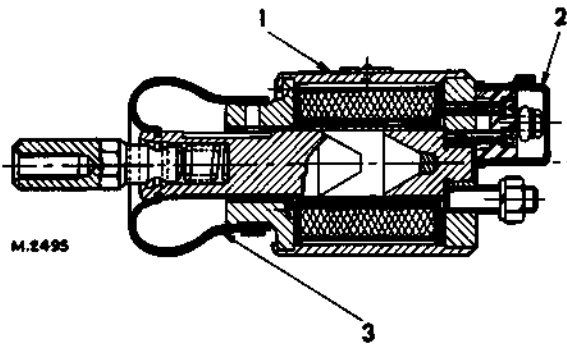


FIG. 8. NUMBER PLATE LAMP

- |                          |
|--------------------------|
| 1. Lens                  |
| 2. Bulbholder            |
| 3. Bulb, 24 Volt, 5 Watt |



**FIG. 2. SECTION THROUGH SOLENOID**

1. Body    2. Terminal cover    3. Bellows

**To Dismantle the Solenoid**

1. Remove all external dirt and grease.
2. Detach the clamp securing the rubber bellows and slide the bellows off the solenoid body and plunger.
3. Remove the plunger.
4. Remove the terminal cover.
5. Scrape out the sealing over the heads of the terminal block retaining screws and remove the screws.
6. Unsolder the coil leads to the terminals, and detach the terminal block.
7. Remove the circlip securing the solenoid end plate, and detach the end plate.
8. Detach the rubber washer and withdraw the solenoid coil from the body.

Clean the plunger and core of the solenoid and smear lightly with Shell Tellus oil No. 11 before reassembly. Inspect the rubber bellows and terminal cover for cracks or damage, and if faulty replace with new or undamaged parts.

Clean the terminals with a brush moistened in petrol or white spirit.

**To Reassemble the Solenoid**

1. Insert the solenoid coil (lead end first) into the solenoid body, ensuring that the lug on the coil engages in the keyway in the body and at the same time feed the leads through the hole in the solenoid end.
2. Place the rubber washer in position at the end of the solenoid coil, offer up the solenoid end plate, and secure in position with the circlip.
3. Fit the terminal block insulating washer over the coil leads, pass the leads into the terminals and solder them into position.
4. Insert the securing screws and screw the terminal block to the solenoid body.
5. Push the rubber terminal cover over the terminal block.
6. Fit the rubber bellows to the plunger and ensure that the breather hole in the bellows is at the bottom on final assembly. Insert the plunger into the solenoid core. Secure the rubber bellows to the solenoid with the bellows securing clamp.

**Testing**

If operation of the solenoid is faulty in any way, the following checks should be made:

1. Check that fuel pump lever, Fig. 1, item (1) is hard against stop with solenoid de-energised. If not, this may be due to incorrect adjustment of link allowing solenoid plunger too much travel.
2. Check plunger for free movement in its bore.
3. Ensure that current is reaching the solenoid terminals.
4. Check solenoid for continuity; the resistance value is 2.5 Ohm.

The current rating of the stop solenoid is 9.5 amperes.



## SECTION 8

## Engine Stop Solenoid

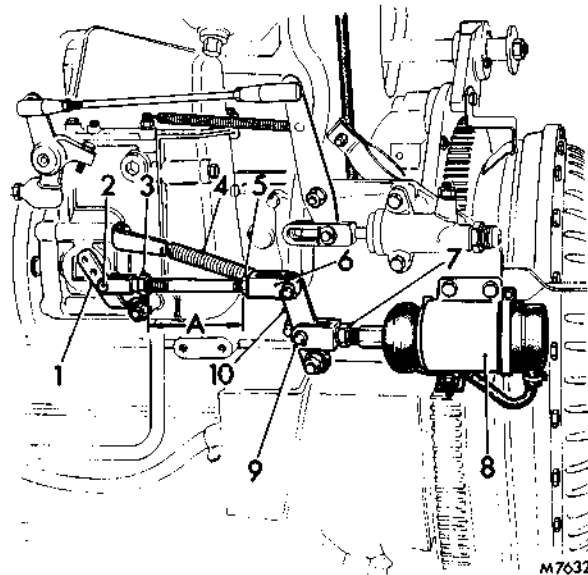


FIG. 1. ENGINE STOP SOLENOID  
AND LINKAGE

- |                  |                    |
|------------------|--------------------|
| 1. Pump lever    | 6. Clevis          |
| 2. Clevis        | 7. Plunger locknut |
| 3. Locknut       | 8. Solenoid        |
| 4. Return spring | 9. Clevis pin      |
| 5. Locknut       | 10. Fulcrum lever  |

## SOLENOID TYPE C.A.V. 263

## DESCRIPTION

The engine stop solenoid is a short-rated type with replaceable coils, connected directly to the fuel pump lever by a short connecting link, Fig. 1.

When current is supplied to the solenoid, the winding is energised to draw the plunger inwards. The winding has a fairly high current consumption and should not be allowed to remain energised for more than 30 seconds as overheating will lead to coil failure.

## Note:

If it is necessary to remove the plunger, note distance between locknuts, 'A' Fig. 1, first. Plunger can then be released by slackening locknut (7) and removing clevis pin (9).

## SERVICING

## To Remove the Solenoid

1. Pull back rubber terminal cover and disconnect leads from both terminals.
2. Remove two plain nuts and spring washers securing solenoid to its bracket.
3. Remove clip securing rubber bellows to solenoid; body of solenoid can now be withdrawn leaving plunger in position.

## To Replace the Solenoid

1. Refit plunger to linkage, adjusting length 'A', if necessary, to dimension obtained before removal.
2. Lightly oil plunger before reassembly, see Lubrication Chart for specification.
3. Position bellows and clip over plunger, then refit solenoid, securing to bracket with nuts and spring washers.
4. Secure bellows with clip.

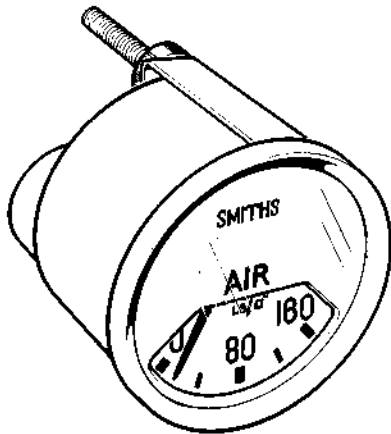


## Fault Detection

Correct polarisation is imperative—refer to wiring diagram.

