Bristol VRT-3
Index

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 kgf/cm^2 (120 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.

Emergency Release of Spring Applied Parking Brake

To release the spring applied parking brakes when the engine cannot be run to charge the air system, an external airline may be connected to the auto-shut-off valve at the front of the vehicle—workshop airline type coupling.
The supply pressure should be 7.0 kgf/cm^2 (100 lbf/in^2) minimum 8.4 kgf/cm^2 (120 lbf/in^2) maximum.

WARNING—Before connecting an external airline, move the parking brake control to PARK 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 minimises 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.

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.

GENERAL RECOMMENDATIONS

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 are threaded 1 in B.S.F., fitted to the front frame member as standard equipment.
Similar brackets may be fitted as optional equipment to the rear frame member.
The brackets are for towing only and must not be used to lift the vehicle.
Always use a rigid tow bar if the brakes have been wound off.

Tyre Care
Always maintain the tyres at the correct pressures. If non-standard tyre equipment is fitted consult the tyre manufacturer for operating pressure.

At regular periods check that tyres conform to legal requirements. Remove any flints or sharp objects from the tread, if neglected these may penetrate the cover and damage the cords.

Vulcanise damaged tyre if necessary. Remove oil or grease using a suitable solvent; DO NOT use paraffin (kerosene).

Vehicle Jacking
The vehicle should be raised using suitable jacking equipment. Do not work beneath the vehicle with a jack as the sole means of support.

Renewing the Tyres
It is recommended that tyres of the same sizes and construction as the originals be fitted. Do not fit tyres with a lower load rating than is legally required for the axle; if in doubt, consult the nearest Distributor or Dealer.

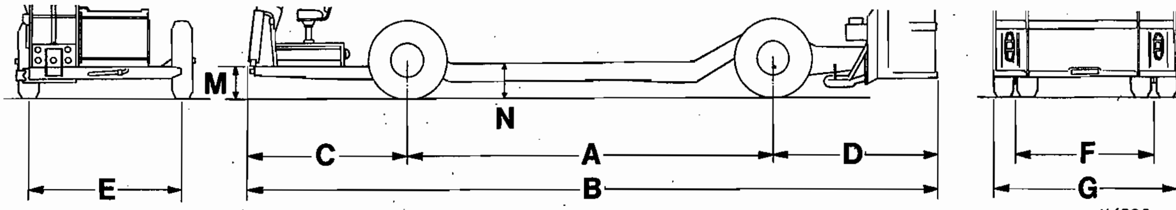
Cross-ply and Radial-ply Tyres
The vehicle should always be fitted with a complete set of cross-ply or radial-ply tyres. It is only legal to fit both types to a vehicle when radial-ply tyres are fitted to the rear wheels and cross-ply tyres are fitted to the front wheels. Any other combination is dangerous.

MODEL RANGE

The models covered by this manual are:

Bristol VRT 3

Chassis Identification	V	R	T /	S	L —	(L	H) or	(L	L)
Vertical engine	V								
Rear engine		R							
Transverse engine			T						
Short wheelbase				S					
Low frame					L			L	
Long wheelbase						L			L
High frame							H		



M6805

Nominal Chassis Dimensions

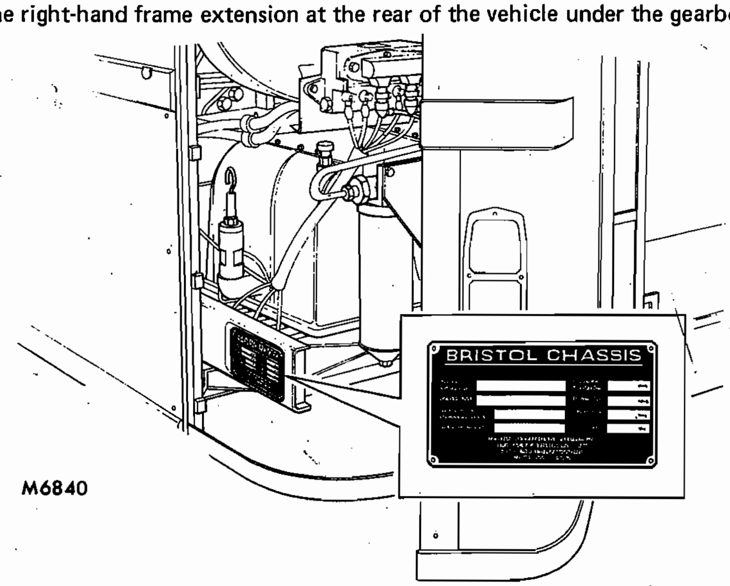
MODEL	A	B	C	D	E	F	G	FRAME WIDTH	M	N
VRT/SL	4928 mm 194 in	9322 mm 367 in	2210 mm 87 in	2184 mm 86 in	2102 mm 82.75 in	1892 mm 74.5 in	2464 mm 97 in	1168 mm 46 in	432 mm 17 in	457 mm 18 in
VRT/LH	5638 mm 222 in	10033 mm 395 in	2210 mm 87 in	2184 mm 86 in	2102 mm 82.75 in	1892 mm 74.5 in	2464 mm 97 in	1168 mm 46 in	432 mm 17 in	533 mm 21 in
VRT/LL	5638 mm 222 in	10033 mm 395 in	2210 mm 87 in	2184 mm 86 in	2102 mm 82.75 in	1892 mm 74.5 in	2464 mm 97 in	1168 mm 46 in	432 mm 17 in	457 mm 18 in

Approximate Chassis Weights

MODEL	CHASSIS WEIGHT DRY			CHASSIS KERB WEIGHT			PAYLOAD INCLUDING BODY	GROSS VEHICLE WEIGHT
	FRONT AXLE	REAR AXLE	TOTAL	FRONT AXLE	REAR AXLE	TOTAL		
VRT/SL	1373 kg 3024 lb	4249 kg 9360 lb	5745 kg 12665 lb	1424 kg 3136 lb	4525 kg 9968 lb	5949 kg 13104 lb	9312 kg 20512 lb	15261 kg 33616 lb
VRT/LH	1515 kg 3338 lb	4299 kg 9469 lb	5814 kg 12807 lb	1566 kg 3450 lb	4452 kg 9807 lb	6018 kg 13257 lb	9312 kg 20512 lb	15330 kg 33768 lb
VRT/LL	1515 kg 3338 lb	4299 kg 9469 lb	5814 kg 12807 lb	1566 kg 3450 lb	4452 kg 9807 lb	6018 kg 13257 lb	9312 kg 20512 lb	15330 kg 33768 lb

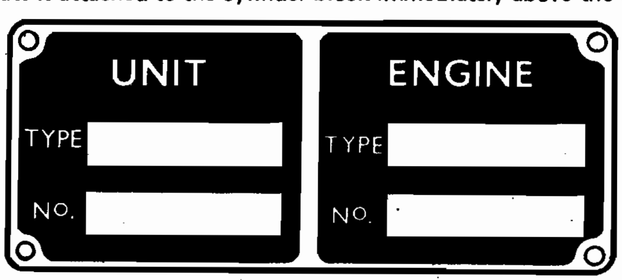
Identification Plates

The chassis identification plate, which carries details of the chassis and engine numbers, engine type and axle ratio, is attached to the right-hand frame extension at the rear of the vehicle under the gearbox.



M6840

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



M2532

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

GENERAL DATA

Engine – Leyland

Types	510 and 501 (8.2 litres) turbocharged
Number of cylinders	Six
Bore	118 mm (4.65 in)
Stroke	125 mm (4.92 in)
Net installed hp (approximate)	129 kW (170 bhp) at 2000 rev/min
Maximum torque (approximate)	742 kW (525 lbf at 1200 rev/min)
Compression ratio	15.4:1
Firing order	1, 5, 3, 6, 2, 4
Oil pressure	4/4.5 kgf/cm^2 (57/64 lbf/in^2) at normal running speeds 1.05 kgf/cm^2 (15 lbf/in^2) at idling speed
Fuel injection pump	C.A.V. NN type
Starting aid	Thermostart '357' coldstart (when fitted)
Main fuel filter	Double agglomerator type
Approximate weight (for lifting purposes)	1840 lb

Gearbox

Type . . . . . 5-speed pneumocyclic close ratio with fully automatic or semi-automatic gear selection

Ratios

1st	2nd	3rd	4th	5th
5.204 : 1	3.226 : 1	2.123 : 1	1.502 : 1	1.00 : 1
Rev.				
3.73:1				

Fluid coupling

Type . . . . . Fully charged

Steering Gear

Ratio	25.2:1—power assisted. 29.6:1—manual straight ahead. 50.4:1—at full lock.
Number of turns of steering wheel, lock to lock	5.75 turns—power assisted. 7.5 turns—manual.
Front wheel alignment	Parallel to 1.5 mm (.0625 in) toe in at rim of wheel.
Turning circle (approximate)	2138 mm (840 in).

Rear Axle . . . . . Dropped centre, double reduction.

Ratios 3.8:1 4.2:1 4.79:1 5.27:1
Including gearbox transfer gearing.

Brake System

Type . . . . . Dual circuit air pressure system.

Operation	
Footbrake	Air pressure operating front and rear brakes.
Parking brake	Spring brake actuators operating rear brakes only.
Brake shoe adjustment	Slack adjuster on brake camshaft.
Brake lining running clearance	0,41 mm (0.016 in).
Minimum brake lining thickness	4.8 mm (0.19 in).

Electrical Equipment

Voltage	24 volt insulated return throughout.
Batteries	2-12V 80 amp/hr rating.
Charging system—Leyland	Butec type A24AB, 60 amp output alternator and reverse polarity relay.
—Gardner	CAV type AC203 60 amp output alternator with transistorised voltage regulator and reverse polarity relay.

Lamp bulbs

Headlamps	24V x 54.44W.
Side lamps	24V x 6W S.B.C.
Tail lamps	24V x 6W S.B.C.
Stop lamps	12V x 6W S.B.C.
Panel and warning lamps	14V x 24W M.E.S.
Flasher lamps	12V x 21W S.B.C.
Reversing lamp	12V x 21W S.B.C.
Fog lamp	24V x 44W S.B.C.
Fuses	10 amp—one strand 34 SWG tinned copper wire 0.233 mm (0.0092 in) diameter.

Suspension

Front and rear springs	Laminated semi-elliptical type springs with rolled eyes and plain bushes.
Shock absorbers	Hydraulic telescopic—double acting.
Wheels	3 piece welded—10 stud fixing.

Unit Capacities

	litres	pints
Leyland engine including heat exchanger and oil filter	22.5	39
Gearbox including fluid coupling and mitre box	39.8	70
Rear axle	17	30
Power assisted steering box	8.5	15
Manual steering box	2.6	4.5
Automatic lubrication	4.54	8
Fuel tanks	227	400
Cooling system	63.6	112 ¼

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. The procedure to be adopted when carrying out these operations is given in the applicable Groups, when necessary.

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.

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

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 fan mountings.
5. Clean the fuel filters and agglomerators.
6. Check for oil, water or fuel leaks.
7. Check the oil pressure.
8. Reset the valve clearances.
9. Check the engine timing.
10. Check the engine idling speed.
11. Check the drive belt tension.
12. Check the injector opening pressure and the spray pattern.
13. Lightly grease the performance (kick-down) switch plunger. Lift the guide tube for access.
14. Check operation of performance (kick-down) switch, see Group 8. For correct setting see Group 2.
15. Check the operation of the throttle dip (override) control, see Group 2.

Fluid Coupling and Transmission

1. Drain the fluid coupling, mitre and gearbox. Clean filter and refill the system with correct type and grade of lubricant.
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, 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 and refill with correct fluid.
7. Renew power steering reservoir filter.

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.

Brakes and Air System

1. Check operation of automatic slack adjusters.
2. Check security of foot brake valve at mounting.
3. Lubricate pedal linkage and ensure that the pedal returns fully.
4. Check torque setting of spring brake chamber release bolts.
5. Check that warning tags are legible on spring brake chambers.
6. Check clamping rings and brake chambers for security.
7. Examine all air valves for security.
8. Carry out air system pressure test, see Group 7.
9. Check output pressure of limiting valve and adjust if necessary. See Group 4 Data for correct pressure setting.

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.
4. Check headlight beam settings.

Chassis and Auxiliaries

1. Visually check all points fed by the automatic lubrication system when fitted, 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.

DAILY CHECKS

Engine

1. Check the engine oil level and top up if necessary.
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 main beam, dip, side, tail and stop light.
4. Test the operation of the direction indicators and the monitor light.
5. Inspect the interior lights and the courtesy light 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 and service if required.
2. Top up anti-freeze evaporator bottle if fitted.
3. Drain engine mounted filter agglomerator.
4. Drain chassis mounted sedimenter.
5. Clean fuel pre-filter gauze and replace.

Gearbox

1. Check and top up if necessary.

Steering Gear

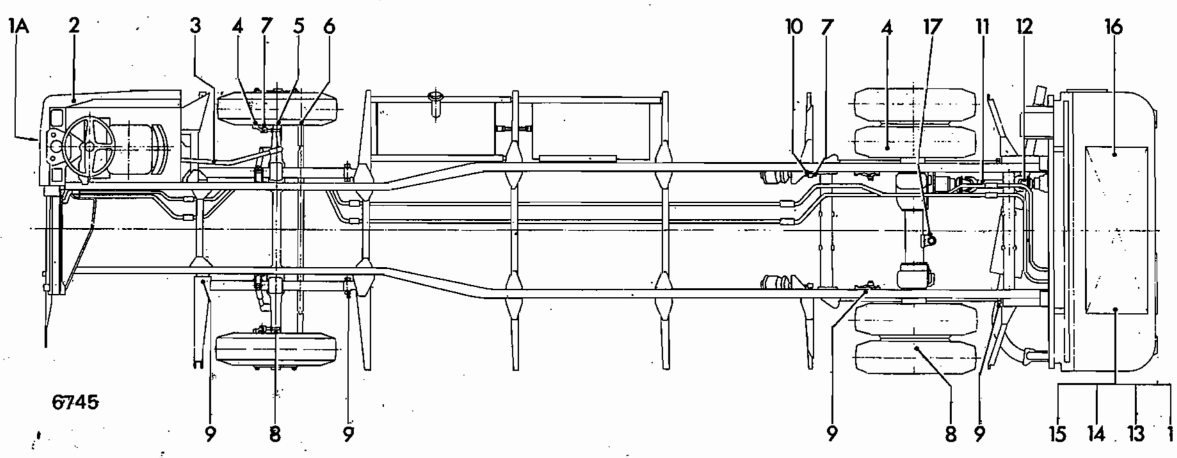
1. Check and top up if required, the power steering reservoir.

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.



LUBRICATION DIAGRAM

Component	Number of points
1. Power steering	1
1A. Manual steering	1
2. Accelerator pedal	3
3. Drag link	2
4. Brake camshafts	4
5. King pin top and bottom	4
6. Track rods	2
7. Brake pivot pins	8
8. Hub bearings	4
9. Spring shackles	12
10. Brake transfer levers	2
11. Propeller shaft splines	1
12. Propeller shaft universal joints	2
13. Alternator	1
14. Starter	3
15. Engine oil filler and dipstick	1
16. Fully charged coupling and gearbox	1
17. Rear axle	1

LUBRICATION—SERVICES

	EVERY KM x 1000	EVERY MILES x 1000
Engine		
Change engine oil and renew oil filter element Grease water pump bearings . . . . Grease fan shaft joints and splines . . . . . . Grease fan centre bearing	20	12.5
Transmission		
Change oil and clean the filter in fully charged transmission . . . . Includes fluid coupling, gearbox and mitre box	20	12.5
Front Axle		
Clean and re-pack hubs with grease	ANNUALLY	
Electrical		
Re-charge starter motor wick lubricator . . Grease starter motor drive end bush and splines	ANNUALLY	
Rear Axle		
Clean and re-pack hubs with grease	ANNUALLY	
Change oil in axle casing	40	25
Steering Gear		
Change filter and fluid in power steering system	ANNUALLY	
Chassis and Suspension		
Grease prop-shaft splines and joints . . . . Lubricate foot brake pedal linkage	8	5
Lightly grease performance (kick-down) switch plunger. Lift guide tube for access . .	40	25

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

COMPONENT	No. OF POINTS	COMPONENT	No. OF POINTS
King-pins	4	Fan shaft bearing	1
Drag-link ends	3	Spring shackles	12
Relay lever pivot	1	Steering box	1
Track-rod ends	2	Power steering ram	3
Brake pedal pivot	1	Slack adjuster	4

MAINTENANCE SERVICES

	EVERY	
	KM x 1000	MILES x 1000
Engine		
Check drive belt tension	10	6
Check engine for loose pipe and manifold connections etc.		
Examine air filters—service if necessary	20	12.5
Change fuel filter elements—clean filter bowls		
Remove compressor delivery pipe, check for carbon, clean if necessary		
Drain sedimenter (when fitted)		
Check inlet and exhaust valve clearances		
Remove heat exchanger and clean—when fitted	40	25
Check water pump, overhaul if necessary		
Remove, clean and check thermostat		
Check operation of performance (kick-down) switch, see Group 8. For correct setting see Group 2		
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		
Cooling System		
Drain system, flush out and refill	AUTUMN	
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	10	6
Check for oil leakage and rectify any fault immediately		
Gearbox, Mitre Box and Propeller Shaft		
Check propeller shaft joints and splines for wear and flange securing bolts for tightness—rectify if required		
Check for leakage at limiting valve and connections using a soap solution	20	12.5
Check top speed piston travel		
Check security of nuts, bolts, setscrews, unions		
Check gearbox piston seals. See Group 4		
Examine feed pipes from electro-pneumatic unit for security.		
Install air gauge at limiting valve output and check output pressure	40	25
Electro-pneumatic valve—remove drain plugs and drain off any condensate	20	12.5

	EVERY	
	KM x 1000	MILES x 1000
Front Axle and Steering Gear		
Inspect drop arm for security	40	25
Examine drag link ends for wear, check clamp bolts are secured		
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	ANNUALLY	
Rear Axle		
Check joints for leakage	40	25
Check tightness of all nuts, bolts and setscrews		
Remove axle breather and clean in paraffin .		
Check/adjust hub bearing end float. See Group 6	ANNUALLY	
Brakes		
Check brake linings for wear, see Group 7, renew or adjust as necessary	10	6
Check operation of slack adjusters. See Group 7		
Check security of foot brake valve at mounting		
Ensure pedal returns to fully released position		
Check torque setting of spring brake chamber release bolts	20	12.5
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 automatic condensate drain valve situated below condenser unit and clean the filter	see Ref. 1–2–6	
Test the air pressure system. See Group 7 . .	40	25
Electrical System		
Check, and adjust if required, the alternator drive belt tension. Clean the alternator externally paying particular attention to ventilation slots	20	12.5
Generally check for security and cleanliness the battery, flasher relay, voltage regulator, relay panel and starter motor		
Check the headlamp beam settings	ANNUALLY	
Check the starter motor brushes and commutator		
Check the connections at the starter motor and alternator for cleanliness and security . .		

	EVERY	
	KM x 1000	MILES x 1000
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	40	25
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		

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

BENDIX WESTINGHOUSE

Every year at 80 000 km (50 000 miles)

Safety valve—renew
Pressure regulating valve—renew
Hand control valve—overhaul
Double check valve—overhaul
Single diaphragm brake chambers—overhaul
Spring brake actuators—overhaul
Quick release valve—overhaul
Double check valve—overhaul

SAB

Every 2 years or 160 000 km (100 000 miles)
Automatic slack adjusters—overhaul

CLAYTON DEWANDRE

Every three months or 40 000 km (25 000 miles)
Condenser and drain valve filter—clean

Every six months or 80 000 km (50 000 miles)
Condenser and drain valve—overhaul

Every year or 80 000 km (50 000 miles)

Compressor cylinder head—overhaul
Unloader valve—overhaul
Foot brake valve—overhaul
Condenser and drain valve—overhaul
Pressure protection valve—overhaul
Single diaphragm brake chambers—overhaul

Every 2 years or 160 000 km (100 000 miles)

Non-return valve—renew
Stop light switch—overhaul
Low pressure switch—overhaul

Every 2 years or 240 000 km (150 000 miles)
Compressor—overhaul

LUBRICATION PROCEDURE

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.

Some assemblies are only dismantled for lubrication at docking or overhaul. These parts, however, will require more frequent attention if the vehicle operates under exceptionally arduous conditions, which can only be determined by local experience or by periodic inspection of representative units.

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

Engine (Fig. 2)

Lift engine cover and check the oil level with the dipstick (1). To top-up or fill the sump lift the filler cap (2) and add specified oil until the level registers with the full mark on the dipstick. When filling the sump after oil filter element renewal, run the engine to prime the filter and top-up if necessary.

To drain the sump remove the sump plug (3) and drain the oil into suitable container. Replace plug when drainage is complete. While the sump is draining renew the oil filter element.

Power Steering Reservoir (Fig. 3)

Remove reservoir cap and check level on attached dipstick. Top-up if required.

Starter Motor (Fig. 4)

Add a few drops of engine oil in each of the three wick lubricators indicated.

Gearbox, Fluid Coupling and Mitre Box

It is imperative that the correct oil is used in the system; lubricants normally associated with heavy duty and semi-automatic gearboxes are not adequate to meet the combined operating requirement of gearbox and fluid coupling. The oil must conform to Leyland Specification E Approved Grades Only. Refer to Section 3 for lubricant and approximate capacities.

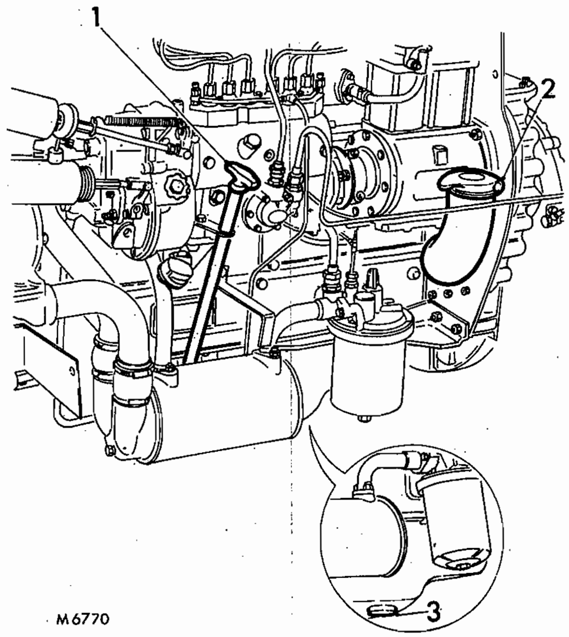


FIG. 2 ENGINE FILLER

1. Dipstick 2. Filler 3. Drain plug

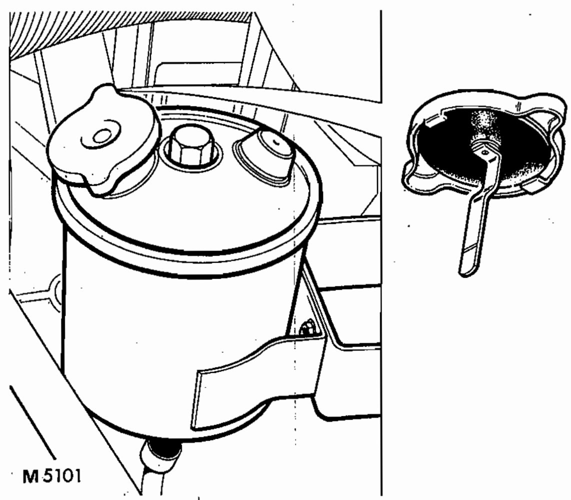


FIG. 3 POWER STEERING RESERVOIR

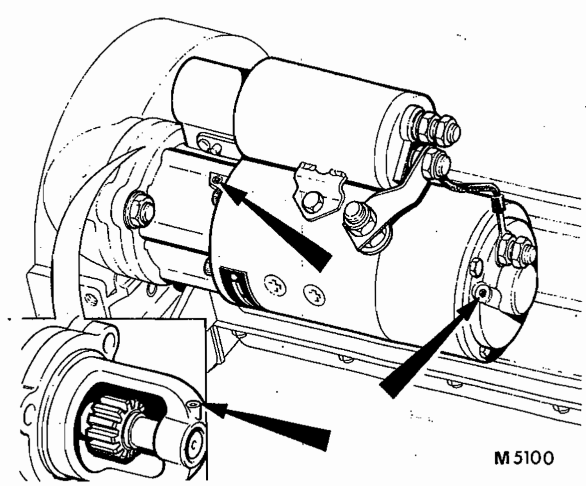


FIG. 4 STARTER MOTOR

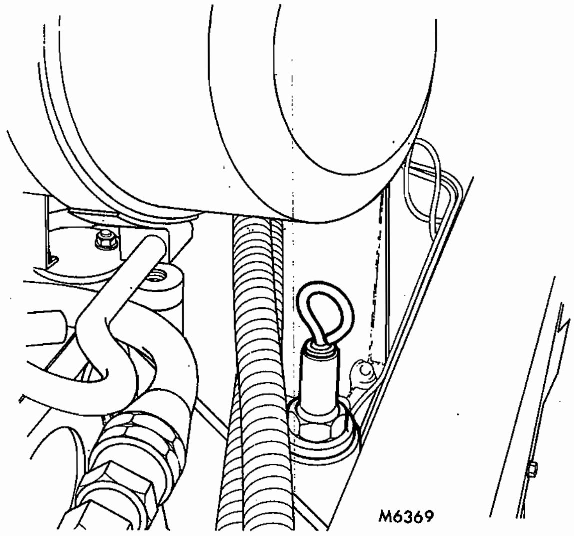


FIG. 5 GEARBOX FILLER AND DIPSTICK

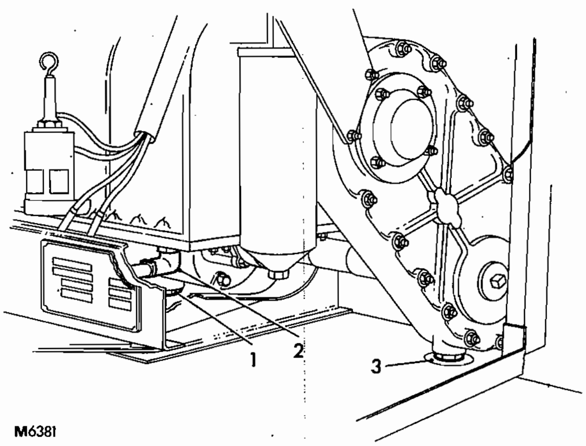


FIG. 6 GEARBOX DRAIN PLUGS
1. Mitre box 2. Gearbox 3. Transfer drive

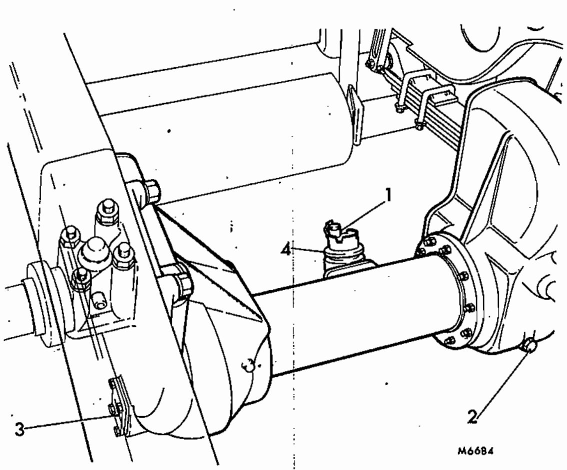


FIG. 7 REAR AXLE FILLER AND DRAIN PLATE
1. Dipstick
2. Drain plug
3. Plate
4. Filler plug

Note: DO NOT remove the level plug if the vehicle has been stopped for any length of time; the oil level being higher because the fluid has drained back from the clutch.

Topping Up

1. Ensure that the vehicle is standing on level ground.
2. Run the engine at approximately 1,000 rev/min for two to three minutes to circulate the oil.
3. With engine idling lift the engine cover to gain access to the filler plug Fig. 5. Clean the filler plug and surrounding area to prevent ingress of dirt, remove the plug and top up with oil of the correct specification to the relevant mark on the dipstick.
4. Replace plug and stop the engine.

Oil changing

The following operations should be carried out immediately after the vehicle has been in service when the oil will be warm and flow more freely.

1. Remove the undershield from beneath the gearbox and clutch housing.
2. Rotate the clutch until the drain plug is visible through the aperture at the bottom of the clutch housing. Clean the area around the clutch, gearbox and mitre box drain plugs; place a suitable container beneath, remove each plug and allow sufficient time for complete drainage. Clean and replace plugs and fit undershield.
3. Lift the engine cover to gain access to the top of the gearbox; clean the area around the top filler plug; remove the plug and pour 39.8 litres (70 pints) of oil into the gearbox. Clean and replace the plug.
4. Run the engine at approximately 1 000 rev/min for two to three minutes. With engine idling remove the filler and fill with oil to the COLD mark of the dipstick. Replace both plugs. Stop the engine.

Rear Axle

Topping Up

1. Remove dipstick (1), check oil level and top up if required.

Oil Changing

1. Place suitable container beneath driving head; remove plate (3), plug (2) and allow sufficient time for complete drainage.
2. Fit plate and plug (2). Remove plug (4) and fill axle with oil to the correct level on the dipstick; fit plug.

Propeller Shaft (Fig. 10)

Lubricate the propeller shaft splines (1) and universal joints (2) with a hand operated grease gun.

It is most important that a hand operated grease gun is used for the above operation. The use of high pressure equipment results in only partial lubrication of the universal joints and damage to the trunnion seals.

The lubrication period quoted is normally acceptable, but should the vehicle be operating in arduous conditions more frequent lubrication would improve journal life.

King Pins and Steering Ball Joints (Fig. 8)

Lubricate the upper and lower king pin bushes and steering ball joints at each end of the drag link and track rod at the points indicated using a grease gun.

Brake Camshafts and Slack Adjusters (Fig. 9)

Lubricate the front and rear brake camshafts and the slack adjusters at the points indicated using a grease gun.

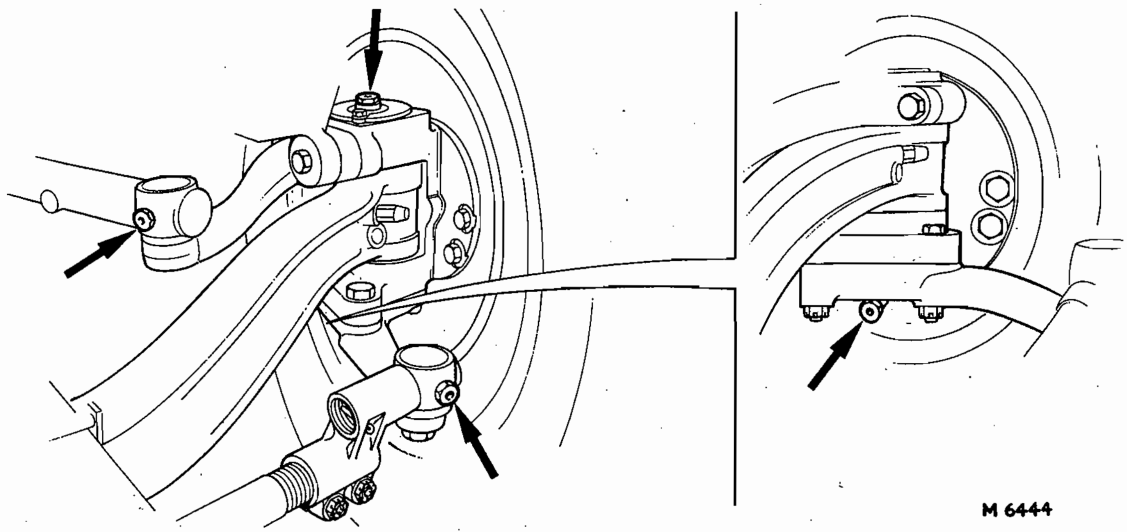


FIG. 8 KING PIN AND STEERING BALL JOINT LUBRICATORS

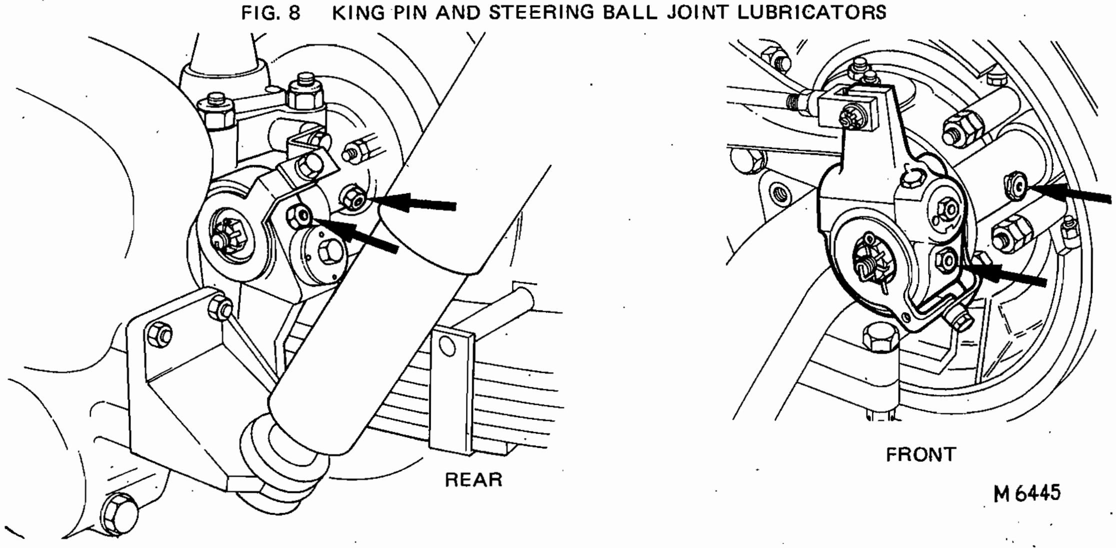


FIG. 9 BRAKE CAMSHAFT AND SLACK ADJUSTERS

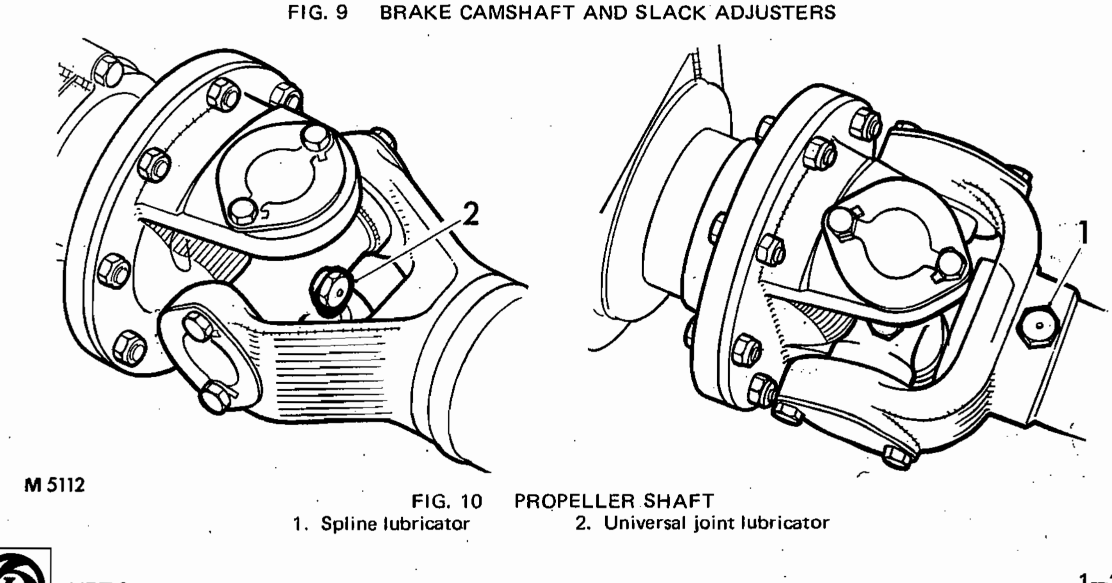


FIG. 10 PROPELLER SHAFT
1. Spline lubricator 2. Universal joint lubricator

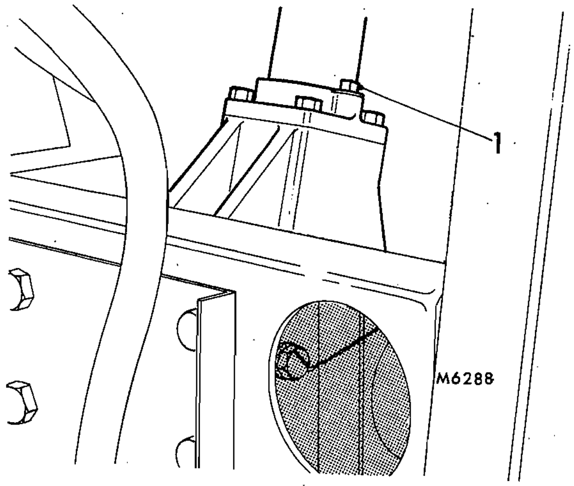


FIG. 11 MANUAL STEERING BOX
1. Filler plug

Manual Steering Box (Fig. 11)

Remove the front detachable panel and remove the steering box filler plug (1). Top up to bottom of filler hole if necessary.

Front and Rear Shackle Pins (Fig. 12)

Lubricate at the points indicated using a grease gun.

Front Hubs

Remove all old grease from the hubs and apply specified grease as directed on page 5–3–6, taking care to leave adequate space for expansion.

Rear Hubs

Remove all old grease from the hubs and apply specified grease as directed on page 6–1–7, taking care to leave adequate space for expansion.

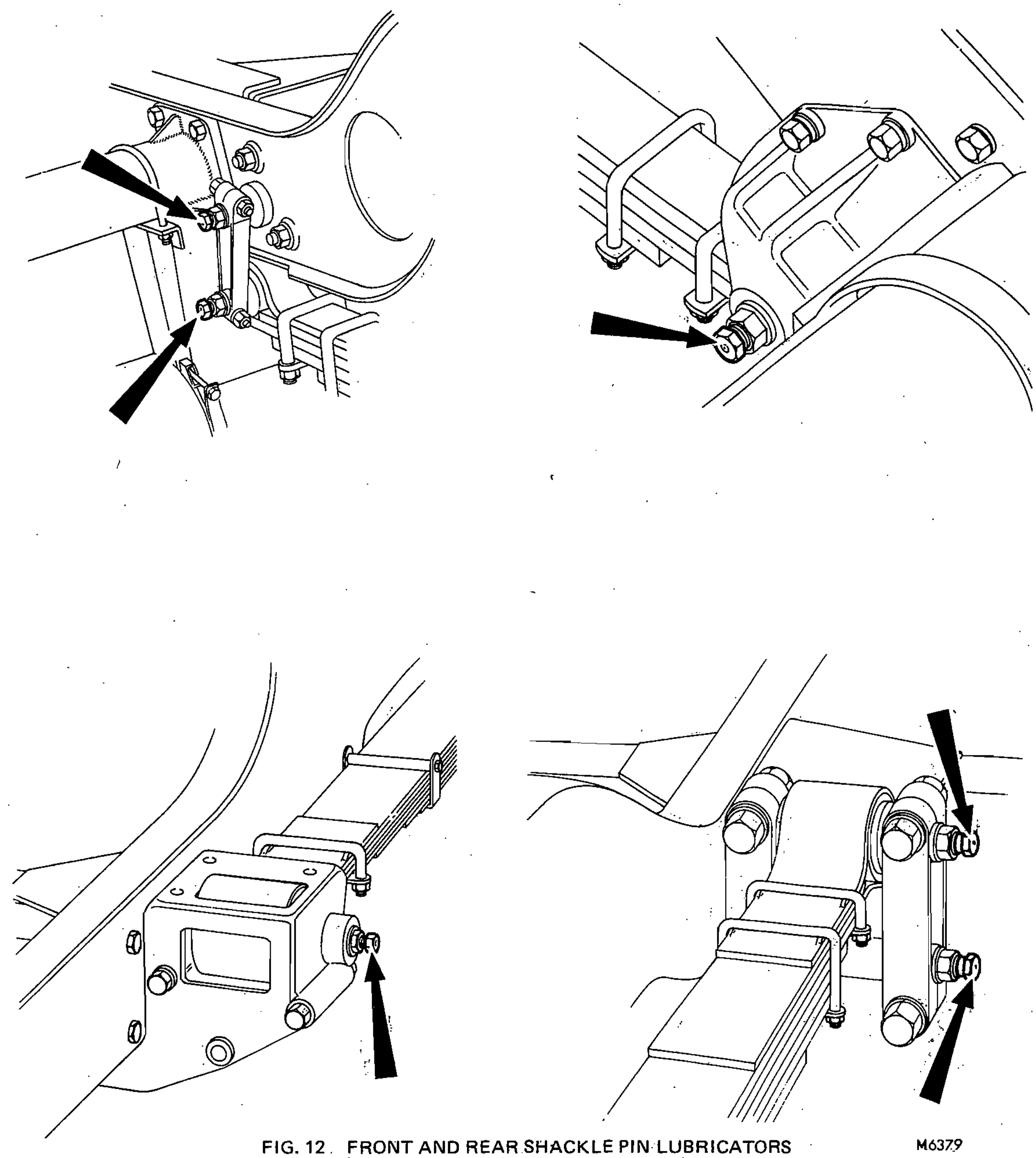


FIG. 12 FRONT AND REAR SHACKLE PIN LUBRICATORS
(When automatic lubrication is not fitted)

M6379

Oil Filter (Fig. 13)

To renew the filter element unscrew the tie bolt (1) and remove filter bowl (2). Remove element (3) and sealing rings (4) and discard. Wash all components in paraffin and dry thoroughly. Re-assemble the filter with new element and sealing rings ensuring that the top face of the filter bowl sits evenly onto the sealing ring. Tighten the tie bolt firmly.

Cooling System (Fig. 14)

Open the filler cap on the header tank to check/top-up the cooling system. The level should be to the top of the filler neck. If the system is filled with anti-freeze ensure that any coolant mixture added is in the same proportions.

Do not open filler cap whilst the engine is hot.

Drain the system by opening the drain taps.

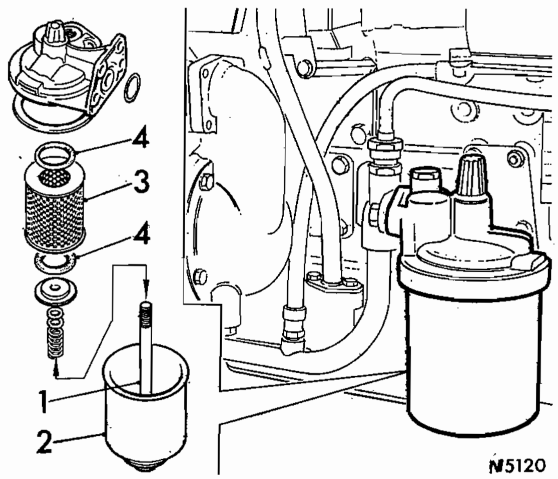


FIG. 13 TYPICAL ENGINE OIL FILTER

1. Tiebolt
2. Filter bowl
3. Element
4. Sealing rings

Fuel Filter Sedimenter (Fig. 15)

Remove bleed pipe adaptor and the centre bolt (13). Remove and discard element (4) and clean the filter bowl (16).

Reassemble element, seals and O-rings. Ensure correct location of element on the seals, tighten the retaining bolt and bleed the system.

Drain the fuel sedimenter of accumulated water and solid matter by slackening or removing the drain screw (15) in the base.

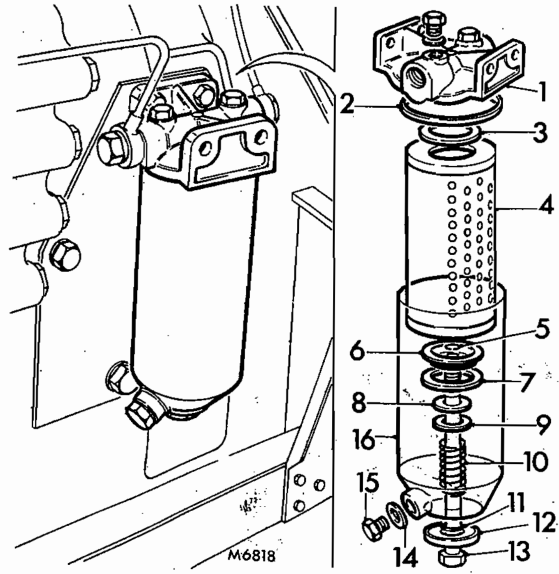


FIG. 15 FUEL FILTER SEDIMENTER

1. Filter head
2. Seal, sump to head
3. Seal, upper
4. Element
5. Circlip
6. Element guide
7. Seal, lower
8. Gasket
9. Washer
10. Spring
11. O-ring seal
12. Reinforcing plate
13. Centre bolt
14. Washer
15. Plug
16. Filter bowl

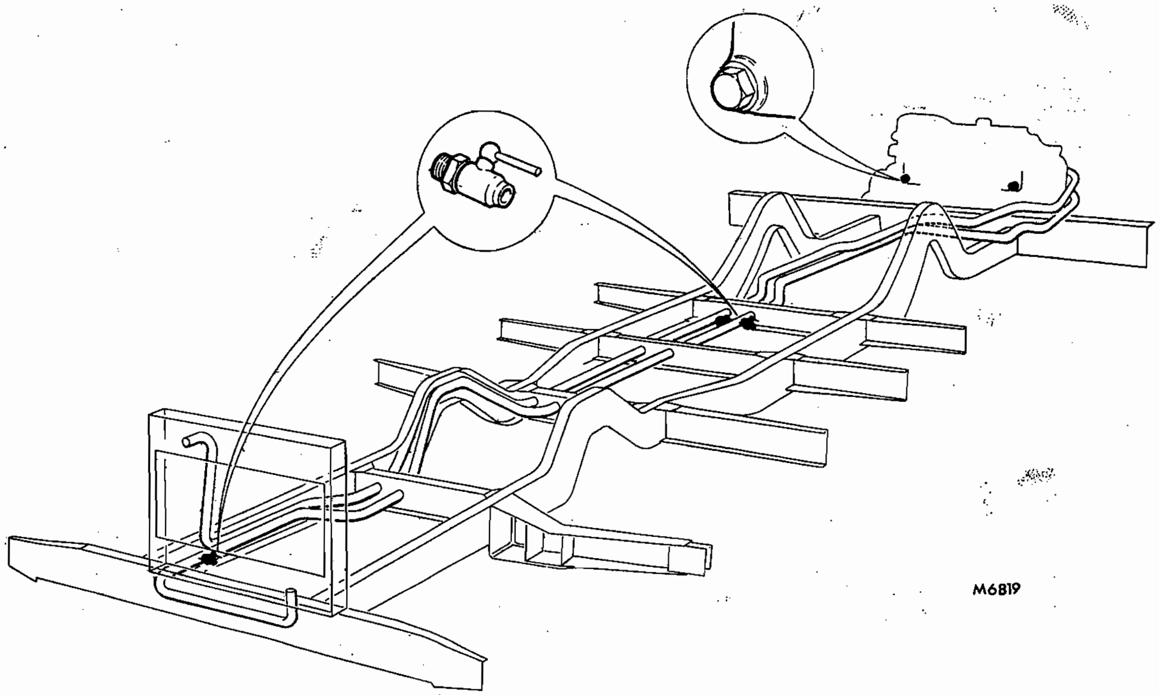


FIG. 14 COOLING SYSTEM DRAIN POINTS

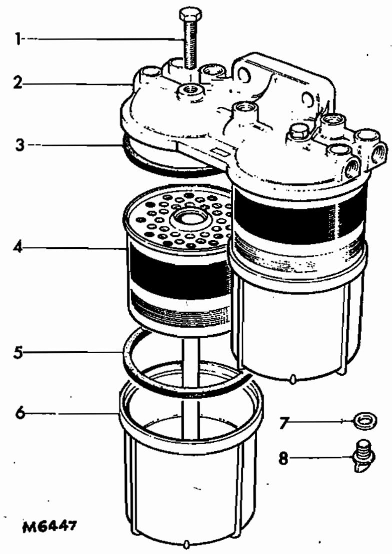


FIG. 16 FUEL FILTERS

1. Retaining bolt
2. Filter head
3. O-ring
4. Element
5. Seal
6. Base
7. Seal
8. Drain tap

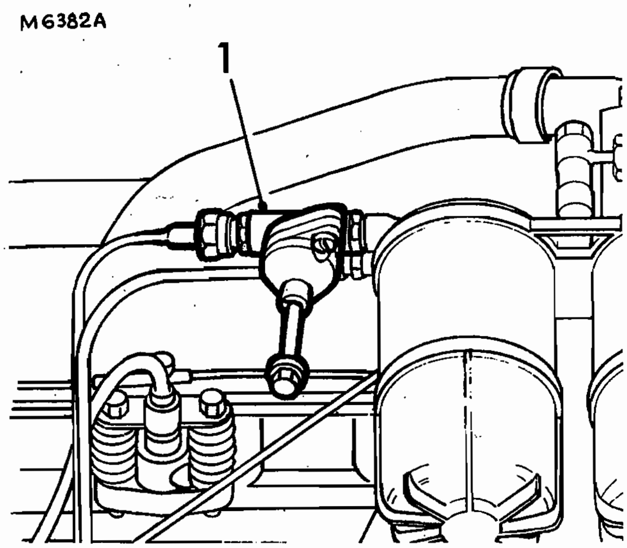


FIG. 17 QUICK ACTING VALVE

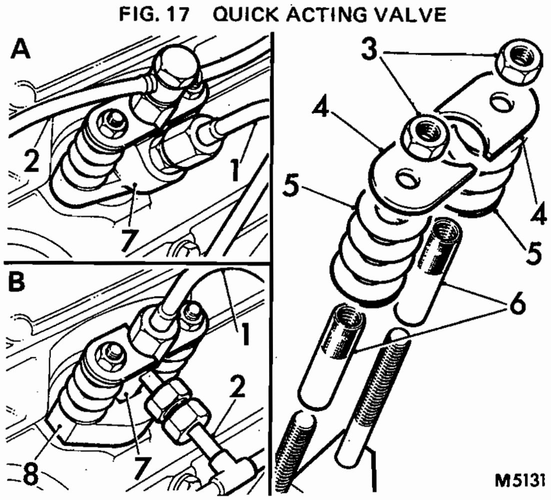


FIG. 18 FUEL INJECTORS
A—Leyland injectors in position
B—AMBAC injectors in position

1. Injector pipe
2. Leak-off pipe
3. Nuts
4. Locking plates
5. Springs
6. Ferrules
7. Injector
8. Clamp plate

Fuel Filter (Fig. 16)

Open drain plug (8) in base of filter unit. Remove bleed pipe adaptor and retaining bolt (1). Remove element (4) and discard, clean filter bowl (6). Reassemble using new element and seals (5 and 3) ensuring the element seats evenly. Tighten retaining bolt and repeat above procedure for remaining filter unit, finally bleeding the system.