1. Detach wiring connector, unscrew coupling nut, remove generator.
2. a. Using an Avometer switched to resistance range, apply positive (+) probe to blue cable termination and the negative (-) probe to brown cable terminal—infinite resistance should be indicated.  
b. Rotate shaft by hand, pointer should waiver between infinity and some lower indefinite value.
3. a. With positive (+) probe applied to brown cable terminal and negative (-) probe to blue cable terminal, a reading below 3k ohms should be indicated.  
b. Rotate drive shaft by hand, pointer should waver above and below value obtained at a.

When refitting generator, coupling nut must not be tightened in excess of 2.8 kgf m (20.0 lbf ft).



M7626

FIG. 4. SINGLE AIR GAUGE

**Warning:** Under no circumstances should supply voltage be applied to the generator whilst checking.

## Speedometer—To Remove and Refit

1. Release the four setscrews securing the instrument panel base cover plate.
2. From beneath the instrument panel withdraw the connector socket and lamp holder.
3. Unscrew the two knurled thumbscrews, take off the clamps, the instrument may now be removed.

Refitment is a reversal of the removal procedure.

## Single Air Pressure Gauges

Three gauges are fitted to indicate air system pressure in the auxiliary, front and rear reservoirs. They are all calibrated 0 to 11 kgf/cm<sup>2</sup> (0 to 160 lbf/in<sup>2</sup>), Fig 4.

## To Remove and Refit

1. Exhaust the front and rear brake reservoirs.
2. Remove the instrument panel base cover plate.
3. Label air pipes for ease of reassembly and unscrew pipe unions.
4. Release the two knurled thumbscrews on each instrument, each instrument may now be removed.

Refitment is a reversal of the above procedure.

## Testing

Remove each instrument from the vehicle and attach each gauge in turn to an air line and master gauge. If there is any discrepancy between either gauge and the master gauge, the instrument should be rejected and a replacement fitted.



## SECTION 9

### INSTRUMENTS

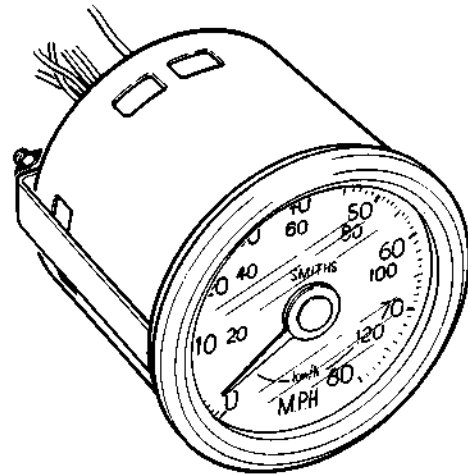
#### ELECTRONIC SPEEDOMETER

##### Description

This is an integrated circuit electronic speedometer. The system comprises a panel-mounted instrument, Fig. 1, connected electrically to a pulse generator mounted on the transmission, driven by a shaft rotating at 800 revolutions per mile.

##### Operation

Square pattern wave pulses are sent by the pulse generator, Fig. 2, to the instrument, and these are converted by an electronic circuit to operate the speed indicator.



M7636

FIG. 1. ELECTRONIC SPEEDOMETER

##### Fault Detection

There are three possible faults:

1. The instrument.
2. The pulse generator.
3. The wiring.

##### Faults

1. Speedometer not indicating.
2. Odometer (where fitted) not recording.

If one of the above faults occurs, or if both faults occur simultaneously, the fault lies in the indicator.

Should the fault persist:

1. Check wiring for continuity.
  2. Check speedometer fuse.
  3. Check wiring in socket, Fig. 3.
  4. If wiring is satisfactory, renew pulse generator.
- Repair. Defective instruments should be returned to the manufacturer for overhaul.

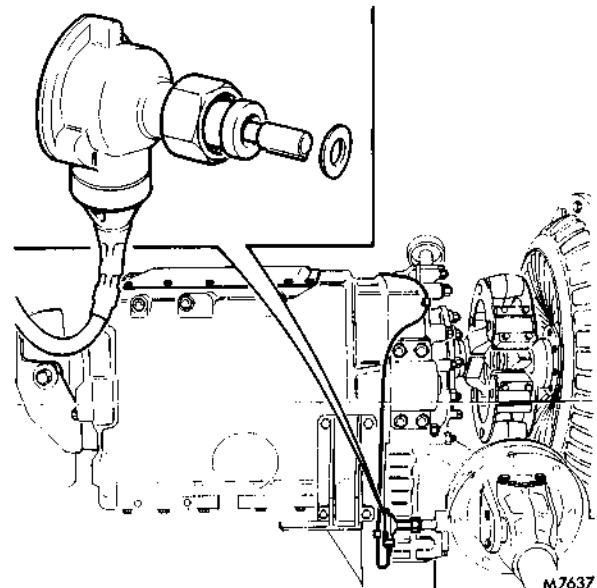


FIG. 2. LOCATION OF PULSE GENERATOR

##### Pulse Generator, Fig. 2

This fifteen pole unit driven via the speedometer gear which is keyed to the transfer box output shaft, at 800 revolutions per mile, produces alternating voltage—interpreted by the instrument.

##### Pulse Generator—To Remove and Refit

1. Disconnect the wiring after sliding the rubber sleeve towards the generator, first slackening the clamp screw.
2. Release the coupling nut and the unit may then be withdrawn from the transfer box output shaft housing.