Quick Acting Valve Operation (Fig. 17)

To check if the valve functions correctly disconnect outlet fuel line from valve and operate lift pump. In this position fuel should pass through the valve. Bring valve to closed position and again operate lift pump, there should be no seepage of fuel. If there is a leak of fuel tighten the valve body securing screws slightly, should this fail then remove valve and overhaul.

Injectors (Fig. 18)

Do not attempt to dismantle a faulty injector or injection pump as this requires the use of specialised equipment. To locate a faulty injector slacken the high pressure pipe of the suspect injector whilst the engine is running slowly. If there is no change in engine performance or if a condition such as smoky exhaust has disappeared, it may be assumed thatthe suspect injector is faulty.

To renew an injector disconnect the high pressure injection pipe (1) and interlinking leak-off pipe (2). Remove nuts (3), locking plates (4) and springs (5). Unscrew the knurled ferrules (6) and withdraw the injector (7) copper sealing washer and injector sleeve (early models only).

Clean the injector housing seat and refit the replacement injector making sure that the sleeve is correctly positioned. Fit a new sealing washer and ensure that the clamp plate (8) is correctly located on the flat machined on the injector.

Screw on knurled ferrules to finger tightness only and place the coil springs and locking plates over the studs. Fit the securing nuts and tighten evenly. Connect up the leak-off and injection pipes.

Tighten injection pipes to a torque of 2.6/2.9 kgf m (19/21 lbf ft).

Bleeding the Fuel System (Fig. 19)

Air can enter the system if the fuel tank has been allowed to become empty, or if any part of the system has been disturbed. Before bleeding check there is an adequate supply of fuel in the tank.

1. Slacken the bleed screw on the filter cover and operate the feed pump priming lever (1). Tighten the bleed screw when air-free fuel emerges.

2. Slacken the bleed screws (2) on the fuel injection pump and operate the feed pump priming lever. Tighten the bleed screw when air-free fuel emerges.

3. Bleed the high pressure injection pipes by turning the engine with starter for a few seconds with the union nuts at the injectors slackened. Tighten when air-free fuel emerges from around the nuts. Start the engine in the normal manner.

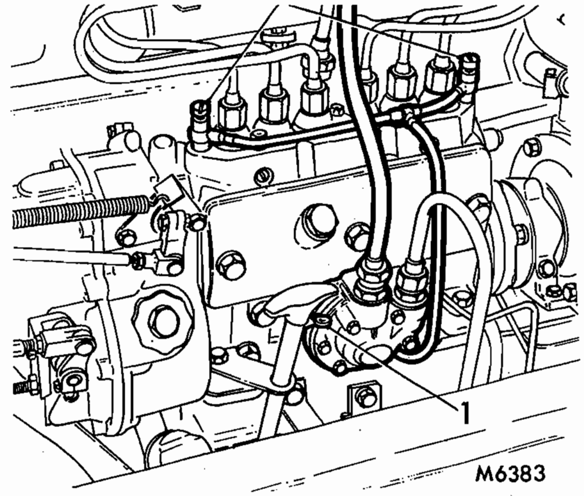


FIG. 19 FUEL PUMP BLEED POINTS

1. Priming lever
2. Bleed screws

Air Filter (Fig. 20)

Remove the clamp ring (10), detach the dust cap (2) and clean. This need only be carried out at the period quoted if the vehicle is operating in adverse conditions. In normal conditions the vacuator valve (1) is sufficient to keep the dust cap clear. Do not use oil in the dust cap. Remove stack cap (7) and clean.

Some air filters may incorporate a restriction indicator (9) which indicates, by the appearance of a red sleeve in the window aperture, when the filter requires servicing.

Remove element (6) by detaching the dust cap, unscrewing the wing nut (5) and extracting the element and baffle (3). The pre-cleaning fins are not removable from the filter body (8). Inspect sealing ring (4), renew if necessary.

Areas of concentrated dust on the clean side of the element indicates a damaged element which should be replaced. Refit a new element and ensure that all seals are in good condition.

The element is treated to extend service life where atmospheric pollution by exhaust carbon prevails. It is not intended that the element be cleaned except in an emergency. It can be serviced by reverse blowing with compressed air of 7.03 kgf/cm^2 (100 lbf/in^2) maximum pressure. Hold the nozzle inside the element and direct it towards the clean side of the element.

The efficiency of the element will however be reduced by this treatment.

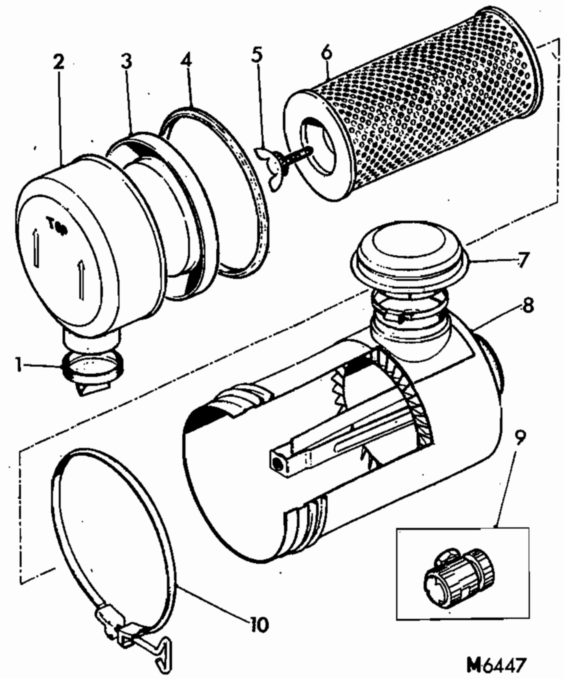


FIG. 20 CYCLOPAC AIR FILTER

1. Vacuator valve
2. Dust cap
3. Baffle
4. Sealing ring
5. Wing nut
6. Element
7. Stack cap
8. Filter body
9. Restriction indicator
10. Clamp ring

M5132

Engine Breather (Fig. 21)

Remove setscrews (1) and disconnect hose (2) from pipe (3). Remove cover (4), extract gauze element (5) and perforated plate (6). Clean with paraffin and refit.

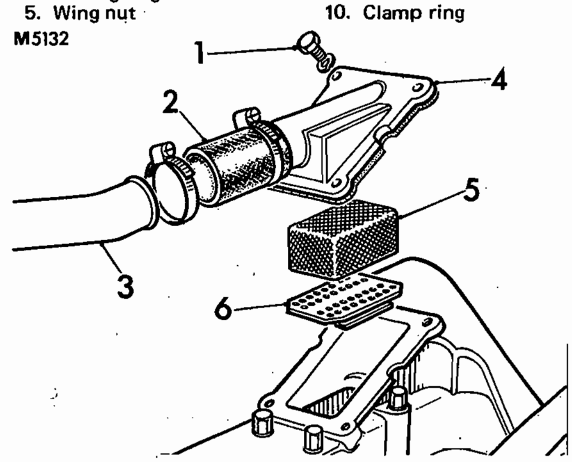


FIG. 21 ENGINE BREATHER

1. Setscrew
2. Hose
3. Pipe
4. Cover
5. Gauze element
6. Perforated plate

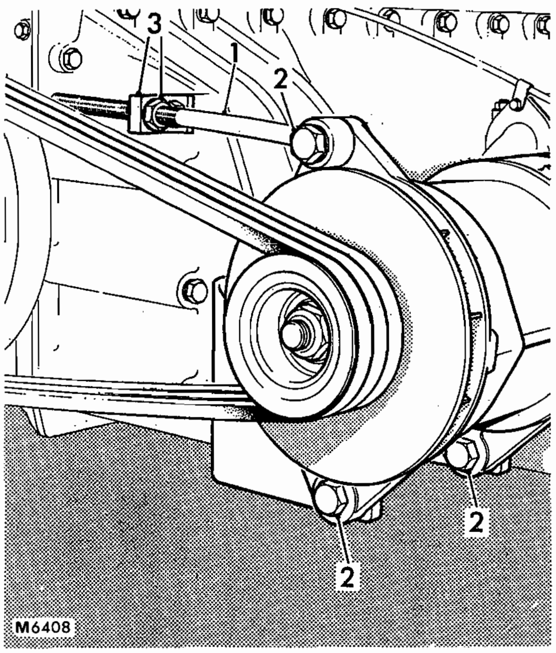


FIG. 22 ALTERNATOR DRIVE BELT TENSION

1. Adjustable rod 2. Mounting bolts 3. Adjusting nuts

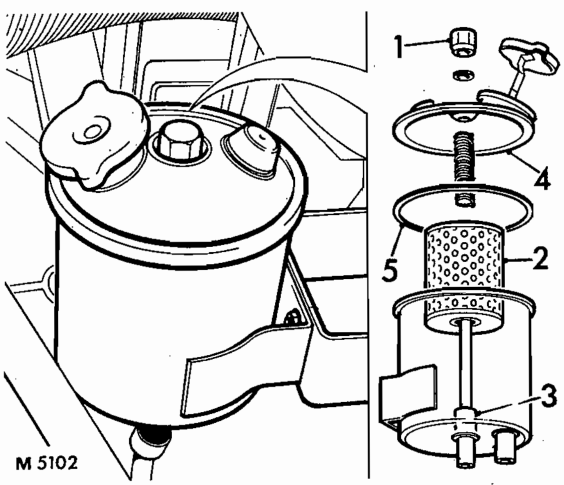


FIG. 23 POWER STEERING FILTER ELEMENT

1. Retaining nut
2. Element
3. Base spigot
4. Cover
5. Joint

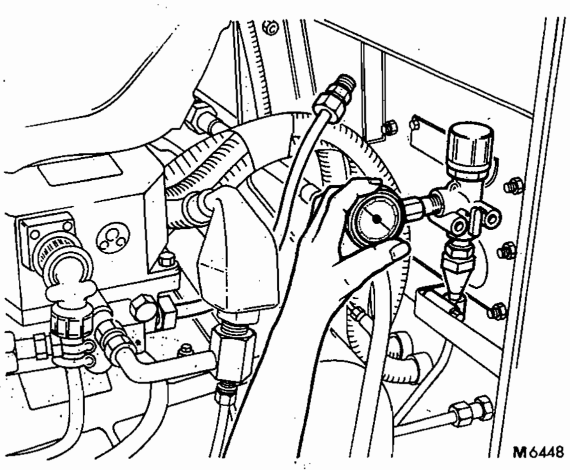


FIG. 24 AIR GAUGE IN LIMITING VALVE

Alternator (Fig. 22)

Occasionally check the condition and tension of the drive belts. Check the belt tension with finger pressure applied to the centre of the longest span, deflection should be one belt thickness per foot. Re-set if necessary by slackening the alternator mounting bolts (2) and adjusting the length of the rod (1).

Belts with a glazed appearance should be renewed.

Power Steering Filter Element and Oil Change (Fig. 23)

Jack and block up the front of the vehicle with the front wheels clear of the ground. Disconnect the lower delivery pipe from the steering gear case and allow the fluid to drain. Start and run the engine for a maximum period of ten seconds whilst turning the steering wheel from lock to lock to expel all fluid from the system. Reconnect the delivery pipe when drainage is complete.

Remove the reservoir cover retaining nut (1) and extract the filter element (2). Fit a new element taking care to locate the lower end on the base spigot (3). Refit the cover (4) checking that joint (5) is in good condition.

Fill up the reservoir with the specified grade of fluid and bleed the system. Do not allow the reservoir to become empty during the following bleeding operation.

Start the engine and allow it to idle. Slowly move the steering from lock to lock to ensure complete filling of the system. Re-check the fluid level, top-up, and repeat the procedure until the level remains constant.

Lower the vehicle to the ground and with the engine running at approximately 1 500 rev/min, again turn the steering from lock to lock. Re-check fluid level and inspect the system for leaks.

GEARBOX

Limiting Valve Setting

Install an accurate air gauge reading to 7 kgf/cm^2 (100 lbf/in^2) in the pipeline from the limiting valve to the electro-pneumatic valve, Fig. 24. It is imperative that the pressure at this point is correct, the pressure being controlled by the output setting of the limiting valve and if found to be incorrect, the fault must be traced and rectified. Refer to Group 4 Data pages to determine the correct setting. Check around the charging valve and limiting valve joint faces to the reservoir and pipe connections with a solution of soap and water, for leakage. Renew any gaskets or unions if leakage is apparent.

Upper Piston Seals

Check the condition of the upper piston seals by removing the chamber drain plugs. Select each gear in turn, if oil is blown out, the piston seal should be renewed. Further information can be found in Group 4.

Top Speed Piston

Manufacture a service tool to the specifications given in Fig. 25, and check the top speed piston travel Fig. 26, as follows.

1. Remove top speed cylinder drain plug.
2. Adjust setscrew until back face of cap is against the face of the adaptor.
3. Fit service tool in drain plug hole.
4. Screw down setscrew until light contact is made with piston. Measure thread length (A).
5. Select top gear.
6. Screw down setscrew until light contact is again made with the piston; measure thread length (B). Subtract length (B) from (A) to give piston travel (C). If dimension is less than 34.9 mm (1.375 in):
7. Screw setscrew right back and disengage top gear.
8. Remove service tool and replace cylinder drain plug.

If dimension (C) is more than 34.9 mm (1.375 in):

9. Screw setscrew right back and disengage top gear.

10. Remove top cover and withdraw piston and spring; check condition of seals.

11. Pull out the end of push rod and fit relevant thickness washers (1) to give a dimension (C) of 22 to 25 mm (0.87 to 0.97 in).

Note: The maximum permissible build-up of shims is 26.2 mm (1.032 in) which is equivalent to three of the thickest shims. The need for more shims indicates that the limits of wear have been reached on the clutch.

12. Slide piston and spring into cylinder, ensuring that seals are not distorted.

13. Fit cover, remove tool and fit drain plug.

14. Select top speed gear and check for leaks.

Test vehicle under normal road and load conditions.

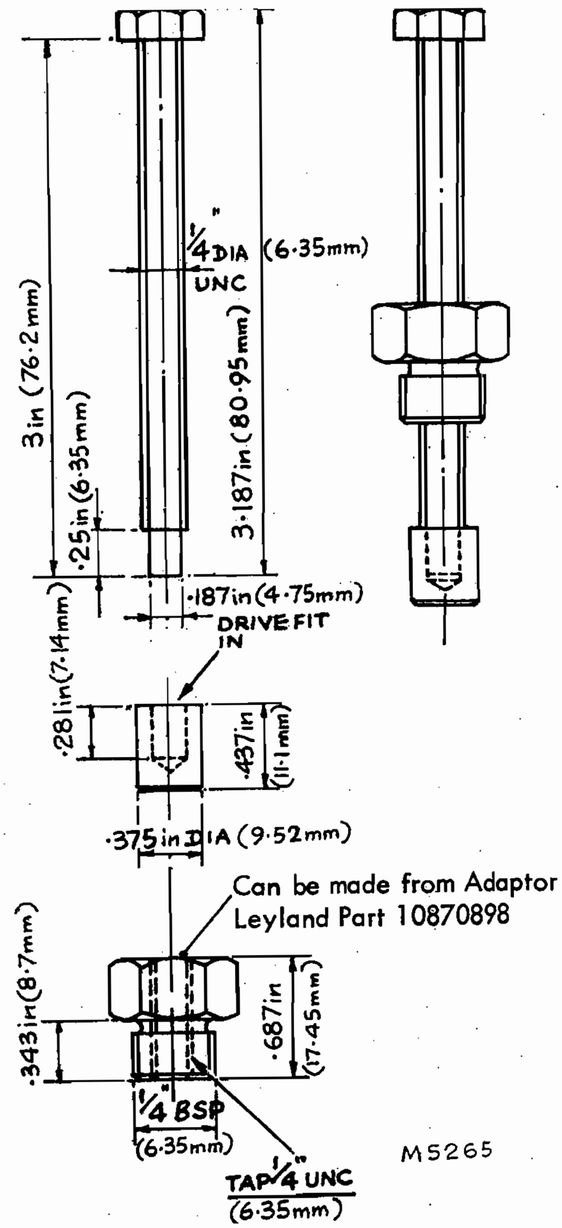


FIG. 25 SERVICE TOOL SPECIFICATION

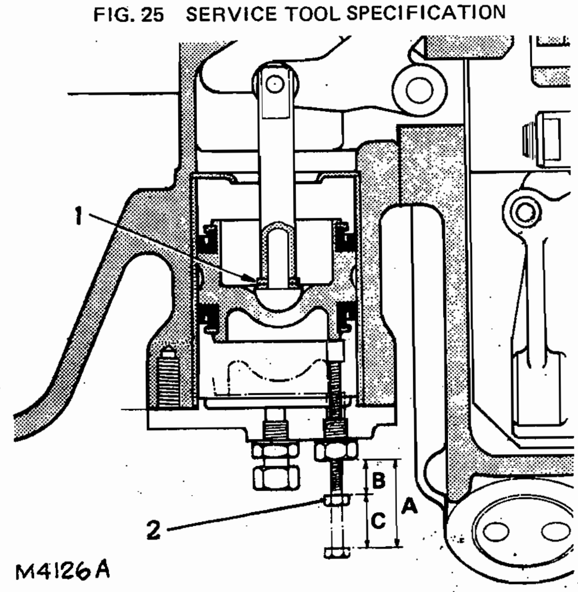


FIG. 26 CHECKING PISTON TRAVEL

1. Distance washer 2. Service tool

A. Clutch released B. Clutch engaged

C. Piston travel (A–B)

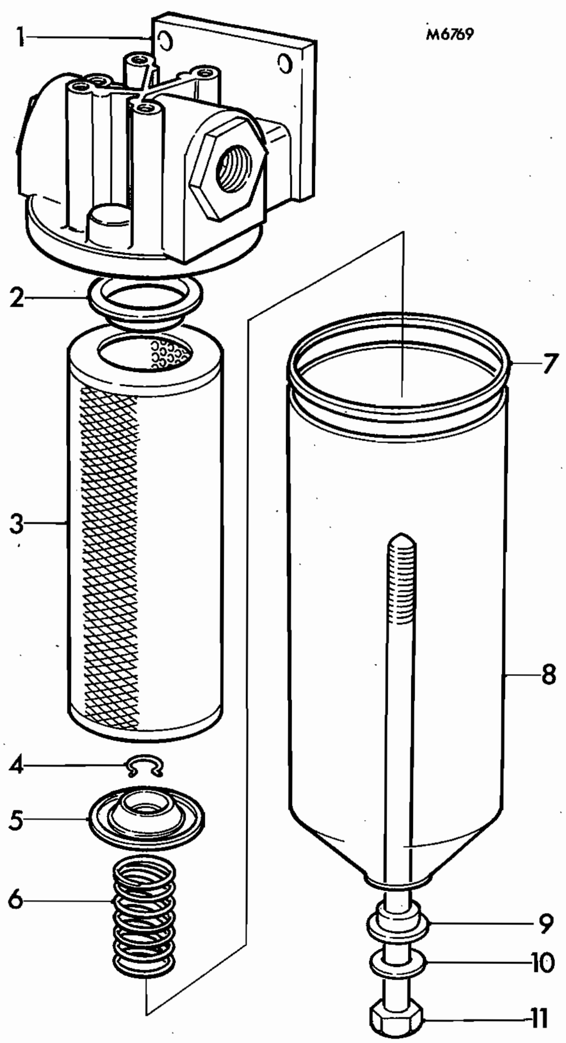


FIG. 27 EXPLODED VIEW OF OIL FILTER

1. Filter head
2. Seal
3. Element
4. Circlip
5. Element guide
6. Spring
7. Seal
8. Sump
9. Seal
10. Washer
11. Centre bolt

Oil Filter (Fig. 27)

To Remove

1. Open relevant access panels.
2. Position suitable container below filter, to catch escaping oil.
3. Remove centre bolt and separate sump from filter head.
4. Remove and clean the filter element in paraffin or white spirit. Use a low pressure air source and blow through the element from the inside whilst brushing the contaminate from the outer surface with a soft bristle brush.
5. Clean sump and filter head ports.

To Refit

1. Position new rubber seal in filter head.
2. Locate element with seals correctly positioned in sump.
3. Fit sump assembly to filter head and tighten securing bolt to 1.4/2.1 kgf m (10/15 lbf ft).
4. Pour two pints of oil into gearbox to compensate for loss during filter clean.
5. Run engine and check for oil leaks.

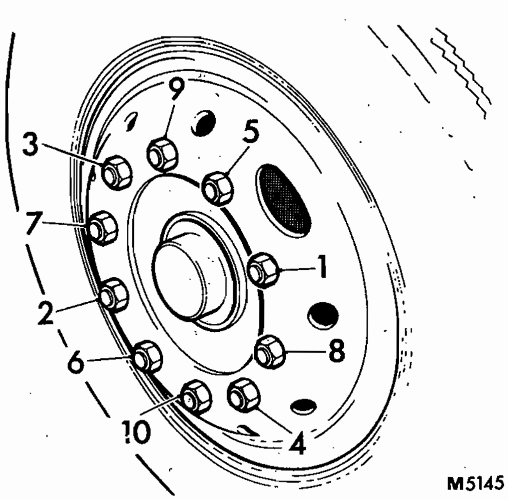


FIG. 28 WHEEL NUT TIGHTENING SEQUENCE

Wheel Removal and Replacement

Chock the road wheels and place a jack under the appropriate axle. Slacken the wheel nuts by diametrical selection noting that right-hand wheels have R.H. threaded studs and left-hand wheels have L.H. threaded studs. Jack up the vehicle until the wheel is clear of the ground, remove the nuts and lift the wheel from the studs.

When replacing the wheel, run the nuts down and tighten a quarter turn at a time, in the sequence shown, in Fig. 28, to locate the conical faces. Lower the vehicle to the ground and continue tightening the nuts in the same sequence to a torque of 55.2 kgf m (400 lbf ft).

When fitting twin wheels ensure that the tyre valves are located 180° to one another.

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 recognised 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 (API) Engine Service Classification shown below. Where two API classifications are shown, the oil must meet the requirements of both.

Type	API 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)	SAE 5W/20
0° to 30° C (32° to 86° F)	SAE 20W/20 or SAE 10W/30
Above 30° C (above 86° F)	SAE 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.

LEYLAND SPECIFICATIONS

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

All greases used for lubrication of road wheel bearings must conform to the British Timken Specification for Lithium-base 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-base greases should not be mixed with greases 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-base grease, care should be taken to ensure that the bearings and cage assemblies are fully packed, but the hub itself should be packed with grease as described in Section 2 of this Group.

Leyland Specification A Oil (revised January 1964) for steering box as shown on the lubrication table.

The oil used should be a good quality mineral oil to the requirements of the following SAE viscosity numbers:

Atmospheric temperatures above 0° C (above 32° F)	SAE 140
Atmospheric temperatures below 0° C (below 32° F)	SAE 90

Additionally, the oil should have a viscosity index of not less than 80 and may contain anti-oxidant additives, but should not contain hypoid or extreme-pressure additives.

Under certain circumstances, alternative types of lubricants may be advantageous, but these should be used only with the fullest co-operation of the oil supplier under controlled conditions. Truck and Bus Division cannot accept responsibility for difficulties which may arise through the use of oil not conforming to Leyland Specification A.

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

Important: The brands quoted under the relevant heading on page 1—3—5 have been approved by Leyland Truck and Bus for use in the fully charged gearbox.

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 KOG/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)	75–100	85–112
0° to 30° C (30° F to 90° F)	100–135	112–150
Above 30° C (above 90° F)	135–180	150–200

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 between 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-base) 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-base 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-base 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-base 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.

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 BS 3151 or BS 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	
% anti-freeze	° 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.

LUBRICANT SPECIFICATIONS

UNIT	MINIMUM PERFORMANCE REQUIREMENT: MILITARY	MINIMUM PERFORMANCE REQUIREMENT: OTHER	ATMOSPHERIC TEMPERATURE RANGE	VISCOSITY REQUIREMENT	B.P.	DALTON'S (SILKDLENE)	DUCKHAM'S	ESSO	FILTRATE	GULF	CASTROL	MOBIL	PETROFINA	SHELL	STERNOL	TEXACO
Gearbox Fluid Clutch Mitre Box		Leyland Specification E Oil Approved grades only	Below 0°C (32°F)													
			0°C to 30°C (32°F to 86°F)		Gear Oil LA110			Teresso 52		Harmony 53	Perfecto PSG	Fluid 98		Donax T3		Torque Fluid 'E'
			Above 30°C (86°F)													
Rear Axle	MIL-L-2105	British Specification CS3000	Below 0°C (32°F)	SAE 80EP	Gear Oil 80EP	Boa 80 or Mamba 80	Fleetoid 80	Gear Oil GP80 Gear Oil GX80	EP80 Gear Oil	Gear Lubricant 80 or Multipurpose Gear Lubricant 80	Hypoy Light or Deusol Gear EP80	Mobilube HD80	Pontonic MP SAE 80	Spirax 80EP	HD80	Universal Gear Lubricant EP80 Multigear Lubricant EP80
			0°C to 30°C (32°F to 86°F)	SAE 90EP	Gear Oil 90EP	Boa 90 or Python 90	Fleetoid 90	Gear Oil GP90/140 } UK Gear Oil GX90/140 } Gear Oil GP90 } Overseas Gear Oil GX90 }	EP90 Gear Oil	Gear Lubricant 90 or Multipurpose Gear Lubricant 90	Hypoy or Deusol Gear EP90	Mobilube HD90	Pontonic MP SAE 90	Spirax 90EP	HD90/140	Universal Gear Lubricant EP90 Multigear Lubricant EP90 Fleet Gear Oil (90/140)
			Above 30°C (86°F)	SAE 140EP	Gear Oil 140EP	Boa 90/140 or Viper 90/140	Fleetoid 140	Gear Oil GP140 Gear Oil GX140	EP140 Gear Oil	Gear Lubricant 140 or Multipurpose Gear Lubricant 140	Hipress or Deusol Gear EP140	Mobilube HD140	Pontonic MP SAE 140	Spirax 140EP	HD90/140	Universal Gear Lubricant EP140 Multigear Lubricant EP140 Fleetgear Oil (90/140)
Steering Box (Manual)		Leyland Specification A Oil	Below 0°C (32°F)	SAE 90	Gear Oil 90	Hippo 90	Fleetmesh 90	Gear Oil ST90	Gear Oil 90	Transmission Oil 90 or Prem. Trans. Oil 90	ST or Deusol Gear Light 90	Mobilube C90	Pontonic WA SAE 90	Dentax 90	G90	Thuban 90
			Above 0°C (32°F)	SAE 140	Gear Oil 140	Rhino 140	Fleetmesh L17 or Fleetmesh 140	Gear Oil GP90/140 UK Gear Oil ST140 Overseas	Gear Oil 140	Transmission Oil 140 or Prem. Trans. Oil 140	D or Deusol Gear Medium	Mobilube C140	Pontonic WA SAE 140	Dentax 140	Elite CU	Thuban 140
Power Steering System		Leyland Specification H. Hydraulic Fluid	All Temperatures		Hydraulic TF-C2	Zebra 75ATF	Fleetmatic A	Glide	ATF Fluid	Gulf Automatic Transmission Fluid Type A Suffix A	Castrol TQ or Deusol TFA	ATF 200	Purfimatic	Dexron ATF	Lynx Type F	Texamatic Type F
		Dexron			Autran DX	Grade 987 Dextron R	Fleetmatic CD	Automatic Transmission Fluid Dexron	ATF Fluid Dexron	Gulf ATF Dexron	Castrol TQ Dexron Castrol TFA Dexron	ATF 220	Dexron ATF	Dexron ATF	Lynx Dexron	Texamatic Fluid-6673
All Lubrication Nipples Clutch Spigot Bearing Front Axle Hub Bearings Speedometer Drive Cable Overhaul Applications (unless special recommendation)		Leyland Specification G Grease	All Temperatures		Energrease L.2	G.55/T	Admax L2	Multipurpose Grease M or Beacon 2	Super Lithium Grease	Gulfcrown Grease No. 2	LM Grease or Spheerol APT2	Mobilgrease MP or Mobilgrease Super	Marson HTL2	Retinax A	LHT2	Multifak EP2 Marfak All Purpose

76 Turbine 68

SECTION 4

Service Tools

Listed below are service tools which are considered necessary for overhauling the various units, and are obtainable from:

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

British Leyland UK Ltd.
Truck and Bus
Butec Plant
Cleveland Road
Leyland, Preston PR5 1XB

Sykes-Pickavant Ltd
Warwick Works
Kilnhouse Lane
Lytham St Annes
Lancs.
FY8 3DU

Bristol Commercial Vehicles Ltd
Bath Road
Brislington
Bristol 4

S.A.B. Brake Regulator Co Ltd
Howden Way
Aycliffe Industrial Estate
Darlington
Co Durham
DL5 6HR

Illustrated on page 1—4—3 are the drawings of tools which can be manufactured locally. They can also be made to order from V L Churchill.

Churchill	Bristol	Title
Group 2 Engine		
LC201		Cylinder block retaining nut torque adaptor.
LC142		Valve guide remover/replacer.
LC143		Injector bore seat cleaning tool. Leyland (injectors)
LC202		Injector bore seat cleaning tool. Ambac (injectors)
LC145		Cylinder block lifting plate.
LC146		Cutter—for cutting annular groove in cylinder liner to accommodate removal tool.
LC147		Cylinder liner replacer. Use with 20/30 ton hollow hydraulic ram Epco type P382 and pump Epco type P365 available from: Tangye-Epco Ltd, Gough Road, Greet, Birmingham B11 2NH
6118		Valve spring compressor.
6118-2		Valve spring compressor adaptor. Use with 6118.
6118-6		Adjustable stirrup.
LC149		Crankshaft sleeve remover.
6312A		Gear remover; crankshaft; alternator; steering pump; fuel injection pump flywheel.
18G1014		Water pump drive gear and impeller remover.
No. 8		Piston ring compressor.
LC152		Leyland injector extractor, flanged injectors.
LC152-1		AMBAC injector extractor adaptor.
LC152-2		LEYLAND injector extractor adaptor.
6000C-19		AMBAC compression test adaptor.

Churchill	Bristol	Title
LC148		Valve seat remover/replacer.
18G629		Valve grinding-in tool.
Group 3 Fluid coupling		
LC200		Pressure test equipment.
LC154		Impeller ring nut spanner.
LC113A		Holding wrench for use with LC154.
Group 4 Gearbox		
LC153		Input shaft ring nut spanner.
LC128-2		Length gauge for checking gearcase height and running gear end-float. Used with bridge piece from LC128 obtainable separately as LC128X.
LC166		Gauge for re-aligning the oil pump cover.
LC134		Nut runner for use when setting brake bands.
LC133A		Setting gauge for initial setting of brake bands.

Size	Application
31.75 mm (1.25 in)	1st, 2nd, 3rd and reverse speeds
34.29 mm (1.35 in)	4th speed

Churchill	Bristol	Title
Mitre Box		
	3VRS-254SZ	Split ring for removing inner race from input pinion.
	3VRS-255SZ	Split ring for removing inner race from output pinion.
	3VRS-251SZ	Spanner for removing ring nut from input pinion.
	2VRS-226SZ	Apex setting gauge.
	3VRS-478	Spanner for locking transfer shaft tube.
Group 5 Steering		
LC169		Selector shaft pre-load gauge.
LC170		End cover T-bar jacking screw.
LC138		Steering box piston installing tool.
LC172		Oil seal protection tool.
MS64		Valve block and pressure test equipment.
Group 6 Rear Axle		
Sykes-Pickavant	3VRM-227SZ	Bridge piece to prevent the differential cage from spreading.
	841SZ	Apex setting gauge.
		Support tool for removing driving head.
		Tool for removing pinion bearing inner race.
		Tool for removing differential cage bearing inner races.
	836SZ	Spanner for removing hub nut.
831		Bearing puller.
952		Bearing separator.

Churchill	S.A.B.	Title
Group 7 Brakes		
	4600-008-999	Kit of tools for servicing slack adjusters.
MS61		Brake actuator main spring releasing tool.
MS61-5		Adaptor for Westinghouse spring brake actuators. Use with MS61.

Churchill	Butec	
Group 8 Electrical		
	CEG14/1	Timing gauge.
	CEG14/3	Abutment gauge.
	CET55/105	Solenoid switch adjusting tool.
	CET55/60	Tee wrench.
18G581		Commutator end cover bush extractor.

SECTION 5

Conversion Factors and Abbreviations

Weights and measures with approximate equivalents

Length

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

Area

1 square centimetre	= 0.155 square inch	1 square inch	= 6.452 square centimetre
1 square metre	= 10.764 square foot	1 square foot	= 929.03 square centimetre
1 square metre	= 1.196 square yard	1 square yard	= 0.836 square metre
1 square kilometre	= 0.386 square mile	1 square mile	= 2.59 square kilometre

Volume

1 cubic centimetre	= 0.061 cubic inch	1 cubic inch	= 16.387 cubic centimetre
1 cubic metre	= 31.315 cubic foot	1 cubic foot	= 0.0283 cubic metre
1 cubic metre	= 1.308 cubic yard	1 cubic yard	= 0.7633 cubic metre

Capacity

1 litre	= 1.760 Imperial pint	1 Imperial pint	= 0.568 litre
1 litre	= 2.10 U.S. pint	1 U.S. pint	= 0.476 litre
1 litre	= 0.22 Imperial gallon	1 Imperial gallon	= 4.544 litre
1 litre	= 0.264 U.S. gallon	1 U.S. gallon	= 3.80 litre

Weight

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

Torque

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

Pressure

1 kilogramme per square centimetre	= 14.22 pound per square inch	1 pound per square inch	= 0.0703 kilogramme per square centimetre

Abbreviations

Across flats (both head sizes)	A.F.
After bottom dead centre	A.B.D.C.
Alternating current	a.c.
Amperes	A
Ampere-hour	Ah
Atmospheres	Atm
Before bottom dead centre	B.B.D.C.
Before top dead centre	B.T.D.C.
Bottom dead centre	B.D.C.
Brake horse power	bhp
British standards	B.S.
Centigrade (Celsius)	C.
Centimetres	cm
Centimetres of mercury	cm Hg
Cubic centimetres	cm^3
Cubic inches	in^3
Degree, minute, second (angle)	° ′ ″
Degree (temperature)	°
Diameter	dia
Direct current	d.c.
Fahrenheit	F
Feet	ft
Gallons (Imperial)	gal
Grammes	g
Inches	in
Inches of mercury	in Hg
Internal diameter	i.dia
Kilogrammes (force)	kgf
Kilogrammes (mass)	kg
Kilogramme centimetre (force)	kgf cm
Kilogramme metre (force)	kgf m
Kilogrammes per square centimetre (force)	kgf/cm^2
Kilometres	km
Kilowatts	kW
Left hand	L.H.
Left hand drive	L.H.D.
Maximum	max.
Metres	m
Microfarad	μf
Millimetres	mm
Minimum	min.
Minus (of tolerance)	—

Negative (electrical)	—
Newton metres	Nm
Ohms	ohm or Ω
Ounces	oz
Outside diameter	o.dia
Pints (Imperial)	pt
Plus or minus	±
Plus (of tolerance)	+
Positive (electrical)	+
Pounds (force)	lbf
Pounds (mass)	lb
Pounds feet (torque)	lbf ft
Pounds inches (torque)	lbf in
Pounds force per square inch	lbf/in^2
Ratio	:
Revolutions per minute	rev/MIN
Right hand	R.H.
Right hand drive	R.H.D.
Society of Automobile Engs.	S.A.E.
Specific gravity	sp. gr.
Square centimetres	cm^2
Square inches	in^2
Standard wire gauge	s.w.g.
Top dead centre	T.D.C.
United Kingdom	U.K.
Volts	V
Watts	W

Screw Threads

British Association	B.A.
British Standard Fine	B.S.F.
British Standard Pipe	B.S.P.
Unified Coarse	U.N.C.
Unified Fine	U.N.F.
Metric (millimetres)	M

GROUP 2

ENGINE

General Information

ENGINE DATA

Types	510 and 501 (8.2 litres) turbocharged
Number of cylinders	Six
Bore	118 mm (4.65 in)
Stroke	125 mm (4.92 in)
Net installed hp (approximate) 510 and 501 engine	129 kW (170 bhp) at 2000 rev/min
Maximum torque (approximate) 510 and 501 engine	742 Nm (525 lbf ft) at 1200 rev/min
Compression ratio 510 and 501 engine	16.6:1
Firing order	1, 5, 3, 6, 2, 4

REMOVAL AND REFITMENT

ENGINE/POWER PACK UNIT–LEYLAND

To Remove

Note: It is recommended that the power pack is removed complete using a stand similar to that shown in Section 4, Group 1. The gearbox and fluid coupling can then be separated from the engine.

1. Isolate batteries.
2. Open or remove engine access doors.
3. Remove setbolts and withdraw splash trays secured below engine compartment.
4. Drain cooling system.
5. Remove rear seats and rear access panel from bulkhead.
6. Disconnect electrical connections from starter motor.
7. Release all hose pipe connections at bulkhead.
8. Disconnect override switch.
9. Remove turbocharger air inlet pipe.
10. Exhaust air from system and remove air throttle cylinder pipes and stop solenoid connections.
11. Remove exhaust pipe from turbocharger to flexible exhaust pipe.
12. Disconnect alternator and oil pressure switch removing any relevant brackets and clips securing the harness to engine and gearbox. Suspend harness clear of power pack.
13. Disconnect compressor air inlet and outlet pipes.
14. Disconnect fuel feed pipe at bulkhead.
15. Remove cold start aid connections.
16. Remove setbolts securing fan drive shaft to drive unit.
17. Disconnect air feed pipes from adaptors at gearbox.
18. Drain power steering and remove flexible pipes from hydraulic pump (if fitted).
19. Disconnect propeller shaft.
20. Pull off gaiter.
21. Disconnect speed sensing probe and speedometer drive.
22. Release upper rear panel support strut and secure panel.
23. Remove header tank.
24. Release the two upright members at either corner of engine compartment which secure engine access panels.
25. Position and adjust the height of stand under engine cross-member. Support engine on bottle jack, remove the nuts and bolts securing cross-member to bulkhead, and lower engine and cross-member onto stand.

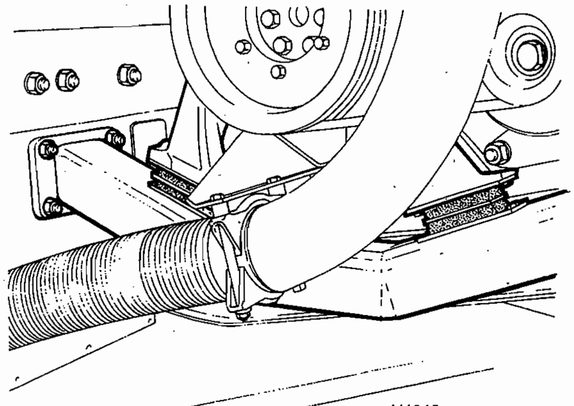

M6065

FIG. 1 FRONT ENGINE MOUNTING

26. Position bottle jack on stand adjustable platform and take the weight beneath the engine flywheel housing.
27. Position trolley jack under rear of gearbox.
28. Release rear gearbox mounting.
29. Remove nuts and bolts securing combined rear transverse cross-member and gearbox mounting to chassis members.
30. Disconnect any ancillary equipment which may obstruct power pack removal.
31. Withdraw power pack complete on engine stand or roll vehicle forward.

    Note: Adjust height of engine beneath flywheel housing support to clear chassis member.
32. Rotate clutch driving member (impeller) until drain plug is visible through air vent at bottom of clutch housing.

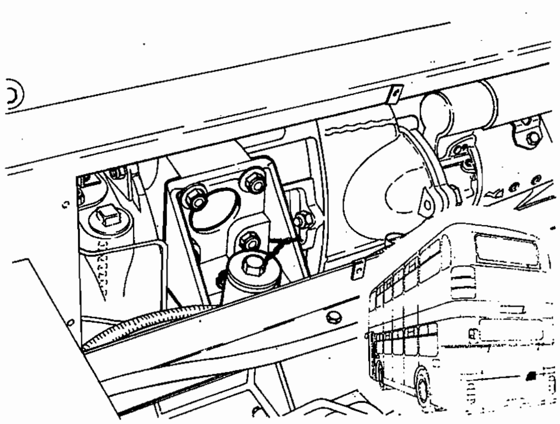

M6064

FIG. 2 REAR ENGINE MOUNTING

33. Place a suitable container beneath drain plug and sump-to-sump feed pipe. Remove plug; unscrew the pipe and allow sufficient time for oil to drain. Clean and replace plug and feed pipe.
34. Fit lifting eyes to gearcase or manufacture bracket, see Group 1 Section 4, and take gearbox weight using suitable overhead lifting equipment.
35. Remove clutch to flywheel housing retaining bolts and separate gearbox from engine.
36. For fluid coupling removal refer to Group 3.

To Refit

1. Refit fluid coupling, refer to Group 3.
2. Remove seal ring from pump drive gear, Fig. 4, and fill the groove with grease. Re-position the seal ring ensuring that the lugs overlap as shown. Centralise the ring, which will be held in position by the grease long enough to fit the gearbox.
3. Secure vice grip pliers onto flywheel housing studs, see Group 4, and raise and manoeuvre gearbox into mesh with input shaft splines, until gearbox abuts against the vice grip pliers. At this stage remove the vice grip pliers. Further movement will engage pump drive gear and seal ring. If resistance is felt DO NOT use force. The oil pump drive gears have failed to engage or the seal ring has been dislodged.
   Pull back gearbox, check and if necessary re-align the seal ring. Repeat above procedure until satisfactory engagement is achieved.
4. Fit clutch to flywheel housing retaining bolts and tighten.
5. Position power pack under chassis.
6. Refit combined rear cross-member and gearbox mounting.
7. Reconnect any ancillary equipment.
8. Refit gearbox mounting bolts.
9. Jack engine and refit engine transverse cross-member to bulkhead.
10. Lower engine stand support points clear of power pack.
11. Roll stand and trolley jack clear of chassis.

12. Refit header tank.

13. Refit the two upright members at either corner of engine compartment.

14. Refit upper panel support strut.

15. Refit speed sensing probe and speedometer drive.

16. Push on gaiter and refit propeller shaft.

17. Refit flexible pipes to hydraulic pump (if fitted).

18. Reconnect air feed pipes to adaptors on gearbox.

19. Refit bolts securing fan drive shaft to drive unit.

20. Reconnect cold start aid connections.

21. Refit fuel feed pipe at bulkhead.

22. Refit compressor air inlet and outlet pipes.

23. Reconnect alternator and oil pressure switch securing the harness with any relevant brackets and clips.

24. Refit exhaust pipe from flexible exhaust pipe to turbocharger.

25. Refit air throttle cylinder pipes and stop solenoid connections.

26. Reconnect turbocharger air inlet pipe.

27. Reconnect override switch.

28. Secure all hose connections.

29. Refit starter motor connections.

30. Refit rear access panel to bulkhead and refit rear seats.

31. Refit splash trays.

32. Operate isolation switch.

33. Refill cooling system with coolant.

34. Refill engine, gearbox and fluid coupling as described in Group 1.

35. Bleed fuel system as described in Group 1.

36. Refill power steering reservoir (if fitted) with specified lubricant and bleed the system as described in Group 5.

37. Run engine and check for air, oil and water leaks, topping up oil and water if necessary.

38. Close engine access doors.

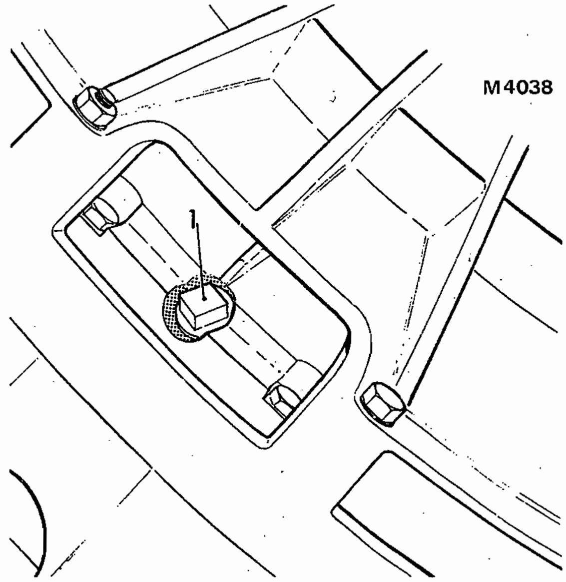


FIG. 3 CLUTCH DRAIN PLUG THROUGH BOTTOM APERTURE

1. Drain plug

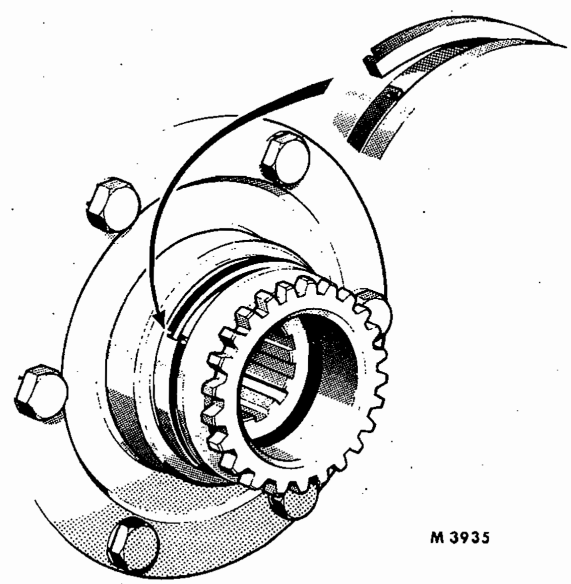


FIG. 4 THE SEAL RING IN POSITION
Inset shows how the ring is locked

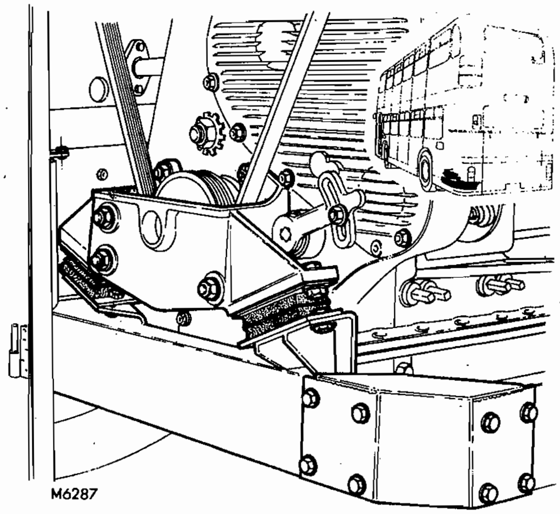


FIG. 5 FRONT ENGINE MOUNTING

REMOVAL AND REFITMENT

ENGINE/POWER PACK UNIT—GARDNER

To Remove

Note: It is recommended that the power pack is removed complete using a stand similar to that shown in Section 4 Group 1. The gearbox and fluid coupling can then be separated from the engine.

1. Isolate batteries.
2. Open or remove engine access doors.
3. Remove setbolts and withdraw splash trays below engine compartment.
4. Drain cooling system.