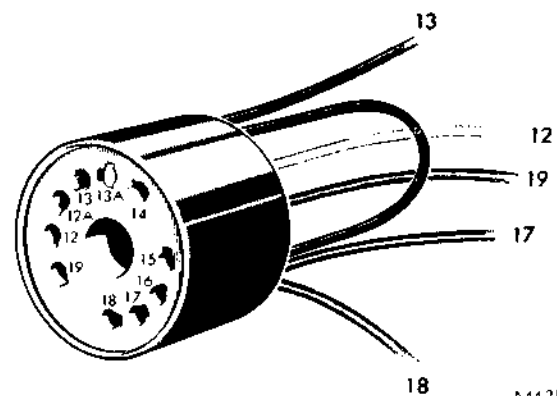


FIG. 3. SOCKET CONNECTIONS—ELECTRONIC SPEEDOMETER

- |                     |                     |
|---------------------|---------------------|
| 12. To A4           | 17. To door switch  |
| 13. Negative return | 18. Pulse generator |
| 16. Negative return | 19. Pulse generator |

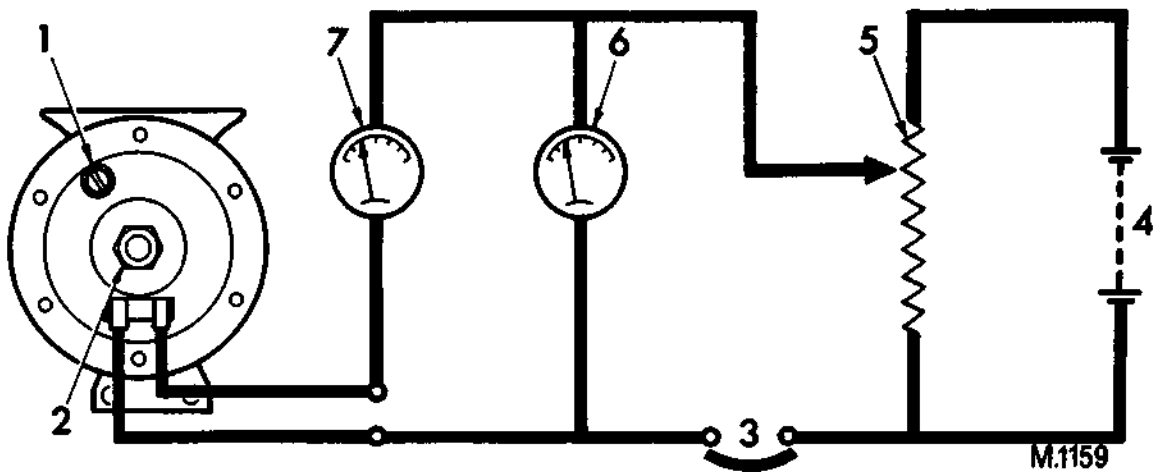


FIG. 2. HORN TEST CIRCUIT

- |                                     |                  |
|-------------------------------------|------------------|
| 1. Contact breaker adjusting screw  | 5. Potentiometer |
| 2. Slotted centre core and lock-nut | 6. Voltmeter     |
| 3. Push-switch                      | 7. Ammeter       |
| 4. Batteries—30 volts               |                  |

The equipment required for setting consists of a 0–30 volt first-grade moving coil voltmeter, a 0–10 ampere first-grade moving coil ammeter, and a battery and potentiometer capable of providing a pure DC supply over the voltage range 20–24–28 volts. Rectified AC is unsuitable.

This completes the coarse adjustment, the fine adjustment should now be carried out as follows:

1. Slacken the centre core nut and lightly rotate the centre core clockwise until it just touches the armature, when opposition to further rotation will be felt.
2. Rotate the centre core anti-clockwise for 1½ turns and lightly tighten the lock nut.
3. After disconnecting the vehicle supply connect each horn in series with an ammeter and horn push, then apply the appropriate nominal voltage to the circuit via the external source.
4. Depress the horn push and note the operating current indicated by the ammeter. If necessary, turn the contact breaker adjusting screw until the correct current is obtained – turning the screw clockwise to increase the current or anti-clockwise to decrease it.

Release the horn push.

1. Set the circuit voltage to the upper limit of 28 volts.
2. Depress the horn push and turn the centre core clockwise until the armature just impacts against the core as indicated by the emission of a harsh note.
3. Turn the centre core anti-clockwise ¼ to ½ turn until a good clear note of adequate volume is emitted.

Release the horn push.

4. Tighten the centre core lock-nut.
5. Depress the horn push and observe the ammeter pointer, turning the contact breaker adjustment screw if necessary until the correct current is obtained. Release the horn push.

When the horns have been adjusted in the manner described a good clear note should be obtained from each over the range 20–28 volts. Any horn which cannot be adjusted satisfactorily should be replaced.

## SECTION 10

## Horns

## HORNS Lucas Type 7H Low Note

## DATA

Resistance of operating coil . . . . .	2.4/2.8 ohms
Current consumption at nominal voltage . . . . .	2.75/3.25 amps
Tightening torque for centre core locknut . . . . .	0.092/1.15 kgf m

## GENERAL DESCRIPTION

The Model 7H Windtone horn operates on the principle of a resonating air column, vibrated by means of a diaphragm, actuated electro-magnetically by a self-interruptory circuit.

These horns are riveted assemblies and cannot normally be dismantled for subsequent re-assembly.

## SERVICING

## Fault Tracing

Before despatch every horn is adjusted to give its best performance and should operate for a considerable period without attention.

If trouble is encountered the fault may not necessarily be in the horns and a check should be made for loose or dirty connections, discharged batteries, loose fixing bolts or a blown fuse. Persistent fuse failure indicates a short circuit in the horn wiring and this should be rectified before renewing the fuse.

If the foregoing points are found to be in order and the horns have been in use a considerable time the contact breaker may need adjustment.

## To Adjust the Contact Breaker

This adjustment does not alter the pitch of the note but merely takes up wear of moving parts. Before adjusting one horn the lead to the other must be disconnected and temporarily secured so that its bare end cannot contact adjacent material. The horn fuse should also be shorted out until the operation is complete.

A small serrated screw is provided on the side of the horn on which the cables terminate and this should be turned anti-clockwise until the horn just fails to sound, then turned forward for about one quarter-turn. If the horn fails to sound after adjustment the horn push must be released immediately.

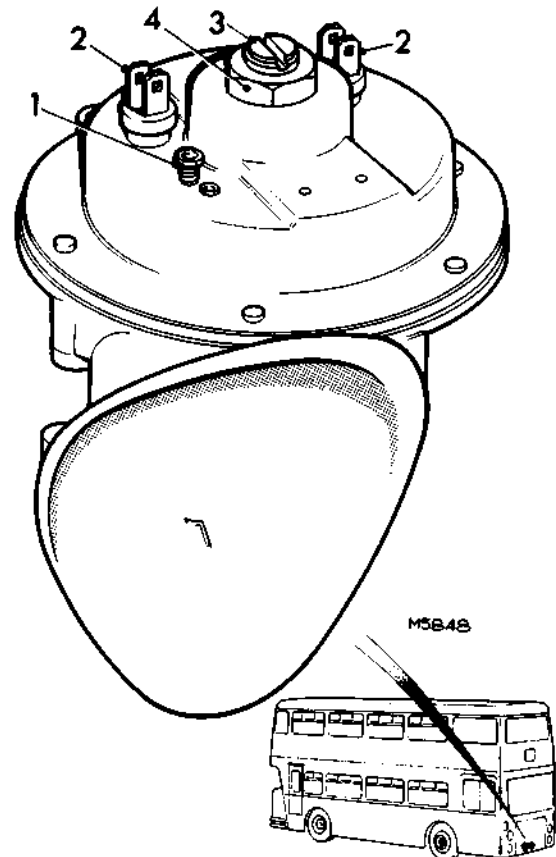


FIG. 1. WINDTONE HORN

- |  |                              |
|--|------------------------------|
| 1. Serrated screw —<br>Contact breaker | 3. Centre core —<br>armature |
| 2. Lucas connector                     | 4. Locknut                   |

**Warning:** It is essential that the slotted centre core and its locking nut are not disturbed when carrying out the above adjustment.

## To Set the Horn Movement

In the event of the armature air gap having been disturbed, the horn movement can be reset as described below.

The method of setting the horn movement is firstly to make coarse adjustment to both the armature air gap and contact breaker and secondly and in the same order, to make critical or fine adjustments of these parts.

**Inspection**

If the contact unit has in any way become damaged it will be necessary to replace the complete unit.

**Setting Contact Unit Gaps**

1. Set each gap to  $1.5 \pm 0.2$  mm ( $0.060 \pm 0.010$  in) by slight adjustment of the respective fixed arm contact.
2. Connect the warning light and reassemble the unit in the main body.
3. Connect a 24 V supply in series with a 24 V 2.8 W light to the supply terminal of the contact unit. Connect the return terminal of the contact unit together with each of the gear selector terminals to the return side of the supply.

**Note:** Correct polarity of connections must be made otherwise the transistorised protection unit will be damaged.

4. Select each gear position in turn and using a spring balance check the force required to separate the contacts. It should be a minimum of 200 gf (7 ozf). The test light will extinguish when the contacts open.
5. If the contact pressures vary a great deal on opposite sides of the terminal block release slightly the contact unit retaining screws then move the unit in the direction of the greatest contact pressure. Re-tighten the screws and check the contact pressure and gaps.

**TRANSISTORISED PROTECTION UNIT, Fig. 2**

The protection unit is mounted within the gear selector switch and should it become faulty it must be replaced.

**Operation of Transistorised (CAV type) System**

Terminals R, A, B, C and D are connected to their respective solenoids which in turn are returned to negative.

The system incorporates a two-transistor circuit arranged so that, in normal operation transistor T1 is 'off' and transistor T2 is 'on'. The base of T2 is connected to the collector of T1 which is held 'off'

while T2 is 'on'. A positive feed to any solenoid is therefore obtained from positive supply via T2 and the gear selector contacts. Diode D1 is connected across the gear solenoids and quenches voltage surge which would be produced by switching off the solenoids. Capacitor C1 is intended to prevent T2 switching 'off' under transient voltage conditions.

If the current drawn through T2 is increased, a point will be reached when the transistor will cease to be in a saturated condition. Above this point, the voltage across the transistor will increase and cause T1 to switch 'on' which will switch T2 'off'. T1 will remain 'on' and hence T2 'off' until the circuit is reset.

The value of the current at which T2 is switched 'off' depends on the resistance in the base circuit R1 and R2. R2 is a variable resistor which is used for setting the switching current of T2.

At normal temperatures the gear solenoids take approximately 0.7 amp and if, due to a fault, two solenoids become energised simultaneously, a total of 1.4 amperes will be drawn. The unit is adjusted so that T2 will turn 'off' at a current value within the range of 1.05 and 1.1 amperes. The faulty operation of any two solenoids together will therefore disconnect all solenoids from the supply. The circuit may be reset by returning the gear selector switch to neutral.

The tight limits of current adjustment permit the unit to function over a wide range of ambient temperature.

**Removal and Refitment**

**To Remove**

1. Remove locking strip and plates.
2. Remove the unit from its mountings, note the position of connections, and then disconnect them.

**To Refit**

Refitment is a reversal of the removal procedure but care must be taken to connect wires to their respective terminals.

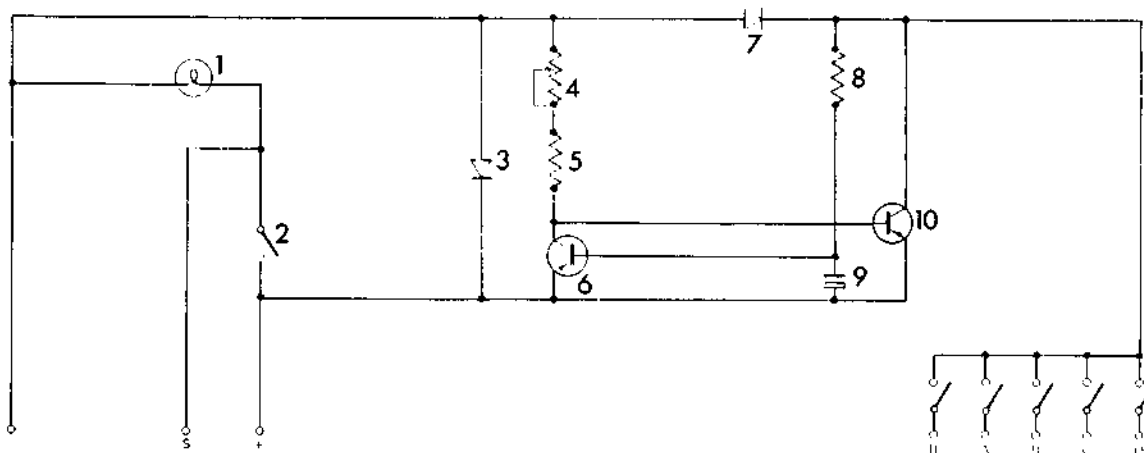


FIG. 2 TRANSISTORISED TWO GEAR PROTECTION CIRCUIT

- |                        |                    |                     |
|------------------------|--------------------|---------------------|
| 1. Warning lamp        | 4. Resistor (R2)   | 7. Diode (D2)       |
| 2. Warning lamp switch | 5. Resistor (R1)   | 8. Resistor (R3)    |
| 3. Diode (D1)          | 6. Transistor (T1) | 9. Capacitor (C1)   |
|                        |                    | 10. Transistor (T2) |