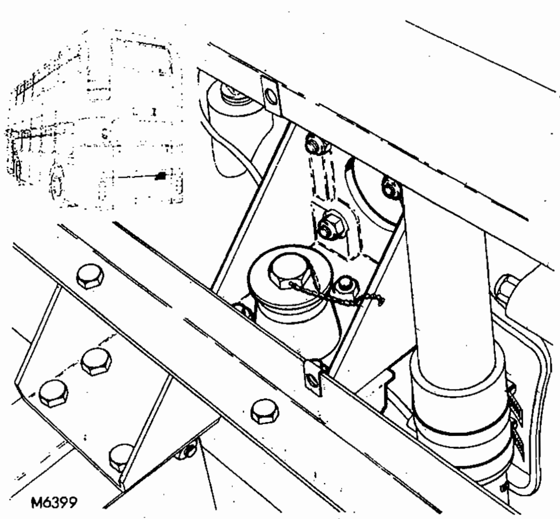


FIG. 6 REAR ENGINE MOUNTING

5. Remove rear seats and rear access panel from bulkhead.
6. Disconnect electrical connections from starter motor.
7. Release all hose pipe connections at bulkhead.
8. Remove flexible exhaust pipe.
9. Remove header tank, and disconnect electrical connections.
10. Drain power steering reservoir, and remove pipes from hydraulic pump.
11. Remove power steering reservoir (if fitted).
12. Disconnect alternator and oil switch removing any relevant brackets and clips securing the harness to engine and gearbox. Suspend harness clear of power pack.
13. Remove heat exchanger connections.
14. Exhaust air from system and remove air throttle cylinder pipes and stop solenoid connections.
15. Disconnect fuel feed pipes to primary filter.
16. Disconnect compressor air inlet and outlet pipes.
17. Remove air inlet hose.
18. Remove setbolts securing fan drive shaft to coupling.
19. Disconnect propeller shaft.
20. Pull off gaiter.
21. Disconnect speed sensing probe and speedometer drive.
22. Disconnect air feed pipes from adaptors at gearbox.
23. Release upper rear panel support strut and secure panel.
24. Release the two upright members at either corner of engine compartment which secure engine access panels.
25. Roll stand under engine and position a jack and a block of wood under front of engine sump.
26. Remove front engine mounting bolts and apply load on the jack to lift engine mountings just clear of engine cross-member.
27. Remove nuts and bolts securing cross-member to bulkhead, and to the combined rear transverse cross-member and gearbox mounting.
28. Position stand and adjust height to beneath engine mountings; lower engine onto stand.
29. Adjust stand rear support to beneath rear of sump, position jack and take the weight off the engine/gearbox mountings.
30. Position trolley jack under rear of gearbox.
31. Release back gearbox mounting.
32. Remove nuts and bolts securing combined rear transverse cross-member and gearbox mounting to chassis members.

SERVICE TOOL SPECIFICATION FOR LOCAL MANUFACTURE

IMPORTANT: Safety laws require that lifting frames and brackets for specific jobs must be capable of lifting or supporting a weight 50% greater than the weight of the unit to be lifted. Such equipment must be tested to this value before use. Refer to relevant Data for unit weight.

GROUP 2

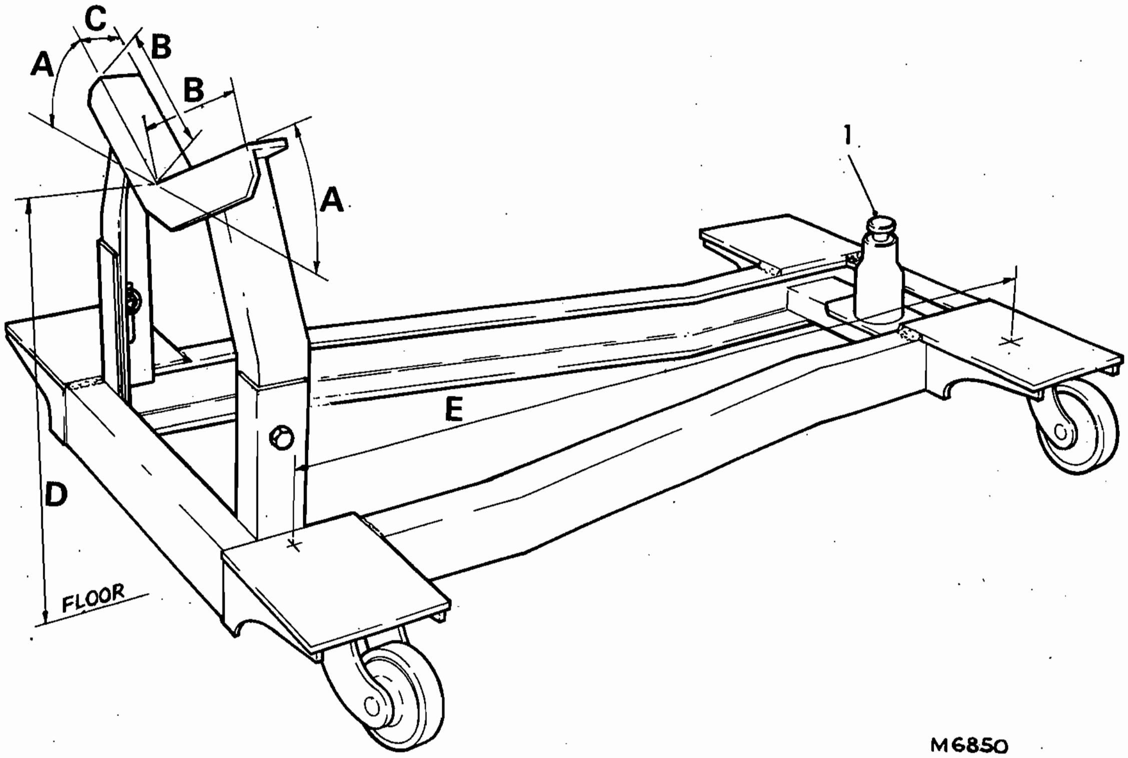


FIG. 1 ENGINE REMOVAL STAND

APPLICATION

	LEYLAND	GARDNER
A	21 deg.	21 deg
B	17 in	17 in
C	3 in	3 in
D	10 in	22.5 in
E	40 in min to 55 in max.	

1. Bottle jack

GROUP 4

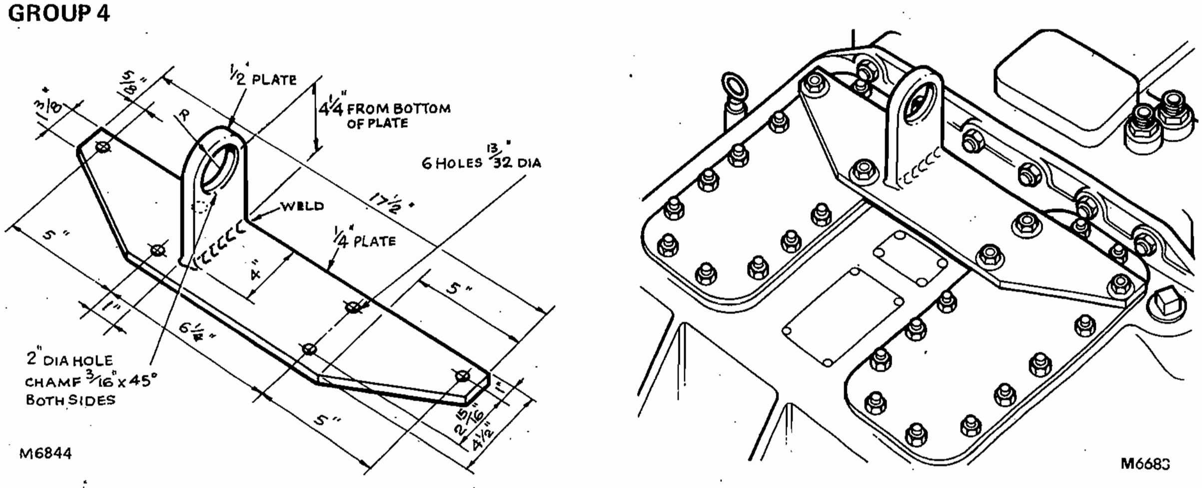


FIG. 2 GEARBOX LIFTING BRACKET

GROUP 6

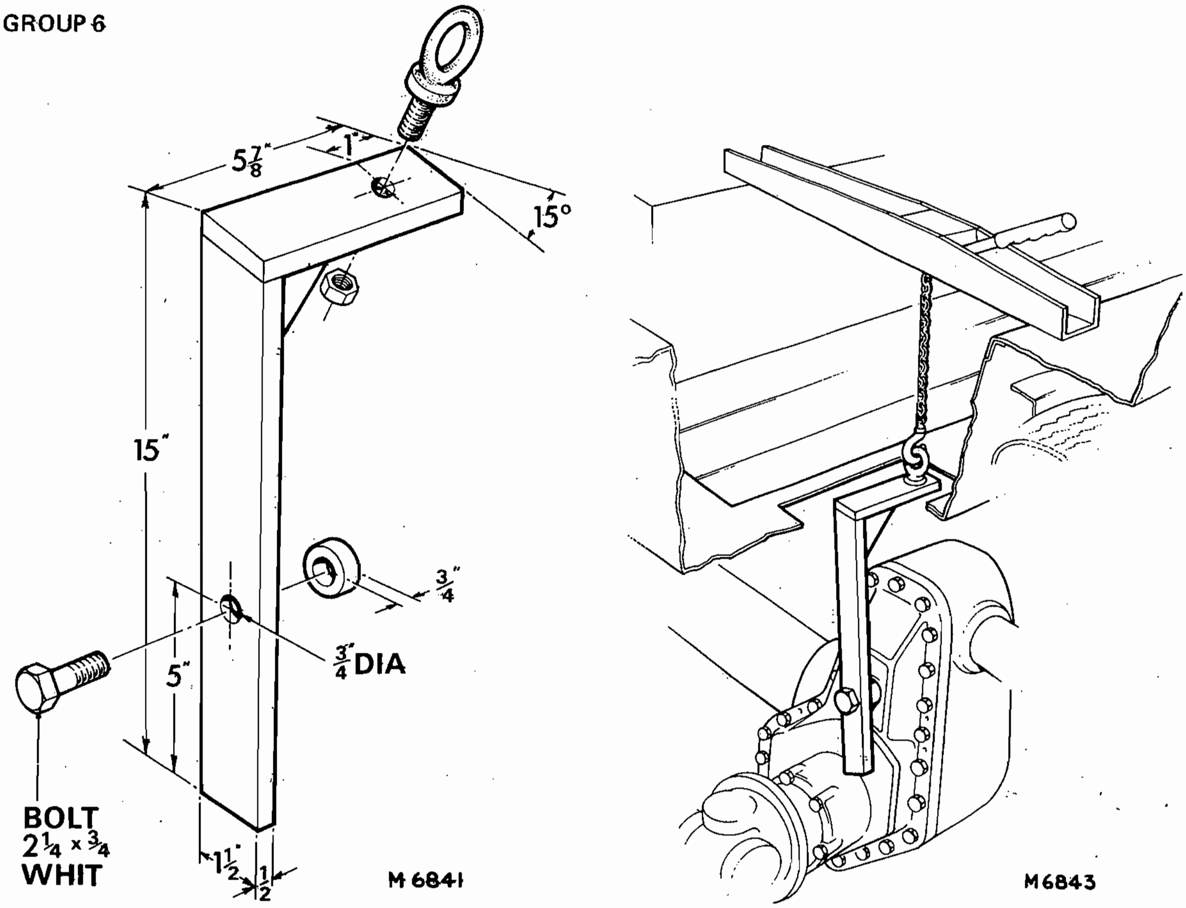


FIG. 3 DRIVING HEAD REMOVAL BRACKET

GROUP 8

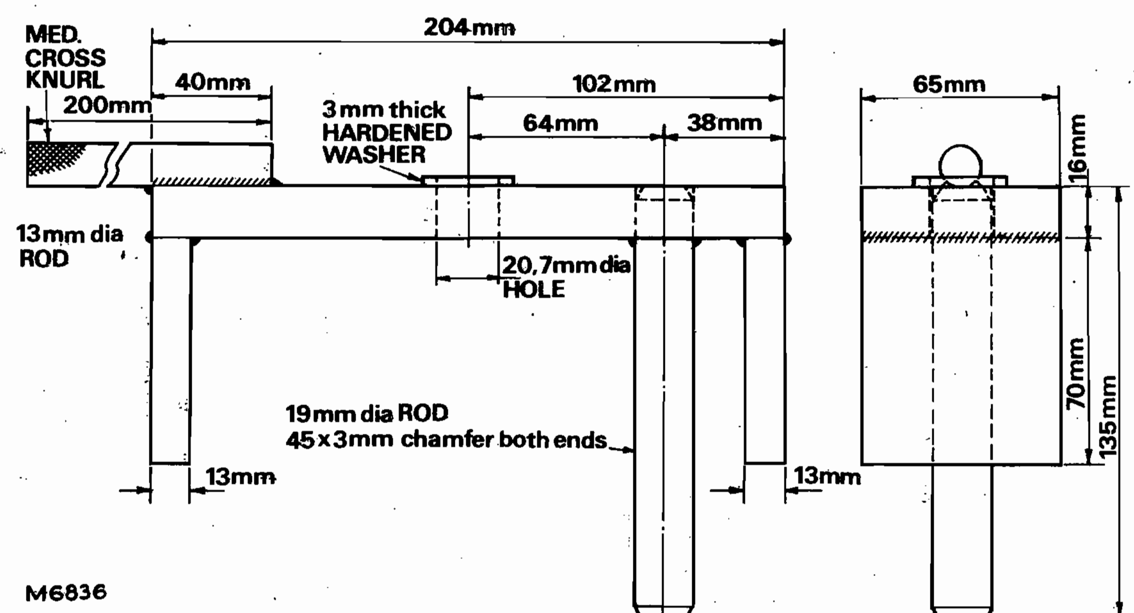


FIG. 4 CAV ALTERNATOR ROTOR EXTRACTOR

33. Disconnect any ancillary equipment which may obstruct power pack removal.

34. Withdraw power pack complete on engine stand or roll vehicle forward.

    Note: Adjust height of engine beneath rear sump support to clear chassis member.

35. Rotate clutch driving member (impeller) until drain plug is visible through air vent at bottom of clutch housing.

36. Place a suitable container beneath drain plug and sump-to-sump feed pipe. Remove plug; unscrew the pipe and allow sufficient time for oil to drain. Clean and replace plug and feed pipe.

37. Fit lifting eyes to gearcase or manufacture bracket, see Group 1 Section 4, and take gearbox weight using suitable overhead lifting equipment.

38. Remove clutch to flywheel housing retaining bolts and separate gearbox from engine.

39. For fluid coupling removal refer to Group 3.

To Refit

1. Refit fluid coupling, refer to Group 3.

2. Remove seal ring from pump drive gear, Fig. 4 and fill the groove with grease. Re-position the seal ring ensuring that the lugs overlap as shown. Centralise the ring, which will be held in position by the grease long enough to fit the gearbox.

3. Secure vice grip pliers onto a flywheel housing bolt, see Group 4, and raise and manoeuvre gearbox into mesh with input shaft splines, until gearbox abuts against the vice grip pliers. At this stage remove the vice grip pliers. Further movement will engage pump drive gear and seal ring. If resistance is felt DO NOT use force. The oil pump drive gears have failed to engage or the seal ring has been dislodged.
   Pull back gearbox, check and if necessary re-align the seal ring. Repeat above procedure until satisfactory engagement is achieved.

4. Fit clutch to flywheel housing retaining bolts and tighten.

5. Position power pack under chassis.

6. Refit combined rear transverse cross-member and gearbox mounting.

7. Reconnect any ancillary equipment.

8. Refit back gearbox mounting bolts.

9. Position jack and block of wood beneath front of sump and take the engine weight from the stand.

10. Lower stand rear support bottle jack.

11. Roll stand clear of engine mountings and position engine cross-member and secure.

12. Lower engine onto cross-member and secure mountings.

13. Remove jack and block of wood and withdraw stand clear of chassis.

14. Refit the two upright members at either corner of engine compartment.

15. Refit upper panel strut to upright member.

16. Reconnect gearbox air feed pipes.

17. Refit speedometer drive and sensing probe, setting probe to 0.127/0.381 mm (0.005/0.015 in) above gear teeth.

18. Refit propeller shaft and gaiter.

19. Refit fan drive shaft to coupling.

20. Refit air inlet hose.

21. Reconnect compressor air inlet and outlet pipes.

22. Reconnect fuel feed pipes to primary filter.

23. Refit air throttle cylinder pipes and stop solenoid connections.

24. Reconnect alternator and oil pressure switch securing harness with any relevant brackets and clips.

25. Refit power steering reservoir.

26. Reconnect pipes to hydraulic pump and reservoir.

27. Refit header tank and electrical connections.

28. Refit flexible exhaust pipe.

29. Reconnect all hose pipe connections at bulkhead.

30. Reconnect starter motor connections.

31. Refit rear access panel and rear seats.

32. Refit splash trays.

33. Operate isolation switch.

34. Refill cooling system with coolant.

35. Refill engine, gearbox and fluid coupling, refer to Group 1.

36. Bleed fuel system, refer to manufacturers workshop manual.

37. Refill power steering reservoir (if fitted) with specified lubricant and bleed the system as described in Group 5.

38. Run engine and check for air, oil and water leaks, topping up oil and water if necessary.

39. Close engine access doors.

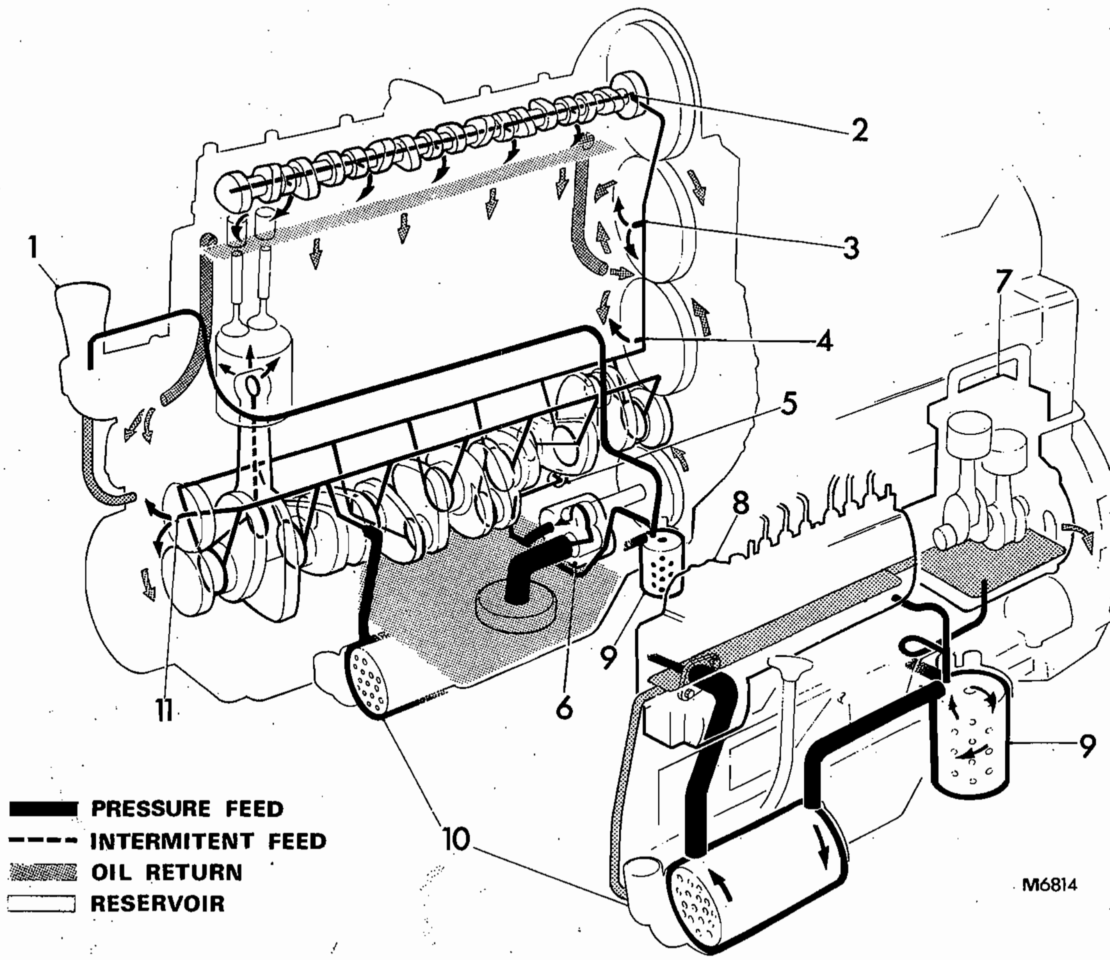


FIG. 7 LUBRICATION DIAGRAM

1. Turbocharger
2. Feed to camshaft and tappets
3. Rear upper idler gear hub
4. Rear lower idler gear hub
5. Oil pressure relief valve
6. Oil pump
7. Compressor
8. Fuel injection pump
9. Oil filter—full flow
10. Heat exchanger (when fitted)
11. Front idler gear hub

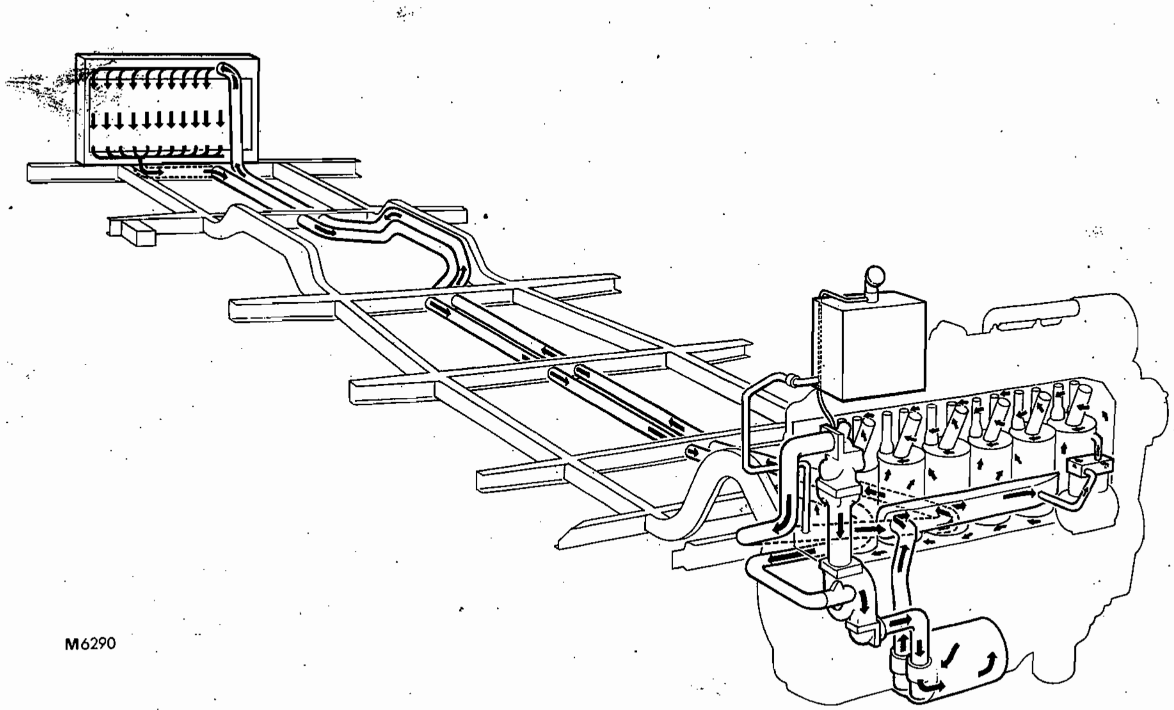


FIG. 8 WATER CIRCULATION DIAGRAM

REMOVAL AND REFITMENT OF COOLING SYSTEM COMPONENTS

Water Pump

To Remove

1. Drain cooling system.
2. Disconnect hoses from radiator to water pump and from radiator to thermostat housing.
3. Remove air throttle cylinder and stop control solenoid.
4. Remove thermostat housing and by-pass pipe from cylinder block and water pump.
5. Disconnect outlet pipe at pump body flange.
6. Disconnect compressor coolant pipe from inlet elbow of water pump.
7. Remove heat exchanger to cylinder block water pipe.
8. Remove bolts securing pump to timing gear case and withdraw pump.

To Refit

Refitment is a reversal of removal procedure using new joints and rubber sealing rings. Before refitting heat exchanger to cylinder block water pipe install long bolt into pipe elbow to clear fuel filter. Ensure that joints and connections are securely made and system refilled with coolant. Check joints and connections after a short run for signs of leakage, rectify if necessary.

Heat Exchanger

To Remove

1. Drain lubricating and cooling systems.
2. Slacken off clips then slide rubber hoses up water inlet and outlet pipes.
3. Disconnect oil inlet and outlet pipes.
4. Remove setbolts securing heat exchanger to crankcase and withdraw heat exchanger.

To Refit

Refitment is a reversal of removal procedure ensuring that O-rings are fitted in oil inlet and outlet pipe flanges. Refill lubrication and cooling systems and run engine to check for leaks, rectify as necessary.

Thermostat

To Remove

1. Drain cooling system.
2. Disconnect hose from thermostat outlet elbow to radiator.
3. Remove elbow and extract thermostat.

To Refit

Refitment is a reversal of the removal procedure ensuring that a new outlet elbow joint is used.

Radiator, Fig. 1

To Remove

1. Isolate batteries.
2. Remove front detachable panel.
3. Drain coolant from radiator by opening the drain tap at front of vehicle.
4. Remove setscrews securing wiring harness to radiator.
5. Remove panel on inside of vehicle.

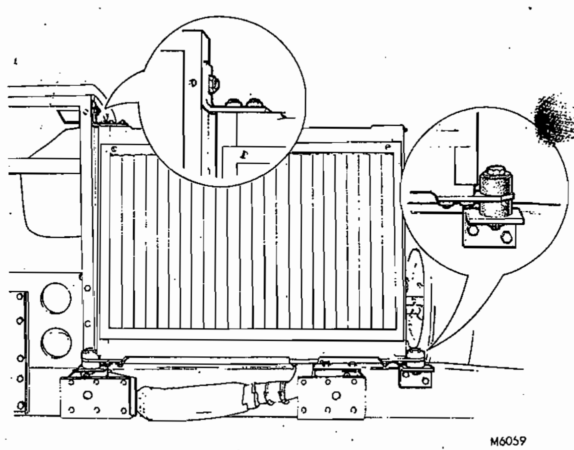


FIG. 1 RADIATOR MOUNTING POINTS

6. Disconnect terminals to fan (if fitted).

7. Turn up lockwashers and remove fan motor body lower half clamp.

8. The fan assembly can now be lowered through radiator cowl.

9. Disconnect fan upper half clamp, complete with support arms from frame side-members and lower through radiator cowl.

10. Slacken the hose clips on inlet and outlet radiator joints and remove any heater system connections or vent pipes from radiator.

11. Remove the setscrew securing upper offside mounting bracket.

12. Remove the two fixing bolts and rubber mountings and withdraw radiator and lower to ground.

To Refit

1. Refit the two fixing bolts and rubber mountings to radiator and secure to frame.

2. Refit the setscrew securing upper offside mounting bracket.

3. Reposition and secure hoses and hose clips on inlet and outlet elbows to radiator.

4. Position and secure fan upper half clamp, complete with support arms from frame side-members.

5. Position fan assembly up through radiator cowl.

6. Refit fan motor body lower half clamp and bend up lockwashers.

7. Reconnect terminals to fan (if fitted).

8. Replace panel on inside of vehicle.

9. Replace setscrews and clips securing wiring harness.

10. Close drain tap and refill system with coolant.

11. Refit front panel.

12. Operate isolation switch.

Run the engine and check pipe connections and coolant level, topping up if necessary.

Header Tank, Fig. 2

Removal and Refitment

To Remove

1. Isolate batteries.

2. Open nearside and rear engine access panels.

3. Loosen hose clips and slide rubber hose along water pipe and allow header tank to drain catching the coolant in a suitable container.

4. Disconnect electrical connections.

5. Loosen hose clips securing hose between header tank and filler neck.

6. Remove four bolts, nuts and washers and lower header tank to ground.

To Refit

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

1. Once the header tank has been refilled check pipe connections for leaks.

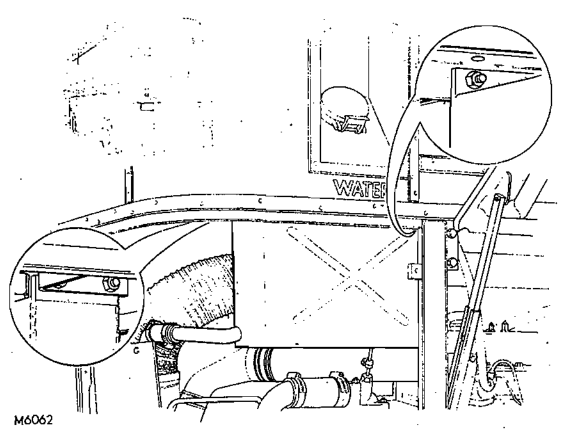


FIG. 2 HEADER-TANK FIXTURE

Testing

Heat Exchanger

Test the assembled heat exchanger on either the oil side or the water side using compressed air at 4.2 kgf/cm^2 (60 lbf/in^2) with the cooler immersed in water so that any leaks are revealed by the release of air bubbles.

Leakage past the sealing ring necessitates their replacement. If one tube leaks it should be sealed with a turned hardwood plug. Should more than six tubes be excluded a new tubestack should be fitted.

Thermostat

1. Remove thermostat and suspend it in a container of water.

2. Heat water gradually, stirring continuously to ensure uniformity of temperature.

3. Measure water temperature and note that valve should start to lift off its seat at 71/76.5°C (160/170°F).

4. Continue to heat water until valve is fully open, approximately 14 mm (0.55 in), at a temperature of 85/88°C (185/190°F).

If thermostat does not operate as described it should be replaced by a new unit.

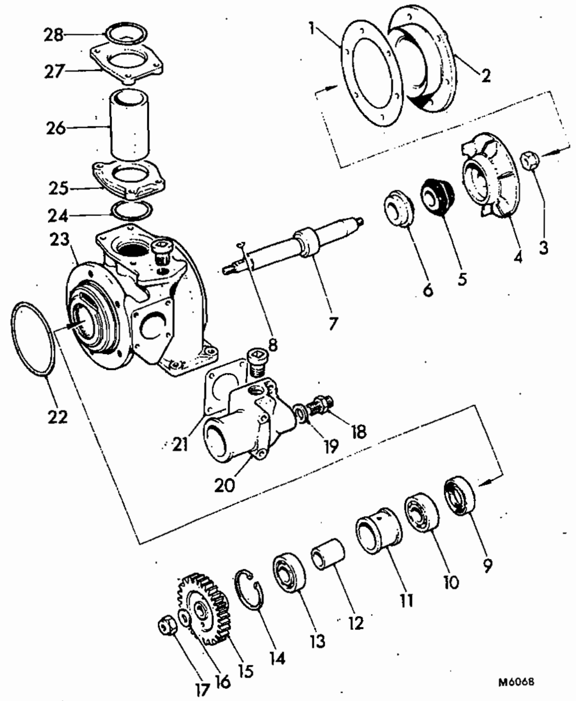


FIG. 3 WATER PUMP

1.	Joint	10.	Ball bearing	19.	Washer
2.	End cover	11.	Distance piece (outer)	20.	Inlet elbow
3.	Domed nut	12.	Distance piece (inner)	21.	Joint
4.	Impeller	13.	Roller bearing	22.	O-ring
5.	Ceramic insert	14.	Circlip	23.	Housing
6.	Water seal	15.	Drive gear	24.	O-ring
7.	Drive shaft	16.	Washer	25.	Flange
8.	Key	17.	Locknut	26.	By-pass pipe
9.	Oil seal	18.	Adaptor	27.	Flange
				28.	O-ring

OVERHAUL

Water Pump, Fig. 3

To Dismantle

1. Remove end cover (2) and joint (1).

2. Remove nut (3) securing impeller (4).

3. Using tool No. 155 withdraw impeller from drive shaft (7).

4. Remove nut (17) and washer (16) securing drive gear (15).

5. Using tool No. 155 withdraw drive gear from drive shaft.

6. Remove circlip (14).

7. Press out drive shaft complete with bearings (10 and 13) and distance pieces (11 and 12).

8. Remove water pump seal (6) and oil seal (9).

9. Press drive shaft (7) out of bearings.

10. If necessary remove ceramic impeller insert (5).

To Reassemble

Reassembly is a reversal of dismantling procedure using new joints. Take care when fitting seals not to damage sealing faces. Torque impeller securing nut to 3.8/4.5 kgf m (27.5/31.8 lbf ft).

Heat Exchanger, Fig. 4

To Dismantle

1. Unscrew retaining screws and remove washers.

2. Push tubestack a little way out of the cylinder to expose the O-ring. Remove O-ring.

3. Push the tubestack in the opposite direction until the other O-ring is exposed and remove.

4. Slide the tubestack out of the cylinder.

To Clean

Clean the oil side of heat exchanger by immersing it in paraffin or degreasing plant. The water side if badly scaled, can be cleaned using a proprietary type of descaling preparation.

On no account use stiff metal brushes or probes, which may damage the tubes and flow guide plates.

Ensure that all parts are perfectly clean before assembly paying particular attention to the O-ring grooves. Replace the O-rings if they are damaged or hardened.

1. Smear the inside of the cylinder with clean engine oil.
2. Insert tubestack into the cylinder until the O-ring groove is just exposed.
3. Rotate the tubestack until the notch lines up with the screw hole and fit greased O-ring into exposed groove.
4. Push the tubestack to the opposite end to expose the O-ring groove and fit greased O-ring.
5. Push the tubestack back into the cylinder and fit retaining screws and washers at each end.

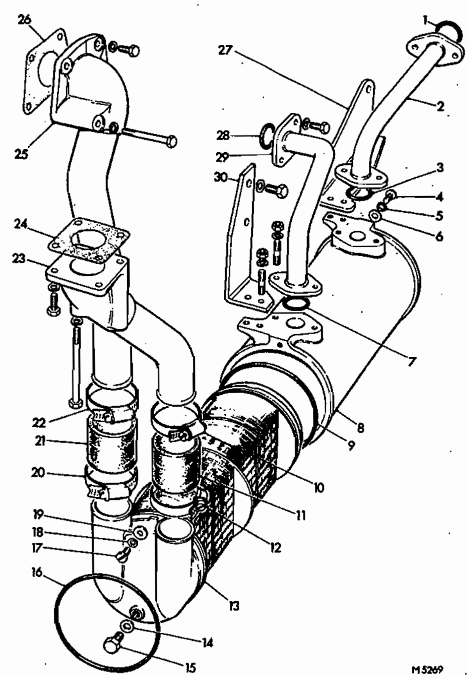


FIG. 4 EXPLODED VIEW OF HEAT EXCHANGER

1. O-ring
2. Oil inlet pipe
3. O-ring
4. Screw
5. Spring washer
6. Plain washer
7. O-ring
8. Cylinder
9. O-ring
10. Worm-drive clip
11. Rubber hoses
12. Worm-drive clip
13. Tubestack
14. Copper washer
15. Drain plug
16. O-ring
17. Screw
18. Spring washer
19. Plain washer
20. Worm-drive clip
21. Rubber hose
22. Worm-drive clip
23. Water inlet pipe
24. Joint
25. Water outlet pipe
26. Joint
27. Mounting bracket
28. O-ring
29. Oil outlet pipe
30. Mounting bracket

Cylinder Block Assembly

GENERAL INFORMATION

Data

Camshaft	
Journal diameters	41.186/41.211 mm (1.6214/1.6225 in)
End float	0.11/0.28 mm (0.0043/0.011 in)
Cam lift	13.1/13.2 mm (0.5157/0.5196 in)
Renew camshaft	When difference between base circle diameter of cam and the nose dimension is 12.7 mm (0.50 in) or less
Tappets	
Overall height	50 mm (1.9685 in)
Outside diameter	50.925/50.94 mm (2.0049/2.0055 in)
Tappet clearance	0.5 mm (0.020 in) cold
Tappet adjustment washer	In 16 sizes from 2.575 mm (0.1014 in) to 3.7 mm (0.1456 in) in increments of 0.075 mm (0.003 in)
Pistons	
1st ring groove width	2.438 mm nominal (0.0960 in)
2nd ring groove width	2.446/2.471 mm (0.0963/0.0973 in)
3rd ring groove width	4.826/4.851 mm (0.190/0.191 in)
Compression ring (wedge) width	2.356/2.382 mm (0.0928/0.0938 in)
Initial gap in cylinder bore	0.483/0.660 mm (0.019/0.026 in)
Compression ring (parallel) width	2.356/2.382 mm (0.0928/0.0938 in)
Initial gap in cylinder bore	0.483/0.660 mm (0.019/0.026 in)
Oil control ring width	4.737/4.763 mm (0.1865/0.1875 in)
Initial gap in cylinder bore	0.483/0.660 mm (0.019/0.026 in)
Gudgeon Pin	
Outside diameter	44.704/44.710 mm (1.7599/1.7601 in)
Connecting Rod	
Distance between centres of big-end and small-end	218.46/218.54 mm (8.6008/8.6039 in)
Alignment	Refer to Fig. 13
Small End Bush	
Inside diameter after reaming in position	44.7408/44.7484 mm (1.76145/1.76175 in)
Initial fit of gudgeon pin in bush	0.031/0.044 mm (0.0012/0.0017 in)

Big End Bearings

Running clearance	0.046/0.094 mm (0.0018/0.0037 in)
Assembled bearing bore (standard)	76.255/76.291 mm (3.002/3.004 in).
Service sizes available	Pre-finished in five sizes from 76.005/76.041 mm (2.9923/2.9937 in) down to 75.005/75.041 mm (2.9529/2.9543 in) in decrements of 0.25 mm (0.010 in).

Engine Block and Liners

Finished chrome bore diameter	118.100/118.125 mm (4.6496/4.6506 in)
Water pressure test	1.76 kgf/cm^2 (25.0 lbf/in^2)
Interference fit of liner in block	0.060/0.102 mm (0.0023/0.0040 in)
Clearance of liner at top of bore	0.075/0.275 mm (0.003/0.011 in)

Valve Seats

Seat angle (inlet and exhaust)	30°
Outside diameter of service valve insert:	
(Press fit) Inlet	54.736/54.744 mm (2.1550/2.1553 in)
(Press fit) Exhaust	48.373/48.381 mm (1.9044/1.9047 in)
Maximum permissible eccentricity between:	
Valve seat and valve guide bore	0.013 mm (0.005 in) total clock reading
Valve seat and valve stem	0.05 mm (0.002 in) total clock reading

Valve Guides

Inside diameter	11.10/11.12 mm (0.4370/0.4378 in)
Interference fit of guide in cylinder head	0.025/0.050 mm (0.0009/0.0018 in)
Guide protrusion above top face of cylinder block	14.0 mm (0.5512 in)

Valves (Inlet and Exhaust)

Valve stem diameter — inlet	11.025/11.040 mm (0.4340 /0.4346 in)
Valve stem diameter — exhaust	10.985/11.000 mm (0.4324/0.4331 in)
Clearance fit of valve stem in guide	
Inlet	0.060/0.095 mm (0.0023/0.0037 in)
Exhaust	0.100/0.135 mm (0.0039/0.0052 in)
Valve head diameter — inlet	52.9/53.1 mm (2.0826/2.0905 in)
Valve head diameter — exhaust	45.9/46.1 mm (1.8070/1.8149 in)
Valve face angle (inlet and exhaust)	30°
Valve head protrusion into cylinder — inlet	0.293 mm (0.0115 in)
Valve head protrusion into cylinder — exhaust	0.153 mm (0.0060 in)

Valve stem protrusion above cylinder block top face	50.9/51.6 mm (2.0039/2.0315 in)

Valve Springs

Free length (inner spring)	45.7 mm (1.799 in)
Free length (outer spring)	54.9 mm (2.161 in)
Spring pressures (inner)	54.4 kg (119.816 lb)± 2.7 kg (616 lb) when compressed to a length of 29.3 mm (1.153 in) 11.3 kg (25 lb) ± 2.7 kg (6 lb) when compressed to a length of 42 mm (1.654 in)
Spring pressures (outer)	68.6 kg (151 lb) ± 3.4 kg (7.5 lb) when compressed to a length of 34.3 mm (1.35 in) 26.4 kg (58.1 lb) ± 3.4 kg (7.5 lb) when compressed to a length of 47 mm (1.85 in)

Torque Loads

Cylinder block to crankcase nuts (M 12)	12.2/12.9 kgf m (88.24/93.3 lbf ft)
Cylinder block to crankcase nuts (M 16)	26.0/26.7 kgf m (188/193 lbf ft)
Big end bolts: stretch	0.15/0.20 mm (0.006/0.008 in)
Big end bolts: torque (reference only)	17.95/19.35 kgf m (129/140 lbf ft)
Camshaft drive gear bolts (taper lock)	15.45/16.15 kgf m (112/117 lbf ft)
Camshaft drive gear bolts (Durlok)	17.98 kgf m (130 lbf ft)

Note: 'Durlok' bolts to be coated with 'Loctite' 242

Camshaft bearing cap bolts	4.15/4.55 kgf m (30/33 lbf ft)
Jointing Compound	B.C.E. elastomer—P.R.C. PR1301 S12

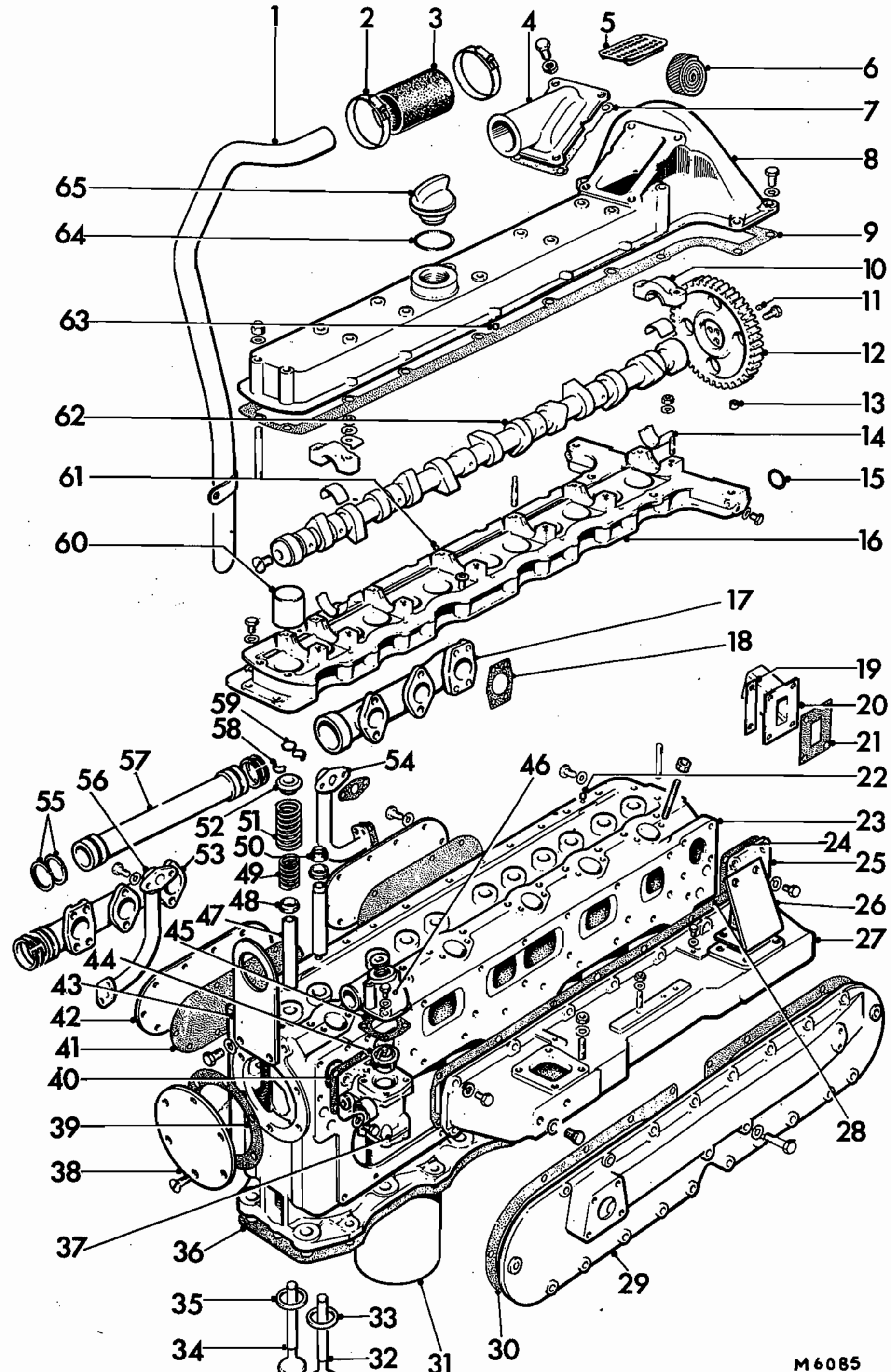


FIG. 1 EXPLODED VIEW OF CYLINDER BLOCK

1. Breather pipe
2. Hose clip
3. Hose
4. Breather
5. Baffle
6. Wire mesh pack
7. Joint
8. Top cover
9. Joint
10. Bearing cap
11. Dowel
12. Camshaft drive gear
13. Thread insert
14. Bearing shell
15. O-ring
16. Tappet block
17. Exhaust manifold
18. Joint
19. Tab washer
20. Water inlet nozzle
21. Joint
22. Dowel
23. Cylinder block
24. Joint
25. Blanking plate
26. Fuel filter bracket
27. Inlet manifold
28. Joint
29. Side cover and water rail
30. Joint
31. Cylinder liner
32. Inlet valve
33. Valve seat
34. Exhaust valve
35. Valve seat
36. Joint
37. Thermostat housing
38. Front cover
39. Joint
40. Joint
41. Joint
42. Side cover
43. Lifting eye
44. Thermostat
45. Joint
46. Water outlet elbow
47. Valve guide
48. Spring collar (lower)
49. Spring (inner)
50. Valve seal
51. Spring (outer)
52. Spring collar (upper)
53. Exhaust manifold
54. Drain pipe
55. Exhaust sealing rings
56. Drain pipe
57. Exhaust manifold tube
58. Split cone
59. Adjustment washer
60. Tappet
61. Dowel
62. Camshaft
63. Dowel
64. O-ring
65. Filler cap

REMOVAL AND REFITMENT OF CYLINDER BLOCK AND COMPONENTS

Camshaft and Tappets

To Remove

1. Disconnect batteries.

2. Disconnect cold start aid pipes and remove cold start reservoir and bracket. Refer to Driver's Handbook for cold start operation (if fitted).

3. Remove breather pipe from top cover.

4. Remove setscrews and dome headed nuts securing top cover. Lift top cover clear of studs.

Note: Before removing camshaft check tappet settings and note readings for subsequent assembly.

The tappet clearances should be checked when back of cam is over tappet.

5. Commence checking tappets by turning engine by hand until No. 1 piston is at T.D.C. of compression stroke, that is, both valves closed. Check and record inlet and exhaust tappet clearances and then give the engine one-third of a revolution to bring No. 5 piston on compression stroke. Check and record clearances for this cylinder and then repeat process for Nos. 3, 6, 2 and 4 cylinders in turn and in this order.

6. Slacken evenly the nuts holding down the camshaft bearing caps.

7. Remove bearing caps and carefully lift camshaft complete with drive gear out of its location.

8. Where necessary remove special bolts securing camshaft gear and remove gear from its hub and dowel location.

9. Remove each tappet and adjusting washer and suitably mark them for correct relocation purposes.

To Refit

Note: Before refitting tappets check that the smallest size adjusting washer stands proud of valve spring collar when placed in position. Fig. 2.

If a new valve has been fitted it is recommended that size 6 adjustment washer be installed for first tappet clearance checks. If tappet clearance was correct and valves have not been changed, replace original adjustment washer.

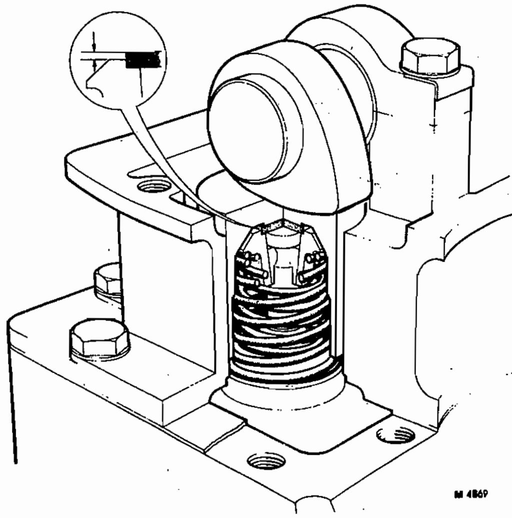


FIG. 2 ADJUSTING WASHER LOCATION

Selection of adjustment washers of appropriate thickness is straightforward. For example, if a particular clearance is 0.45 mm (0.017 in), then bearing in mind that the difference in nominal thickness between each washer size is 0.075 mm (0.003 in), it will be appreciated that the next smallest size is required to obtain the necessary clearance. Should, however, the clearance be 0.6 mm (0.023 in) then in this case the next largest size would be required. Reference to the part number and size marked on the edge of each washer will enable the correct replacement washer to be selected.

1. Place a suitable length of 9.5 mm (0.375 in) diameter rod in hole marked T.D.C. on top of flywheel housing.

2. Rotate engine crankshaft slowly until rod engages in timing hole in flywheel and No. 6 piston is on compression stroke, that is both valves closed, injection pump having just delivered. Injection pump delivery can be ascertained by observing pump flywheel timing mark in relation to pointer as crankshaft is being rotated.

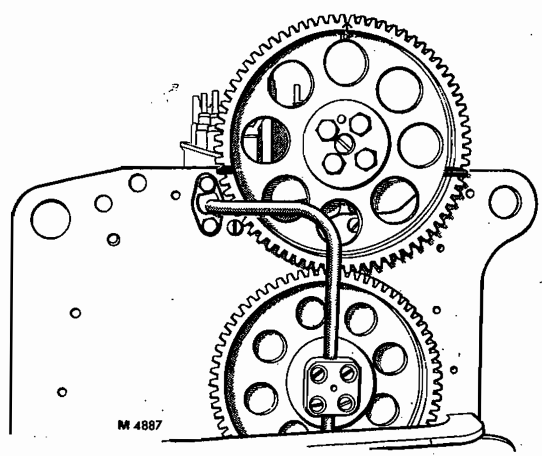


FIG. 3 CAMSHAFT GEAR TIMING MARKS

3. Place gear onto camshaft, if it has been removed, correctly positioning it on its dowel location. Replace special bolts and tighten to torque figure quoted in Data.

4. Fit lower half of camshaft bearings in position, if removed, ensuring that tab end is correctly located in machined recess.

5. Lubricate camshaft bearings with clean engine oil and place camshaft in position with timing marks on gear in line with top face of tappet block, Fig. 3.

6. Fit upper half of bearings into bearing caps ensuring that tab ends are located correctly. Lubricate bearings with clean engine oil. Position caps over camshaft ensuring that identification stampings correspond.

7. Place distance pieces, of sufficient diameter and length to clear larger diameter portion, onto studs of numbers 4 and 6 bearing caps. Fit nuts and washers onto smaller diameter of these studs and tighten down evenly until bearing cap nuts can be fitted throughout.

8. Tighten all bearing cap nuts evenly ensuring that drive gear is pulled down correctly into mesh with upper idler gear. Remove timing rod and rotate camshaft for two revolutions. Recheck timing mark alignment. Tighten bearing cap nuts to torque figure quoted in Data.

9. Check all tappet clearances.

10. Apply jointing compound, see Data, to mating faces of tappet block and top cover. Fit new joint and locate top cover into position.

11. Secure top cover with setscrews and dome headed nuts.

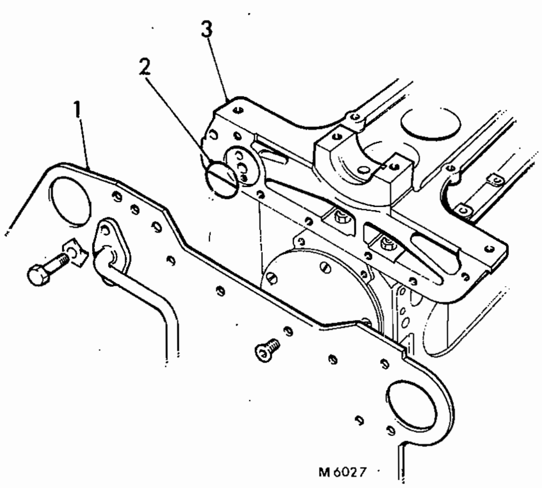


FIG. 4 LOCATION OF O-RING IN TAPPER BLOCK
1. Rear gear plate 2. O-ring 3. Tappet block

12. Refit breather pipe.

13. Refit cold start reservoir and bracket and reconnect cold start aid pipes.

14. Reconnect batteries.

15. Run engine to check for leaks, rectify if necessary.

Tappet Block

To Remove

1. Remove top cover, camshaft, bearings, tappets and adjusting washers as previously described.

2. Remove auxiliary drive unit.

3. Remove rear upper timing cover.

4. Remove the two bolts securing oil feed pipe to mounting plate and the four countersunk screws along top of mounting plate.

5. Remove nuts, hexagon and socket headed bolts which secure tappet block to cylinder block.

6. Ease tappet block from the four locating dowels and lift clear.

To Refit

1. Ensure that all faces are clean and free from traces of old jointing compound, and position a new O-ring into tappet block recess.

2. Apply an even coat of jointing compound, see Data, to cylinder block, rear gear plate and tappet block faces, then locate tappet block onto dowels and secure in position.

   Note: Check that O-ring is correctly seated in tappet block recess before any further assembly, see Fig. 4.

3. Fit the four countersunk screws securing mounting plate to tappet block and the two bolts securing oil feed pipe to mounting plate.

4. Replace adjustment washers, tappets, camshaft, top cover and breather as previously detailed.

Cylinder Block

To Remove

1. Isolate batteries.
2. Drain coolant from system and engine oil from sump.
3. Remove camshaft and tappet block as previously detailed.
4. Remove fuel oil filters and fuel pipes.
5. Remove turbocharger air outlet pipe.
6. Remove injector pipes, leak-off pipe and injectors.
7. Remove stop solenoid and throttle cylinder.
8. Remove water feed pipe to water rail.
9. Remove water pump and thermostat housing, see Section 2C.
10. Remove compressor air, oil, and water pipes.
11. Remove drive coupling, fuel injection pump and compressor, see Section 5C and Group 7.
12. Remove turbocharger oil feed and drain pipes.
13. Remove turbocharger air inlet pipe.
14. Remove turbocharger, turbocharger mounting bracket, inlet and exhaust manifolds.

Note: To prevent nut seizure, the exhaust manifold nuts are graphite treated.

15. Remove front and rear oil return pipes.
16. Remove sump, sump brackets and lubricating oil pump, see Section 4C.
17. Rotate crankshaft in normal direction of rotation to bring Nos. 1 and 6 pistons to B.D.C. Remove connecting rod cap securing nuts and bearing caps.

Note: To enable crankshaft to be turned tool LC 144 should be positioned and secured as shown in Fig. 5. This tool centralises the compressor drive gear and prevents jamming of gear train when crankshaft is rotated.

18. Repeat this procedure for Nos. 2 and 5 and 3 and 4 bearing caps in turn.

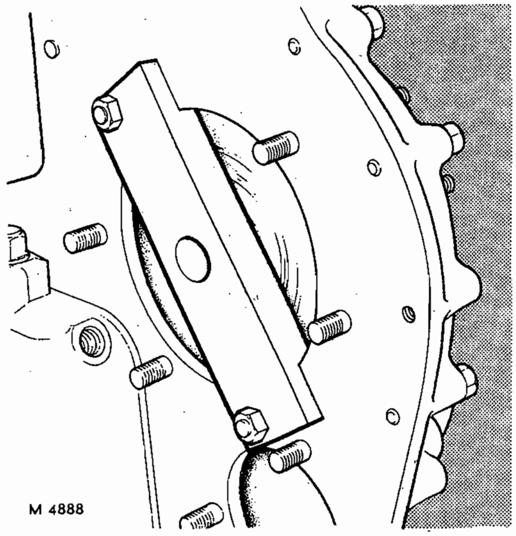


FIG. 5 CENTRALISING COMPRESSOR DRIVE GEAR

19. Turn crankshaft back slowly to bring Nos. 1 and 6 pistons to T.D.C. Check position using timing aperture in flywheel housing.

Note: As the crankshaft is being rotated keep Nos. 2 and 5 connecting rods in contact with their respective crankpins.

20. Remove cylinder block to crankcase retaining nuts then carefully raise cylinder block parallel to crankcase, complete with piston and connecting rod assemblies.

    Rock cylinder block slightly during initial lift to free it from crankcase location dowels.

21. As cylinder block is being raised ensure that connecting rods clear cut-outs in top of crankcase. When clear, push each rod and piston assembly to T.D.C. position in cylinder block.

Note: Should any piston and connecting rod assembly fail to hold in position as cylinder block is being raised, it should be removed carefully when sufficient clearance is obtained and suitably marked to identify it to its original bore.

22. Lower cylinder block carefully and suitably support in the horizontal position ready for piston and connecting rod removal.

To Refit

1. Ensure that both mating faces of crankcase and cylinder block are perfectly clean and free from old jointing. Coat both faces with jointing compound, see Data and fit new gaskets.

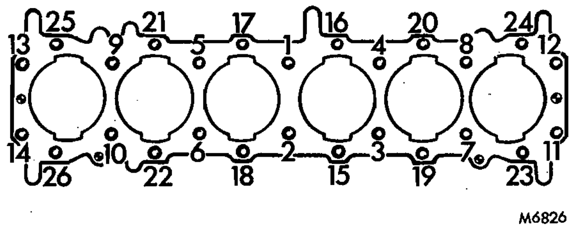


FIG. 6 TIGHTENING SEQUENCE OF CYLINDER BLOCK NUTS

Nuts 1/14 Stud size 16 mm Nuts 15/26 Stud size 12 mm

2. Turn crankshaft to bring Nos. 1 and 6 crankpins to T.D.C. position. Lubricate each crankpin liberally with clean engine oil.

3. With piston and connecting rod assemblies correctly fitted into cylinder block, lower block carefully and parallel to crankcase, allowing suspended rods, minus bearing caps but with upper half bearings fitted, to pass through cut-outs in top of crankcase.

Note: Ensure that cylinder block is correctly positioned relative to crankcase, i.e., injectors on same side as fuel injection pump when engine build is complete.

4. Lower cylinder block fully over securing studs to obtain a positive location on dowels situated at each end of crankcase. Fit cylinder block to crankcase nuts, tighten to torque figure quoted in Data using tool LC 139 and a crow foot wrench. Tighten in sequence shown in Fig. 6.

Note: Nos. 1 and 6 connecting rods will now be correctly located on their respective crankpins, Nos. 2, 3, 4 and 5 are freely suspended from their piston locations.

5. With Nos. 1 and 6 crankpins still at T.D.C. fit these two connecting rod bearing caps and secure with retaining nuts.

Note: During manufacture each connecting rod and cap is machined as a complete assembly and stamped in its correctly assembled state with an identification number. Connecting rod caps are not interchangeable and must be fitted to their parent rods.

6. Pull each of the four remaining connecting rods carefully down on to their respective crankpins in turn, then turn crankshaft slowly in normal direction of rotation to bring Nos. 3 and 4 crankpins to B.D.C. Fit bearing caps and secure with nuts. Use connecting rod location tool to hold connecting rods in contact with crankpins whilst crankshaft is being slowly rotated.

7. Repeat procedure for Nos. 2 and 5 assemblies.

8. With all connecting rod bearing caps fitted bring each pair in turn to B.D.C. and tighten securing nuts to figure quoted in Data.
   Rotate crankshaft to ensure freedom of movement.

9. Fit oil pump, sump and sump brackets, see Section 4C.

10. Fit front and rear oil return pipes followed by exhaust manifold checking that correct nuts are used.

11. Fit inlet manifold.

12. Fit turbocharger and mounting bracket along with oil feed and drain pipes.

13. Fit turbocharger air inlet pipe.

14. Fit compressor, fuel injection pump and drive shaft, see Group 7 and Section 5C of this Group.

15. Fit compressor air, oil and water pipes.

16. Fit water pump and thermostat housing, see Section 2C.

17. Fit water feed pipe to water rail.

18. Fit stop solenoid and throttle cylinder.

19. Fit tappet block. At this stage turn engine by hand to ensure freedom of movement.

20. Fit injectors and leak-off pipes, see Section 5C.

21. Fit fuel oil filters and fuel pipes.

22. Fill sump to correct level with clean engine oil of correct type and grade, see Group 1, and cooling system with appropriate coolant.

23. Connect batteries in preparation for starting.

Pistons and Connecting Rods

To Remove

1. Remove cylinder block as previously detailed.

2. With cylinder block suitably supported carefully withdraw each piston and connecting rod assembly, marking them in a suitable manner for reassembly purposes.

3. Replace bearing caps on connecting rods, with bearing shells if satisfactory for further service, and loosely fit nuts. Caps are identified to their parent rods by means of identification numbers stamped on one end of cap.
   Therefore connecting rod caps are not interchangeable and when correctly fitted into cylinder block the numbers should be adjacent and on same side as injection bores.

To Refit

1. Ensure that all parts are correctly assembled, liberally lubricate cylinder bores, piston rings and bearing surfaces with clean engine oil.

2. Stagger piston ring gaps at intervals of approximately 180°.

3. Compress rings with the aid of compressing tool No. 8 as shown in Fig. 7.

4. Position piston in its original bore with offset combustion chamber in piston crown, together with identification number stamped on connecting rod, facing towards injector bore side of cylinder block.

5. Push piston fully home into cylinder bore with the aid of connecting rod.

6. Repeat items 2–5 for remaining piston and connecting rod assemblies. With each piston assembly at T.D.C. in their respective bores the cylinder block is now ready to assemble to crankcase.

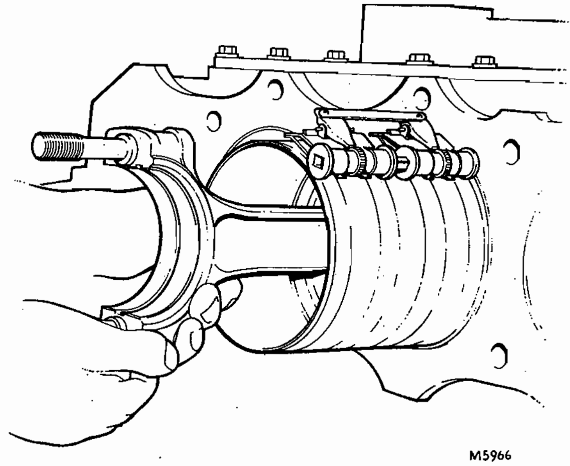


FIG. 7 FITTING PISTON AND CONNECTING ROD INTO CYLINDER BORES

1. Connecting rod 2. Ring compressing tool

Cylinder Liners

To Remove

1. Remove cylinder block as described in this section.

2. Before the cylinder liner can be withdrawn an annular groove must be cut at top of liner using tool LC 146.

3. Set cutting tool, using depth gauge shown in Fig. 8, by operating knurled feed nut. Lock stop screw.

Note: It is important that the depth of cut is set correctly to prevent damage to parent bore.

4. With block in an inverted position take precautions against swarf entering valve porting and guide bores and with cutting bit retracted insert tool into bore.

5. Tighten knurled feed nut to bring cutting bit in contact with liner and turn complete tool in a clockwise direction. Continue turning and adjusting knurled nut until cutting bit has reached extent of its travel.

6. Unscrew feed nut and remove tool from cylinder bore. Remove swarf.

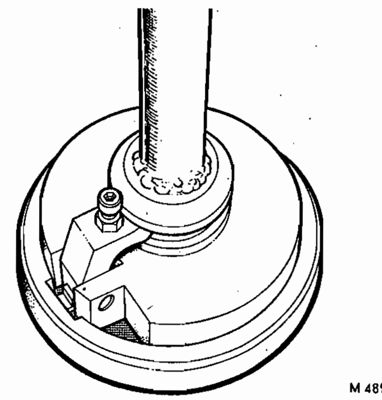


FIG. 8 SETTING CUTTING DEPTH USING RING GAUGE

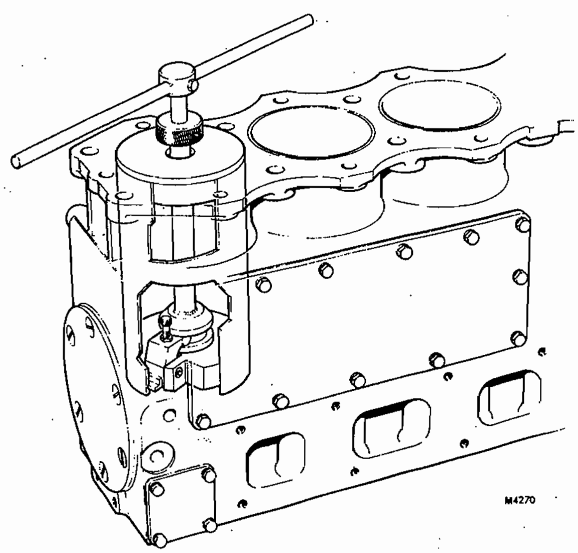


FIG. 9 CUTTING ANNULAR GROOVE IN CYLINDER LINER

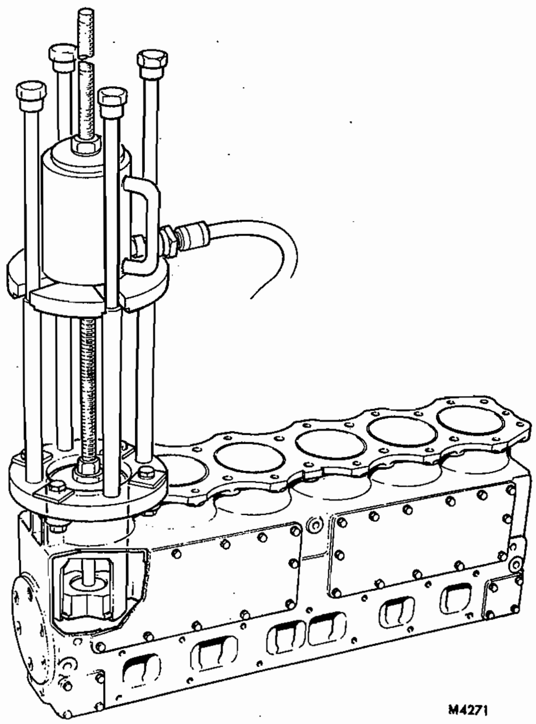


FIG. 10 WITHDRAWING CYLINDER LINER

7. The liner can now be withdrawn using tool LC147 and a 20 ton hydraulic ram and pump.

8. Screw lead screw into puller adaptor and insert it into cylinder with split collar located as shown in Fig. 10.

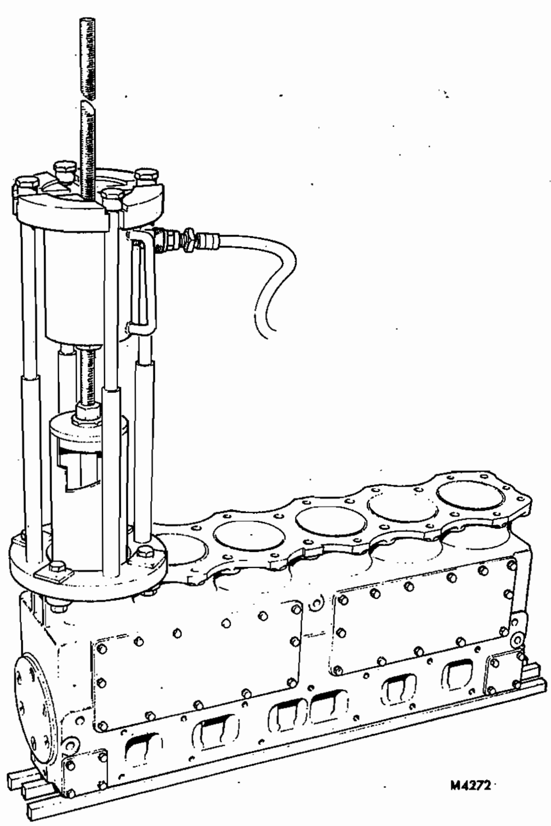


FIG. 11 INSERTING CYLINDER LINER

9. Lower frame over screw until base ring rests on cylinder block. Secure base ring with the four bolts and washers.

10. Place ram unit on top of frame so that it locates in recess in top plate with piston uppermost. Screw one of the nuts and washers onto lead screw and tighten down onto the ram.

11. Check that all parts are correctly located and with pump connected to ram commence to operate pump to withdraw liner, checking that base ring will not impede liner's progress.

12. When liner is withdrawn to full extent of ram piston, resistance will be felt at pump. Open release valve on pump and as piston retracts screw down the hexagon nut on lead screw to compensate for initial travel of ram piston.

13. Repeat withdrawal procedure until liner is completely withdrawn. Remove any swarf remaining in bore.

To Refit

Note: Invert cylinder block and place it on three support rails running full length of block. Ensure that centre rail is equi-spaced about centre-line of valve guides.

1. Place frame of tool LC147 onto cylinder block, positioning bottom plate so that securing holes line up with stud holes in cylinder block. Secure frame with the four bolts, nuts and square washers provided.

2. Remove top plate from frame and smear outside of new liner with engine oil and place in position within framework.

3. Remove centralising dolly from cutting tool and place it so that it spigots into liner.

4. Place one of the nuts and washers on the lead screw and place it through centralising dolly. Ensure that length of screw inserted does not exceed overall length of liner.

5. Run remaining nut and washer down lead screw and place ram unit in position with piston pointing downwards. Fit top plate and secure with the four special nuts, adjusting nut on lead screw if necessary.

6. Liner insertion can now commence by operating hydraulic pump ensuring that liner is entering parent bore squarely.

Note: Initial insertion of liner can be done at the discretion of user by turning nut on lead screw against ram thereby pressing liner into cylinder bore.

7. As liner is pressed in to full extent of ram piston, resistance will be felt at pump. Open release valve on pump and as piston retracts screw up nut on lead screw to compensate for travel of piston.

8. Repeat this procedure until liner is pressed in flush with cylinder block face. The liner must not bottom in the bore. See Data.

Valves

To Remove

1. Remove cylinder block, piston and connecting rod assemblies as previously detailed.

Note: Before carrying out the following operation, six wooden distance pieces should be prepared of a length equal to depth of cylinder bore and of sufficient thickness to span valve heads. Mount these distance pieces on a common platform, spaced out to conform to cylinder bores.

2. Insert and retain wooden distance piece and with the aid of valve spring compressing tool LC6118, LC6118-6 adjusting stirrup and LC6118-2 thread adaptor remove split retaining cones, collars and springs.

3. Remove distance pieces and extract valves from their guides suitably identifying them to their original locations.

To Refit

Ensure that cylinder block and all component parts are perfectly clean.

1. Lightly lubricate each valve stem with engine oil and locate them in their original locations. Insert and retain wooden distance pieces.

2. Fit lower collars over valve stems followed by inner and outer valve springs and upper collars.

3. With the aid of valve spring compressing tool carefully compress spring assemblies and locate split retaining cones. Remove compressing tool and tap assembly with a soft faced hammer to ensure positive split cone location.

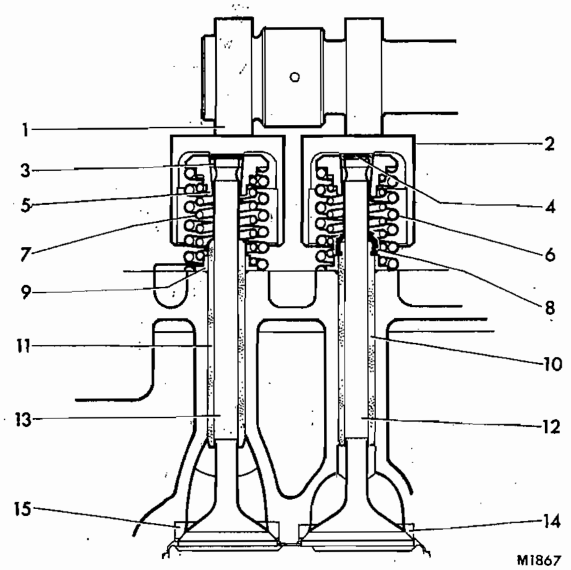


FIG. 12 SECTIONED VIEW OF VALVES AND SPRINGS

1. Camshaft
2. Tappet
3. Valve split cone
4. Tappet adjustment washer
5. Valve spring collar, upper
6. Valve spring, outer
7. Valve spring, inner
8. Inlet valve seal
9. Valve spring collar, lower
10. Valve guide, inlet
11. Valve guide, exhaust
12. Inlet valve
13. Exhaust valve
14. Valve seat, inlet
15. Valve seat, exhaust

OVERHAUL

Piston and Connecting Rod

To Dismantle

Ensure before dismantling that each piston is suitably marked to identify it to both connecting rod and cylinder bore.

1. Remove piston rings from each piston using a suitable ring expanding tool.

2. Using suitable circlip pliers remove circlips which retain gudgeon pins in piston boss.

3. Heat piston by placing piston crown in boiling or very hot water, this will enable the pin to be readily pushed out, thus releasing piston from connecting rod.

4. Repeat items 1 – 3 for remaining assemblies. Keep all parts for each assembly separate from other assemblies.

Inspection

1. Thoroughly clean all dismantled components.

2. Examine pistons for signs of scoring or ring groove damage.

3. Check clearance of piston rings in their respective grooves.

4. Check piston ring gaps in their respective cylinder bores, bearing in mind that in the case of worn bores these gaps should be checked with rings sited in bores at lower limit of ring travel.

5. Check fit of gudgeon pin in small end bushes, if clearance is excessive renew bushes as follows:
   (i) Press out old bushes using a suitable press and dolly.

   (ii) Press new bushes carefully into position, one from each side of connecting rod, so that when in position an oil groove is formed between the two bushes.

   (iii) Ream bore to size given in Data.

6. Check each connecting rod for parallelism and twist. Refer to Connecting Rod Alignment Data, Fig. 13.

7. Examine big-end bearing shells for signs of excessive wear or pitting. Renew as necessary. The plain half shells locate in bearing caps whilst grooved half shells with oil feed hole locate in rods.

8. Check crankpins both visually and dimensionally, should any damage or undue wear be apparent, the crankshaft should be removed from engine, followed by a complete dimensional check to ascertain whether regrinding or a replacement crankshaft is indicated, see Section 4C of this Group.

To Reassemble

All original parts being used should be fitted in their original positions.

1. Replace one circlip in piston body recess.

2. Heat piston to approximately 100° C (212° F) this will enable the gudgeon pin to be located easily in piston boss, when piston and rod are correctly aligned.

3. Position piston over connecting rod so that off-set combustion chamber is towards same side as identification number stamped on rod and cap. Insert gudgeon pin and secure with second circlip. Ensure that both circlips are fully located.

4. Repeat items 1 to 3 for remaining pistons and connecting rod assemblies.

Before fitting piston rings the pistons should be thoroughly dried preferably with compressed air. The piston rings should be fitted with the aid of a suitable ring expanding tool in the following sequence:

1. Spring loaded oil control ring—3rd groove.

   Fit spring assembly into groove and carefully position ring over spring assembly so that ring gap lies diametrically opposite joint in spring assembly.

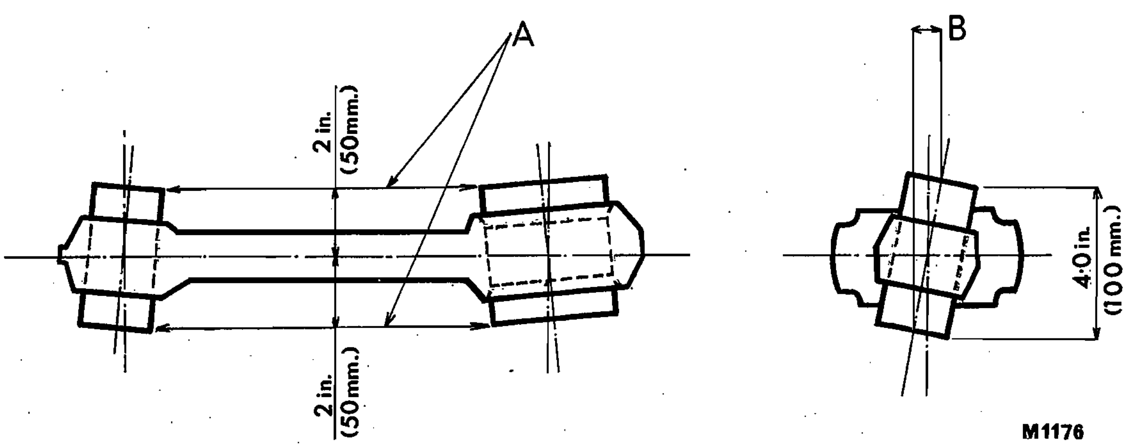


FIG. 13 CONNECTING ROD ALIGNMENT

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

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

2. Wedge compression ring—2nd groove.

3. Wedge compression ring—Top groove.

Note: Wedge compression rings are marked TOP to indicate correct positioning.

Examination and Reconditioning Valve Components

Valve Guides, Fig. 15

Check valve guide stem clearance. Refer Data. If this is excessive, renew guide. If stem is worn, renew valve. Always check fit of a valve in new guide, they must have the clearance quoted. Guides can be pressed out of their locations and new ones pressed in with the aid of tool LC142 which will give correct guide protrusion above valve spring seat. After fitting a new guide always regrind valve seat so that it is concentric with guide.

Valve Springs

Valve springs deteriorate gradually due to fatigue, it is therefore advisable to check squareness of ends (in free state) and pressures developed at specific lengths quoted in Data whenever valve assembly is dismantled. Renew weak springs as necessary.

Valves and Valve Seats

Check valves dimensionally (heads and stems), also visually for signs of burning. If valves and seats are in good condition they can be lightly hand lapped together. On no account should badly pitted valves and seats be lapped together as this will cause excessively wide seats.

Finally wash block and valves in clean paraffin to remove all traces of lapping paste and loose carbon particles.

If valve facings and seats are badly pitted they should be reconditioned using specialised equipment. The high speed carborundum stone for grinding the seat must have a working face accurately dressed to correct angle and work on a spindle located in valve guide. The face of the seat should be concentric with valve guide bore to within recommended limit.

The valve facing machine should hold valve at correct angle to stone and valve facing should be concentric to valve stem within recommended limit.

In both these machining operations the minimum amount of material should be removed. Wash both block and valves in clean paraffin after machining is completed.

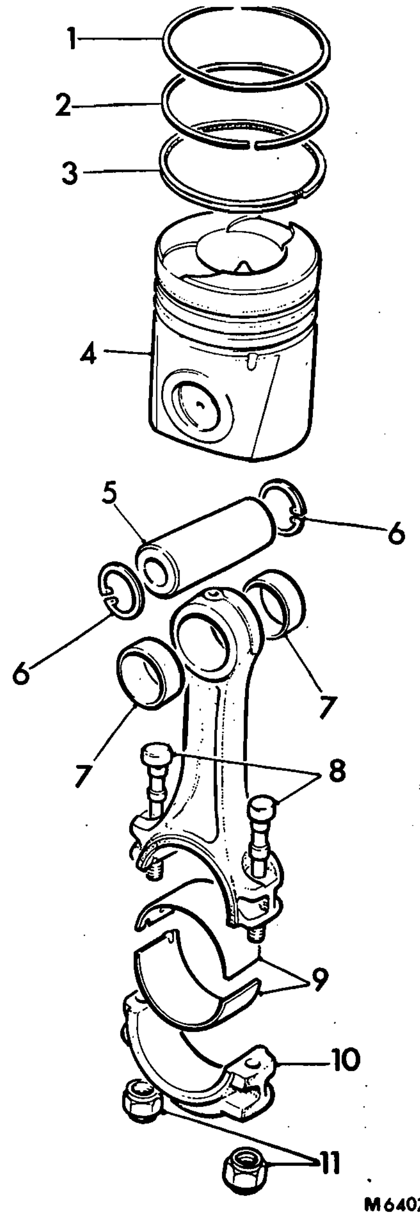


FIG. 14 EXPLODED VIEW OF PISTONS

1. Ring (wedged compression)
2. Ring (parallel compression)
3. Ring (oil control)
4. Piston (panel)
5. Gudgeon pin
6. Circlip
7. Small end bushes
8. Bolts
9. Big end bearings
10. Bearing cap
11. Nuts

After re-lapping or re-seating valves, check the valve head protrusion and that the protrusion of the valve stem above top surface of cylinder block is within 50.9/51.6 mm (2.004/2.031 in) refer to Data.

Valve Seat Inserts, Fig. 16 and 17

To Remove

1. Select appropriate remover body i.e. inlet or exhaust, extractor tool LC148.

2. Insert remover body into cylinder bore and locate stem of remover into valve guide.

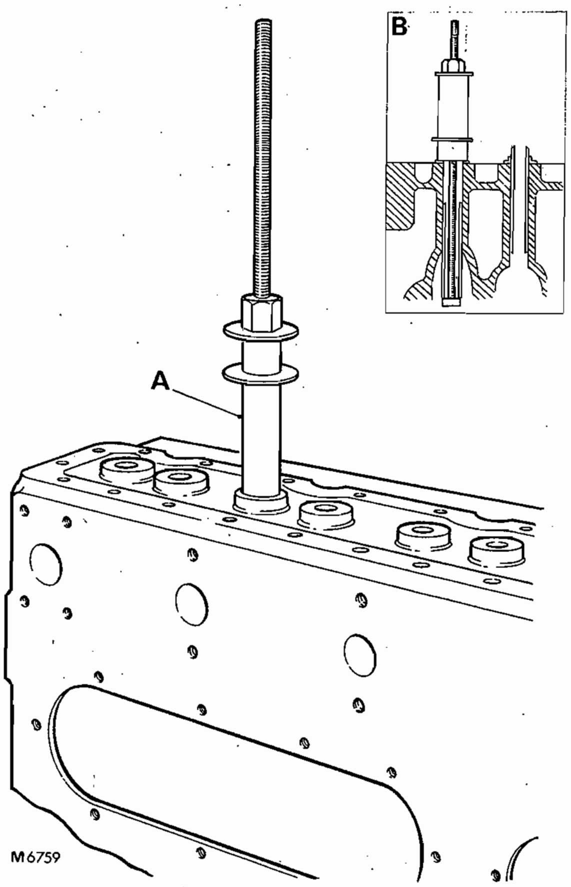


FIG. 15 VALVE GUIDE EXTRACTOR
'A' Removing valve guide 'B' Refitting valve guide

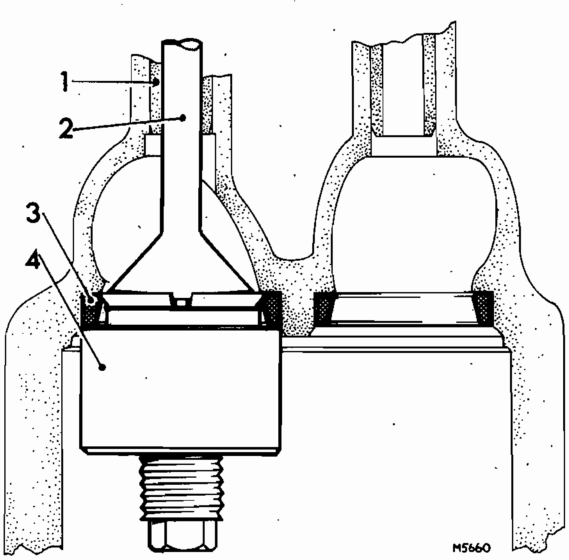


FIG. 16 VALVE SEAT EXTRACTOR

1. Valve guide
2. Remover stem
3. Valve seat insert
4. Remover body

3. Tighten plug on remover body until slight resistance is felt. Rotate remover body several times to remove carbon deposits from chamfer on valve seat insert. Tighten plug securely.

4. Install bridge onto cylinder block face and align centre screw into recess in remover body stem.

Note: The bridge plate is designed to remove inserts from cylinders 1, 2 and 3 when assembled one way and from 4, 5 and 6 when inverted.

5. Tighten centre screw until valve seat insert is removed.

To Refit

Note: Before fitting a new insert ensure that the parent bore is not damaged in any way and is perfectly clean.

1. Locate new valve seat insert onto remover body then insert assembly into cylinder bore. Position replacer pad against remover body and tap pad until insert is fully located.

2. Lightly lap valves to new seats. If seating face is not concentric within limits quoted, check valve guide for wear and renew if necessary.

Valve Timing

The timing is determined by mesh of camshaft drive gear through gear train to crankshaft gear and cannot therefore alter in service. Any inaccuracy can only arise from faulty assembly or if serious damage has occurred to engine.

To Check Valve Timing

1. Remove top cover.

2. Place a suitable length of 9.5 mm (0.375 in) diameter rod in hole marked T.D.C. on top of flywheel housing.

3. Rotate engine crankshaft slowly until rod engages in timing hole in flywheel and No. 6 piston is on compression stroke, that is, both valves closed, injection pump having just delivered. Injection pump delivery can be ascertained by observing pump flywheel timing mark in relation to pointer as crankshaft is being rotated. At this point inlet and exhaust valves are closed.

Note: Camshaft gear markers should be level with top edge of upper rear gear cover as in Fig. 18 for correct position of T.D.C.

Cleaning

On no account should any form of abrasive be used for cleaning carbon from piston crowns or combustion area within cylinder block.

Carborundum paste for lapping must be confined to vicinity of valves and seats and all traces removed before reassembly.

Remove superficial carbon from combustion area within cylinder block and piston crowns by careful scraping.

Any carbon deposit at bottom of injector bores can be removed with the aid of tool LC143, or LC202 for engines with Ambac 7 mm (0.275 in) diameter nozzles.

Excessive deposits caused by hard water within upper region of cylinder block water jacket can be removed with the aid of a proprietary solution formulated specifically for this purpose.

Water test cylinder block at recommended pressure after such treatment.

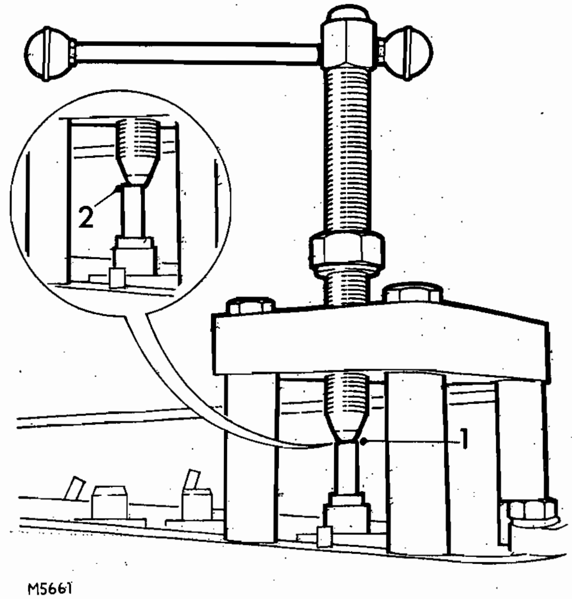


FIG. 17 BRIDGE IN POSITION
1. Correct alignment of tool 2. Tool misaligned

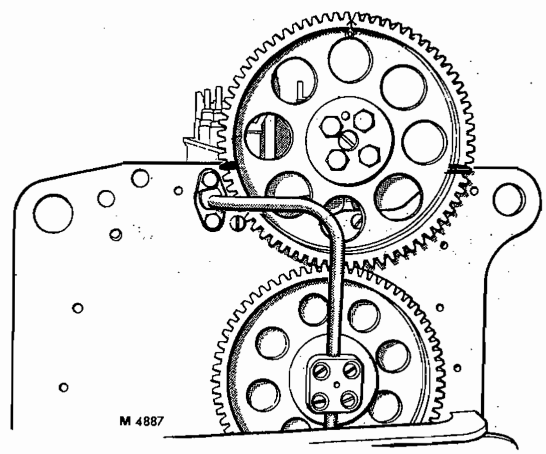


FIG. 18 CAMSHAFT GEAR TIMING MARKS

SECTION 4C

Crankcase Assembly

GENERAL INFORMATION

Data

Idler Gears

Number of teeth — rear upper	65.
Number of teeth — rear lower	60.
Clearance fit of bush in gear bore	0.110/0.143 mm (0.0043/0.0056 in)
Clearance fit of bush on hub	0.04/0.09 mm (0.0015/0.0031 in)
Idler gear end float	0.175/0.30 mm (0.0067/0.0118 in)
Permissible backlash with mating gears	0.05/0.11 mm (0.002/0.004 in)

Oil Pump

Permissible backlash with crankshaft gear	0.05/0.11 mm (0.002/0.004 in).
Shims available in following sizes	0.51 mm (0.002 in) 2.54 mm (0.010 in) 0.76 mm (0.003 in) 3.71 mm (0.015 in) 1.27 mm (0.005 in) 5.08 mm (0.020 in)
Oil pressure	4/4.5 kgf/cm^2 (57/64 lbf/in^2) at normal running speeds 1.0 kgf/cm^2 (15 lbf/in^2) at idling speed
Pump delivery	90.8 litres (20 gals.) approx. per min. at 2000 rev/min

Crankshaft

Thrust taken on	Centre journal.
Initial end float	0.100/0.302 mm (0.0039/0.0119 in)
Renew thrust washers when end clearance exceeds	0.355 mm (0.014 in)
Oversize thrust washers available, Standard	2.299/2.350 mm (0.0804/0.0925 in)
Service oversize S1	2.424/2.475 mm (0.1109/0.1168 in)
Service oversize S2	2.549/2.600 mm (0.1002/0.1023 in)
Service oversize S3	2.799/2.850 mm (0.1101/0.1121 in)
Regrind journals and crankpins	When 0.076 mm (0.003 in) oval
Main bearing initial diametral clearance	0.051/0.107 mm (0.0020/0.0041 in)
Renew when diametral clearance exceeds	0.228 mm (0.009 in)
Maximum run-out on shaft	0.075 mm (0.003 in). Total dial gauge reading 0.15 mm (0.006 in)

TABLE OF CRANKSHAFT DIMENSIONS

TYPE	PART	CRANKPIN DIAMETER		CRANKPIN WIDTH		JOURNAL DIAMETER		JOURNAL WIDTH					
								FRONT AND REAR		CENTRE		INTERMEDIATE	
		mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
Standard Service	801861	76.213 76.195	3.0004 2.9996	46.04 45.96	1.8125 1.8093	88.913 88.895	3.5005 3.4997	57.2 57.0	2.3519 2.2441	57.05 57.00	2.2460 2.2441	42.1 41.9	1.6574 1.6496
1st Service	801861/S1	75.963 75.945	2.9906 2.9899	46.04 45.96	1.8125 1.8093	88.662 88.645	3.4906 3.4898	57.2 57.0	2.3519 2.2441	57.05 57.00	2.2460 2.2441	42.1 41.9	1.6574 1.6496
2nd Service	801861/S2	75.713 75.695	2.9808 2.9800	46.04 45.96	1.8125 1.8093	88.412 88.395	3.4807 3.4800	57.2 57.0	2.3519 2.2441	57.05 57.00	2.2460 2.2441	42.1 41.9	1.6574 1.6496
3rd Service	801861/S3	75.463 75.445	2.9710 2.9702	46.04 45.96	1.8125 1.8093	88.162 88.145	3.4709 3.4702	57.2 57.0	2.3519 2.2441	57.05 57.00	2.2460 2.2441	42.1 41.9	1.6574 1.6496
4th Service	801861/S4	75.213 75.195	2.9611 2.9603	46.04 45.96	1.8125 1.8093	87.912 87.895	3.4611 3.4603	57.2 57.0	2.3519 2.2441	57.05 57.00	2.2460 2.2441	42.1 41.9	1.6574 1.6496
5th Service	801861/S5	74.963 74.945	2.9512 2.9505	46.04 45.96	1.8125 1.8093	87.662 87.645	3.4512 3.4504	57.2 57.0	2.3519 2.2441	57.05 57.00	2.2460 2.2441	42.1 41.9	1.6574 1.6496

Assembled bearing bore

Standard	88.963/89.002 mm (3.5024/3.5040 in)
Service undersize S1	88.713/88.752 mm (3.4926/3.4942 in)
Service undersize S2	88.463/88.502 mm (3.4828/3.4843 in)
Service undersize S3	88.213/88.252 mm (3.4729/3.4745 in)
Service undersize S4	87.963/88.002 mm (3.4630/3.4647 in)
Service undersize S5	87.713/87.752 mm (3.4532/3.4548 in)

Torque loads

Crankcase main bearing cap bolts	41.95/43.35 kgf m (303/314 lbf ft)
Flywheel to crankshaft bolts	39.35/40.75 kgf m (285/295 lbf ft)
Damper to crankshaft bolts	15.00/15.75 kgf m (108/114 lbf ft)
Oil pump drive gear bolts (taper lock)	4.4/5.06 kgf m (32/37 lbf ft)
Oil pump drive gear bolts (Durlok)	5.11 kgf m (38 lbf ft)

Note: 'Durlok' bolts to be coated with 'Loctite' 242

Jointing Compound . . . . B.C.E. elastomer–P.R.C.–PR1301 S12

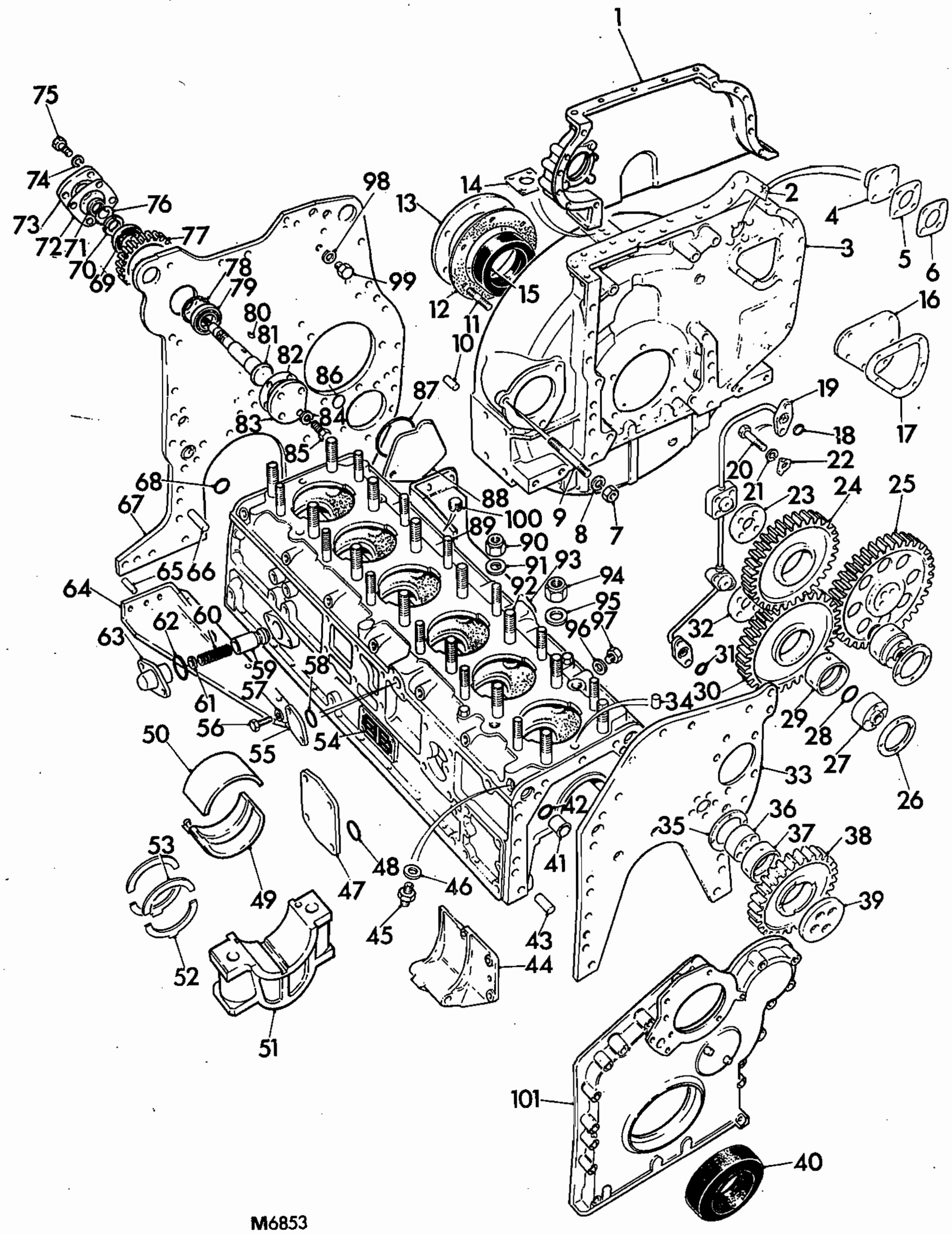


FIG. 1 EXPLODED VIEW OF CRANKCASE

1. Rear gear cover
2. Joint
3. Flywheel housing
4. Tachometer pick up
5. Shim
6. Joint
7. Nut
8. Washer
9. Stud
10. Dowel
11. Stud
12. Joint
13. Oil seal housing
14. Timing plate
15. Oil seal
16. Compressor cover plate
17. Joint
18. O-ring
19. Oil feed pipe
20. Setscrew
21. Washer
22. Lock tab
23. End plate
24. Idler gear (small)
25. Compressor drive gear
26. Thrust washer
27. Idler gear hub
28. O-ring
29. Bush
30. Idler gear (large)
31. O-ring
32. End plate
33. Front gear plate
34. Dowel
35. Thrust washer
36. Idler gear hub
37. Bush
38. Front idler gear
39. End plate
40. Oil seal
41. Ferrule
42. O-ring
43. Dowel
44. Mounting bracket
45. Adaptor
46. Copper washer
47. Blanking plate
48. O-ring
49. Bearing (lower)
50. Bearing (upper)
51. Bearing cap
52. Thrust washer (lower)
53. Thrust washer (upper)
54. Identification plate
55. Blanking plate
56. Setscrew
57. Washer
58. O-ring
59. Relief valve
60. Relief valve spring
61. Shims
62. O-ring
63. Relief valve cover
64. Strengthener bracket
65. Dowel
66. Dowel
67. Rear gear plate
68. O-ring
69. Bearing
70. Locknut
71. Oil seal
72. Joint
73. End cover
74. Washer
75. Setscrew
76. Lock washer
77. Drive gear (auxiliary)
78. Circlip
79. Bearing
80. Key
81. Shaft
82. Joint
83. End cover
84. Washer
85. Setscrew
86. O-ring
87. O-ring
88. Steering pump cover plate
89. Stud
90. Locknut
91. Plain washer
92. Stud
93. Strengthener bracket
94. Locknut
95. Plain washer
96. Washer
97. Blanking plug
98. Washer
99. Blanking plug
100. Blanking plug
101. Front gear cover

REMOVAL AND REFITMENT OF CRANKCASE COMPONENTS

Flywheel

To Remove

1. Remove gearbox, refer to Group 4.
2. Remove fluid coupling, refer to Group 3.
3. Remove two of the six securing bolts and fabricate two bars to act as guide bars.
4. Remove other securing bolts and ease flywheel from locating dowel along the length of the guide bars, then lift flywheel clear of flywheel housing.
5. Place flywheel on a flat surface.