M5510A



## SECTION 11

## Gear Selector Switches

## SEMI-AUTOMATIC ELECTRO-PNEUMATIC

## Description

The electro-pneumatic gear change system consists of two major components—the selector switch and the electro-pneumatic valve unit.

The column mounted switch comprises a selector lever, an operating cam, a contact unit and a transistorised protection unit. A latch prevents direct down changes from top gear without engagement of the next lower gear and a plunger prevents inadvertent engagement of reverse gear whilst the vehicle is moving forward. A similar device may be fitted to protect first gear. A warning light, mounted in the centre of the indicator plate, illuminates when the selector is in neutral or if the protection unit detects an electrical malfunction.

The electro-pneumatic valve unit houses five solenoids and valves, with an additional valve unit mounted adjacent to the main unit. The air feed is taken via the limiting valve from the auxiliary reservoir. The unit is located rear of the bulkhead and is accessible from behind the off side engine canopy. See Section 6 for further details.

Selection of a gear position closes a corresponding set of contacts and in turn the respective solenoid is energised causing the plunger valve to be withdrawn and so allow air to pass to the gearbox.

## REMOVAL AND REFITMENT

## To Remove

1. Withdraw the mounting bolts and remove the selector switch from the instrument panel.
2. Remove the locking strip and terminal cover plates.
3. Record the location point of each connection and then disconnect. Withdraw the cables through the guides taking care not to damage the contact unit.

## To Refit

Refitment is a reversal of the removal procedure.

## CONTACT UNIT

## To Remove

1. Remove the gear selector switch.
2. Remove the four setscrews fastening the contact unit into the housing, note the position of the cable connections and then disconnect them. Withdraw the contact unit.

## To Refit

Refitment is a reversal of the removal procedure.

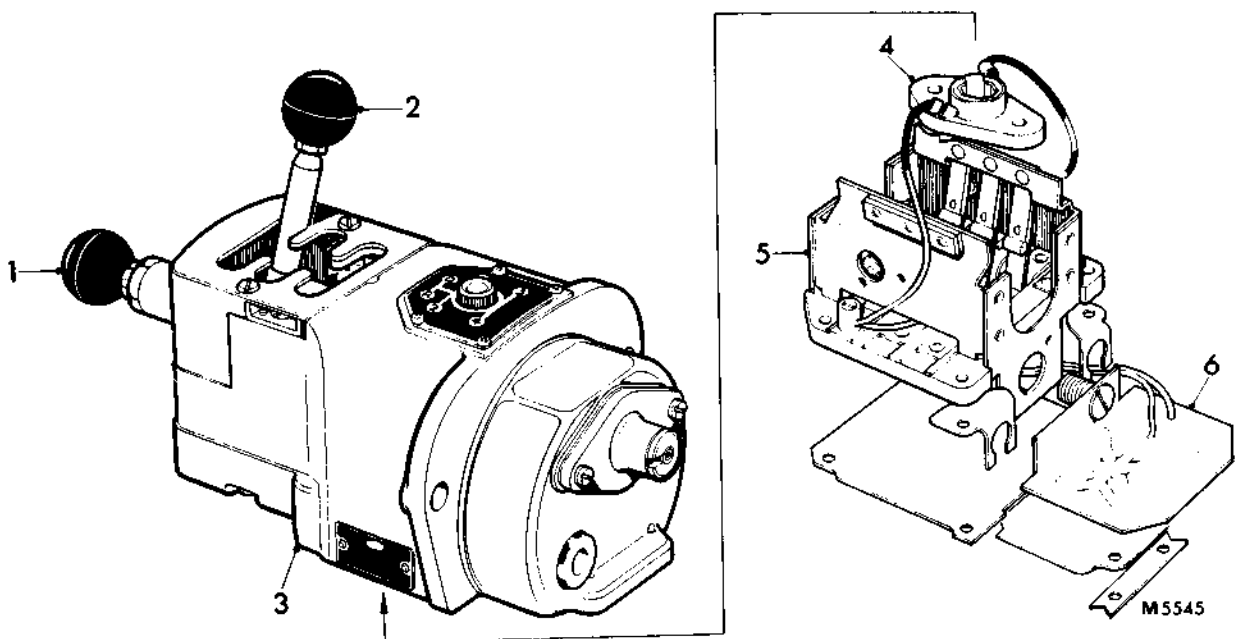


FIG. 1 EXPLODED VIEW OF SELECTOR SWITCH

- |                                    |                                   |
|------------------------------------|-----------------------------------|
| 1. Reverse gear protection plunger | 4. Bulb holder                    |
| 2. Selector lever                  | 5. Contact unit                   |
| 3. Switch body                     | 6. Transistorised protection unit |

Remove the securing nuts and washers from the contact holder (1) and withdraw same. Remove the common terminal board.

Thoroughly clean the interior and exterior of the valve body (4) with a suitable cleaning fluid and dry with compressed air. Do not use fluffy rags. Clean all dismantled parts. Inspect the felt seal pads on either end of the slot in the solenoid mounting face and, if necessary, renew.

Examine the seats in the valve seat block (10). If any seat is scored or worn, the valve seat must be removed and a new block inserted.

Tool, Fig. 4, for re-forming seats on a valve seat (10) and for removing and inserting a valve seat in a body, may be manufactured locally.

To re-form a valve seat in a valve body position the tool – pointed end of item 1 Fig. 4, in the defective seat and gently tap the tool with a light hammer. After a few taps, the seat should be re-formed.