To Refit

1. Ensure that mating faces of flywheel and crankshaft are perfectly clean.
2. Locate guide bars, position dowel location hole in flywheel relative to dowel in crankshaft.
3. Locate flywheel and secure with four self-locking bolts, remove the guide bars and position other securing bolts, tightening to torque figure quoted in Data.
4. With the aid of a dial test indicator check that flywheel runs true to crankshaft to within 0.1 mm (0.004 in). Should this limit be exceeded foreign matter between crankshaft and flywheel mating faces could be responsible. Remove, clean and re-check where applicable.

Flywheel Housing

To Remove

1. Remove flywheel as previously described.
2. Remove starter motor, refer to Group 8.
3. Remove nuts securing rear crankshaft oil seal assembly. Jack seal housing from its location by means of two 8 mm diameter setscrews screwed evenly into threaded holes provided.
4. Remove nuts and hexagon headed bolts securing flywheel housing to rear gear plate and setscrews securing upper rear gear cover to flywheel housing.

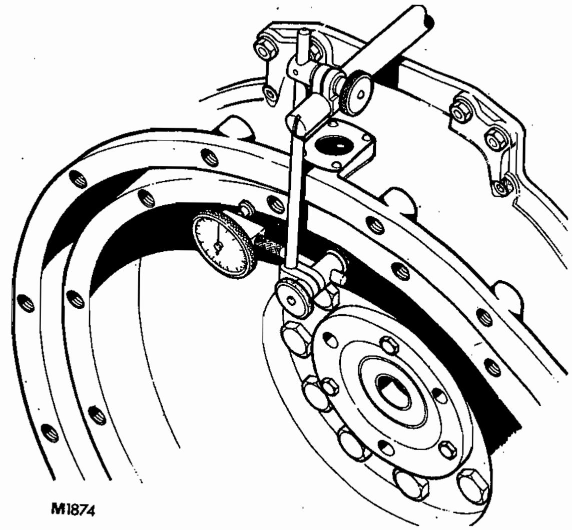


FIG. 2 CHECKING FLYWHEEL FOR ALIGNMENT WITH CRANKSHAFT

5. Remove setscrews and washers securing rear of sump to flywheel housing.
6. Support weight of flywheel housing and ease housing from locating dowels.

To Refit

Ensure that mating faces of both gear plate and timing cover are clean and apply jointing compound see Data.

1. Locate flywheel housing onto dowels and secure into position.
2. Apply jointing compound, see Data and carefully replace crankshaft oil seal assembly, exercising care not to damage the radial sealing face in any way. Secure firmly with the retaining nuts.
3. Check that mating faces of crankshaft and flywheel are perfectly clean, then refit flywheel as previously described.
4. Refit starter motor, refer to Group 8.

Rear Upper Timing Cover

To Remove

1. Disconnect auxiliary drive unit.
2. Remove top cover.
3. Remove setscrews securing upper timing cover to gear plate and flywheel housing then remove cover.
4. Remove old gasket.

To Refit

Ensure all faces are perfectly clean.

1. Apply jointing compound, see Data to all faces and fit new gasket to top edge of flywheel housing.
2. Refit setscrews to upper timing cover and secure.
3. Refit top cover.
4. Reconnect auxiliary drive unit.

Rear Idler Gears

To Remove

1. Remove flywheel, flywheel housing and upper timing cover as previously detailed.
2. Remove oil supply pipe.
3. Remove end plate and ease upper idler gear from its hub location followed by bush, thrust washer and idler gear hub.
4. Remove lower idler gear in same manner.

To Refit

1. Fit idler gear hubs in their respective locations in rear gear plate.
2. Place upper idler gear thrust washer in position followed by floating bush.
3. Fit gear over floating bush.
4. Repeat items 2 and 3 for lower idler gear assembly.
5. Fit end plate to lower idler gear hub.
6. Fit oil feed pipe assembly and upper end plate.
7. Refit upper timing cover, flywheel housing and flywheel as previously detailed.

Rear Gear Plate

To Remove

1. Remove flywheel, flywheel housing, upper timing cover and idler gears as previously detailed.
2. Remove self-locking bolts securing camshaft gear and ease gear from its dowelled location.
3. Remove oil filler.
4. Remove compressor drive gear and the compressor, see Group 7.
5. Remove countersunk screws securing rear gear plate to tappet block and crankcase.
6. Remove nuts securing cylinder block oil return pipe at gear plate end.
7. Ease rear gear plate from two locating dowels.

To Refit

1. Ensure that mating faces are perfectly clean and that O-rings are satisfactory and in situ.
2. Coat both mating faces with recommended jointing compound, see Data, then locate gear plate onto dowels.
3. Apply 'Loctite' sparingly to threads of countersunk setscrews and then screw tightly into position. Stake screws with a centre punch.
4. Refit cylinder block oil return pipe.
5. Refit compressor and drive gear, see Group 7.
6. Refit oil filler.
7. Locate camshaft gear onto dowels and tighten securing bolts to torque figure quoted in Data.

Rear Crankshaft Gear

To Remove

1. Remove flywheel, flywheel housing, idler gears and gear plate as previously detailed.
2. Withdraw rear crankshaft gear and sleeve using tool No. 6312A.

Should crankshaft sleeve only need attention, removal and refitment can be carried out as follows:

1. Place tool LC149 over end of crankshaft and screw three taps into holes so that they cut into outer surface of sleeve.
2. Remove taps and insert three setscrews. Do not overtighten.

3. Withdraw sleeve by screwing in centre extraction screw.

To Refit

1. Heat gear and sleeve in oven to approximately 66°C (150°F) then quickly place in position on crankshaft ensuring that keyway in gear locates with key on crankshaft.

2. Refit gear plate, idler gears, flywheel housing and flywheel as previously detailed.

Front Timing Cover

To Remove

1. Slacken the alternator belt adjustment assembly, see Group 1.

2. Remove bolts securing crankshaft damper and pulley to crankshaft, remove alternator belts and withdraw damper assembly.

3. Remove setscrews securing crankshaft front oil seal assembly. Jack seal housing from its location by means of two 8 mm diameter setscrews screwed evenly into threaded holes provided.

4. Remove setscrews securing front end of sump to underside of timing cover.

5. Remove turbocharger oil drain pipe to front cover.

6. Remove bolts securing timing cover to gear mounting plate, ease cover from its locating dowels.

To Refit

1. Ensure that both mating faces are perfectly clean then coat both faces with recommended jointing compound, see Data.

2. Locate timing cover onto the two dowels.

Note: Due to variation in length of securing bolts it is advisable to first place all relevant bolts in position to ensure correct selection.

3. Fit setscrews which secure front end of sump to underside of timing cover.

4. Tighten all securing bolts and setscrews evenly.

5. Coat oil seal housing and timing cover with jointing compound.

6. Carefully replace front crankshaft oil seal assembly, exercising care not to scratch or damage radial sealing face in any way. Secure firmly ~~with retaining~~ nuts.

7. Fit crankshaft damper and alternator drive belts tightening securing bolts evenly to torque figure quoted in Data.

8. Adjust belt tension as described in Group 1.

Front Idler Gear

To Remove

1. Remove front timing cover as previously detailed.

2. Remove four countersunk screws securing idler gear hub end plate.

3. Ease idler gear together with floating bush from hub followed by thrust washer.

4. Remove idler gear hub from its spigot location in gear plate.

To Refit

1. Locate idler gear hub spigot in gear plate noting relative positions of securing screw holes and oil feed hole.

2. Fit thrust washer, floating bush and idler gear.

3. Fit end plate and secure with four countersunk screws noting for assembly purposes there is a difference in length between each pair.

4. Refit front timing cover as previously detailed.

Front Gear Plate

To Remove

1. Remove front timing cover and idler gear as previously detailed.

2. Remove countersunk screws securing gear plate to front face of crankcase.

3. Ease gear plate from locating dowels leaving water pump in position.

To Refit

1. Ensure that mating faces are perfectly clean and that O-rings and ferrules are satisfactory and in situ.

2. Coat both mating faces with recommended jointing compound, see Data, then locate gear plate onto dowels.

3. Apply 'Loctite' sparingly to threads of countersunk setscrews and then screw tightly into position. Stake screws with a centre punch.

4. Refit idler gear and front timing cover as previously detailed.

Front Crankshaft Gear

To Remove

1. Remove front timing cover, idler gear and gear plate as previously detailed.

2. Withdraw front crankshaft gear and sleeve using tool No. 6312A.

Should the crankshaft sleeve only, need attention, removal and replacement can be carried out as follows:

1. Using tool LC149 remove and replace sleeve as described for crankshaft rear sleeve.

To Refit

1. Heat gear and sleeve in oven to approximately 66° C (150° F) then quickly place in position on crankshaft ensuring that keyway in gear locates with key on crankshaft.

2. Refit gear plate, idler gear and front timing cover as previously detailed.

Sump

To Remove

1. Remove sump drain plug and drain lubricant into a suitable container.

2. Remove dipstick tube, housing and fuel pump return pipe.

3. Remove sump brackets.

4. Remove setscrews and nuts then ease sump clear of oil strainer.

To Refit

1. Check that all sump joints are in good condition. Fit new joints where necessary.

2. Locate sump onto studs and fit front retaining nuts.

3. Fit sump brackets along with the remaining setscrews and secure.

4. Fit dipstick tube, housing and fuel pump return pipe.

5. Replace and tighten sump plug. Refill sump with appropriate quantity and type of engine oil. Check level on dipstick and top up if required, refer to Group 1.

Oil Pump

To Remove

1. Drain lubricant and remove sump as previously detailed.

2. Remove the four setscrews which secure mounting plate to crankcase. If access to rear main bearing is required then the latter method would be preferred.

3. Ease oil pump from its dowelled location as applicable and remove as a complete assembly. Take care to retain shims.

To Refit

1. Check that joints between delivery pipes and crankcase are in good condition and mating faces are clean.

2. Locate pump and secure into position with setscrews.

3. Check backlash between oil pump drive gear and crankshaft gear. Shim to figure quoted in Data.

4. Fit setscrews securing each delivery pipe to crankcase.

5. Fit sump and refill engine with clean lubricating oil.

Oil Pressure Relief Valve

To Remove

1. Remove the two setscrews securing cover, holding cover against crankcase to control pressure of spring.

2. Slowly remove cover complete with spring, piston and shims if fitted.

To Refit

1. Ensure that O-ring is in good condition and that joint faces are clean.

2. Fit assembly to crankcase and check that oil pressure regulation is normal when engine is running.

Note: The relief valve setting is adjusted during initial engine testing by addition of shims placed between spring and body. Always replace any shims originally fitted when assembling relief valve.

Crankshaft

To Remove

1. Isolate batteries.

2. Drain coolant and lubricant from engine.

3. Remove engine from chassis, Section 1C, and place in suitable dismantling stand.

4. Remove cylinder block complete with pistons from crankcase, Section 3C.

5. Remove front timing cover, flywheel and flywheel housing as previously detailed.

6. Invert crankcase and remove sump and oil pump, as previously detailed.

7. Remove all main bearing cap securing bolts then tap out bearing caps.

8. Lift crankshaft carefully out of crankcase.

Note: Bearing shell halves should be suitably marked, on back face, for subsequent reassembly.

Refer to Important Notes on Crankshaft Grinding, Ref. 2–4C–11.

To Refit

The main bearing caps and bearing shells should always be refitted in their original locations. The caps are numbered 1–7 in sequence from front to rear, the respective number being stamped on bridge of each cap.

1. Ensure that crankshaft, crankcase and bearing shells are perfectly clean. Locate upper half bearing shells correctly in position ready to receive crankshaft.

2. Lubricate crankshaft journals and bearing shells liberally with clean engine oil. Lower crankshaft carefully into position noting that flywheel end has dowelled location.

3. Fit two upper thrust washer halves either side of centre main bearing housing by rotating them around crankshaft, ensuring that slotted surface of each washer faces outwards.

Note: The two lower thrust washer halves locate in machined grooves at either side of centre main bearing cap. The tongue location, shown arrowed in Fig. 3, prevents thrust washer rotation under running conditions.

4. Fit bearing caps ensuring that both caps, and, where applicable half shells, have been correctly identified and located. The centre main bearing cap is fitted with lower thrust washer halves held in position as shown in Fig. 3.

5. Tighten main bearing cap bolts to figure quoted in Data. Start with centre main bearing and work outwards to both ends. Rotate crankshaft periodically to check freedom of rotation.

6. Check crankshaft end float by moving crankshaft to limit of its travel in one direction and insert feeler gauges between crankshaft and thrust washer to measure clearance.

   See Data for limits and oversize thrust washers.

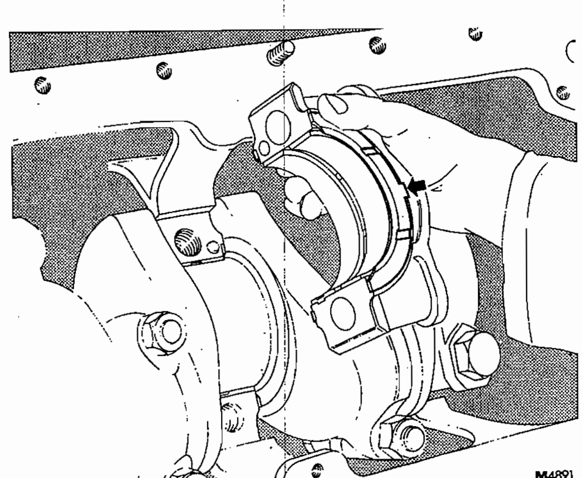


FIG. 3 FITTING CENTRE MAIN BEARING CAP SHOWING TONGUE LOCATION OF LOWER THRUST WASHER

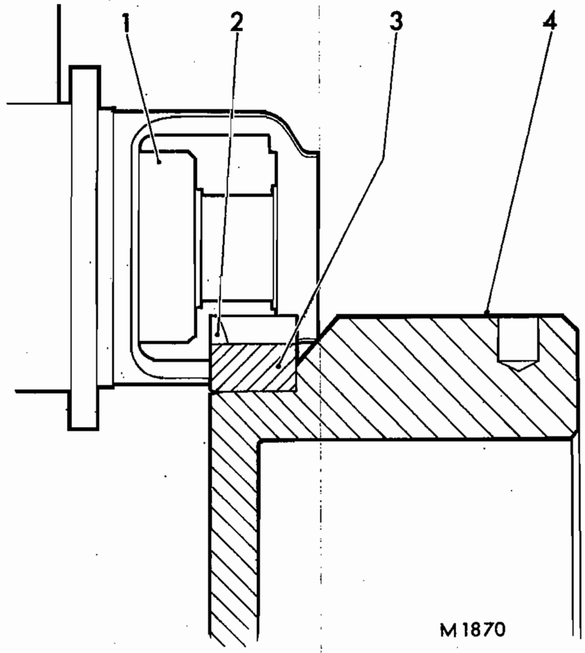


FIG. 4 RELATIONSHIP OF STARTER RING TO FLYWHEEL

1. Starter motor pinion
2. Tooth lead-in
3. Starter ring
4. Flywheel

7. Refit oil pump and sump as previously detailed.

8. Refit flywheel housing, flywheel and front timing cover as previously detailed.

9. Refit cylinder block, Section 3C.

10. Refit engine into chassis, Section 1C.

11. Refill engine with coolant and lubricant.

12. Reconnect electrical supply.

OVERHAUL

Starter Ring

To Renew

The starter ring should be examined for signs of excessive wear or tooth damage and where necessary the following renewal procedure adopted:

1. Remove old ring by laying flywheel on a flat surface with ring uppermost and carefully splitting ring with a suitable cold chisel, taking care not to damage flywheel.

2. Check that mating faces of flywheel and new ring are clean and free from burrs or damage of any kind which would prevent a positive location of ring on flywheel.

3. Slowly heat new ring to a temperature of 110/120° C (230/248° F) preferably in controllable oven.

Note: Excessive heat should be avoided otherwise temper of teeth could be adversely affected. With new ring heated to correct temperature it will have expanded sufficiently to allow it to pass over locating rim of flywheel without difficulty.

4. Place heated ring quickly in position with lead on teeth facing uppermost, see Fig. 4. Ensure that back face of ring abuts flywheel.

5. Allow ring to cool normally in air.

Main Bearings and Thrust Washers

To Renew

Normally by the time the main bearings require replacing, the crankshaft will need to be removed for grinding.

However, if at any time one or more bearings should have to be renewed or removed for inspection, this can be done without removing engine from vehicle.

1. Isolate batteries.

2. Drain lubricant from engine, remove sump and oil pump as previously detailed.

3. To renew or inspect an individual bearing, take off bearing cap in question, and remove lower half bearing from cap.

Note: To facilitate removal of upper half shell, remaining main bearing bolts should be slackened approximately one turn.

4. In the case of centre main bearing, the half shell can be removed completely by rotating shell with crankshaft.

5. The upper shell half of any of remaining main bearings may be removed by standard practised method.

Note: In all cases bearing shell halves are pushed out tag location end first.

6. Inspect old bearing shells and if they require renewing, insert a new half-bearing in top and also fit a new half-bearing in cap by reversing removal procedure. Ensure that tab end is correctly lined up and located. If old bearings are undersize, replace by a new bearing of same size.

7. Thrust washers are also renewable. The bottom halves are tongue located in bearing cap and care must be taken to ensure that tongues fit correctly in cap.

8. Tighten all main bearing cap securing bolts to torque figure quoted in Data.

9. Refit oil pump and sump as previously detailed then refill engine with lubricant.

10. Reconnect batteries.

Oil Pump, Fig. 5

To Dismantle

1. Remove pump mounting plate, if applicable.

2. Remove suction and delivery pipes from cover.

3. Remove oil pump cover securing bolts and lift it clear of drive shaft and idler gear spindle.

Note: To ensure correct positioning of inlet and delivery ports it is advisable to suitably mark the cover in relation to pump body before removal.

4. Slide idler gear from its spindle.

5. Remove bolts securing drive gear to drive shaft and remove gear.

6. Press drive shaft out through driven gear.

To Reassemble

1. Check that all parts are in good condition and thoroughly clean. Fit new joints. Check fit of drive shaft in bush, renew bush if necessary.

2. Position drive shaft in pump end plate and press driven gear fully home onto its keyed location.

3. Place idler gear in position on its spindle.

4. With joint in position secure cover, noting positioning marks made during dismantling.

5. Fit driving gear and secure with the special bolts. Tighten to torque figure quoted in Data. Rotate drive gear to ensure freedom of rotation of pump gears.

6. Place joint in position and secure delivery pipe assembly.

7. Position joint and secure suction branch followed by suction filter.

8. Fit mounting plate, if applicable.

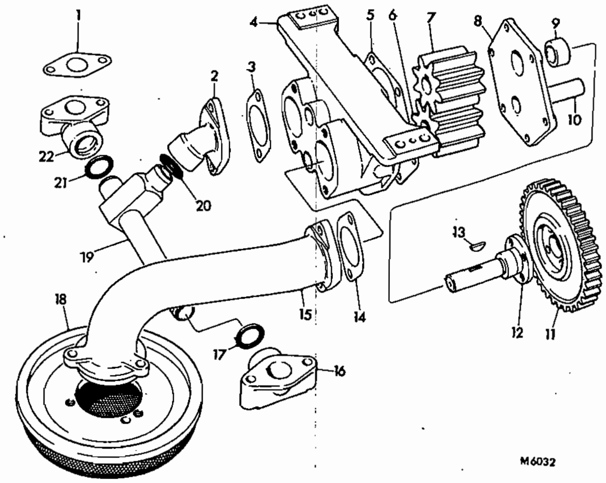


FIG. 5 OIL PUMP

1.	Joint	13.	Drive gear
2.	Flange	14.	Drive shaft
3.	Joint	15.	Key
4.	Cover	16.	Bush
5.	Driver's gear	17.	Joint
6.	Idler gear	18.	Suction pipe
7.	Spindle	19.	Filter
8.	Joint	20.	Elbow
9.	Pump body	21.	O-ring
10.	Dowel	22.	Supply pipe
11.	Dowel	23.	O-ring
12.	Mounting plate	24.	Elbow

Important Notes on Crankshaft Grinding

1. When grinding crankpins and main bearing journals the end faces must not be ground. If, however, location faces of centre bearing have been damaged, the width may be increased to 57.25/57.30 mm (2.2539/2.2559 in) otherwise dimensions should be as shown in table in Data.

2. It cannot be emphasised too strongly that in cases where grinding is carried out without afterwards renitriding, extreme care should be taken to ensure that an excessive amount of case is not removed from fillets.

   A grinding wheel having a corner radius of not less than 4 mm (0.157 in) should be used. If any doubt exists in this connection, it is recommended that crankshaft should be renitrided irrespective of amount of case removed from pin or journal diameter.

3. After grinding, support crankshaft on front and rear journals. Check relative eccentricity of centre main journal; this must not exceed 0.075 mm (0.003 in) radius i.e. a total run-out of 0.15 mm (0.006 in). The permissible error between one bearing and its neighbour must not exceed a total run out of 0.075 mm (0.003 in). Under no circumstances should any attempt be made to straighten a crankshaft.

4. Crankshafts should be renitrided at service sizes S2 and S4.

SECTION 5C

Fuel System

GENERAL INFORMATION

Injection Pump

Type	C.A.V. NN
Injection begins	24° B.T.D.C
Maximum governed speed	2000 rev/min
Idling speed	400 rev/min

Fuel Feed Pump

Pressure maintained	0.35/0.56 kgf/cm^2 (5/8 lbf/in^2)

Injectors

Type	AMBAC.
Discharge pressure	235/245 atmospheres (243/251 kgf/cm^2)
Angle of spray	150°
Number of spray holes	5
Diameter of spray holes	0.30 mm (0.0118 in)

Quick Acting Valve

Type	Saunders

Throttle Control

Control Valve

Type	Clayton Dewandre

Control Cylinder

Type	Clayton Dewandre

Boost Control Override

Type	Bellows Valvair

Torque Loads

Injector to cylinder block nut	2.6/2.9 kgf m (19/21 lbf ft)
Nozzle cap nut	4.15/4.98 kgf m (30/35 lbf ft)
Injector union nut	2.6/2.9 kgf m (19/21 lbf ft)

REMOVAL AND REFITMENT OF FUEL SYSTEM COMPONENTS

Fuel Injection Pump, Fig. 1

To Remove

1. Remove fuel pipe from tank to lift pump (5).
2. Remove low pressure fuel pipes between lift pump, injection pump and filters (3).
3. Disconnect lubricating oil feed and drain pipes from injection pump.
4. Disconnect stop control and governor speed control levers from injection pump (7).
5. Remove stop control solenoid and air throttle cylinder.
6. Disconnect high pressure delivery pipes (1), union nuts and clamps (2) then remove pipes from pump and inlet manifold.
7. Remove pinch bolt securing drive shaft coupling to compressor drive shaft (4).
8. Remove the four setbolts (6) securing injection pump to mounting bracket, then remove pump complete.
9. Remove drive shaft coupling from fuel pump if necessary.

To Refit

1. Locate pump into position by inserting securing setbolts.

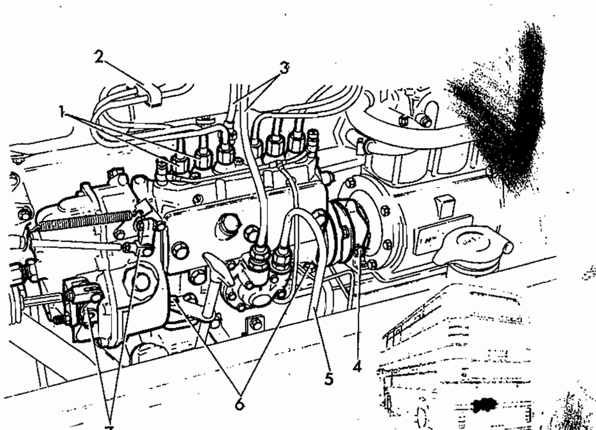


FIG. 1 GENERAL VIEW OF FUEL PUMP

1. High pressure delivery pipe union nuts.
2. Delivery pipe clamp
3. Lift pump to fuel filter pipes
4. Pinch bolt
5. Fuel feed pipe
6. Fuel pump setbolts
7. Stop control and governor linkages

2. Tighten setbolts to secure pump to mounting bracket.
3. Fit lubricating oil feed and drain pipes.
4. Reconnect high pressure delivery pipes and clamps.
5. Connect stop solenoid and throttle cylinder.
6. Fit low pressure fuel pipes.
7. Remove oil filler plug and prime pump with sufficient clean engine oil to ensure full lubrication on initial start.
8. Tighten pinch bolt on drive shaft coupling after re-timing engine.

Injector Pump Timing

1. Remove engine top cover and turn engine in normal direction of rotation until clearance exists on both tappets of No. 1 cylinder, i.e. commencement of compression stroke—both valves closed.
2. Place a suitable length of 9.5 mm (0.375 in) diameter rod in hole marked 'INJ', located on top of flywheel housing.
3. Continue to turn engine slowly in normal direction of rotation until rod drops into timing hole in engine flywheel.
4. Check that mark scribed on injection pump flywheel aligns with pointer.
5. If mark is out of alignment, slacken pinch bolt on drive shaft coupling and turn injection pump until mark on flywheel is in line with timing pointer.
6. Tighten drive shaft pinch bolt, remove timing rod from the flywheel and replace engine top cover.

If replacement pump is being fitted and its flywheel has no timing mark, proceed as follows:

1. Set the engine with No. 1 piston on the compression stroke as previously described.
2. Fit the pump to the engine and couple up the main feed pipes but only No. 1 cylinder delivery pipe and injector.
3. Prime the injection pump through to No. 1 injector.

4. Turn the pump flywheel clockwise until resistance becomes solid. At this point No. 1 injector starts injecting fuel oil.

5. When the pump is correctly timed tighten the clamp bolt and mark the pump flywheel in line with the timing pointer on the pump body.

Injectors, Fig. 2

To Remove

1. Remove injection pipe clamps and remove completely the high pressure injection pipes.

2. Disconnect and remove interlinking leak-off pipe between each injector.

3. Remove evenly the nuts holding clamping springs on each injector and remove locking plates and springs.

4. Unscrew the knurled ferrules from studs and remove each injector from its location. Remove any copper sealing washers remaining in cylinder block injector bores.

5. Remove C-clamp from injector body.

6. Remove sleeve from injector body by loosening the two grub screws (early models).

To Refit

1. Ensure injector bores are clean and free from carbon.

2. Position sleeve (early models) so that the injector seat just protrudes beyond the bottom edge of the sleeve and secure.

3. Place copper washer of correct type over each injector. A light smear of grease will help retain washer as injector is fitted.

4. Refit C-clamp onto injector body.

5. Locate each injector in cylinder block.

Note: When fitting injectors ensure that sleeve and clamp plate are correctly positioned.

6. Screw knurled ferrules onto studs and tighten to finger tightness only.

7. Place coil springs and locking plates over studs and fit securing nuts. Tighten securing nuts evenly to torque figure quoted in Data.

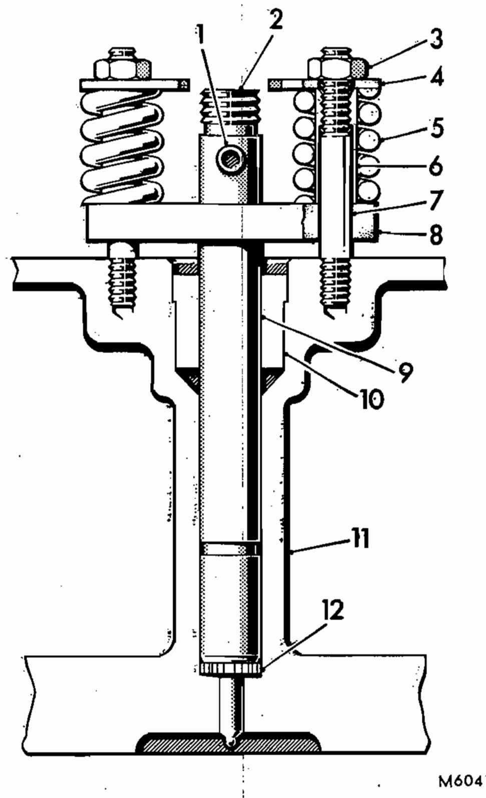


FIG. 2 METHOD OF MOUNTING INJECTORS

1. Leak-off pipe
2. Fuel input
3. Nut
4. Clamp plate
5. Spring
6. Ferrule
7. Stud
8. Mounting plate
9. Injector
10. Sleeve
11. Cylinder block
12. Sealing washer

DANGER: No attempt should be made to turn engine until all injectors have been tightened down. Failure to observe this warning could result in injury or damage caused by an injector being blown out of cylinder block.

8. Fit high pressure injection pipes followed by interlinking fuel leak-off pipes. Tighten injector union nut to torque figure quoted in Data.

9. Prime fuel system through to injectors as described below.

Fuel Tanks (Main and Auxiliary), Fig. 3

To Remove

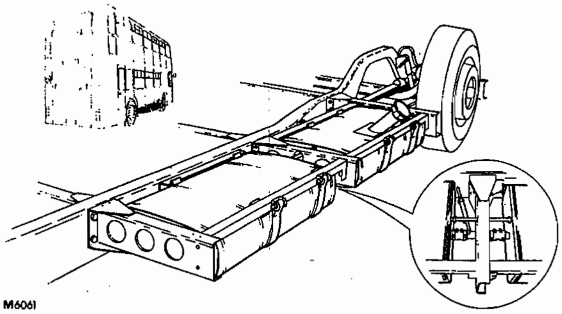
1. Drain tanks into suitable container.

2. Slacken hose clips on tank concerned.

3. Remove tank straps and lower tank to ground.

To Refit

Refitment is a reversal of removal procedure.



M6061

FIG. 3 FUEL TANK FIXTURE

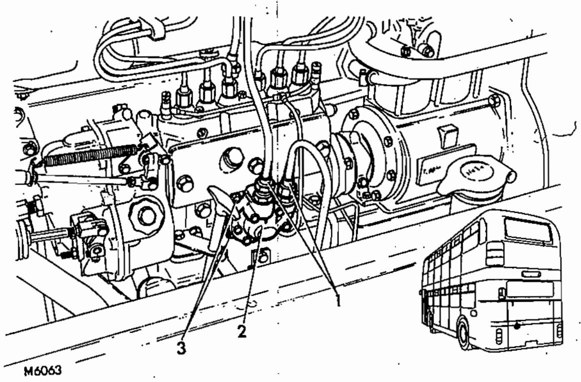


FIG. 4 GENERAL VIEW OF LIFT PUMP

1. Fuel oil inlet and outlet pipes
2. Lift pump
3. Lift pump securing nuts and washers

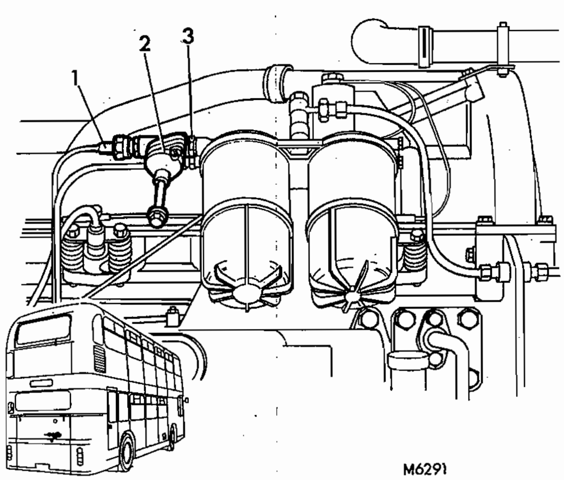


FIG. 5 QUICK ACTING VALVE FIXTURE

1. Low pressure fuel feed pipe
2. Quick acting valve
3. Fuel filter adaptor

Lift Pump, Fig. 4

To Remove

1. Remove fuel oil inlet and outlet pipes.
2. Remove securing nuts and washers holding lift pump to fuel pump body.
3. Remove lift pump and allow fuel pump lubricating oil to drain into a suitable container.

To Refit

Refitment is a reversal of the removal procedure ensuring that a new lift pump gasket is fitted, and the fuel pump is primed with sufficient engine oil to ensure full lubrication on initial start.

Quick Acting Valve, Fig. 5

To Remove

1. Remove low pressure fuel feed pipe from fuel oil filters to fuel pump.
2. Remove quick acting valve from fuel filter adaptor.

To Refit

Refitment is a reversal of the removal procedure, priming the system as described in Section 5C.

Throttle Control Cylinder

To Remove

1. Release the pressure from the air system.
2. Disconnect air inlet and outlet pipes.
3. Disconnect the push rod at the jaw end.
4. Remove circlip and withdraw the pin from the mounting bracket. Remove the throttle control cylinder.

To Refit

1. Position the throttle control cylinder on the mounting bracket and line up the holes, fit and secure pin with circlip.

2. Hold control lever full against idling stop, adjust throttle control push rod to exert tension on control lever when in idling position.

   Note: Ensure that there is sufficient movement in cylinder to allow maximum control lever travel, i.e. idle to maximum fuel.

Throttle Control Valve

To Remove

1. Remove front offside access panel.
2. Release pressure from the air system.
3. Disconnect the feed and delivery pipes.
4. Remove the two valve securing setscrews and lower valve clear of vehicle.

To Refit

1. Locate the plunger into control valve and secure the valve to support plate with setscrews and washers.
2. Reconnect the feed and delivery pipes to control valve.
3. On refitment of valve, the settings governing its movement should not be touched.
4. Ensure pedal returns to the fully released position and check 0.8 mm (0.032 in) clearance between pedal push rod and control valve plunger.
5. Refit front offside access panel.

Performance Level (kick-down) Switch

To Remove

1. Remove front offside access panel.
2. Disconnect electrical connections.
3. 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.
3. Refit front offside access panel.

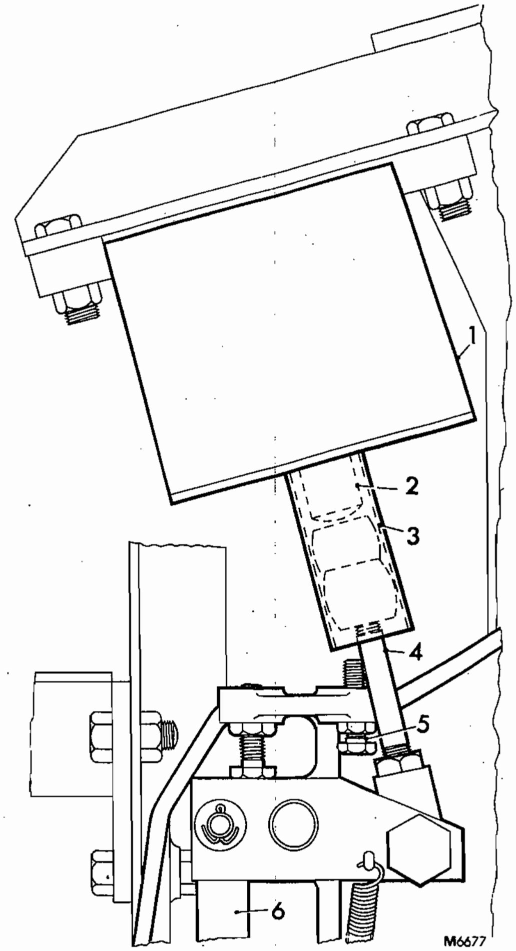


FIG. 6 PERFORMANCE LEVEL (KICK-DOWN) SWITCH

1. Switch
2. Plunger
3. Guide tube
4. Control rod
5. Accelerator pedal stop
6. Pedal push-rod

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'.

Priming Fuel System, Fig. 7

On assembly or whenever fuel system has been disturbed in any way, the system should be primed before re-starting is attempted, procedure is as follows:

1. Partially unscrew vent valve(s) located at end of fuel injection pump gallery. Operate hand primer on fuel lift pump until air-free fuel flows from bleed pipe. Tighten vent valves.

2. Prime high pressure delivery pipes to injectors by motoring engine with injector union nuts slackened. This should be carried out with injection pump giving maximum delivery. When fuel emerges at injector end of pipes, tighten union nuts and start engine in normal manner.

OVERHAUL

Note: Further information and overhaul instructions for fuel injection pumps can be obtained from the maker's agents.

CAV & Simms Service
CAV Limited
P O Box 36
Warple Way
LONDON W3 7SS

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

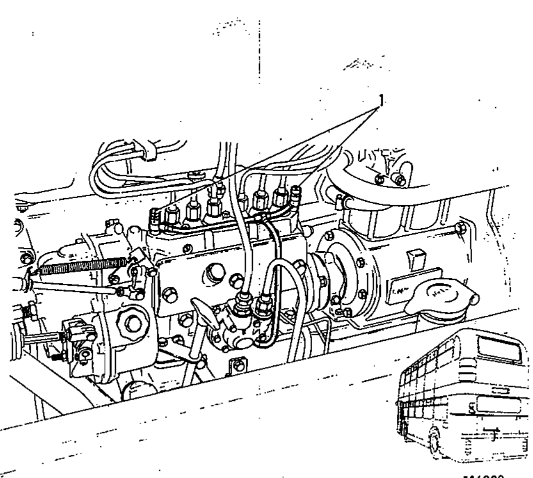


FIG. 7 FUEL PUMP BLEEDING POINTS

Lift Pump

To Test

If failure of the lift pump fitted to 500 engines is suspect, the following checks should be carried out:

1. Connect a vacuum gauge to pump inlet. Operate priming lever approximately 12 times. A steady reading of 25.4/38.1 cm Hg (10/15 in Hg) should be obtainable and should hold for several minutes.

2. Connect a pressure gauge to pump outlet. Operate priming lever approximately 12 times. A steady reading of 0.176/0.352 kgf/cm^2 (2.5/5 lbf/in^2) should be obtainable and should hold for several minutes.

3. If leakge is suspected, block the outlet connection with a plug and connect an air supply not exceeding 0.352 kgf/cm^2 (5 lbf/in^2) maximum to inlet connection. Submerge pump in a container of fuel, any leaks will be indicated by air bubbles.

Lift Pump, Fig. 8

To Dismantle

Note: It is recommended that a new diaphragm and O-rings are obtained before dismantling the unit.

1. Remove lift pump as previously described.

2. Remove securing nuts and washers and withdraw cover.

3. Remove socket head screw retaining actuator lever.

4. Depress hand priming lever and remove actuator lever.

5. Remove the three screws, locking washer and plain washer securing the hand priming lever and shaft.

6. Depress piston by hand and remove priming lever shaft from its location.

7. Remove diaphragm assembly complete.

8. Remove locknut and withdraw piston, fibre washer, dished washer, sandwich plate and diaphragm.

9. Remove inlet and outlet adaptors and remove the two valve assemblies.

Inspection

1. Clean all parts in a suitable solvent and check cam actuator lever for wear, renew if necessary.

2. Check piston and piston bore for scoring marks. If excessive wear is evident then a new lift pump should be obtained.

3. If the lift pump has failed the test procedure, then valve springs, ball seat and ball should be carefully inspected and renewed where necessary.

4. If the disc valve has deteriorated or has been badly scored then it should be renewed.

To Reassemble

Reassembly is the reverse of the dismantling procedure.

Quick Acting Valve, Fig. 9

To Dismantle

1. Remove the two screws securing upper body to lower body flange.

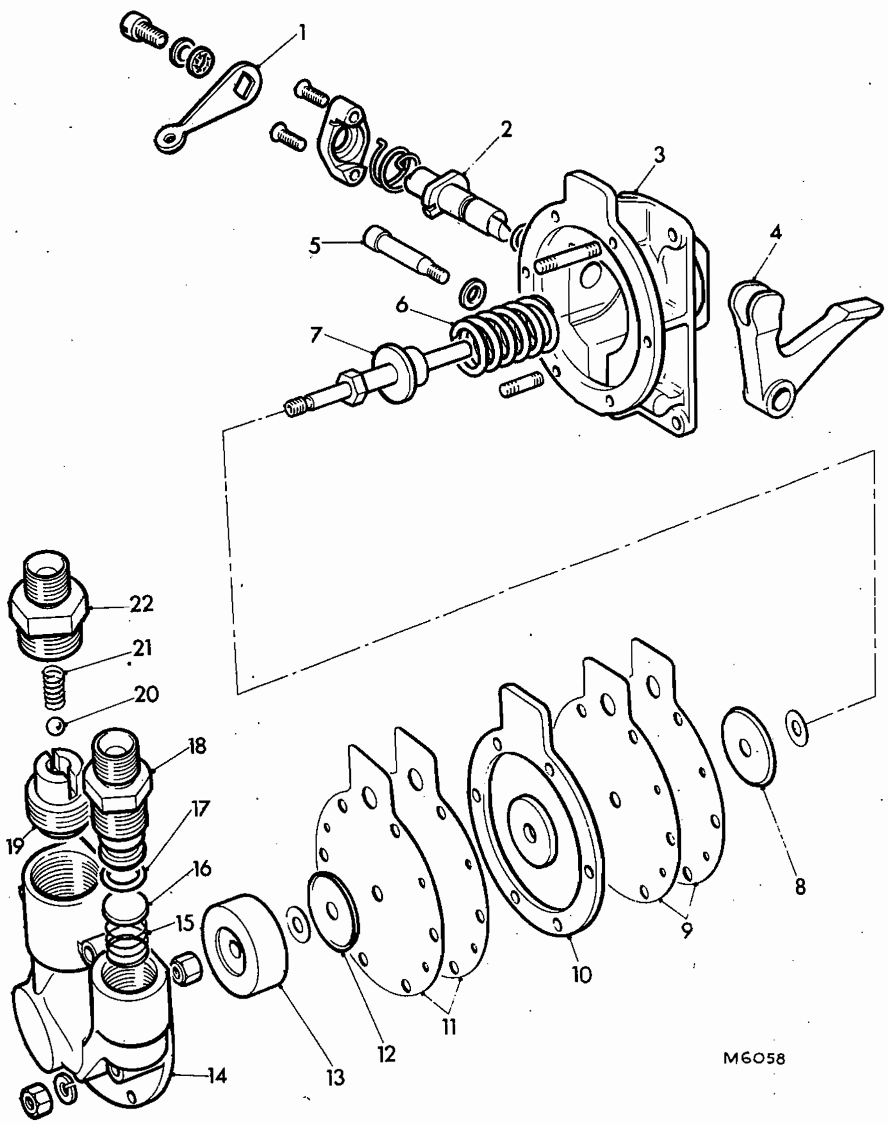


FIG. 8 EXPLODED VIEW OF LIFT PUMP

1. Hand priming lever
2. Hand priming lever shaft
3. Pump body
4. Actuator lever
5. Actuator lever retaining screw
6. Spring
7. Diaphragm assembly shaft
8. Dished washer
9. Diaphragm
10. Sandwich plate
11. Diaphragm
12. Dished washer
13. Piston
14. Pump cover
15. Disc valve spring
16. Disc valve
17. O-ring
18. Inlet adaptor
19. Ball seat
20. Ball
21. Ball spring
22. Outlet adaptor

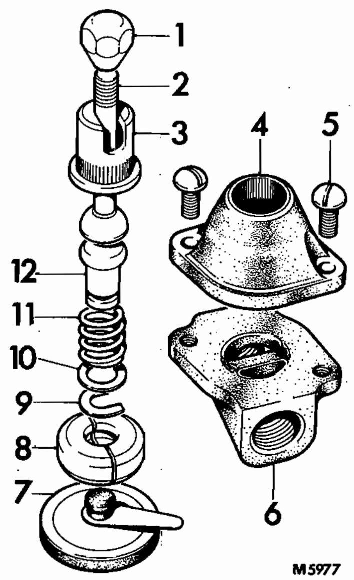


FIG. 9 EXPLODED VIEW OF QUICK ACTING VALVE

1. Knob
2. Handle
3. Bush
4. Bonnet
5. Screw
6. Body
7. Diaphragm
8. Compressor
9. C-clip
10. Washer
11. Spring
12. Spindle

2. Lift body clear of body flange. If difficulty is experienced then slight rocking of the body should break the seal between diaphragm and flange body.

3. Remove diaphragm from its location and clean valve body of any foreign matter.

To Reassemble

1. Check that diaphragm is of correct type.

2. Bring valve body handle into closed position.

3. Smear diaphragm locating button with grease, then press diaphragm into position.

4. Turn diaphragm until locating holes in diaphragm coincide with locating holes in valve body.

5. Refit upper valve body to body flange.

6. Refit securing screws to finger tightness.

7. Operate valve to relieve any stress in the diaphragm.

8. Reconnect valve to fuel line and tighten valve securing screws evenly until no leak of fuel is visible from valve body.

9. Prime the fuel system as previously described and check for leaks.

Note: Do not overtighten securing screws. They are tight enough, when there is no leak between diaphragm and valve body.

Throttle Control Cylinder, Fig. 10

Before dismantling a repair kit should be obtained.

To Dismantle.

1. Peel back the wide end of the bellows.

2. Depress the cover (7) and remove circlip (1), withdraw push rod (2) complete with piston (15), spring (16) and cover (7).

3. Remove self-locking nut (12), washer (13) and dismantle the piston assembly from the push rod.

Inspection

1. All parts must be thoroughly cleaned.

2. Examine cylinder body for damage, particularly the threads.

3. Examine cylinder bore for score marks and excessive wear.

4. Check the spring for corrosion or distortion, renew if necessary.

5. Renew all seals and sealing rings.

To Reassemble

All sliding surfaces, spring, seal and sealing rings should be coated with CDS 156 grease (manufactuer's recommendation).

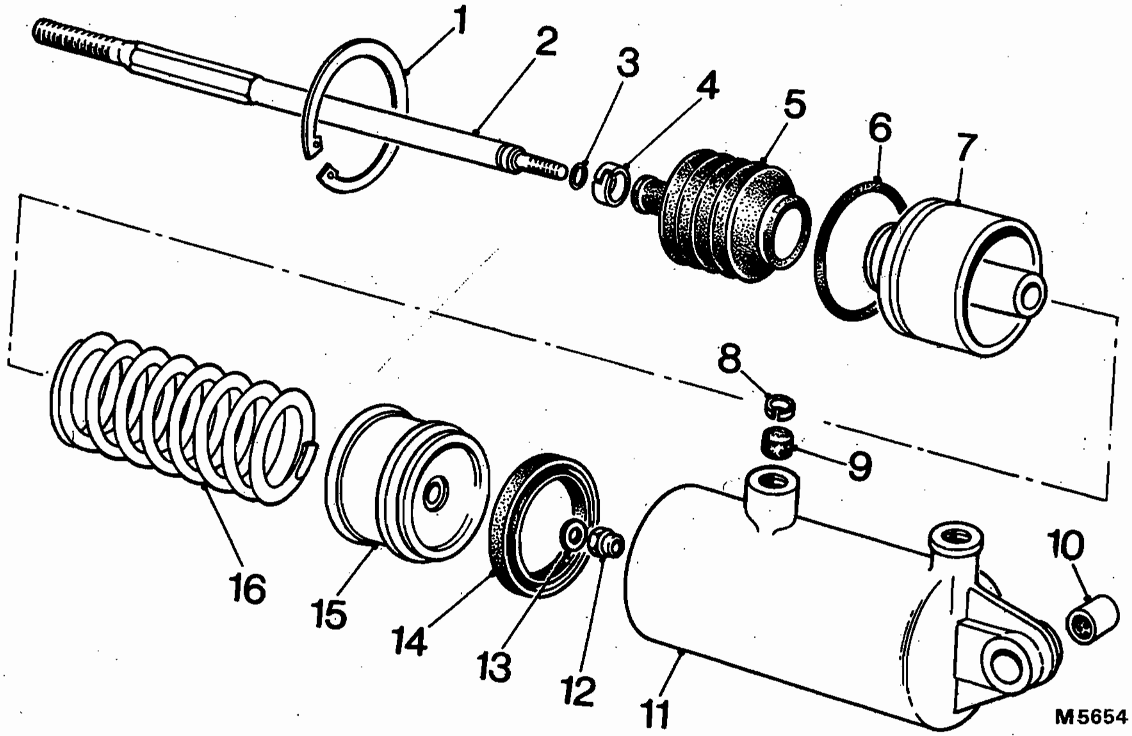


FIG. 10 EXPLODED VIEW OF OPERATING CYLINDER

1. Circlip	5. Gaiter	9. Filter	13. Washer
2. Push-rod	6. Sealing ring	10. Bush	14. Seal
3. Sealing ring	7. Cover	11. Body	15. Piston
4. Clip	8. Retainer	12. Nut	16. Spring

1. With seal ring (3) fitted in the groove on push rod (2), side on rubber bellows (5) neck first up to the hexagonal part of the rod.

2. Fit sealing ring (6) on cover (7) and seal (14) on piston (15).

3. Place cover (7), spring (16), piston (15) on the push rod and retain with self-locking nut and washer.

4. Insert the assembly into the body and retain with circlip (1).

5. Locate the bellows on cover (7) and fit the bellows clip (4) on the neck.

Throttle Control Valve, Fig. 11

Before dismantling a repair kit should be obtained.

To Dismantle.

1. Remove cap nut (26) and withdraw valve assembly from body (14). Remove stop bolt (16).

2. Remove setscrews (18) and separate plunger (4), mounting plate (3) from body (14).

3. Withdraw the piston and graduating spring assembly complete.

Note: Unless the graduated spring is broken, corroded or distorted the assembly must be left intact. Renew assembly if defective.

Inspection

1. All parts must be thoroughly cleaned.

2. Examine body for damage, particularly the threads.

3. Examine valve bore for excessive wear, and score marks.

4. Check valve seats and valves for damage and wear.

5. Check valve springs for corrosion or distortion, renew if necessary.

6. Renew all seals.

To Reassemble

All sliding surfaces, spring, seal and sealing rings should be coated with DCS.156 grease (manufacturer's recommendation).

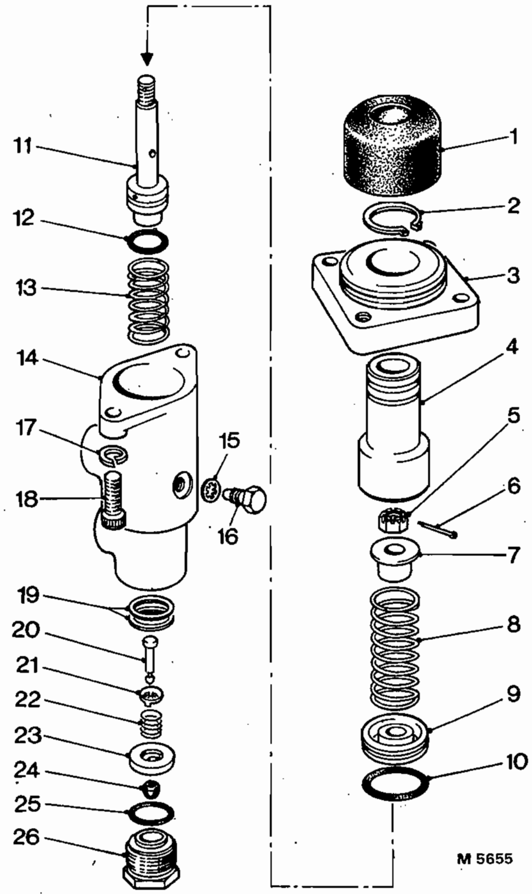


FIG. 11 EXPLODED VIEW OF CONTROL VALVE

1. Gaiter
2. Circlip
3. Mounting plate
4. Plunger
5. Nut
6. Split pin
7. Spring seat
8. Spring
9. Piston
10. Sealing ring
11. Exhaust seat
12. Sealing ring
13. Spring
14. Body
15. Washer
16. Stop bolt
17. Washer
18. Screw
19. Shims
20. Exhaust valve and stem
21. Guide
22. Spring
23. Inlet seat
24. Inlet valve
25. Sealing ring
26. Cap nut

1. Insert graduating spring and piston assembly into body (14).

2. Locate mounting plate (3) to plunger (4) and secure to body (14) with setscrews and washers. Fit circlip (2) on plunger.

3. Place inlet seat (23) on valve (24) and locate valve ring (22) on valve seat.

4. Press guide (21) on valve stem (20) and locate on valve inlet seat.

5. Locate spring (13) on exhaust seat (11) in body (14) then insert valve assembly complete with shims. Fit and tighten cap nut (26) and stop bolt (16).

FAULT DIAGNOSIS

Faulty Fuel Supply

If trouble is experienced with fuel supply to engine, the following procedure may help to establish the cause.

Disconnect fuel outlet pipe from lift pump at a convenient point and operate priming lever.

Satisfactory delivery would indicate a fault on pressure side of system probably due to one of the following.

1. Choked filter element(s).

2. Badly seated unions allowing fuel leakage.

Unsatisfactory delivery would indicate a fault on suction side of system probably due to one of the following.

1. Insufficient fuel in fuel tank or blocked filler vent.

2. Badly seated unions allowing entry of air into system.

3. Choked filter element (where applicable).

4. Fractured or blocked feed pipe.

5. Faulty feed pump.

Where trouble is experienced with dirty fuel, the tanks should be drained, removed from chassis and cleaned out with clean fuel oil to remove any sludge or foreign matter. Should water be present in the fuel, this can be filtered off by draining through fine muslin.

Lack of Power in Engine

1. Pump timing retarded.

2. Pump controls not allowing pump to give full delivery—verify that control lever is hard against maximum stop screw.

3. Maximum delivery of pump too low.

4. Defective injectors.

Smoky Exhaust

1. Pump timing retarded.

2. Maximum delivery of pump too high.

3. Defective injectors.

Engine Difficult to Start

1. Air in pump—bleed fuel system.
2. Maximum stop incorrectly set.
3. Pump incorrectly timed.

Engine will not Idle

1. Seized or tight plungers.
2. Excessive friction in governor or control rod.

Engine Misfires

1. Seized plungers.
2. Broken plunger springs.
3. Sticking delivery valves.
4. Defective injectors.

SECTION 6C

Ancillaries

GENERAL INFORMATION

Data

Turbocharger

Make and type	Airesearch T-04B
Shaft end play	0.025/0.1 mm (0.001/0.004 in)
Torque loads	
Compressor locknut initial torque	0.21/0.23 kgf m (1.5/1.7 lbf ft)
plus—	0.14/0.165 mm (0.006/0.007 in) elongation of further 90° turn of socket
Compressor backplate setscrews	0.86/1.04 kgf m (6.22/7.5 lbf ft)
Compressor housing to centre housing setscrews	1.15/1.50 kgf m (8.3/10.8 lbf ft)
Centre housing to turbine housing setscrews	1.15/1.50 kgf m (8.3/10.8 lbf ft)

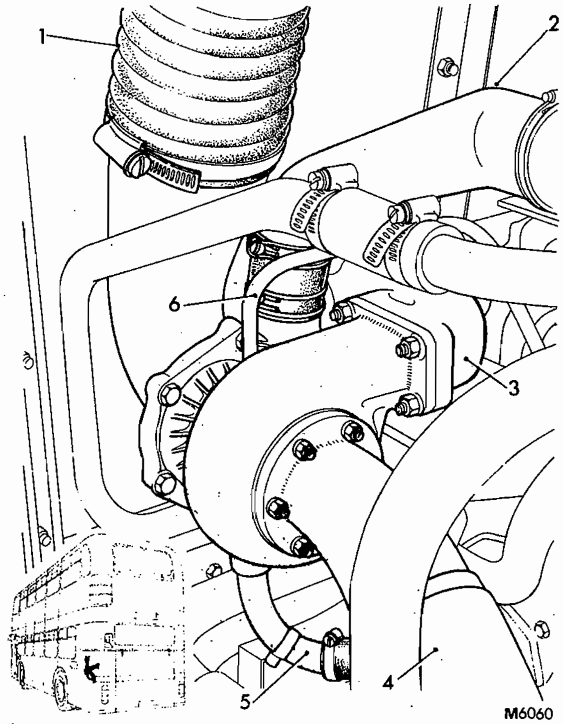


FIG. 1 TURBOCHARGER IN POSITION

1. Air inlet hose
2. Inlet manifold pipe
3. Exhaust manifold
4. Exhaust pipe
5. Oil outlet pipe
6. Oil inlet pipe

REMOVAL AND REFITMENT OF TURBOCHARGER

To Remove

1. Remove flexible air inlet hose from turbocharger.
2. Remove clips securing rubber hose between turbocharger and air inlet pipe. Raise rubber hose clear of turbocharger.
3. Disconnect turbocharger lubrication oil inlet and outlet pipes.
4. Remove nuts and washers securing turbocharger to exhaust manifold and the bolts securing turbocharger to its bracket.

To Refit

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

1. Check the condition of the hose between the air filter and the turbocharger and renew if deterioration is evident.
2. Inspect inlet and exhaust manifold for any foreign material.
3. Use a new gasket between turbine end and manifold.
4. Connect the air inlet tube and make certain that no strain is produced on the compressor cover.
5. Prime the bearing housing with clean engine oil and connect the oil feed pipe.
6. Pull out the engine stop control and crank the engine until a steady flow of oil is observed at the oil drain hole.
7. Connect the oil drain pipe, start the engine and check for oil leaks.

OVERHAUL

To Dismantle

1. Remove setscrews, clamps and lockplates securing compressor and turbine housing to centre housing.
2. Position correct size socket onto turbine shaft end, grip socket in vice to prevent turbine from turning, then, using a T-bar and socket remove compressor locknut.

Note: A T-bar is recommended as opposed to a ratchet set to prevent bending the turbine shaft.

3. Lift compressor off shaft. Remove centre housing from turbine shaft keeping shaft central until clear of bearings. Remove turbine shroud.
4. Remove lockplates and setscrews from backplate.
5. Tap backplate with soft mallet to remove it from recess in centre housing.
6. Remove thrust collar and thrust bearing from centre housing.
7. Remove outer circlips, bearings and inner circlips from centre housing.

Inspection

1. Check thrust collar piston ring groove for damage or burrs.
2. Examine bearings and housings, if wear is excessive renew bearings and/or housings.
3. Check each part prior to reassembly to ensure cleanliness.

Reassembly

1. Install inner bearing circlips. Lubricate bearings with clean engine oil then fit bearings and secure with outer circlips.

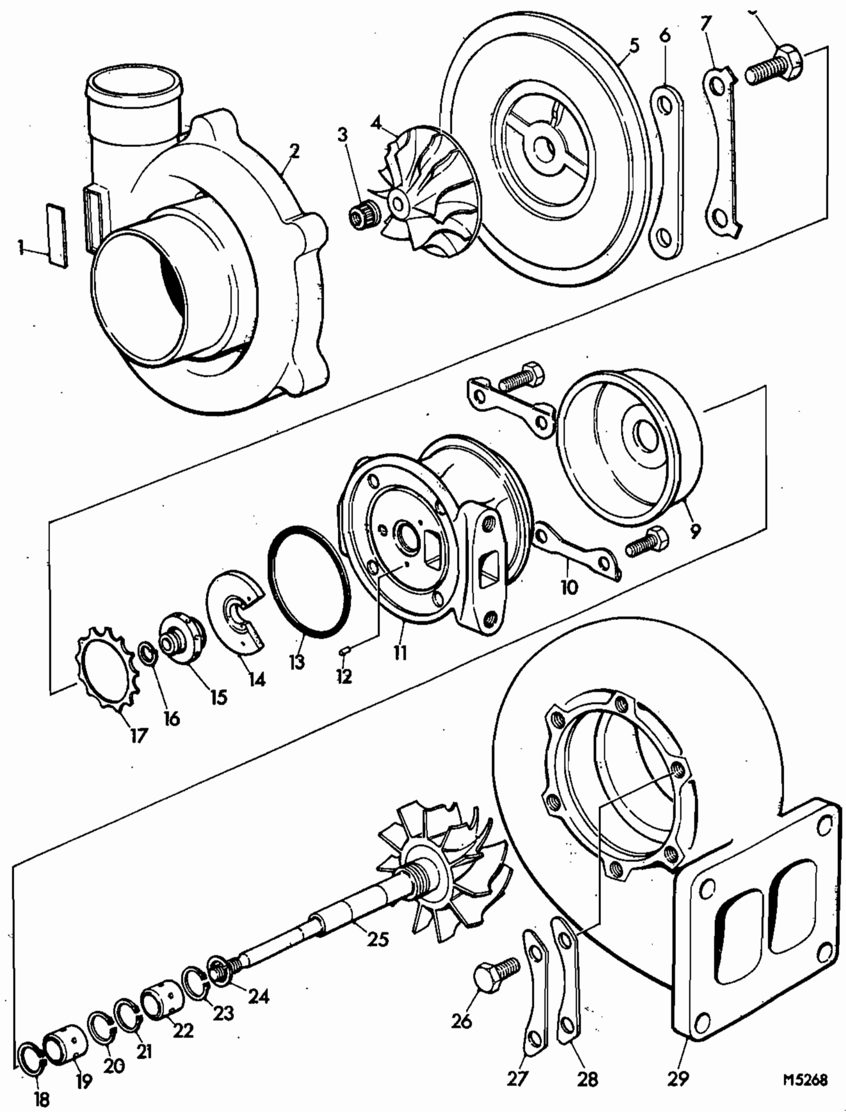


FIG. 2 EXPLODED VIEW OF TURBOCHARGER

1. Nameplate
2. Compressor housing
3. Locknut
4. Compressor wheel
5. Backplate
6. Clamp
7. Lockplate
8. Bolt
9. Wheel shroud
10. Lockplate
11. Centre housing
12. Pin
13. Seal ring
14. Thrust bearing
15. Thrust collar
16. Piston ring
17. Thrust spring
18. Circlip
19. Bearing
20. Circlip
21. Circlip
22. Bearing
23. Circlip
24. Piston ring
25. Shaft
26. Bolt
27. Lockplate
28. Clamp
29. Turbine housing

2. Place turbine shaft upright. Guide shroud and centre housing complete with bearings down over shaft.
3. Fit thrust bearing over thrust collar and fit piston ring onto collar. Slide collar down over shaft so that thrust bearing lies flat against centre housing and engage with centre housing anti-rotating pins.
4. Install seal ring in groove in centre housing.
5. Ensure that thrust spring is installed in back plate. Align mounting holes of centre housing and back plate then slide over shaft and thrust collar.

Note: Take care not to break piston ring when engaging seal into back plate bore. Back plate is easily installed if open end position of piston ring is engaged into back plate bore first.

6. Fit compressor backplate setscrews and lockplate. Torque setscrews to figure quoted in Data.
7. Fit compressor and secure with locknut. The mating faces of locknut and compressor must be smooth and clean. Tighten locknut to give conditions quoted in Data.

Note: Use a T-bar for tightening compressor locknut.

8. Check shaft endplay is within limits quoted in Data.
9. Check that there is clearance between shroud and turbine.
10. Orient compressor housing to centre housing, fit setscrews and lockplates. Tighten setscrews to torque figure quoted in Data.
11. Align turbine housing with centre housing, coat setscrew threads with a high temperature thread lubricant then install setscrews, clamps and lockplates. Tighten setscrews to torque figure quoted in Data.
12. Push rotating assembly as far as possible from turbine end and check for binding. Repeat check pushing fron compressor end.

GROUP 3

FLUID COUPLING

SECTION 1

Fluid Coupling—Fully Charged Type

GENERAL INFORMATION

DATA

Type	450.85 mm (17.75 in) diameter fully charged fluid coupling
Bearings	
Input shaft	Single-row ball-bearing
Coupling spigot	Single-row roller-bearing
Torque figures	
Ring nut	48.4 kgf m (350 lbf ft)
Fluid coupling retaining bolts (Leyland)	4.9 kgf m (35 lbf ft)
(Gardner)	4.2 kgf m (30 lbf ft)

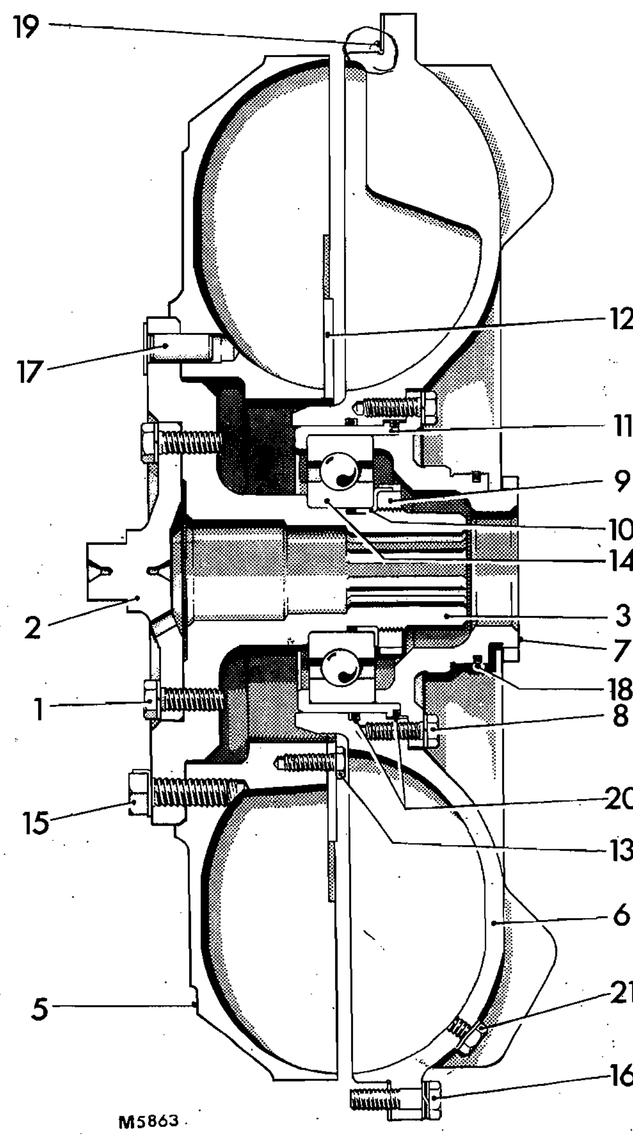


FIG. 1 SECTION THROUGH FLUID COUPLING

1. Setscrew
2. Input coupling spigot
3. Input coupling shaft
5. Driven member (runner)
6. Driving member (impeller)
7. Pump drive gear
8. Bolt
9. Ring nut
10. Tab washer
11. Bearing housing
12. Baffle plate
13. Setscrew
14. Ball bearing
15. Setscrew
16. Setscrew
17. Dowel
18. Piston ring
19. Sealing ring (deleted on later models)
20. O-rings
21. Plug

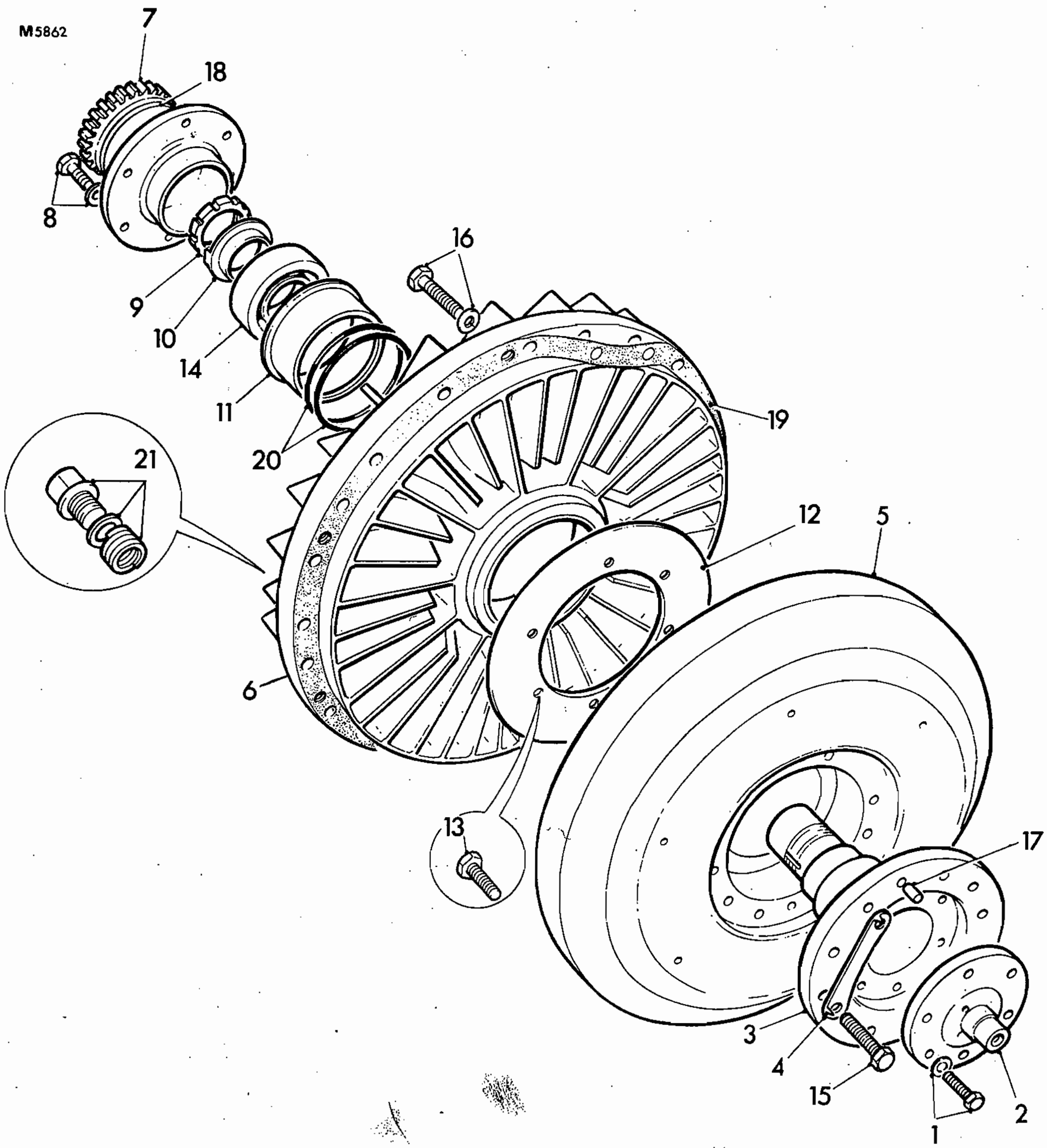


FIG. 2 EXPLODED VIEW OF FLUID COUPLING

1. Setscrew
2. Input coupling spigot
3. Input coupling shaft
4. Tab plate
5. Driven member (runner)
6. Driving member (impeller)
7. Pump drive gear
8. Bolt
9. Ring nut
10. Tab washer
11. Bearing housing
12. Baffle plate
13. Setscrew
14. Ball bearing
15. Setscrew
16. Setscrew
17. Dowel
18. Piston ring
19. Sealing ring (deleted on later models)
20. O-rings
21. Plug

TO REMOVE AND REFIT, Fig. 2

To Remove

1. Drain the oil and remove the gearbox as described in Group 4.
2. Remove the setscrews (16) securing the coupling to the engine flywheel and using the four tapped holes provided for extractor bolts ($\frac{3}{8}$ in UNF), withdraw the assembly.

To Refit

1. Apply Hermetite RTV1473 sealant in a continuous bead to the joint face of the fluid coupling. Spread the sealant evenly and include the undercut. Do not obstruct the bolt holes.
2. Temporarily fit extra length studs to the flywheel, lift the fluid coupling onto the studs and gently tap the unit into place. Remove the studs and fit the retaining bolts using new disc spring washers. Tighten the bolts in a diametrically opposite sequence, to the torque figure given in Data.
3. Plug the extractor holes using grub screws with threads coated with Loctite Hydraulic Seal 10896923.
4. Insert tool LC200 as shown in Fig. 3 and tighten centre bolt until an air tight seal is formed. Pressurise the flywheel to 35 lbf/in^2 and observe reading over a period of 30 minutes. No pressure drop is permissible. A fall in pressure indicates a leak which must be traced and sealed. Exhaust system and remove tool LC200.

   Important: DO NOT pressurise above 35 lbf in^2 or serious damage could result.
5. Fit the piston ring (18). Refer to the relevant operation in Group 4 for the correct procedure.

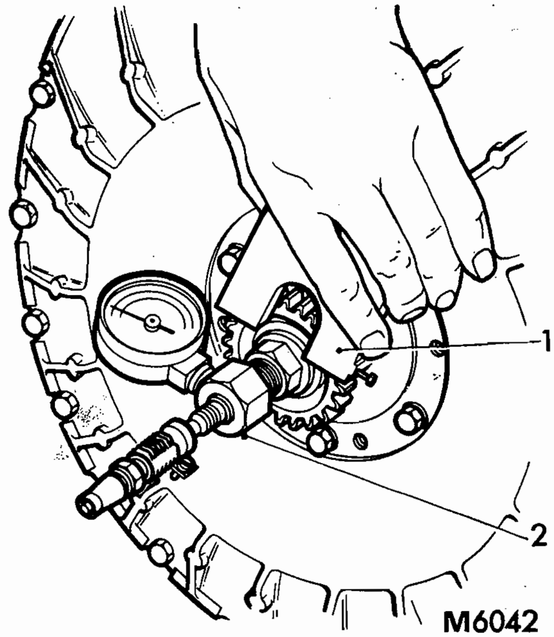


FIG. 3 APPLICATION OF SERVICE TOOL LC200
1. Locking plate 2. Pressure gauge

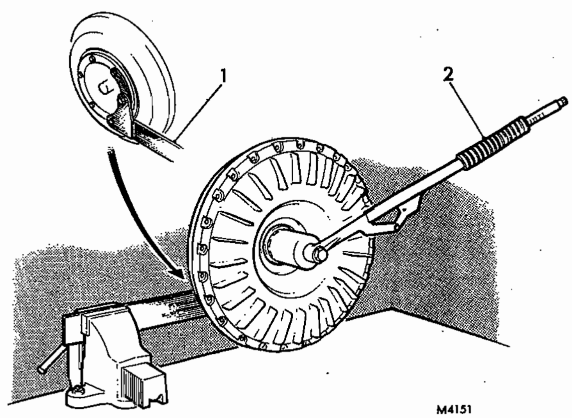


FIG. 4 APPLICATION OF THE SERVICE TOOLS
1. Service tool Part LC113A
2. Service tool Part LC154
Inset shows how the coupling is held

OVERHAUL

To Dismantle

1. Drain the oil and remove the coupling as described above.
2. Scribe a line on the pump gear and driving member to ensure correct re-alignment, withdraw the bolts and remove the gear.
3. Screw the holding wrench Part LC113A to the input shaft and grip the wrench handle in a vice. Bend back the tab washer and release the ring nut using spanner LC154, Fig. 4.
4. Reset the outer flange of the driving member on a suitable support and, protecting the input shaft against damage, drive the shaft out of the bearing.
5. The bearing housing and bearing can now be pressed apart and inspected for signs of wear.

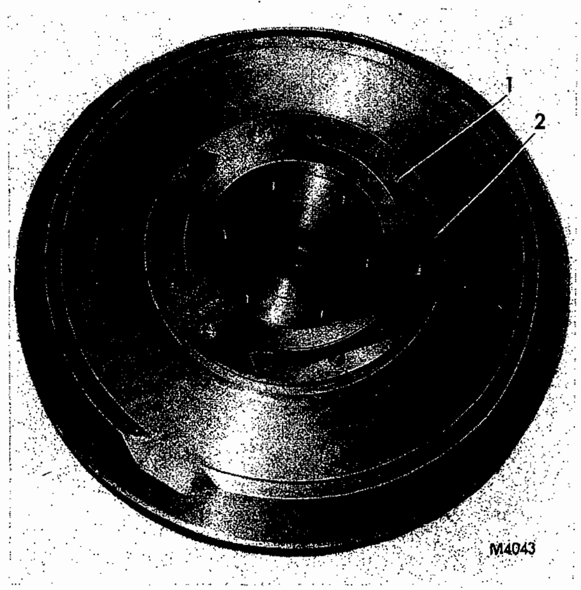


FIG. 5 INPUT SHAFT BOLTED TO THE RUNNER
1. Tab plates 2. Input shaft

6. Release the bolts and separate the coupling spigot from the input shaft.

   Important: DO NOT remove the coupling spigot unless damage is evident. The spigot will require re-aligning with the turbine to ensure that no oscillating is apparent, the cause being dirt or foreign matter trapped between the joint faces of the coupling spigot and input shaft.

7. Bend back the tab plates (4) and release the bolts securing the input shaft to the runner. The shaft is dowel located.

INSPECTION

Wash all components in a suitable solvent and check for signs of wear. Remove all traces of old gasket cement and 'Loctite' from mating surfaces.

Check the condition of the bearing outside diameter and bore for signs of movement within the housing or on the shaft. The bearing is a press fit and no movement is permitted.

Examine the pump gear teeth and input shaft splines for wear or damage. Renew any doubtful component. Renew all O-rings, piston rings, split pins, locking plates and washers.

To Reassemble, Fig. 2

1. Fit the input shaft (3) to the runner, tighten setscrews (15) and lock with tab plates.
2. Fit the coupling spigot (2) to the input shaft.
3. Fit the bearing in the housing and press the housing into the impeller.

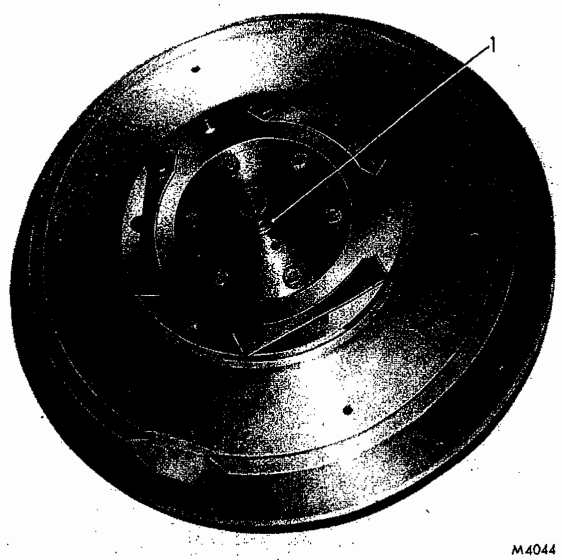
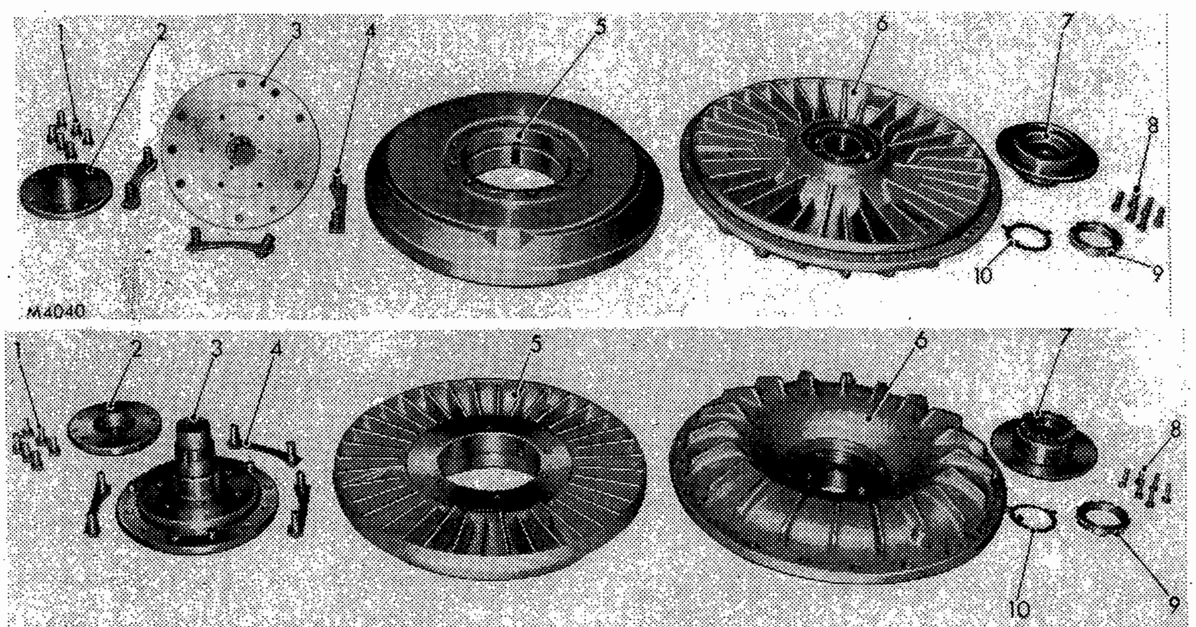


FIG. 6 COUPLING SPIGOT IN POSITION
1. Coupling spigot

4. Position the impeller over the runner and using a suitable tube with a bore big enough to pass over the threads on the coupling shaft, press the bearing (14) onto the shaft.
5. Fit the tab (10) and ring nut (9) and using both service tools as described during the dismantling procedure, Fig. 4, tighten the ring nut to correct torque, see Data.
6. Fit the pump drive gear (7), to the line previously scribed.
7. Fit the coupling as described under the relevant heading on Reference 3–1–3.



FIGS. 7 and 8 TWO VIEWS OF THE COMPONENTS

1. Coupling spigot setscrews
2. Coupling spigot
3. Input coupling shaft
4. Setscrews and tab plates
5. Runner
6. Impeller
7. Pump drive gear
8. Gear to impeller setscrews
9. Ring nut
10. Tab washer

GROUP 4

TRANSMISSION

Propeller Shaft

TO REMOVE AND REFIT (Figs. 2 and 3)
Remove the eight nuts and bolts from the companion flange at each end, and remove the propeller shaft. Release the bolts securing the yoke caps, remove the caps and pull back the coupling. Use rubber bands to retain the needle roller cups in position on the journal unless further dismantling is necessary.

Replacement is the reverse of the above procedure, but there are points to be watched.

1. Where a slip stub shaft has been removed from a sleeve yoke, it should always be replaced so that the arrow stamped on the shaft lines up with the arrow on the yoke, see Fig. 1.

2. When replacing, wipe the companion flange and flange yoke faces clean to ensure that the pilot spigot registers properly 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.

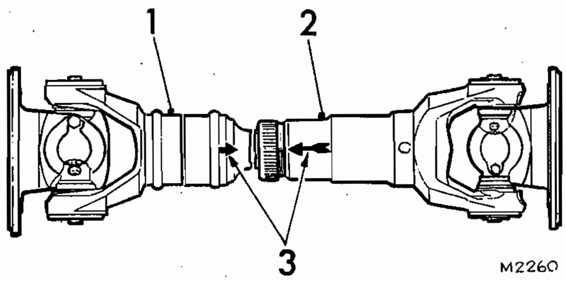


FIG. 1 PROPELLER SHAFT

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

Lubrication and Maintenance Procedures

Refer to Group 1 for lubrication and maintenance periods.

1. Check the tightness of all nuts, bolts and setscrews.

Needle Roller Bearings

1. 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.

2. Check for circumferential movement of the propeller shaft(s) relative to the companion flange yoke(s), by attempting to turn the shaft in the opposite direction to the companion flange. If movement is evident this indicates that wear has taken place on the needle roller bearings, or the splines of the slip joint.

3. Lubricate needle roller bearings (2) Figs. 2 and 3, until grease emerges from all four seals.

4. Lubricate splines through lubricator (11) until grease emerges from hole in closing washer (9). Cover hole with finger and continue application until grease emerges from sleeve end seal. See note below.

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

1. Misalignment or out of balance due to faulty assembly on the vehicle.

2. Worn needle roller bearings.

3. Loose companion flange bolts.

4. Lack of lubrication.

5. Bent propeller shaft tube as a result of accident damage.

Note: High pressure lubrication equipment should not be used for the lubrication of universal joints, as it is possible for the lubricant to be expelled from the relief valve before it reaches the needle roller bearings. The trunnion seals can also be damaged with the use of high pressure lubrication equipment. It is most important, therefore, that a hand-operated gun only is used for this operation.

Do not over lubricate to the extent that surplus lubricant is flung from the joints on to the chassis frame and body. Wipe off any surplus lubricant which expels from the relief valve after lubrication is completed.

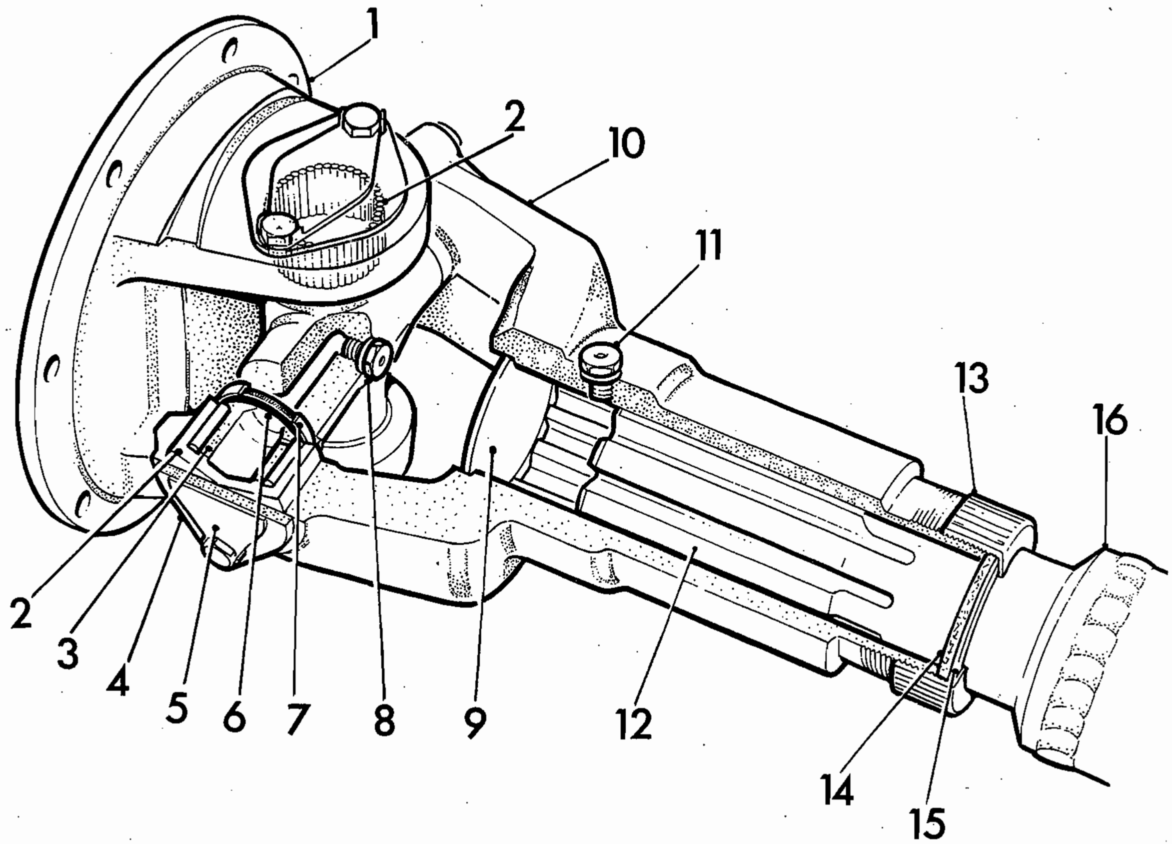


FIG. 2 SECTION THROUGH TYPICAL UNIVERSAL JOINT

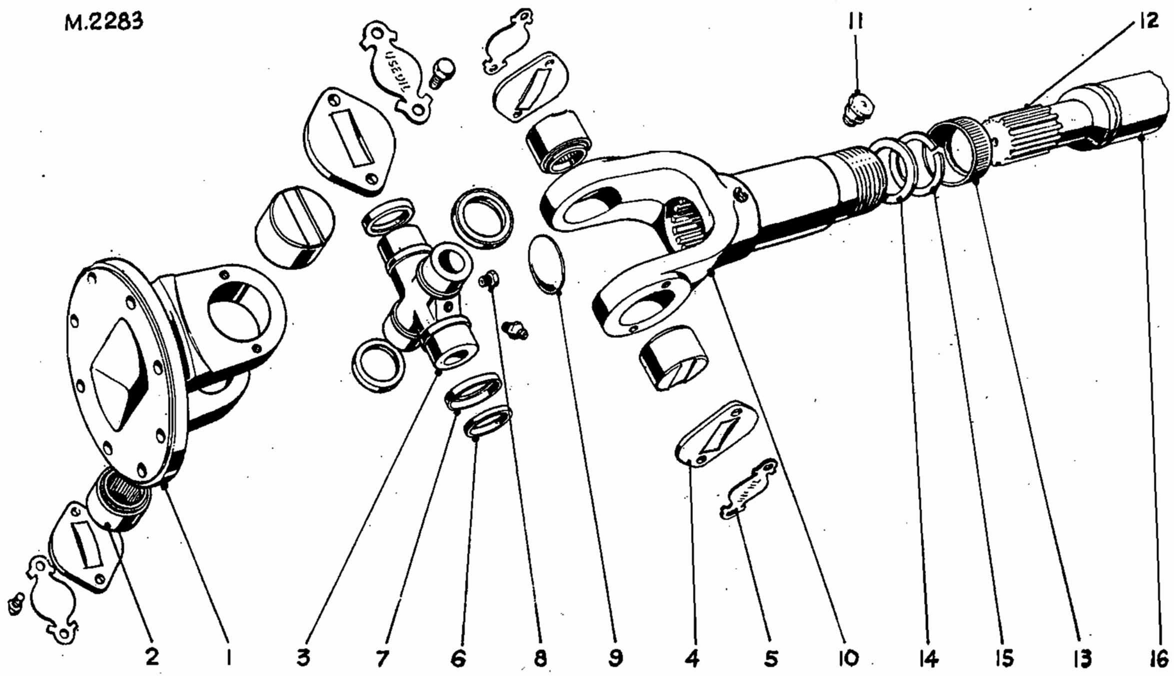


FIG. 3 EXPLODED VIEW OF TYPICAL UNIVERSAL JOINT

Key to Figs. 2 and 3

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

OVERHAUL

Propeller Shaft Joints

To Dismantle

1. Knock down the tabs on the lock strap and remove the bearing 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-nosed 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.

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. In the rare event of wear having 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 total of say 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.

Removal and Refitment

GEARBOX

To Remove

Note: Manufacture a lifting bracket to the dimension given in Group 1.

1. Stand the vehicle over a pit with the power unit positioned above solid ground.
2. Isolate the batteries.
3. Open and remove the engine/gearbox access doors and remove the right-hand support strip.
4. Remove the small side panel situated above the exhaust tail pipe.
5. Remove the splash trays from below the gearbox and fluid coupling.
6. Disconnect and remove the electro-pneumatic valve unit and bracket from the fan cowl.
7. Remove the air cleaner.
8. Remove the rear seats and release the access panel from the bulkhead.
9. Disconnect the fan drive propeller shaft.
10. Disconnect the oil cooler if fitted.
11. Remove the thin body panel strip situated immediately above the fan cowl; remove the cowl bolts and manoeuvre the assembly clear of the vehicle.
12. Disconnect the sump to pump feed pipe and drain the oil into a suitable container.
13. Rotate clutch driving member (impeller) until the drain plug is visible through air vent at the bottom of the clutch housing, Fig. 1. Remove the plug and drain oil into suitable container.
14. Remove the oil filter assembly and associated piping.
15. Drain the lubricant from the mitre box.
16. Release the mitre box oil feed pipe.
17. Remove the plug from the transfer drive cover and withdraw the drive shaft.

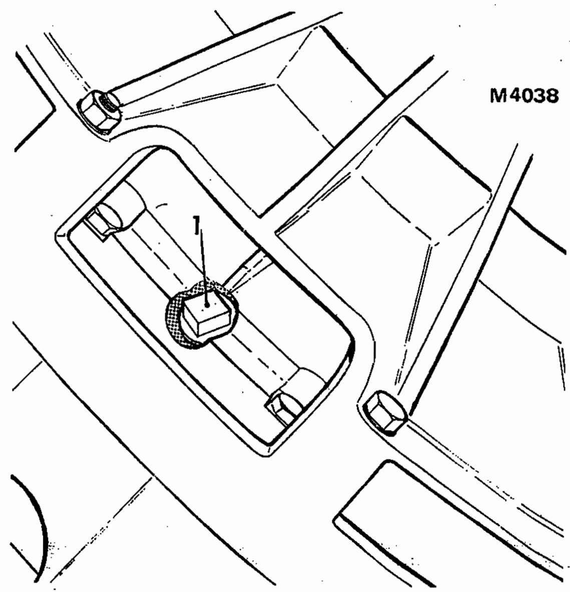


FIG. 1 CLUTCH DRAIN PLUG THROUGH BOTTOM APERTURE

1. Drain plug

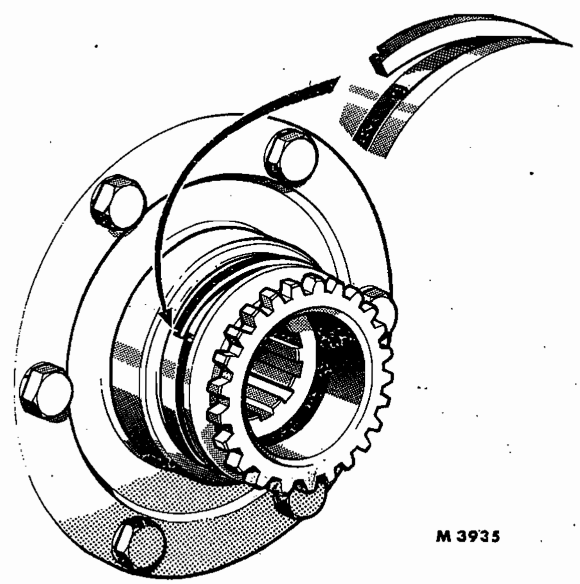


FIG. 2 THE SEAL RING IN POSITION

Inset shows how the ring is locked

18. Release the grub-screw and unscrew the transfer drive tube using tools 3VRS478.

19. Support the mitre box on suitable blocks and a jack, remove the securing bolts and pull the mitre box clear of the gearcase.

20. Adequately support the engine under the flywheel housing using suitable blocks and a jack.

21. Protect any ancillary equipment likely to be damaged during the withdrawal procedure, if necessary by the complete removal from the vehicle.

22. Remove the engine/gearbox inner mounting bracket and clutch housing studs.

23. Fit the lifting bracket (made locally) to the gearbox and take the weight off the rear mountings using suitable overhead lifting equipment.

24. Remove the engine/gearbox outer mounting bracket.

25. Remove the bolts and nuts securing the gearbox to the engine flywheel and manoeuvre the unit clear of the vehicle.

To Refit

1. Remove the seal ring from the pump drive gear Fig. 2 and fill the groove with grease. Re-position the seal ring ensuring that the lugs overlap as shown. Centralise the ring, which will be held in position by the grease long enough to fit the gearbox.

2. Protect the oil pump drive shaft against damage by impact during the alignment procedure as follows:

    a. Leyland engine: Grip one of the top mounting studs with vice grip pliers as shown in Fig. 3.

    b. Gardner engine: Insert a setscrew through one of the top mounting holes and grip the setscrew with vice grip pliers as shown in Fig. 3.

3. Lift the gearcase and carefully manoeuvre the assembly into position until the clutch housing abuts against the side face of the vice-grip pliers. The input shaft splines will be engaged at this stage.

4. Remove the vice grip pliers and gently jog the gearcase into position against the flywheel housing. If resistance is felt DO NOT use force. The oil pump drive gear has failed to engage or the seal ring has been dislodged. Turn the flywheel or pull back the gearbox and if necessary re-align the seal ring. Repeat the procedure until a satisfactory engagement is achieved. Fit and tighten the nuts and setscrews.

5. Fit the engine/gearbox outer mounting bracket.

6. Remove the lifting equipment.

7. Fit engine/gearbox inner mounting bracket and the clutch housing studs.

8. Manoeuvre mitre box into position against the gearcase and secure with setbolts and washers.

9. Fit four new O-rings, two in the grooves in the transfer drive tube and one each in the machined bores of the mitre box and gearcase.

10. Screw the ring down and fit the outer sleeve. Locate one end of the transfer tube in the mitre box, the other end in the gearcase and adjust the length of the tube using tools 3VRS478 until a satisfactory seal is obtained. Secure outer ring by tightening the grub screw.

11. Insert the drive shaft through the hole in the transfer drive cover. Fit the plug.

12. Couple up the mitre box oil feed pipe.

13. Fit the oil filter assembly and couple up the feed pipes.

14. Connect the sump to pump feed pipe.

15. Position and secure the fan cowl assembly.

16. Fit the fan drive propeller shaft.

17. Fit the access panel to the bulkhead and re-position the seats.

18. Fit and secure the air cleaner.

19. Fit and secure the electro-pneumatic valve unit, couple up the air pipes and electrical connections.

20. Locate the splash trays beneath the gearbox and fluid coupling.

21. Fit the side panel situated above the exhaust tail pipe, and the thin body panel strip above the fan cowl.

22. Position the support strip and assemble the engine/gearbox access doors.

23. Fill the gearbox/fluid coupling with specified lubricant as directed in Group 1.
24. Connect the batteries; charge the air system and test the gear selector mechanism.

Oil Filter

To Remove

1. Disconnect inlet and outlet oil feed pipes.

2. Remove the setscrews securing filter to bracket.

To Refit

1. Secure filter to bracket and couple up the oil feed pipes.

2. Run engine and check for oil leaks.

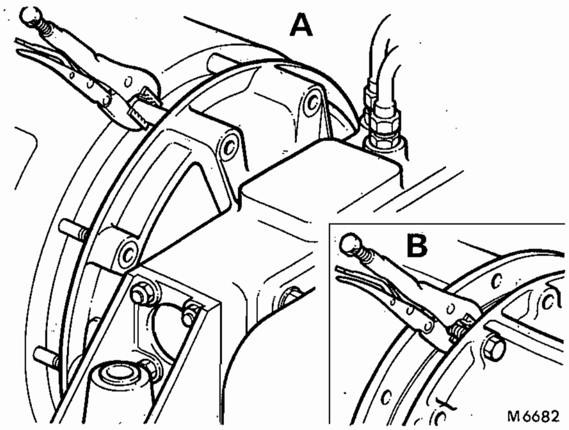


FIG. 3 SHOWING APPLICATION OF VICE GRIP PLIERS

A. Leyland B. Gardner

Gearbox

DATA

		1st	2nd	3rd	4th	5th	Rev.
Type	RV90/2	5.204	3.226	2.123	1.502	1.00	3.73

Approximate weight (wet) . . . . 449 kg (990 lb)

Operating Air Pressures

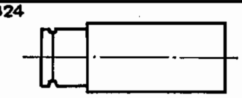
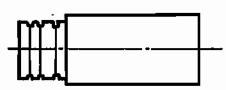
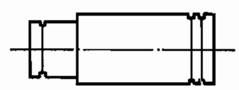
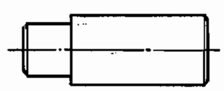
Automatic . . . . 4.9/5.25 kgf/cm² (70/75 lbf/in²)

Semi-automatic . . . . 5.9/6.0 kgf/cm² (80/85 lbf/in²)

Restrictors

Part No.	Application
827472	1st and reverse
827474	2nd
10899080	3rd and 4th
50959399	(Automatic only)

Restrictor Identification

Part No. 827472	Part No. 827474	Part No. 10899080	Part No. 50959399
M6324 			
1·59 / 1·78 mm (0·0625 / 0·070 in)	1·09 mm (0·043 in)	0·71 / 1·09 mm (0·028 / 0·043 in)	1·09 mm (0·043 in)

Oil Capacities

Gearbox and charged coupling . . . . 29.6 litres (6.5 galls)

Gearbox charged coupling mitre box . . . . . . 38.6 litres (8.5 galls)

Oil Pressures

Gearbox relief valve set at . . . . 2.8 kgf/cm² (40 lbf/in²)

Filter differential valve set at . . . . 1.75/2.12 kgf/cm² (25/30 lbf/in²)

Flow Rate

9.09 litres (2 galls) at a pressure of 2.12 kgf/cm² (30 lbf/in²) at 400 r.p.m.