To remove a valve seat (10) from a valve body (4), proceed as follows:

Remove the circlip (11). Place the valve body in a press with the valve plug side of valve body upwards.

Pass the special tool, item 2 Fig. 4, through the valve plug hole and push the small diameter end of the tool in the valve seat (10).

Hold the tool upright and ensure that the tool shoulder is flat on the face of the valve seat. Press out the valve seat.

To insert a new valve seat (10) in a valve body (4) proceed as follows:

Lightly grease the outside of the valve seat and the inside of its location in the valve body. Place the valve body in a press, or on a flat surface, with the solenoid mounting side of the body upwards.

Place the small end of the valve seat (10) on the opening in the valve body (4) ensuring that the side air ports in the valve seat and the body are aligned.

Push the small diameter end of the special tool, item 3 Fig. 4 into the hole in the valve seat (10) Fig. 3. Hold the tool upright and ensure that the tool shoulder is flat on the face of the valve seat. Press the valve seat into the body until the face of the flange on the valve seat is seated squarely on the body. Alternatively, a light hammer may be used to drive the valve seat into the body.

Insert the circlip (11).

To free a sticking armature in the solenoid core, the solenoid (13) must first be removed from the valve unit and dismantled. Thorough cleaning of the parts in a volatile liquid and drying in an air jet will remove the cause of sticking.

To dismantle and assemble a solenoid proceed as follows:

Remove the stirrup by carefully closing the splayed ends and withdrawing the stirrup from the base.

Remove the armature and the washer. Wash the parts, thoroughly dry with an air jet.

Insert the washer, lightly smear the armature with an electrical contact grease – Elvolute – and insert it in the case.

Assemble the stirrup to the base by pushing the split ends through the apertures in the base. Secure the stirrup to the base by opening the split ends and tapping the ends over.

### To Reassemble, Fig. 3

All joint washers should be renewed.

1. Insert the plunger valves (5) in the valve seats (10), fit the springs (6) and secure the assembled parts by screwing and tightening the valve plugs (7) and washers in the valve body (4).
2. Connect the valve unit to a test rig comprised of:  
An air pressure vessel with a minimum capacity of 5.6 kgf/cm<sup>2</sup> (80 lbf/in<sup>2</sup>).  
A pressure gauge with a full scale deflection 0 – 7.0 kgf/cm<sup>2</sup> (0 – 100 lbf/in<sup>2</sup>).  
Two valves, one for regulating the air pressure, the other for cutting off the supply to the pressure vessel.  
Five screwed blanks for sealing the air outlets – these can be adapted from union nuts.
3. Fit the five blanks to the air outlets.
4. Turn on the air supply and adjust the regulating valve to obtain a pressure of 5.6 kgf/cm<sup>2</sup> (80 lbf/in<sup>2</sup>) in the test set. Close the supply valve.
5. The unit is acceptable when the air pressure indicated on the gauge does not fall below 2.8 kgf/cm<sup>2</sup> (40 lbf/in<sup>2</sup>) after five minutes in the condition at Operation 4.





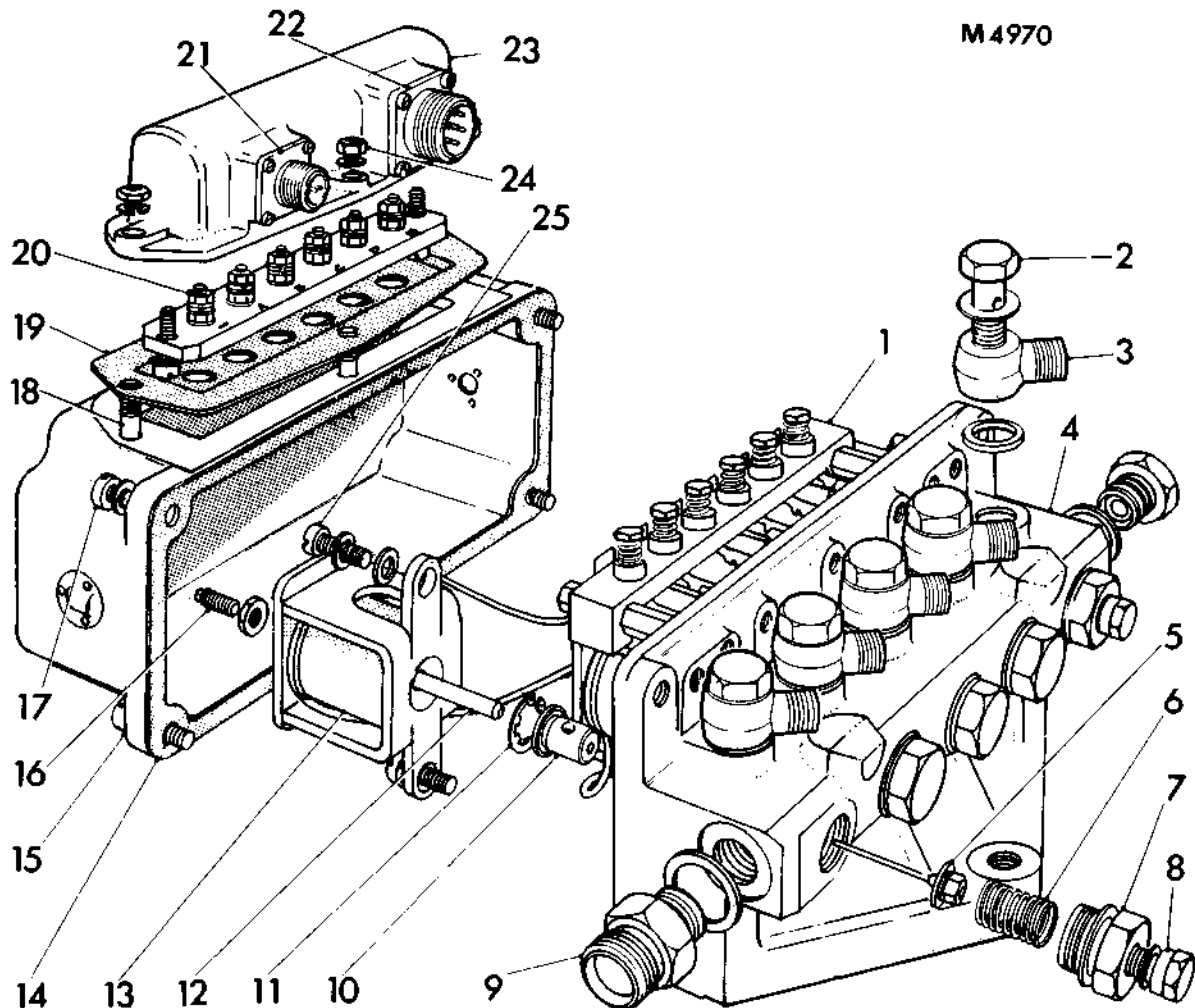


FIG. 3. 5-WAY ELECTRO-PNEUMATIC VALVE

- |                     |                        |                     |                    |
|---------------------|------------------------|---------------------|--------------------|
| 1. Contact holder   | 8. Drain plug          | 14. Gasket          | 20. Terminal strip |
| 2. Screw—air outlet | 9. Connector—air inlet | 15. Cover           | 21. Plug, 2-pin    |
| 3. Pipe connector   | 10. Valve seat         | 16. Adjusting screw | 22. Plug, 7-pin    |
| 4. Valve body       | 11. Circlip            | 17. Screw           | 23. Cover          |
| 5. Plunger valve    | 12. Valve rod          | 18. Stud            | 24. Nut            |
| 6. Spring           | 13. Solenoid           | 19. Gasket          | 25. Screw          |
| 7. Valve plug       |                        |                     |                    |

### 5-Way Electro-Pneumatic Valve Unit

#### Maintenance

Lubrication is not required within the valve, and the only item which needs occasional attention is the drain plug (8) which must be removed to allow any water which may have accumulated in the high pressure gallery to be drained away. The accumulation of water is caused by the moisture content of the compressed air and the quantity depends upon climatic conditions.

### REMOVAL AND REFITMENT

#### To Remove

Open the isolation switch. Exhaust the auxiliary air reservoir and remove the pipes from the air inlet (9) Fig. 3 and outlet connections. Note and record the location of each pipe for correct subsequent re-assembly. Unscrew both wiring connector sockets. Remove three securing bolts retaining the unit to the gearbox — withdraw unit.

#### To Refit

Refitment is a reversal of the removal procedure.

### OVERHAUL

#### To Dismantle, Fig. 3

Remove cover (23) Fig. 10 after releasing four nuts (24) with washers. Release the four screws (17) with washers, then remove the cover (15). Unsolder and remove the solenoid cables from the terminal tags on the contact holder (1). Disconnect the remaining cables from the common terminal block — noting and recording the location of each tag to ensure correct re-assembly. Remove the solenoid fixing screws (25), then carefully withdraw vertically each solenoid (13) and its associated valve rod (12) clear of the plunger valve (5) and the valve seat block (10). Remove the valve rod from the solenoid. Remove each valve plug (7) and washer, spring (6) and plunger valve.



6. Remove the valve unit from the test set.
7. Insert the valve rods (12). Fit and secure the solenoids (13) in position on the valve body.

**Note:** If a leaking valve is detected the valve seat can be re-formed as previously described.

8. Reconnect the air inlet on the valve unit to the test set and repeat Operations 4 and 5. Operate the solenoid manually to check the exhaust valve seal.

**Note:** Leaking exhaust valves may sometimes be rectified by slightly loosening the solenoid fixing screws (25) and re-positioning the solenoid with the air supply connected. Small gentle movements of the solenoid on its mounting will align the valves accurately and should afford a good seal.

Secure the solenoid in the correct position. Repeat Operations 4 and 5.

9. The backlash on valve travel is adjusted on each solenoid with the unit connected to the test set and the air pressure maintained at 5.6 kgf/cm<sup>2</sup> (80 lbf/in<sup>2</sup>). The solenoids being manually operated.
10. Unscrew the solenoid locknut and screw the adjusting grub screw (16) into the armature until the plunger valve (5) is just lifted off its seat and the valve commences to leak. Unscrew the grub screw until the leak is just stopped. Unscrewing the grub screw an additional one-third turn (two flats on the locknut) will give the required backlash.
11. Hold the grub screw in this position and tighten the locknut. To prevent any alteration of the setting during operation, carefully paint the threads of the grub screw and the locknut with shellac before tightening them.

17. Refit covers (15) and (23).
18. Remove the blanking unions.
12. Carry out Operations 9, 10 and 11 on all valves.
13. Repeat the tests on Operations 2, 3, 4, 5 and 6.
14. Fit and secure the contact holder (1) on the pillars.
15. Connect the solenoid cables to the appropriate terminal screws, fit and tighten the securing nuts.
16. Carry out tests in Operations 2, 3, 4, 5 and 6. Operate each solenoid in turn — temporarily connect in sequence one side of a 24 V DC supply to each terminal and the other side to its common terminal 'G'.

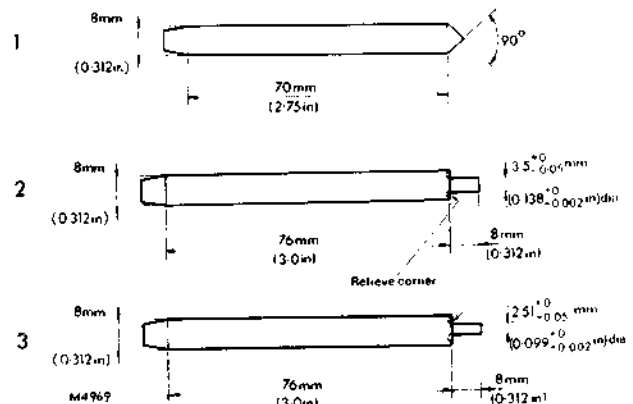


FIG. 4. VALVE SEAT TOOLS

Material — Item 1, Silver steel, hardened and ground.  
Item 2, 3, Mild Steel, fine turned finish