Springs

Top speed multi-plate clutch

Number 6

Rate . . . . 13.6 kg±0.68 kg (30 lb±1.5 lb)

Solid length . . . . 34.29 mm (1.35 in)

Free length . . . . 57.15 mm (2.25 in)

Weak springs to be replaced as a set

End-float Adjusting Washers

2.667/2.540 mm	to 6.223/6.096 mm	in steps of	0.508 mm
(0.105/0.100 in)	(0.245/0.240 in)		(0.020 in)

Top Speed Piston

Limits of travel	26.67 to 29.21 mm (1.050 to 1.150 in)
Adjuster washers	1.52, 3.96, 8.7 mm (0.060, 0.156, 0.343 in)

Brake Band Setting Gauge Application

31.75 mm (1.25 in)	1st, 2nd, 3rd reverse
35.3 mm (1.35 in)	4th

Torque Loadings:

Input shaft nut	48.4 kgf m (350 lbf ft)
Output shaft nut	48.4 kgf m (350 lbf ft)

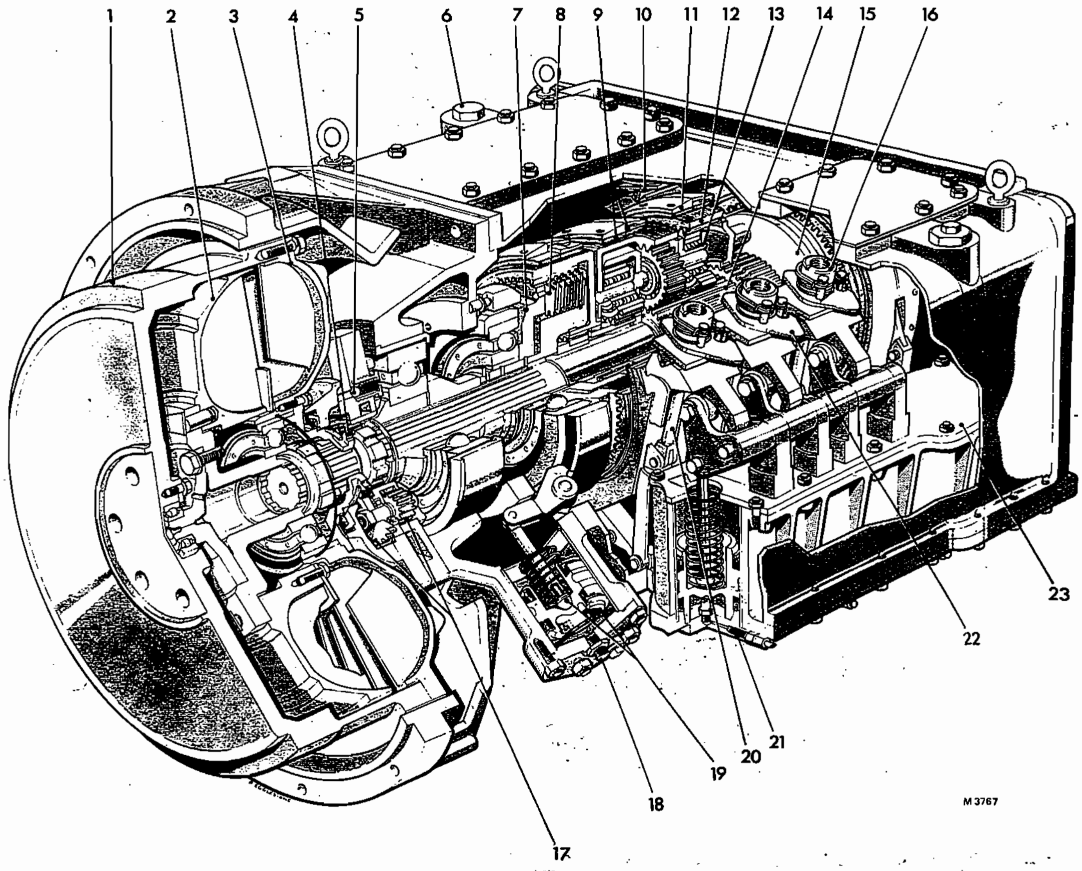


FIG. 2 CUT AWAY VIEW OF THE GEARBOX

1. Flywheel
2. Turbine (Driven member)
3. Impeller (Driving member)
4. Oil pump driving gear
5. Oil pressure relief valve
6. Oil filler plug
7. Sliding member (clutch)
8. Multi-plate clutch (top gear)
9. Brake band linings
10. Reverse-gear operating mechanism
11. Brake band (2nd speed)
12. Annulus (2nd speed)
13. Planetary gear (2nd speed)
14. Sun-wheel and input shaft
15. Coupling member replaces 1st speed assembly on 4 speed gearboxes
16. Second speed band adjuster-mechanism
17. Oil pump gears
18. Air inlet connection for top-speed clutch operation
19. Top-speed clutch operating piston and push-rod assembly
20. 4th speed band operating linkage
21. Air restrictor tube.
22. 3rd speed band automatic adjuster plate
23. Blanking-cover replaces 1st speed operating mechanism on 4-speed gearboxes

DESCRIPTION

The gearbox is of the epicyclic type having five forward speeds and reverse.

Before describing the maintenance and overhaul procedure however, the following paragraphs may help the reader to understand the basic principles of epicyclic gearing.

Simple Epicyclic Gearing

The method of transmitting the drive from the engine to the output shaft is shown in Fig. 3. Here the simple gear has the drive from the engine connected to the shaft SI which is in one with the sun wheel S. The mechanism being driven is connected to the shaft S2, which is integral with the carrier C, and finally the annulus A is held stationary by a hand brake B.

The drive from the engine will cause the sun wheel S to turn and since the planet wheels P are engaged with the sun wheel, they too, will turn and roll around the inside of the annulus, taking with them the planet carrier C and shaft S2. In this way the drive from the engine is transferred to the driven mechanism. The arrows in the diagram indicate the rotation and direction of the various parts.

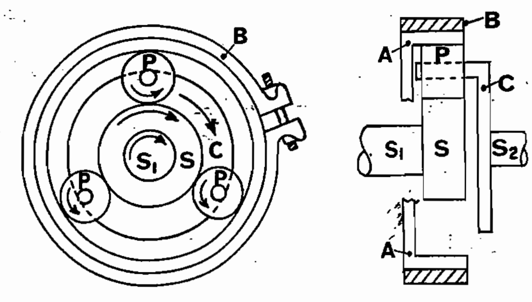


FIG. 3 A VIEW OF A SIMPLE EPICYCLIC GEAR TRAIN TO SHOW THE PURPOSE OF THE BAND BRAKE

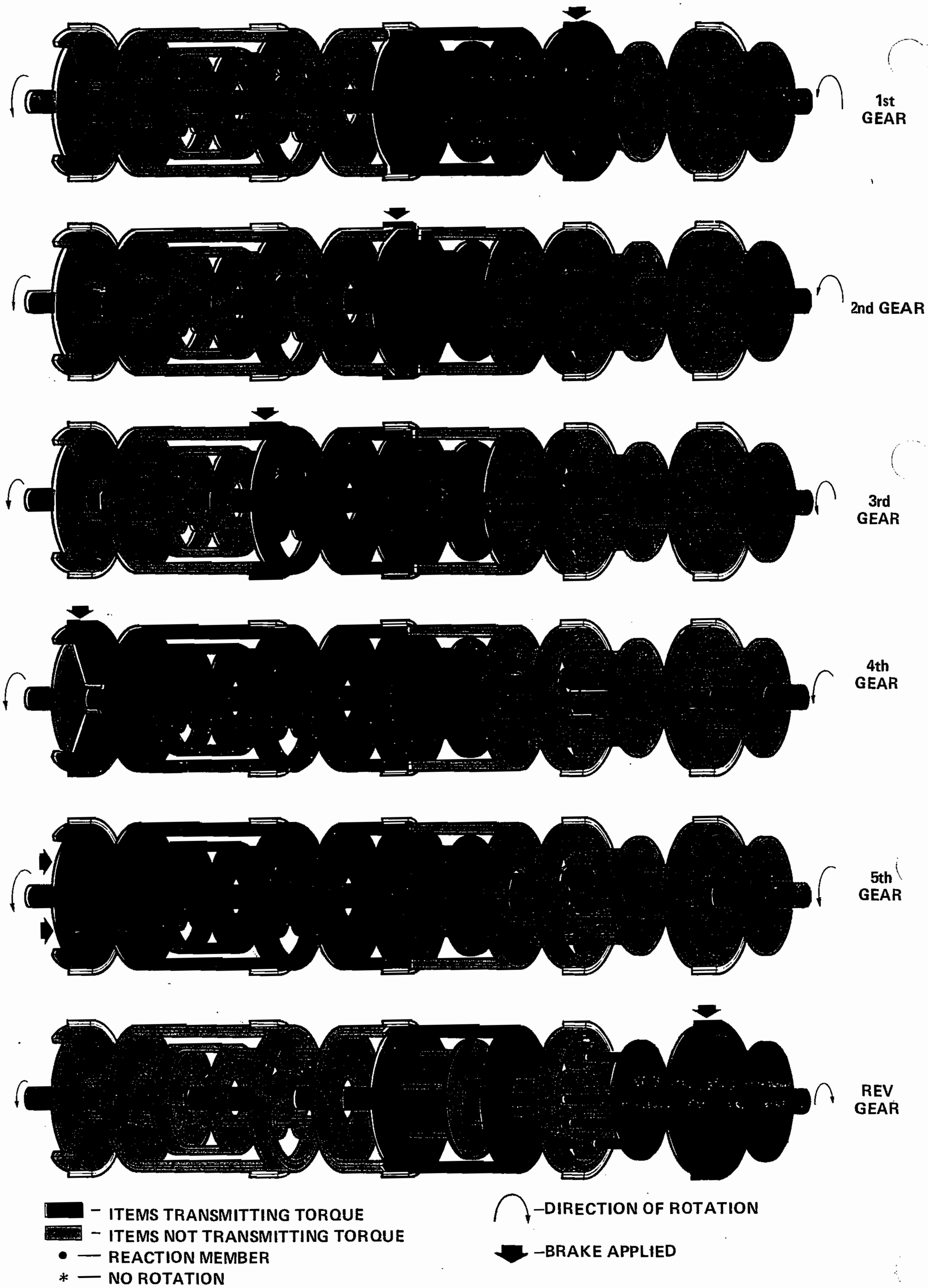


FIG. 4 POWER FLOW DIAGRAM

Compounding of Gears

The gears are not used independently as in conventional gearboxes. Other gears are obtained by rotating the annulus of the simple train at a controlled speed, thus reducing the ratio.

By connecting one or more of the elements of one 'train' with those of similar trains and a band brake provided, then each time a brake is applied a gear change is made and various ratios obtained.

These operations are diagrammatically illustrated in Fig. 4.

The arrows in the diagram indicate how the power flow is transferred.

Note that the first (crawler) gear and reverse gear are in constant mesh with the output shaft.

When top gear is selected, none of the brake bands are applied. Instead a multi plate clutch is engaged which gives a direct drive from the engine to the output shaft.

All the gears are air-operated, each being provided with a separate air cylinder. For the indirect gears the air pistons, working in cylinders mounted on the bottom cover, are used to apply the 1st, 2nd, 3rd, 4th and reverse speed brakes.

Air flow to and from the operating cylinders is controlled by the restrictor valves fitted in the outer adaptors situated in the cover plates of the 1st, 2nd, 3rd, 4th and reverse speed pistons, to release one band while progressively applying the band of the gear to be engaged. This operation is diagrammatically illustrated in Fig. 8.

The restrictor valves should be fitted with the open end towards the outside of the gearbox.

The top speed clutch is operated by a piston acting in an external cylinder cast integral with the clutch housing, Fig. 2.

The function of the clutch is to couple together the gear trains which comprise the direct gears and, by preventing rotation of the trains relative to each other, provide a direct drive from input to output shafts.

Air is admitted to the cylinder (18) Fig. 2, and forces up the piston and with it the piston rod which is linked to a lever which pivots about a pin. Acting on the trunnion ring the lever converts the pressure of the piston into thrust parallel to the input shaft and thus applies the plate clutch.

The trunnion ring is mounted on the sliding panel and is so pivoted as to allow the assembly to take up its own alignment as the clutch is applied.

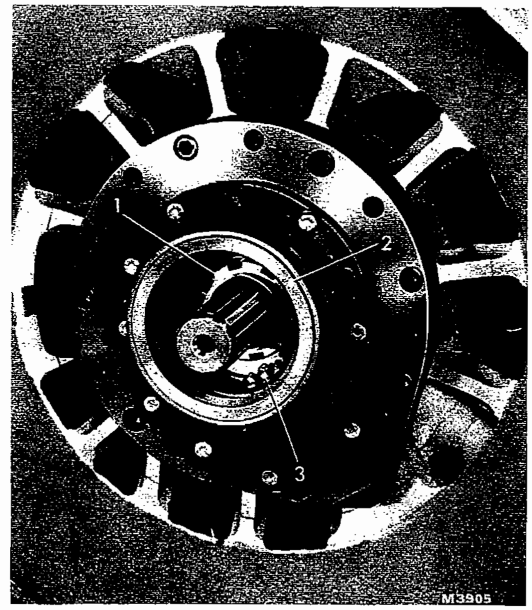


FIG. 5 THE OIL PUMP IN POSITION
1. Input shaft ring nut 2. Oil seal 3. Pump drive gear

A ball bearing of the angular-contact type is fitted between the clutch sliding member and the trunnion ring to take the thrust load in top gear. A ball bearing in the clutch housing locates the input shaft and takes the thrust load and clutch reactions, its inner race being mounted on the input coupling.

At the rear end of the gearbox, the reverse gear train carrier is splined to the output shaft and the brake drum for this gear is carried by a roller bearing. The output coupling is supported by a ball bearing which takes the thrust and journal loads. The two bushes in the output shaft provide location and support for the rear end of the input shaft.

The gearbox is pressure lubricated by a gear type pump situated within the clutch housing Fig. 5. The pump is driven by a gear formed on the clutch impeller which is bolted to the flywheel, and ensures that the system is fully charged even when the vehicle is stationary and the engine at idling speed.

The pump supplies oil to lubricate the gearbox and to operate the fluid clutch, a commonised lubricant being used to achieve uniform temperatures.

A full flow cartridge type oil filter is mounted at the rear of the gearbox and ensures a constant supply of clean oil to the clutch and running units.

The pump assembly comprises three machined castings; the spigot cover (99) pump body and cover plate (2) Fig. 28.

The pump cover is formed to accept the clutch to pump drive gears. The filtered oil is also channelled through the machined gallery and fed to the fluid clutch through the ball bearing.

The cover plate is bolted to the pump body and drilled to support the spigot shafts of the oil pump gears. A ball bearing on which the pump drive gear runs is pressed into the face of the plate. A further drilling forms the oil way to the relief valve.

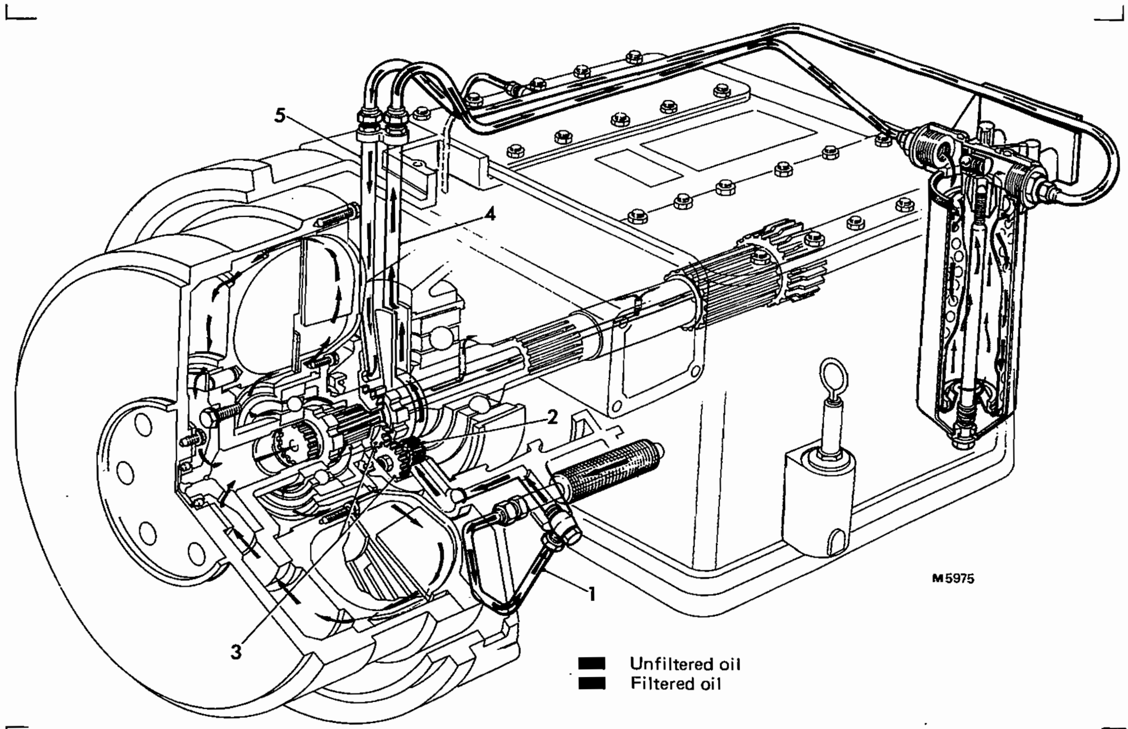


FIG. 6 OIL FLOW DIAGRAM

1. Sump to pump feed pipe
2. Oil pump gears
3. Oil pump drive gear
4. Pump to filter feed pipe
5. Filter return pipe

The pump body houses the pump gears with a machined annular chamber to feed oil from the pump gallery to the filter inlet port. Further drillings serve to transfer the oil from the filter return pipe to the chamber in the pump cover. The pressure relief valve is also situated within the pump body (1) Fig. 11, and comprises a spring loaded ball which is lifted off its seat when the oil pressure exceeds a given figure (refer to the Data pages for the correct value) surplus oil being fed back to the sump.

The oil flow is diagrammatically illustrated in Fig. 6. A coarse wire mesh filter is fitted to the pump feed pipe in the gearbox sump and protects the system against the ingress of large foreign particles.

The oil is drawn from the sump to the pump through feed pipe (1) entering the rear pump chamber and thence to the filter via feed pipe (4). Clean oil is pumped to the front chamber through feed pipe (5) and passes through the ball bearing to the clutch, which, when charged, completes the transfer to the gearbox through holes drilled in the coupling spigot, passing through the centre of the input and output shafts, discharging to various parts of the running gear en route.

The operation is continuous when the engine is running and ensures the movement of oil through the unit thereby eliminating the problems normally associated with excessive pressures.

Two oil seals, one situated at the front of the gearbox and locating on the pump gear shaft, the other on the output coupling, adequately protect the gearbox against fluid loss. Seal rings located in grooves in the oil pump drive gear and input bearing collar serve to retain the high pressure supplied by the pump and to protect the oil seal against damage which could be caused by excessive pressure.

The coupling of the engine to the gearbox is through a fluid clutch the description of which is covered in Group 3 of this manual.

Since at idling speed only minimal fluid drag is present, the appropriate gear can be engaged without stalling the engine. By selecting the gear and slowly depressing the accelerator, the engine speed increases, the fluid drag becomes greater and the drive is slowly taken up.

Detachable covers are fitted to each of the piston chambers, the forward speed chambers being on the left-hand side, whilst the single cover at the rear on the opposite side, is for the reverse speed piston only. Each cover has a separate air inlet valve and a drain plug for periodic draining.

Condensation in the gearbox reservoir can result in a certain amount of water being forced into the cylinders of the gearbox. It is important therefore to drain off any fluid at regular intervals.

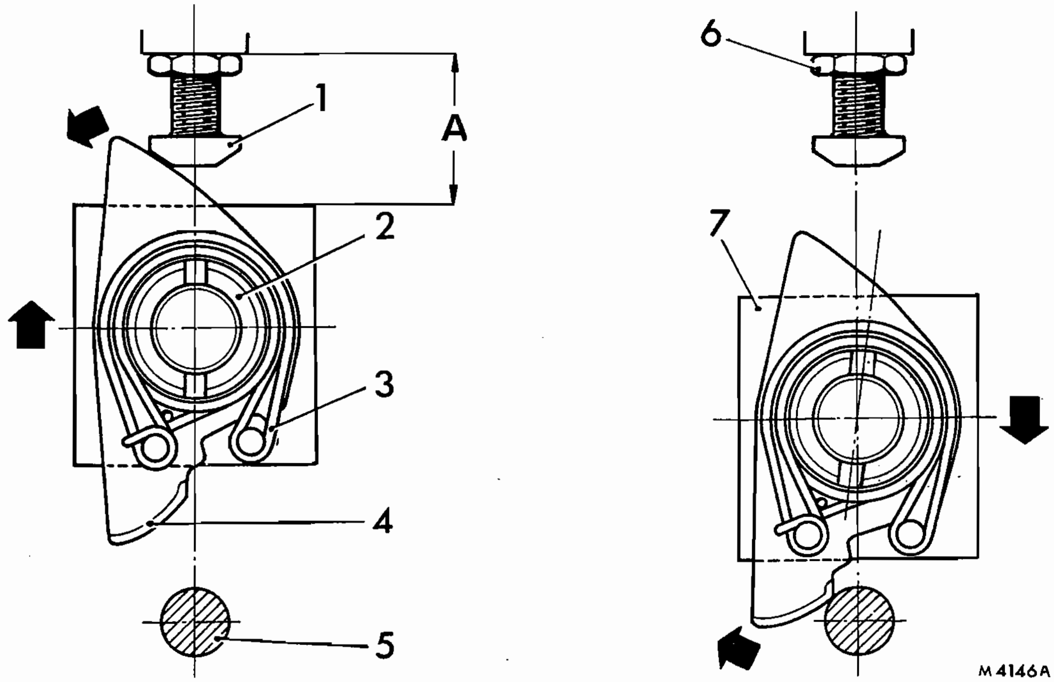


FIG. 7 THE AUTOMATIC ADJUSTERS

1. Adjuster screw
2. Adjuster nut
3. Adjuster spring
4. Adjuster ring
5. Tail pin
6. Lock nut
7. Adjuster table
A. Gauge application

Brake Operation

The brake mechanisms are used to bring into operation the indirect gears, one brake being provided for each gear.

The brake and clutch are operated by compressed air admitted to the appropriate cylinder causing the pistons to move inwards and constrict the brake bands, or close the top gear clutch, through a mechanical linkage.

When a gear is engaged, the appropriate brake grips the brake drum, bringing it to rest, thus providing a reaction so that power is transmitted to the gearbox output shaft.

The importance of correct setting of the brakes cannot be over emphasised. Incorrect settings will result either in excessive loadings in every part of the transmission from engine to road wheels, or in rapid deterioration and wear of the brake linings.

A brake band consists of two concentric bands whose friction linings are situated side by side. The outer band, when constricted by the brake mechanism, closes the inner band, both linings thus being brought into contact with the brake drum.

By using suitable anchorages for the inner and outer bands, the brake is balanced, so preventing the shafts and bearings from being subjected to any journal load arising from the application of the brakes.

The brake linings are made of a material which is extremely hard wearing and is suitable for working in oil. It is inevitable, however, that some wear will occur in time, and this is corrected by the automatic adjuster mechanism which keeps the brake constantly at its initial setting.

When the gear change lever is moved into position, air is admitted to the cylinder, forcing the piston upwards, Figs. 8 and 15. This movement applies an upward force to the thrust pad which pivots about its knife edge on the hooks, thereby raising the adjuster mechanism and the pull rod. Since the pull rod is attached to the lower end of the outer band (the upper end of which is anchored by the hooks) this action constricts the brake band.

It will be seen that in rising, the pull rod and adjuster mechanism move towards the brake band and that the adjuster ring is brought into contact with the adjuster screw in the brake band.

The brake actuating mechanism is similar for all the indirect gears except for the size of the cylinder and piston. The 1st and reverse speed brakes have the largest diameter cylinders because the greatest torque reaction occurs in these gears.

The Automatic Adjuster

The automatic adjuster is a device for reducing the effective length of the pull-rod and thus taking up the extra movement caused by the wear of the brake linings.

All the brakes are automatically adjusted for wear, and they are also centralised with the drums to prevent them rubbing when in the off position.

A section through the 1st speed gear with the brake in the off position and the reverse speed mechanism with the brake in the on position is shown in Fig. 15. The height to which the thrust pad is allowed to swing is the factor which determines the grip of the brake, and the travel of the thrust pad is governed by the automatic adjuster nut. Note carefully that screwing the nut **anti-clockwise** gives more movement and increased brake grip to the limit of movement of the adjuster mechanism.

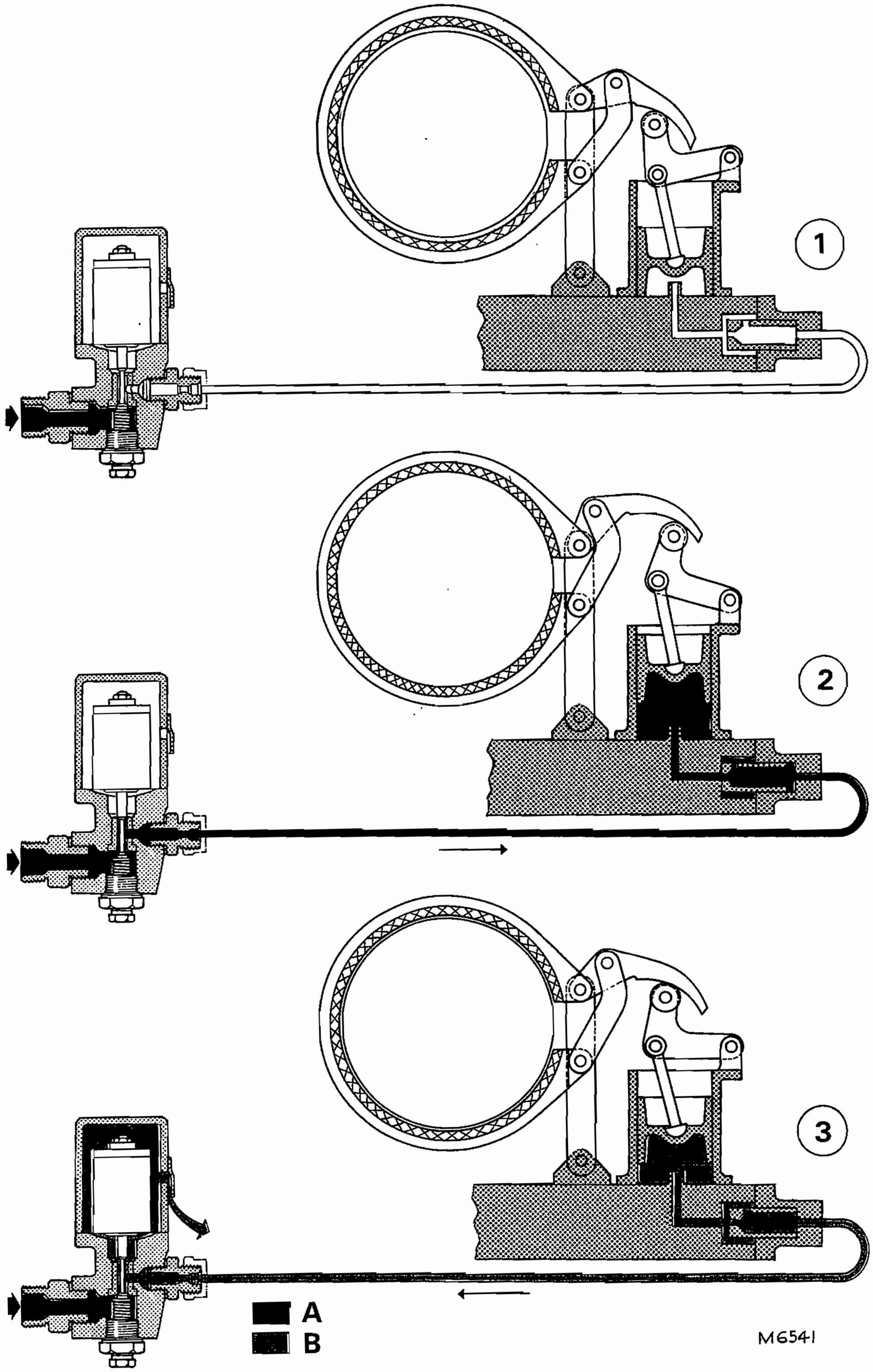


FIG. 8. DIAGRAMMATIC LAYOUT OF GEARBOX ELECTRO-PNEUMATIC CONTROL

A – AIR UNDER PRESSURE B – AIR EXHAUSTING

1. Neutral – Supply pressure held at E.P. valve block, brake released
2. Gear selected – Air pressure applies brake
3. Gear disengaged – Supply pressure held at E.P. valve block, air exhausts to atmosphere, brake released

Assuming that the brakes are correctly set, the automatic adjuster ring will, when the brake is in the on position, just touch the adjuster screw in the brake band.

Wear on the brake linings will allow the thrust pad to move higher. When this occurs the automatic adjuster ring, Fig. 7, striking the adjuster screw will be rotated **anti-clockwise**. The adjuster ring is pinned to the spring in such a manner that this action tightens the spring against the adjuster nut. As the brake approaches the **off** position, the rear portion of the adjuster ring strikes the tail pin. The adjuster ring now rotates in the **clockwise** direction, taking with it the adjuster nut which is thereby screwed down. This reduces the effective length of the pull rod and takes up the extra movement caused by the wear of the brake linings.

ADJUSTMENT

Air Pressure

For the correct air pressure, see Data.

Fierce engagement of all the gears can be caused by having the air pressure too high. If this occurs, the pressure should be adjusted to the correct value.

If the air pressure is low, slip may occur in the gearbox, particularly in the lower gears, and must be adjusted to the correct value. Refer to the relevant page in this section.

Should brake slip be experienced with adequate pressure available, the external air pipe connections to the gearbox should be checked for leaks.

Constant Supply of Air

It is essential when the brakes are being set that the air pressure be kept constant at the operating pressure and this may be carried out as follows:

1. Use an independent air source taken through a reducing valve from the main supply.
2. Employ a portable compressor, set to give the correct pressure.

In both cases the air lines should be connected to the air pipe leading from the limiting valve to the gear change control lever, or valve block, thus enabling the operator to apply and release each brake in the normal way.

3. Use an independent air line capable of supplying at least 5.6 kgf/cm^2 (80 lbf in^2) and connected to the auto shut-off valve situated at the front of the chassis, see Handbook.

If the pressure is maintained and the sequence of operations relative to Setting the Brakes adhered to, the brakes should normally need no attention between overhauls.

Brakes

Normally the automatic adjusters will keep the brakes fully effective and no maintenance should be required for these units.

Slipping Brakes

When brake slip is detected the cause should be corrected immediately or rapid deterioration of the brake linings will occur.

The causes of brake slip and the means of correction are as follows:

1. Low Air Pressure.
2. Leakage in the Air System.
   The air system should be checked by applying a solution of soap and water to the joints in the piping.
3. Leaking Piston Seals.
   Air leaking past the piston seals can be detected by air escaping from the breather or by a burbling sound from within the gearbox. Examine the seals for wear, hardening, cracked lips, etc., and the cylinder bore for scoring, see Piston Seals for method of removal.
4. Incorrect Setting of the Adjuster Mechanism.
   Check the gap between the adjuster table and the boss on the brake band, see Setting the Brakes.
5. Adjuster Mechanism not Operating.
   If slipping persists when these instructions have been followed, see Failure of Adjuster Mechanism.

Fierce Engagement of Brakes

Fierceness of all gears is usually caused by excessive air pressure. This should be adjusted to the correct limits, and the brakes then re-set from operation 9 in Setting the Brakes.

Fierceness of one gear only may be due to:

1. Incorrect Adjuster Setting.
   Apply the brake and check the gap with the gauge. If the gap is only a little too small, carry out the instructions given in Final Adjustment.
2. Adjuster Mechanism not Operating.
   Apply the brake and check the gap with the gauge. If the adjuster has failed, the gap will be much too small, see Failure of Adjuster Mechanism.
3. Failure of the limiting valve.

Failure of Adjuster Mechanism

The first effect of failure of the adjuster mechanism is usually fierceness of the brake concerned, which will increase as the linings wear until the linkage reaches the limit of its travel.

Slip will then occur and will become rapidly worse, giving exactly the same effect as clutch slip in other forms of transmission.

Some possible cause of failure being:

1. Tightness of the Adjuster Nut.
   Remove the spring, adjuster nut, adjuster ring, table and thrust pad; clean these parts and try the adjuster nut on the pull-rod thread. The nut should screw down by hand until the pull-rod protrudes through the top. If tightness persists, examine the threads for damage and correct if necessary. Reassemble and re-set the brake.
2. Weak or Broken Spring
   Renew this component and check the working of the new spring when adjusting the brake as described in Setting the Brakes.

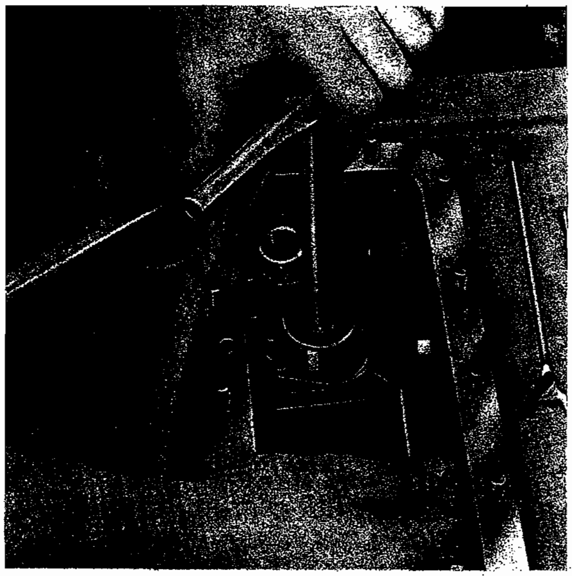


FIG. 9 SETTING THE BRAKE BANDS

Setting the Brakes

When a gear is engaged it will be seen that the adjuster mechanism travels inwards towards the brake band when moving from the off to the on position, Fig. 15.

By measuring between the brake band and the adjuster mechanism with the brake in the on position, it is possible to obtain the setting required for each brake, (A) Fig. 7.

The surfaces convenient for measuring are the face of the boss on the brake band, on which the locknut rests, and the face of the adjuster table, Fig. 9.

Note: This operation should be carried out when the gearbox is cold. Each time the brake is applied it should be left in the on position for at least five seconds to allow the full pressure to be reached in the cylinder.

To engage gears independently when G2 automatic control is fitted, remove the top cover from the electro-pneumatic valve unit and depress each solenoid in turn.

Refer to Data for setting gauge numbers.

1. Slacken the locknut on the adjuster screw in the brake band and screw the adjuster screw right in.
2. Engage the gear concerned and try the appropriate gauge between the face of the adjuster table and the boss on the brake band, Figs. 7 and 9. The correct setting is that which just allows the gauge to enter.
3. If the gap is too small release the brake, remove the two eyes of the adjuster spring from the pin fixed to the adjuster table and remove the loop from the table pin. It is not necessary to remove the spring.
4. Screw the nut, clockwise, apply the brake and check with the gauge. Repeat procedure until the correct setting is obtained.
5. If the gauge has too much clearance, the adjuster nut must be screwed anti-clockwise to obtain the correct setting.
6. When the correct setting has been obtained, release the brake; hold the adjuster ring against the tail pin and remove the service tool. Refit the spring.
7. Apply and release the brake, moving the adjuster screw out at each release, until the adjuster ring just touches the screw in the on position.
8. Lock the adjuster screw (1) Fig. 7.
9. Release the external spring. Insert the service tool and screw the adjuster nut anti-clockwise half a turn. Remove the service tool and replace the external spring.
10. Apply and release the brake several times and note if the adjuster nut has turned. (This may be seen by laying a straight edge across the inspection aperture parallel to the slots in the nut when the brake is in the off position, and then sighting the slots at each release.)
    If the adjuster nut has turned, apply and release the brake repeatedly until the nut stops turning. When the nut appears to have stopped turning, another six applications should be made to ensure that no further movement takes place.
11. If the adjuster nut has not turned, move the adjuster screw out half a turn at a time until the nut commences to turn, apply and release the brake until the nut has ceased to turn, and check the gap with the gauge.

Final Adjustment

1. If the gauge will not enter, release the brake and move the adjuster screw half a turn outwards and re-lock.
2. Apply and release the brake until the adjuster nut stops turning.
3. Check the gap.

Repeat operations 1 to 3 if required.

1. If the gauge has too much clearance, move the adjuster screw half a turn inwards and re-lock.
2. Release the spring. Insert the service tool and screw the adjuster nut half a turn in an anti-clockwise direction.
3. Remove the service tool and replace the external adjuster spring. Apply and release the brake until the adjuster nut stops turning.
4. Check the gap.

Repeat operations 1 to 4 if required.

Note: Should the mechanism fail to respond to this setting sequence, especially failure of adjuster nut to turn when the adjuster spring is considerably deflected, see Failure of Adjuster Mechanism.

New Linings

To facilitate the bedding in of new linings, complete the above operations then turn the adjuster nut clockwise one quarter turn. The slight increase in setting dimension will be absorbed when the grooves in the brake drum form an impression in the linings.

Piston Seals
Every 24,000/32,000 kilometres (15,000/20,000 miles) or at any convenient dock dependent upon the operator's maintenance procedure, the upper piston seals should be checked for oil leakage. Remove the cylinder drain plugs (square-headed), and select each gear in turn; if oil is blown out the piston seal should be replaced.
Periodically the seals should be inspected for wear or deterioration, any seals which have hardened in service, or show worn or cracked lips, should be replaced.

To Remove the Pistons

1. Clean all road dirt from the lower face of the gearbox.

2. Disconnect the flexible air supply pipes at the adaptors in the lower cover.

3. Remove the nuts and washers and allow the cover to be pushed down by the piston return spring.

4. Remove the piston and spring.

5. Grip the protruding lip of the cylinder liner and remove for inspection.

6. Remove the seals from the piston.

7. Fit the new seals by carefully stretching them over the piston flanges. The groove in the seals must be to the outer ends of the piston when in position. Carefully refit the retaining rings.

8. Renew the O-ring in the cover.

9. Thinly coat the new seals with a mixture of colloidal graphite and lubricant as specified for the semi-automatic gearbox, prior to refitting the pistons. Make a final check to ensure that the seals are correctly located and are seating squarely on the piston.

10. Position the piston and spring in the cylinder liner taking care not to damage the piston seals. Guide the liner into the cylinder until resistance is felt on the piston spring.

11. Position the piston cover with its new O-ring over the cylinder liner and press the assembly up until the cover locates correctly.

12. Tighten the retaining nuts with their respective washer and couple up the air pipes.
    Finally, with the engine running to maintain a constant air pressure, engage the gears concerned a number of times and check for leakage. If the system is operating satisfactorily, test the vehicle under road and load conditions.

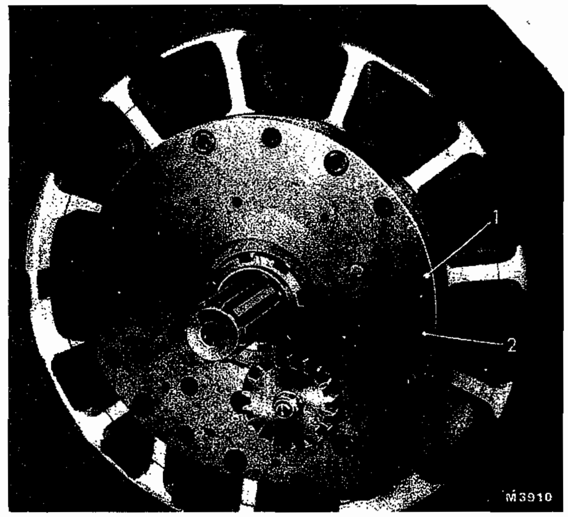


FIG. 10 THE PUMP MINUS FRONT COVER
1. Pump to clutch housing screws
2. Cover plate to pump body screws

OVERHAUL

OIL PUMP

Refer to Figs. 28 and 29 unless otherwise stated.

To Remove
1. Release the bolts securing the pump cover to the cover plate and using two bolts as extractors, draw off the pump cover.

2. Release the socket-headed screws securing the cover plate and pump body (2) Fig. 10, to the clutch housing and withdraw the assembly, Fig. 11.

Renew the O-rings (3, 4 and 5) Fig. 11, the oil seal (86) and seal rings (102) as necessary. Remove all trace of 'Loctite' from the oil seal housing and cover plate.

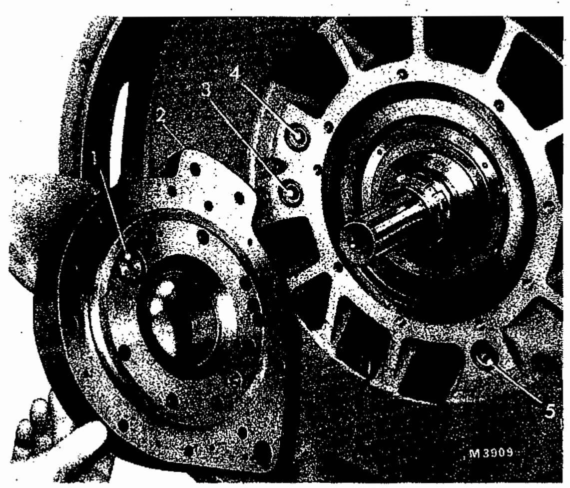


FIG. 11 REMOVING THE PUMP
1. Relief valve
2. Pump body
3. O-ring, filter to pump port
4. O-ring, pump to filter port
5. O-ring, sump to pump port

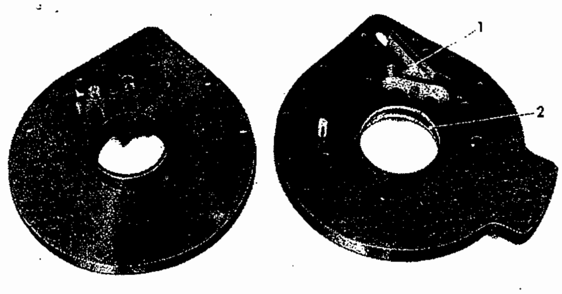


FIG. 12 THE PUMP BODY AND COVER PLATE SEPARATED

1. Feed chamber to pump 2. Annular chamber, pump to filter port

To Refit

Stand gearbox on its output flange and secure with packing.

1. Remove the oil seal (86).
2. Apply a thin coat of gasket cement to the mating faces of the pump body and clutch housing; position the pump and secure with bolts and lock washers. Paint the mating faces of the pump cover and cover plate with 'Locquic' Primer Grade T and allow to dry. Apply a thin coat of 'Loctite' Plastic Gasket No. 68 to the mating faces; fit the pump cover and position the service tool Part LC166, as shown in Fig. 13. Re-align the pump cover with the flange on the clutch housing to within 0.1 mm (0.004 in) taking readings from four positions equally spaced around the flange circumference. Tighten down the pump cover bolts.
3. Fit the oil seal gasket taking care not to disturb the garter spring insert.

IMPORTANT: Correct positioning of the pump cover is essential to ensure even running of the pump gear shaft in the oil seal. Allow sufficient time for the 'Loctite' to cure, see maker's instructions.

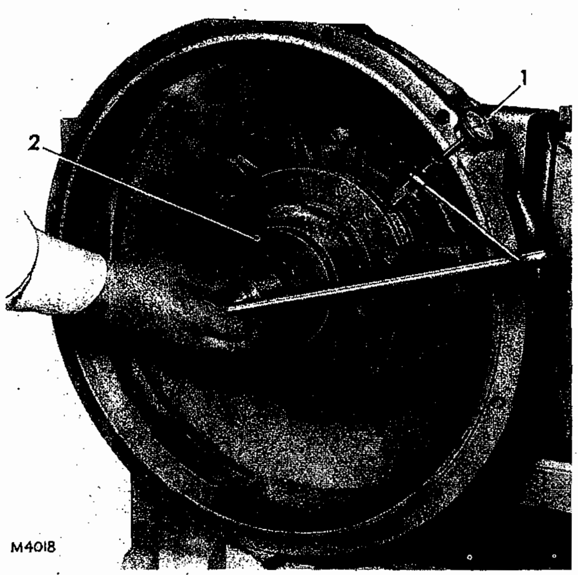


FIG. 13 METHOD USED TO RE-ALIGN THE PUMP COVER

1. Dial gauge 2. Service tool Part LC166

To Dismantle

1. Remove the unit from the clutch housing as previously described.
2. Release the screws set into the face of the cover plate and using two screws as extractors, separate the cover plate and pump body, Fig. 12.
3. Unscrew and inspect the relief valve (1) Fig. 11. Examine the valve seat and ball bearing for pitting or sign of failure.

Do not remove the spigot cover from the pump body unless absolutely necessary, the cover being fitted to a tolerance which will be disturbed by separation.

Remove all trace of 'Loctite'; wash the components in a suitable solvent and check for signs of wear or failure. The oil seal and seal rings should be replaced.

To Assemble

Assembly is a reversal of the procedure for dismantling the pump, the following points however, must be observed.

1. To ensure an oil tight seal, the mating faces of the pump body and cover plate should be treated with 'Locquic' Primer Grade T and allowed to dry. 'Loctite' Plastic Gasket No. 68 is then applied as directed on the container. Allow sufficient time for the 'Loctite' to cure before pressurising the pump.

GEARBOX

To Separate the Gearcase

1. Place gearbox in horizontal position and uncouple oil feed pipes and remove the filter.
2. Remove pump as described on page 4–3–11.
3. Remove mitre box as described on page 4–4–1.
4. Remove transfer driving gear cover.
5. Remove the two inspection covers to gain access to the automatic adjusters.
6. Tighten reverse and 4th speed brake bands; slacken input shaft ring nut and the nut securing transfer driving gear.
   Note: Drift the lip well clear of the output shaft before attempting to remove the nut, or damage to the shaft threads will result.
7. Place gearbox in vertical position.
8. Remove transfer driving gear cover, and driving gear bearing.
9. Mark the gear teeth to ensure correct reassembly; lift out the driving gear.
10. Drive out the spur gear complete with bearings.
11. Remove intermediate gear complete with bearings and eccentric shaft.
12. Remove distance piece.
13. Unscrew each adjuster nut a few turns to give sufficient clearance between the brake drum and bands when lifting off the gearcase.
14. Remove the nuts securing the clutch housing to the gearcase.
15. Lift off the gearcase taking care not to foul the brake bands with the running gear. Gently jog the gearcase when fouling is apparent.