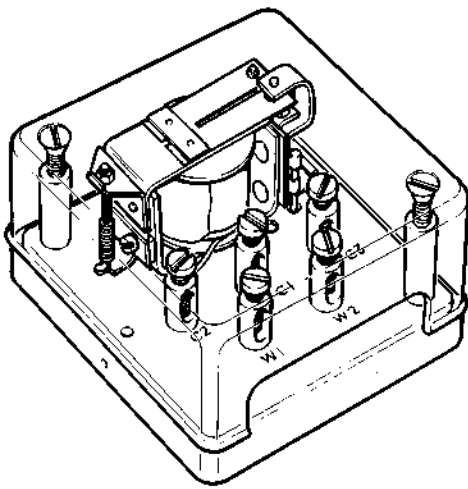
**Starter-Isolation Relay**

**DATA**

Type .....	CAV 247/19
Nominal voltage .....	24 volts
Shunt coil pull-in voltage .....	22-24 volts
Drop-off voltage .....	200 ± 10 ohms
Shunt coil resistance .....	3-4

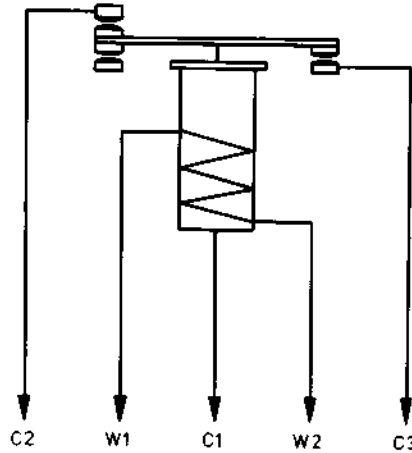
Operation of the above relay is covered in Section 1, page 8-1-2.

A relay not meeting the electrical parameters contained in the above paragraphs should be replaced.



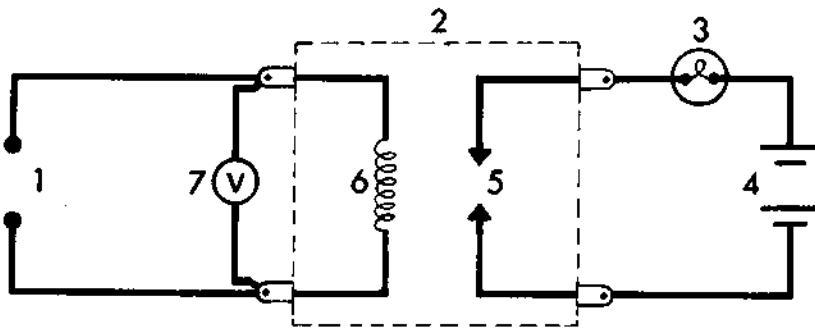
M7629

FIG. 3. STARTER ISOLATION RELAY



M7635

FIG. 4. STARTER ISOLATION RELAY CIRCUIT



M3858

FIG. 5. TEST CIRCUIT-RELAY CUT-IN AND DROP-OFF VOLTAGES

- |                         |                   |
|-------------------------|-------------------|
| 1. Variable d.c. supply | 5. Relay contacts |
| 2. Relay                | 6. Operating coil |
| 3. Test bulb (12V 2.2W) | 7. Voltmeter      |
| 4. 12V battery          |                   |

## SECTION 13

## Relays

## 6RA

## DATA

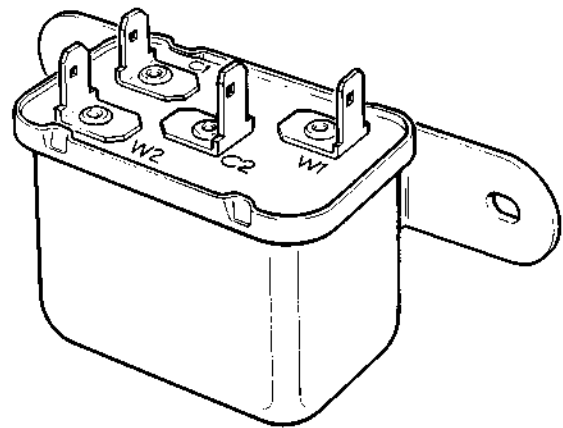
Nominal voltage .....	24 volts
Cut-in voltage .....	16-18 volts
Drop-off voltage .....	8 min
Coil resistance .....	258 ohms
Core air gap closed .....	$0.015 \pm 0.003$
Core air gap open .....	$0.040 \pm 0.005$

Lucas 6RA relays are used in the following circuits:

1. Water temperature
2. Low air pressure
3. Engine stop

Relays 1 and 2 are mounted on the front relay panel and relay 3 is mounted adjacent to the starter isolation relay to the front of the engine bulkhead.

Most relays are permanently sealed and in some cases water-proofed by neoprene dipping. If care is taken to remove the cover, adjustments can be carried out providing suitable facilities are available.



M7633

FIG. 1. 6RA RELAY

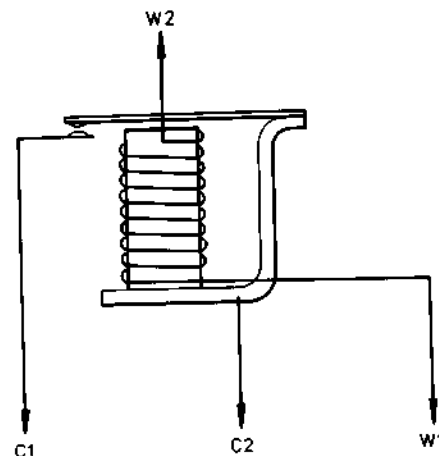
**Adjustment of Cut-in and Drop-off voltages**

The cut-in voltage is raised by increasing the gap between the bobbin core and the underside of the armature, and lowered by decreasing it. Adjustment is carried out on relays having normally open contacts by bending the armature stop plate with a suitable slotted tool. Relays having normally closed contacts are adjusted by bending the fixed contact post.

The drop-off voltage is adjusted by bending the fixed contact post. Upwards to raise the drop-off voltage, downwards to lower it. (Applies only to relays having normally open contacts.)

A variable d.c. voltage supply is required to adjust both cut-in and drop-off settings. This should be connected across the relay operating coil with a suitable moving coil voltmeter connected in parallel. A test bulb with battery should also be connected across the contacts to denote the exact movement the contacts make or break, Fig. 5.

The cut-in and drop-off voltages or current should be checked after adjustments by raising the voltage or current slowly from zero to 125% of the nominal setting and then reducing it below the drop-off value.



M7634

FIG. 2. 6RA RELAY CIRCUIT