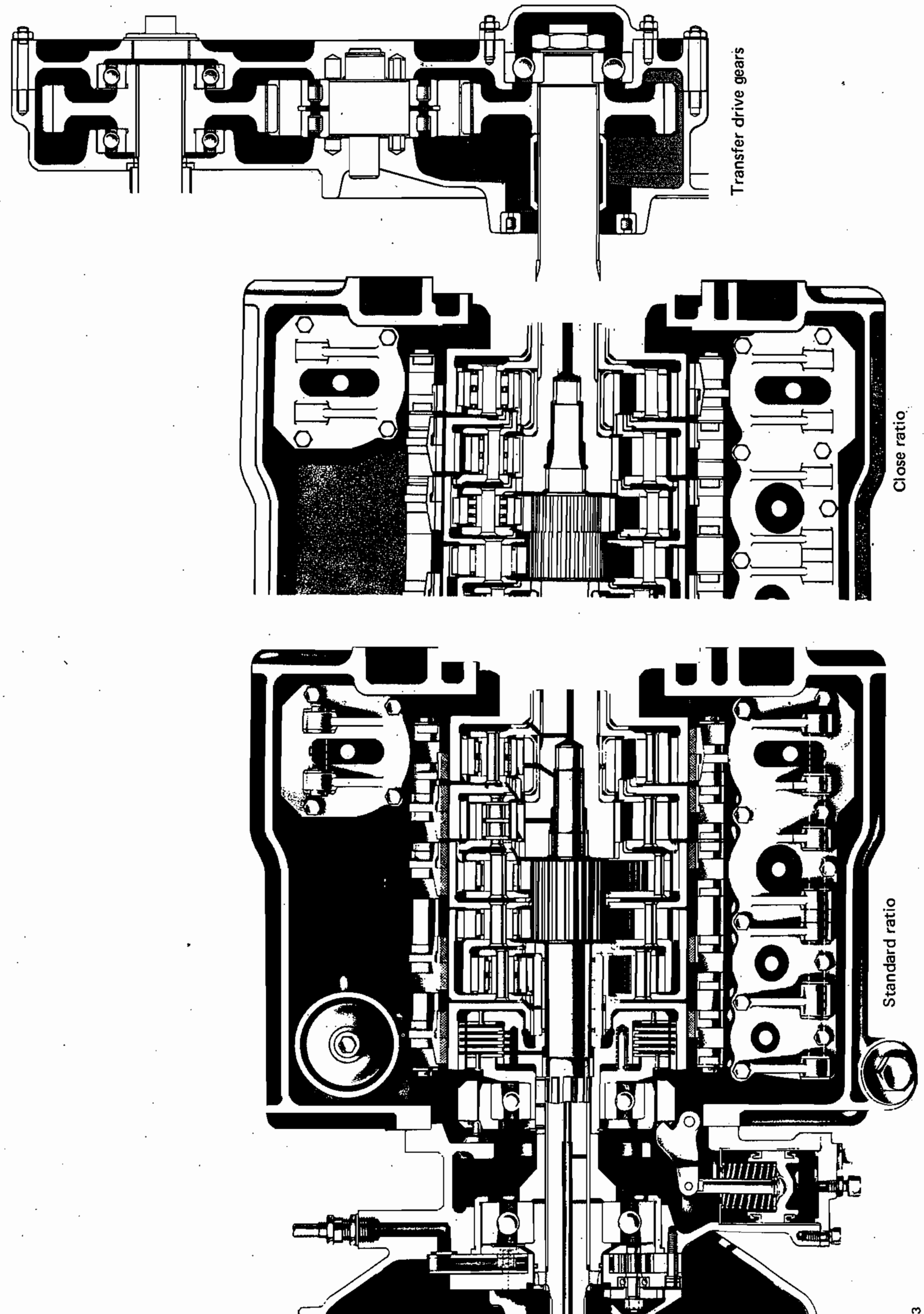


FIG. 14 SECTION THROUGH STANDARD RATIO AND PART SECTION THROUGH 5-SPEED CLOSE RATIO GEARBOXES

To Dismantle the Running Gear and Clutch Housing Assembly, Figs. 28, 29 and 30

1. Remove the reverse speed annulus (30) and intermediate bearing (49).
2. Remove the bush (50).
3. Remove the sub-assembly of the reverse speed gear train (34), reverse speed sun wheel (36), bushes (51 and 53), and bush (54).
4. Remove the 1st speed annulus (28) and bush (55).
5. Remove the sub-assembly of the 1st speed gear train (29) and the bush (57).
6. Remove the sub-assembly of the 2nd speed gear train (25) which comprises the output shaft (44) and the 2nd speed planets.
7. Remove the adjusting washer (59).
8. Reverse the input shaft assembly on to a suitable stand having a hole drilled through which the spigot can pass, Fig. 17. The stand should be high enough to allow clearance between the shaft and the floor.
9. Remove the ring nut (100).
10. Remove the clutch housing (1) complete with top speed piston assembly, collar (4), bearing housing (81) and bearing (80).
11. Slide off the spacer (6).
12. Release the spring clip (79) and remove the sub-assembly of the clutch sliding panel (11) and the trunnion ring (10).
13. Examine the pivot pin face (8) for wear. Any wear will allow the trunnion ring to move away from the multi-plate clutches and cause the top speed piston to travel further before a successful gear change is made. A point will be reached therefore, when the top speed clutch will cease to operate.
14. Remove the clutch springs and pins (62 and 63).
15. Remove the inner and outer clutch plates (14), (16) the clutch inner member and split-ring.
16. Remove the sub-assembly of the 4th speed sun wheel (22), the 4th speed brake drum (17) and the bush (61).
17. Remove the sub-assembly of the 4th speed gear train (21) 3rd speed annulus (20) and 4th speed planets, together with the bushes (18).
18. Remove sub-assembly of 3rd speed gear train (23) which comprises the 4th speed annulus (19) 3rd speed planets and 2nd speed annulus (24).

To Separate the Gearcase from the Bottom Cover

1. Remove the nuts which secure the cover to the gearcase.
2. Remove the gearcase, leaving the bottom cover complete with the brakes actuating mechanism and the air cylinders.

To Remove the Brake Bands

Note: Refer to Fig. 15 when dismantling and re-assembling the brake bands.

1. Unscrew the adjuster nut (8) from each adjuster mechanism, using Service Tool Part LC134.
2. Support the adjuster ring (21), table (18) and the thrust pad (2) as the adjuster nut leaves the thread of the pull rod (24).
   Note: It is essential to keep the parts in sets for reassembly to their respective brake bands.
3. Press down the top of each brake band to remove the hooks (12) and (26).
4. Remove the split pins from the internal band link pins and extract the pins.
5. Lift the bands away, ensuring that precautions have been taken to prevent the centraliser springs from flying out.

To Reline the Brake Bands

Bonded and riveted linings are available as service exchange items, fully machined and ready for installation.

The necessity for relining the brakes is usually shown by the pull rod protruding from the top of the adjuster nut.

To separate the internal band from the external band, simply prise the free end of the band inwards and upwards with a screwdriver.

After relining, the lug on the internal band is led through its slot in the external band, the free end again pushed towards the centre, when the band will slip easily into position.

To Skim the Brake Linings

The brake linings are skimmed to ensure an even grip on the brake drum: the finest possible skim however must be taken to preserve the long life of the linings. Using a jig having the same diameter as the brake drum, mount the bands on the jig with the internal bands against the distance piece; tap square and clamp the ends of the external band firmly. Skim the linings as close to the jig as possible.

Remove the distance piece and reverse the bands in the jig; tap square, clamp the band firmly and skim the remainder of the liner to the same depth as the previous cut, ensuring that no step is evident. This is important to ensure even wear on the brake linings.

To Refit the Brake Bands

Note: Ensure that the adjuster nuts are an easy fit on the pull rod threads.

1. Insert the springs in the centralisers, compress each spring in turn and pass the ears of the bands over them.

2. Secure each external band with the link pins and fit the split pins.
3. Compress each external band and engage the brake hooks (12).
4. Fit the pull rods (24), thrust pads (25), adjuster tables (18) and automatic adjusters, complete.

To Refit the Gearcase

1. Stand gearcase on a flat surface.
2. Temporarily fit transfer drive cover.
3. Screw one leg of service tool LC128-2 into adaptor and position gauge as shown in Fig. 16.
4. Measure gap between flat surface and base of gauge leg; the gap should be 0.51 mm (0.020 in); any variation is taken as plus (+) or minus (–).

Example 1 A reading of 0.635 mm = +0.127 mm (0.025 in = + 0.005 in)

Example 2 A reading of 0.380 mm = –0.127 mm (0.015 in = – 0.005 in)

Suitably record any variation on the gearcase.

5. Remove transfer drive cover.
6. Smear the faces of the gearcase bottom cover with jointing compound and fit new joint.
7. Fit gearcase to bottom cover and secure with the nuts and washers.

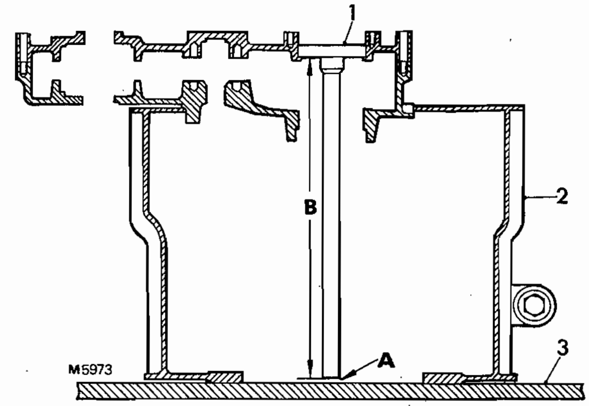


FIG. 16 CHECKING THE GEARCASE HEIGHT

1. Height gauge
2. Gearcase
3. Base plate
A. Gearcase height variation
B= 538.3 mm (21.193 in)

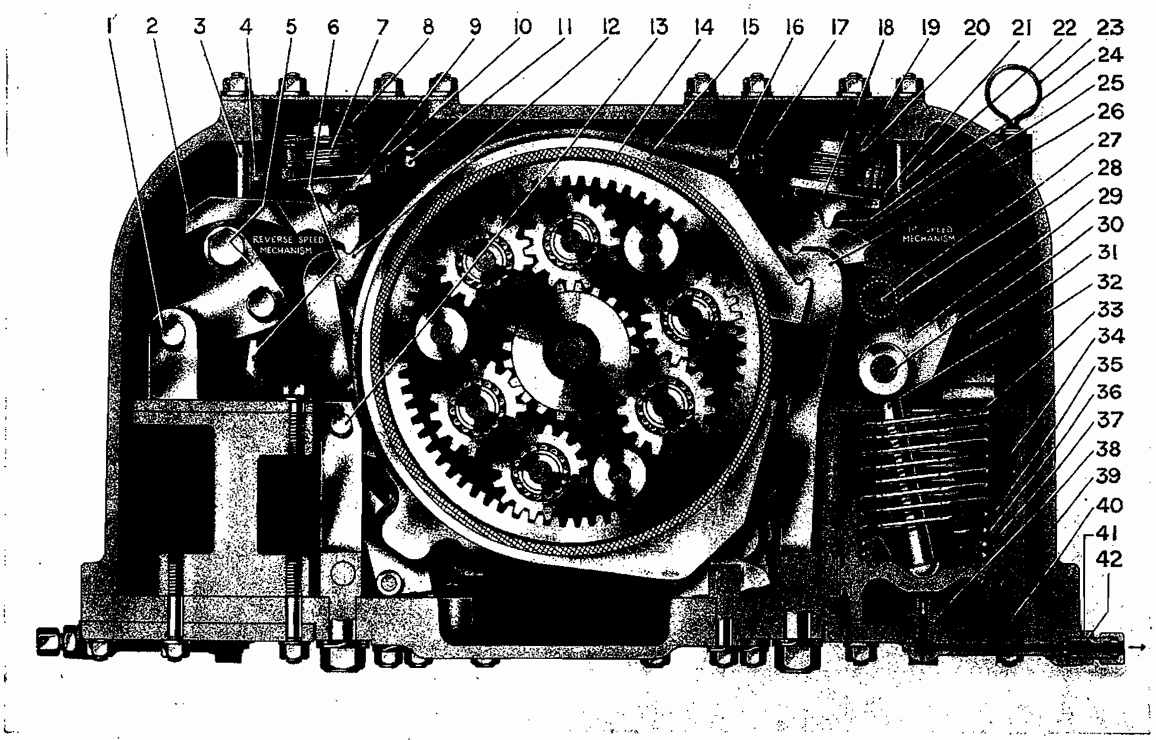


FIG. 15 SECTION THROUGH THE 1st SPEED GEAR (brake OFF) SHOWING REVERSE SPEED MECHANISM (brake ON)

1. Shaft
2. Thrust pad
3. Tail pin
4. Adjuster ring
5. Operating lever
6. Piston rod
7. Adjuster spring
8. Adjuster nut
9. Adjuster table
10. Adjuster screw
11. Locknut
12. Hook
13. Link pin
14. Brake liner
15. Brake band
16. Locknut
17. Adjuster screw
18. Adjuster table
19. Adjuster spring
20. Adjuster nut
21. Adjuster ring
22. Tail pin
23. Dipstick (when fitted)
24. Pull rod
25. Thrust pad
26. Hook
27. Cam roller
28. Cam roller race
29. Operating lever
30. Bearing pin
31. Shaft
32. Piston rod
33. Piston return spring
34. Cylinder liner
35. Piston seal
36. Guide plate
37. Piston
38. Adaptor, inner
39. Piston seal
40. O-ring
41. Adaptor, outer
42. Restrictor valve

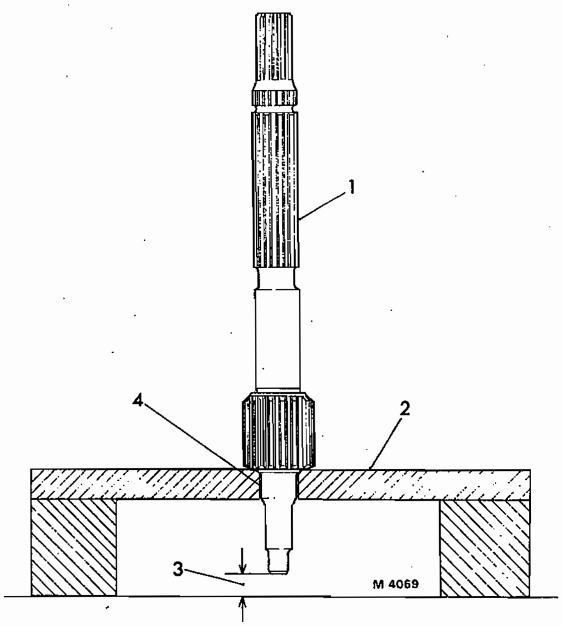


FIG. 17 THE INPUT SHAFT IN A SUITABLE STAND

1. Input shaft
2. Suitable flat surface
3. Spigot to stand clear
4. Hole 31.75 mm (1.25 in) dia.

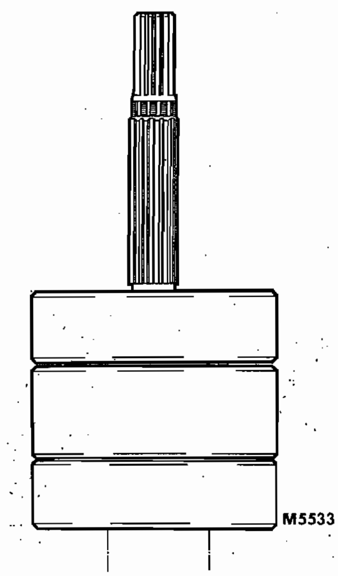


FIG. 18 BRAKE DRUM ASSEMBLY ON INPUT SHAFT

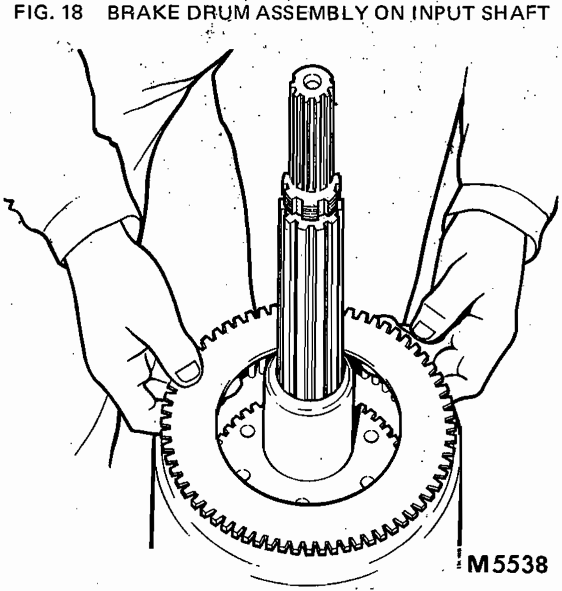


FIG. 19 FITTING TOP SPEED CLUTCH PLATES

To Reassemble the Running Gear, Figs. 28, 29 and 30

1. Place the input shaft (95) in a suitable stand, Fig. 17 and fit the bush (18).

2. Fit sub-assembly of 3rd speed gear train which comprises the 4th speed annulus (19), 3rd speed planets and 2nd speed annulus (24). Fit bush (61).

3. Fit the sub-assembly of the 4th speed gear train (21) which comprises the 3rd speed annulus and the 4th speed planets. Fit the bush (61).

4. Fit the sub-assembly of the 4th speed sun wheel (22) and the 4th speed brake drum (17). Fit the bushes (61) and (18).

5. Fit the split ring, the sub-assembly of the clutch inner member and position the inner and outer clutch plates (14) and (16) alternately. It is advisable to smear the faces of the clutch plates with oil to prevent initial sticking.

6. Fit the clutch springs (62) and insert a pin (63) into each spring.

7. Smear light oil on the input shaft (95) and fit the sub-assembly of the clutch sliding panel (11) and trunnion ring (10), Fig. 20. Press the assembly down and insert the spring clip (79). **Note:** The bearing (9) on the clutch sliding panel is of the angular contact type, and if the bearing has been removed it must be reassembled in the position shown.

8. Fit the clutch housing to which is fitted the 5th speed piston assembly.

9. Fit the spacer (6).

10. Fit the bearing housing (81) and press the bearing collar (4) into the bearing (80). Slide the sub-assembly onto the input shaft.

11. Fit the seal ring (102), washer and ring nut (100). Tighten the nut enough to take up any end-float.

12. Reverse the assembly on to a suitable flat surface.
Important: The input shaft must be supported as shown in Fig. 21. It is advisable to first take the weight on the shaft and steady the unit by inserting packing pieces around the rim of the clutch housing.

13. Smear bottom face of 2nd speed gear assembly with grease to hold adjusting washer (59). Locate washer and fit sub-assembly of 2nd speed gear train which comprises output shaft (44) and 2nd speed planets.

Note: The adjusting washer may need replacing if correct end-float is not recorded when gauge, part LC128-2, is applied later.

14. Fit the bush (57).

15. Fit the sub-assembly of the 1st speed gear train (29), which comprises the 1st speed planets, Fig. 23.

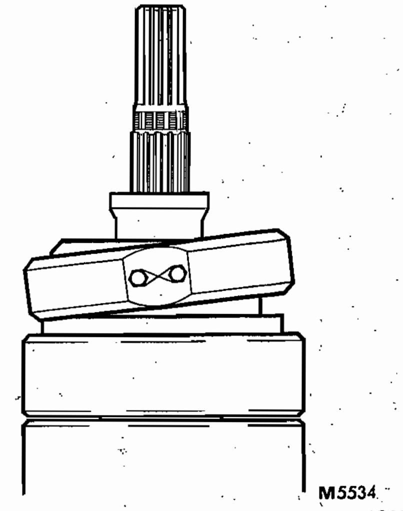


FIG. 20 CLUTCH SLIDING PANEL IN POSITION

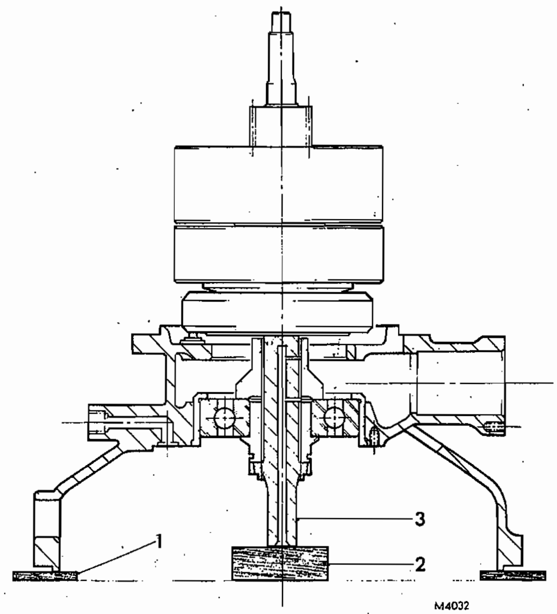


FIG. 21 THE ASSEMBLY SUPPORTED ON SUITABLE BLOCKS

1. Packing 2. Block taking weight of the input shaft 3. Input shaft

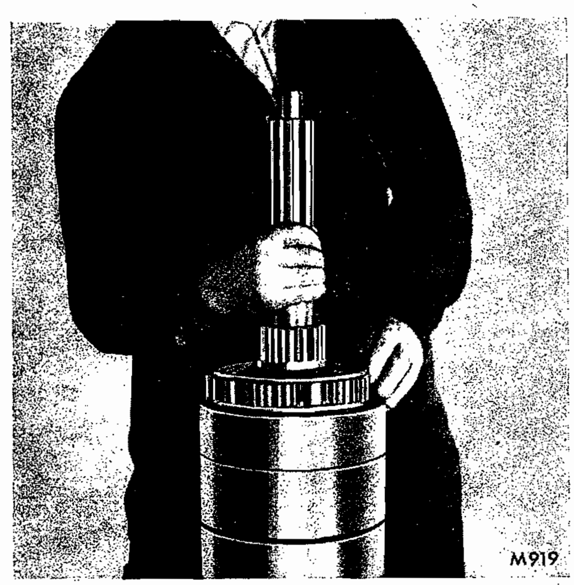


FIG. 22 FITTING THE OUTPUT SHAFT AND 2nd SPEED PLANETS

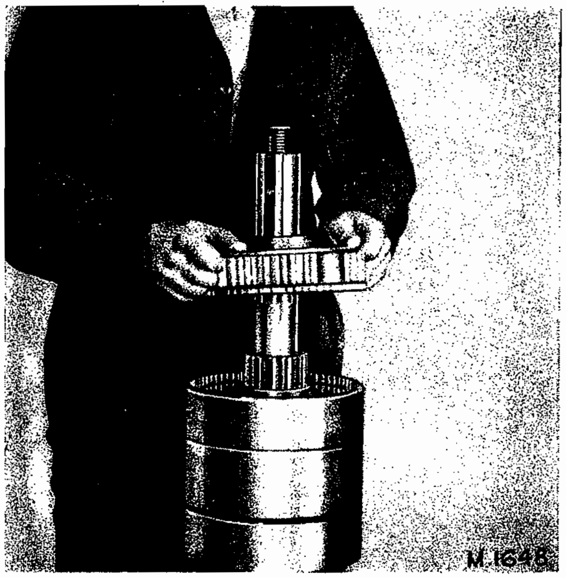


FIG. 23 FITTING THE SUB-ASSEMBLY OF THE 1st SPEED PLANETS

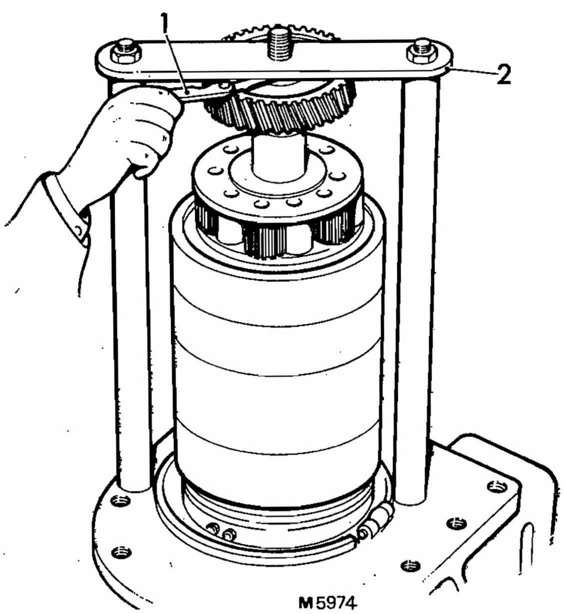


FIG. 24 CHECKING THE MINUS READING

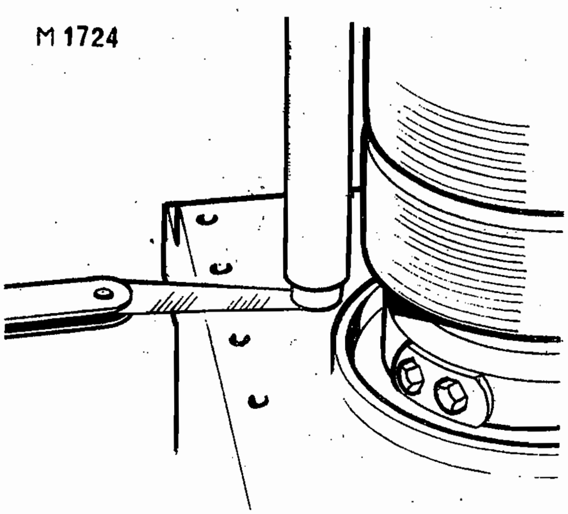


FIG. 25 CHECKING THE PLUS READING

16. Fit the bush (55).

17. Fit the sleeve (53) for the reverse speed sun wheel.

18. Fit the two bushes (51) to reverse speed sun wheel (36).

19. Fit sun wheel (36).

20. Fit the 1st speed annulus (28).

21. Fit the bush (54).

22. Fit the sub-assembly of the reverse speed gear train.

23. Temporarily fit distance piece and transfer gear.

24. Position gauge and measure running gear end float as shown in Fig. 24. A maximum of 0.020 in end-float is permissible.

Nominal allowance + 0.015 to –0.005 in

The allowance is adjusted by moving the figure plus or minus amount previously recorded on the gearcase.

Example 1

Nominal allowance =	+ 0.015 to –0.005 in
Gearcase variation =	+ 0.005
End-float allowance	+ 0.020 to –0.000 in

Example 2

Nominal allowance =	+ 0.015 to –0.005 in
Gearcase variation =	–0.005 in
End-float allowance	+ 0.010 to –0.010 in

If the gap exceeds the above limits, a washer (59) higher in thickness range (see Data) should be fitted until a satisfactory reading is obtained.

Note: To strip down the running gear back to operation 13 is a reversal of the assembly procedure.

25. Remove distance piece and transfer gear.

26. Fit the bush (50).

27. Fit the reverse speed annulus (30).

28. Fit intermediate bearing to reverse speed annulus.

29. Paint the mating faces of the clutch housing and gearbox casing with jointing compound and lower the assembly over the running gear. Gently tap the gearcase to seat the intermediate bearing outer race.

30. Ensure the correct location of the studs in the mating holes in the clutch housing; fit the nuts and tighten securely.

31. Fit distance piece (48) and transfer gear (47).

32. Select appropriate eccentric or intermediate shaft.

33. Assemble the idler gear shaft and bearings as follows:

    a. Fit circlip in gear bore.

    b. Press in both bearing outer races until they abut the circlip.

    c. Press one bearing inner race onto shaft until flush with shoulder face.

    d. Locate shaft in idler gear bore and press second bearing inner race onto shaft until flush with shoulder and gear face.

    e. Press shaft dowel into gearbox.

    f. Align shaft assembly over dowel and press shaft into gearbox.

34. Press bearings onto spur gear and fit gear into transfer case.

Checking transfer gear backlash.

    a. Machine slots in a scrap cover plate to gain access to transfer gear teeth.

    b. Fit cover, press original drive gear bearing into cover and secure with nut.

    c. Measure backlash with feeler gauges, the figure being stamped on the top cover face.

    d. Remove the bearing and test cover plate.

35. Fit transfer cover plate (41).

36. Tap ball bearing (45) onto output shaft.

37. Fit the washer, and nut (43).

38. Place the gearbox in the horizontal position.

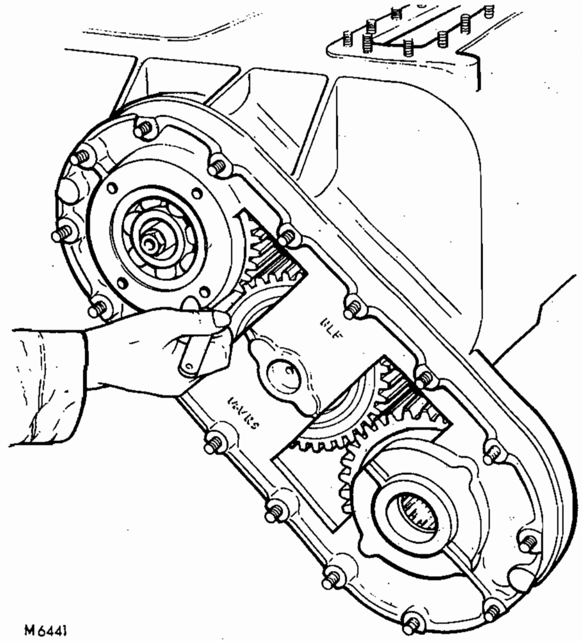


FIG. 26 CHECKING BACKLASH THROUGH A MACHINED END COVER

39. Lock the reverse and 4th speed brake bands to enable the nuts which secure the flanges to be tightened.

40. Tighten the output shaft nut and ring nut by using a torsion spanner set to 350 lbf ft (48.4 kgf m).

41. Assemble the oil pump as described on Reference 4–3–12.

42. Lock the nuts by punching an indentation in the nut lip.

43. Fit bearing cover plate (40).

44. Couple up the oil feed pipes (5).

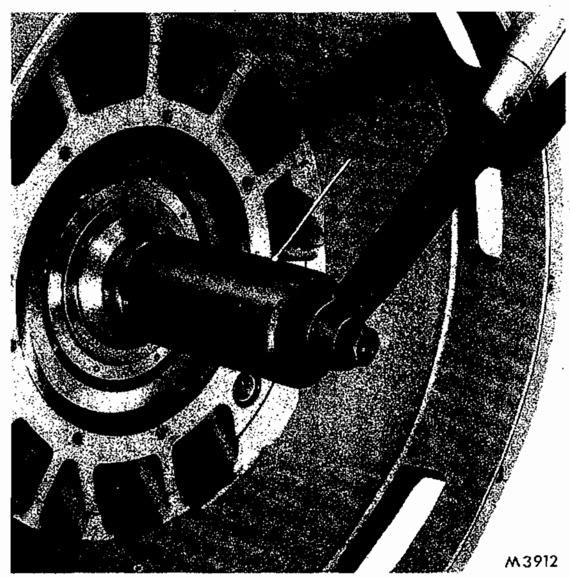


FIG. 27 LOCKING THE INPUT SHAFT RING NUT
1. Service tool part LC153

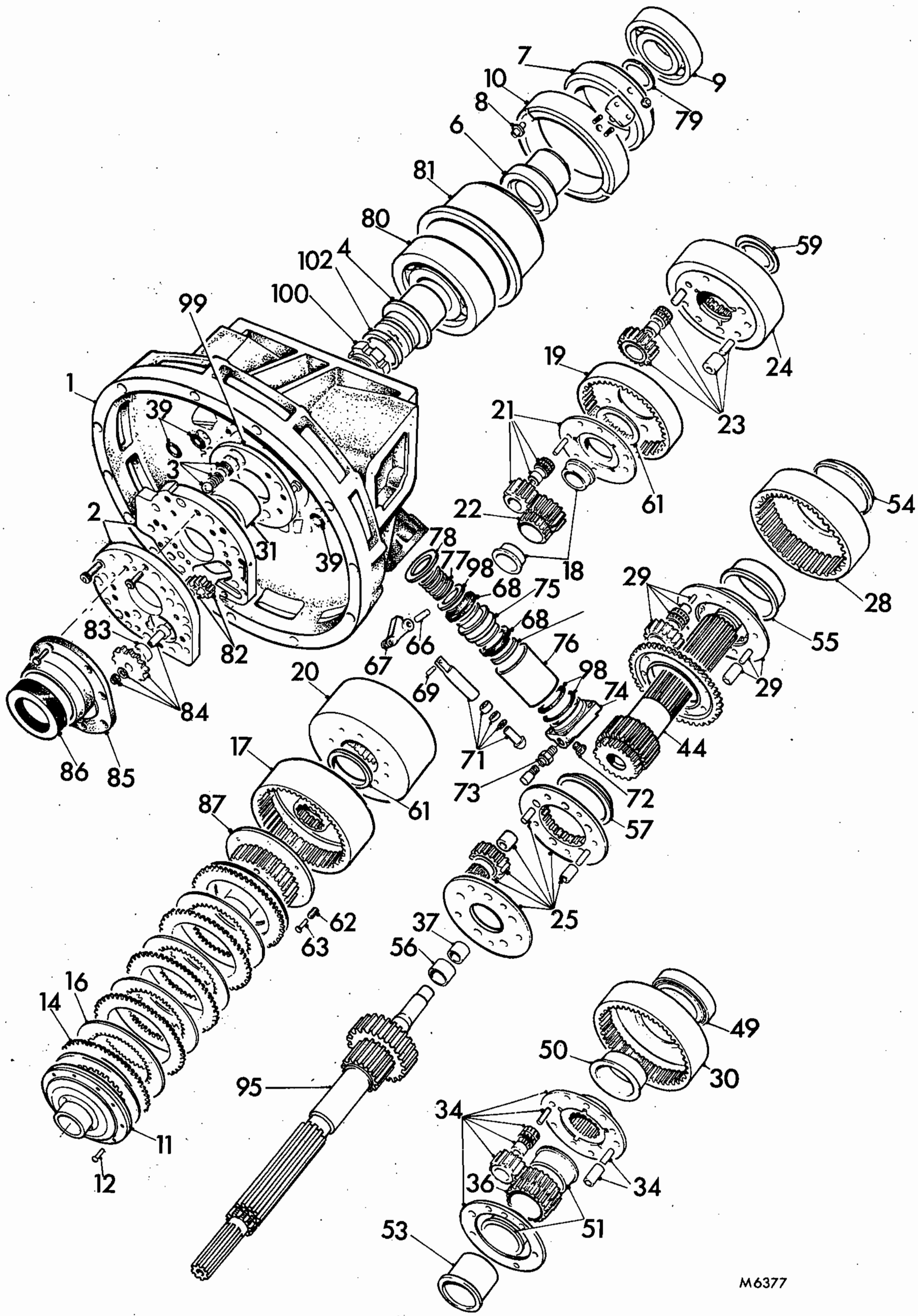


FIG. 28 EXPLODED VIEW OF THE RUNNING GEAR

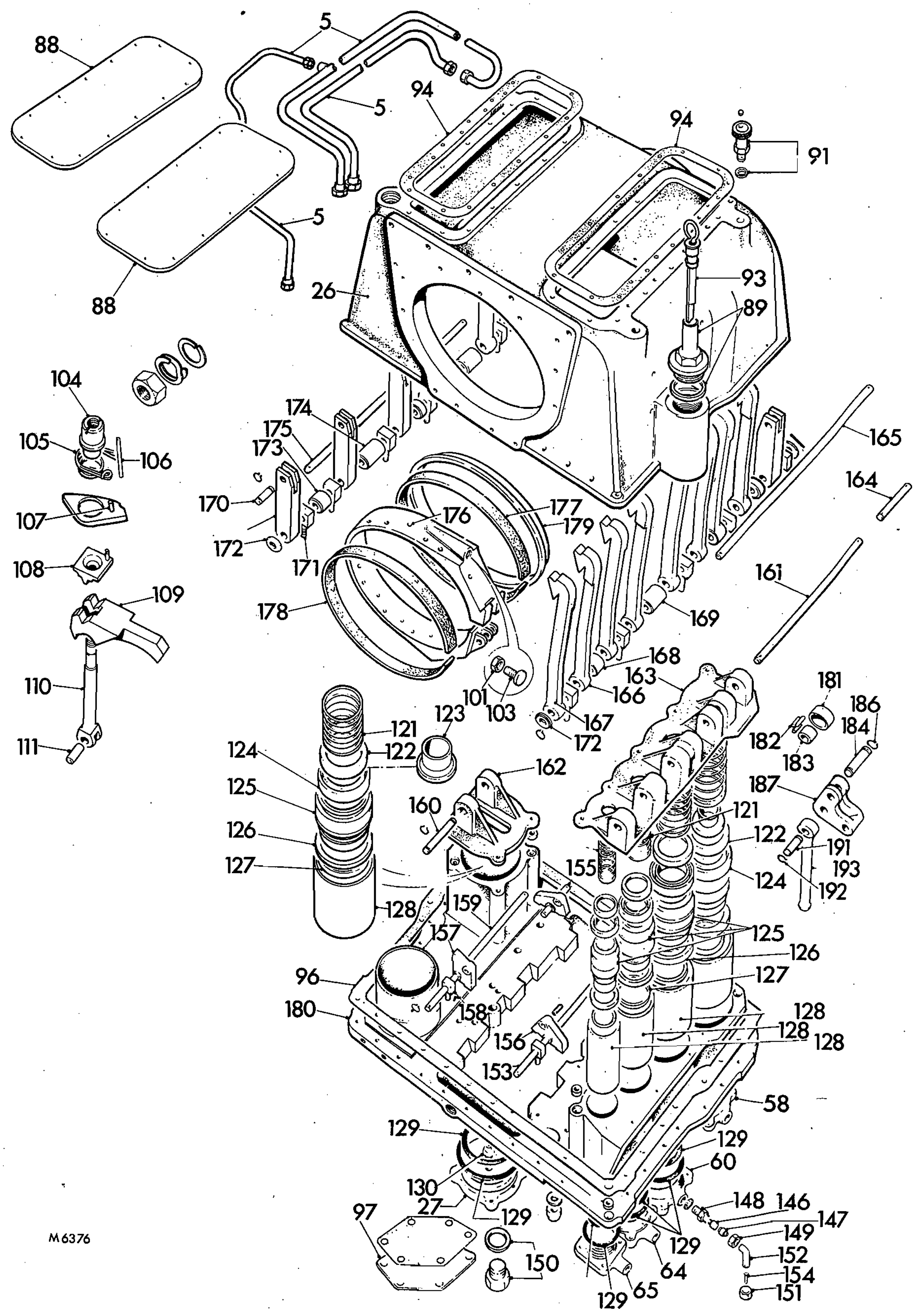


FIG. 29 EXPLODED VIEW OF THE GEARCASE

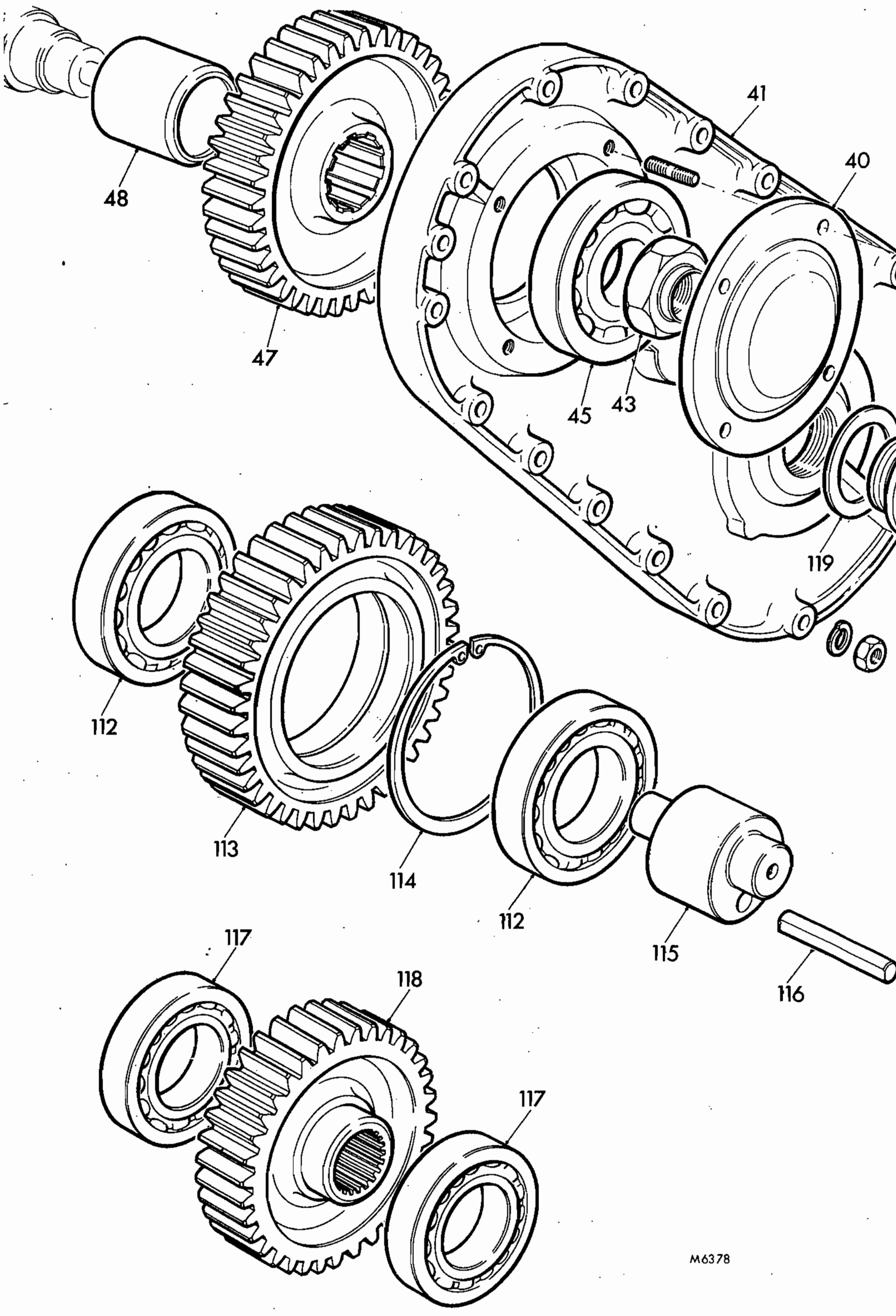


FIG. 30 EXPLODED VIEW OF TRANSFER DRIVE

KEY TO FIGS. 28, 29 and 30

1. Clutch housing
2. Cover plate and pump body
3. Relief valve sub-assembly
4. Input bearing collar
5. Pump feed pipes
6. Spacer
7. Bearing housing
8. Pivot pin
9. Bearing
10. Trunnion ring
11. Sliding panel
12. Rivet
13. Circlip
14. Outer clutch plates
16. Inner clutch plates
17. 4th speed brake drum
18. Sun wheel bushes
19. 4th speed annulus
20. 3rd speed annulus
21. 4th speed gear train
22. 4th speed sun wheel
23. 3rd speed gear train
24. 2nd speed annulus
25. 2nd speed gear train
26. Gearcase
27. Reverse speed cylinder cover plate
28. 1st speed annulus (5-speed gear-boxes only)
29. 1st speed gear train (5-speed gear-boxes only)
30. Reverse speed annulus
31. Oil pump sleeve
34. Reverse speed gear train
36. Reverse speed sun wheel
37. Bush input shaft spigot
39. O-rings, oil pump
40. Bearing end cover
41. Transfer gears cover
43. Locknut
44. Output shaft
45. Output bearing
46. Bearing housing
47. Transfer driving gear
48. Distance piece
49. Bearing
50. Bush
51. 1st speed sun wheel bushes
54. Bush (1st speed when fitted)
55. Bush (1st speed when fitted)
56. Bush, input shaft spigot
57. Bush
58. 1st speed cylinder cover plate
59. Adjusting washer
60. 2nd speed cylinder cover plate
61. Bushes
62. Spring
63. Clutch pin
64. 3rd speed cylinder cover plate
65. 4th speed cylinder cover plate
66. Pivot pin
67. Operating lever
68. Piston seals
69. Pin
71. Adjustable piston rod and distance washers
73. Top speed adaptor
74. Top speed cylinder cover plate
75. Piston
76. Cylinder liner
77. Spring
78. Guide plate
79. Spring clip
80. Bearing
81. Bearing housing
82. Pump gears
83. Bearing
84. Pump drive gear and shaft
85. Pump cover
86. Oil seal
87. Clutch inner member
88. Inspection covers
89. Filler plug
91. Breather and washer
93. Dipstick
94. Gaskets
95. Input shaft
96. Gasket
97. Blanking plate and gasket
98. O-rings, top speed piston
99. Spigot cover
100. Ring nut
101. Locknut
102. Seal rings
103. Adjusting screw
104. Adjuster nut
105. Adjuster spring
106. Tail pin
107. Adjuster ring and pin
108. Adjuster table
109. Thrust pad
110. Pull rod
111. Pin
112. Bearing
113. Intermediate gear
114. Circlip
115. Eccentric shaft
116. Dowel
117. Bearings
118. Spur gear
119. Washer
120. Plug
121. Piston return springs
122. Retaining rings
123. Guide plates
124. Piston seals
125. Pistons
126. Piston seals
127. Retaining rings
128. Cylinder liners
129. O-rings
130. Inner adaptor
146. Restrictors
147. Union sleeve
148. Restrictor housing
149. Union nut
150. Drain plug and washer
151. Coupling
152. Air pipe
153. Centraliser rod
154. Insert
155. Centraliser
156. Centraliser
157. Centraliser
158. Eyebolt
159. Centraliser rod
160. Operating lever shaft, reverse
161. Operating lever shaft
162. Cover
163. Cover
164. Operating lever shaft
165. Fulcrum rod
166. Rear hook
167. Front hook
168. Distance piece
169. Distance piece
170. Band link pin
171. Eyebolt
172. Distance piece
173. Distance piece
174. Distance piece
175. Fulcrum rod
176. Brake band, outer
177. Brake liner
178. Brake liner
179. Brake band, inner
180. Bottom cover
181. Outer race cam roller
182. Needle rollers
183. Inner race cam roller
184. Pin
185. Dowel
186. Circlip
187. Operating lever thrust pad
191. Pin
192. Circlip
193. Piston rod

Mitre Box

DATA

Pre-load

Input and output pinion bearings, new	0.96/1.92 kg cm (10/20 lb in)
original	0.48/0.96 kg cm (5/10 lb in)

Shims	mm	inches
	0.10	0.004
	0.25	0.010
	0.51	0.020
	1.02	0.040

Backlash

As etched on face of input pinion

. . . . Tolerance 0.20/0.28 mm (0.008/0.011 in)

Shims	mm	inches
	0.38	0.015
	0.41	0.016
	0.46	0.018
	0.51	0.020

Signal probe setting . . . . 0.13 to 0.38 mm (0.005 to 0.015 in)

Torque loadings

Input pinion shaft ring nut	55 kgf m (400 lbf ft)
Output pinion shaft nut	55 kgf m (400 lbf ft)
Speedometer drive gear retaining nut	55 kgf m (400 lbf ft)

Mitre Box

To Remove

1. Remove the gearbox as described in Group 4.
2. Remove the signal probe from the bracket.
3. Clear the gaiter from the bulkhead.
4. Disconnect the propeller shaft and lift the mitre box from the vehicle.

To Refit

1. Position the mitre box through the bulkhead.
2. Fit the gearbox as described in Group 4.
3. Secure the gaiter to the engine bulkhead.
4. Fit the signal probe and set the gap to the figure given in Data.
5. Fit the propeller shaft.

OVERHAUL

To Dismantle

1. Secure mitre box by its output flange, in a vice.
2. Remove nuts and withdraw speedometer assembly.
3. Remove nuts and lift off the main case and input pinion assembly.
4. Drift both nut locking lips clear of the groove and threads in the shaft. Remove the speedometer drive/locknut and the output flange nut. Withdraw the flange from the output pinion.
5. Remove signal probe bracket and end cover.
6. Extract oil seals from end cover.
7. Press output gear from the bearing housing and remove distance piece, shims, and outer bearing inner race.
8. Press the output shaft from the gear as necessary.
9. Drift bearing outer races from housing and press bearing inner race from gear using tool 3VRS254SZ.
10. Secure main housing by its attachment flange, in a vice.
11. Remove input pinion drive gear housing and shims.
12. Remove the end cover.
13. Remove pinion retaining ring nut using tool 3VRS251SZ. Press gear from housing and remove outer bearing inner race, distance piece and shims.
14. Drift bearing outer races from housing and press inner race from input pinion using tool 3VRS255SZ.
15. Remove circlip and extract abutment washer.

Inspection

Clean and examine all components, renew any item showing signs of wear, distortion or fatigue.

Bevel wheels are only supplied as matched pairs and marked accordingly. Do not fit one without the other.

Renew all O-rings and oil seals and clean all gasket sealing compound from joint faces.

To Assemble

Lubricate all components during assembly to prevent initial oil starvation.

Input pinion

1. Fit bearing outer races in bearing housing.
2. Press inner bearing inner race onto pinion.
3. Lower housing over pinion, fit distance piece, shims to value of original thickness, and press outer bearing inner race into position.
4. Fit and tighten ring nut to correct torque, see Data.
5. Wrap a length of string three times around the bearing housing and using a spring balance check the pre-load reading against the figure given in Data. Note the different figures given for new and original bearings.

   Adjust shim pack thickness as necessary until satisfactory reading is obtained.
6. Lock ring nut by punching lip into shaft groove, then fit the end cover.
7. Fit housing assembly, with shims to value of 1.02 mm (0.040 in) into mitre box casing.
8. Secure gauge 2VRS226SZ as shown in Fig. 1. Measure clearance between gauge and face of pinion; adjust shim pack thickness as necessary to give feeler gauge clearance as etched on face of pinion.

Example

Subtract feeler gauge clearance of say	0.020 in
from pinion marking of say	0.015 in
	= –0.005 in

Subtract 0.005 in from 0.040 in shim pack thickness, result = 0.035 in.

9. Fit the abutment ring and circlip.
10. Remove setting gauge and pinion assembly; coat flange faces with jointing compound and secure assembly in main casing.

Output Pinion

1. Press bearing outer races into housing.

2. Press inner bearing inner race onto pinion.

3. Press output shaft into pinion until it abuts against hub.

4. Fit and secure speedometer drive gear to correct torque, see Data. Lock the nut by punching the nut lip into the shaft groove.

5. Position the shaft assembly in the housing and fit distance piece, shims to value of original thickness, outer bearing inner race, end cover minus oil seals, output coupling flange and nut.

6. Secure fixture in a vice and tighten retaining nut to correct torque, see Data.

7. Wrap a length of string three times around the bearing housing and using a spring balance, check pre-load reading against the figure given in Data. Note different readings for new and original bearings.
   Adjust shim pack thickness as necessary until satisfactory reading is obtained.

8. Fit new oil seals on final assembly and lock the flange nut by punching the lip into the groove in the output shaft.

9. Fit a nominal 0.040 in shim over studs in mitre casing.

10. Examine the faces of driver and driven gears to identify tooth contact markings and backlash figure, see Fig. 2.

11. Apply grease to the marked tooth; lower output pinion assembly into casing; lift out assembly and check that the grease has been deposited between the arrows. If not, turn gear and re-check. Repeat operation until a satisfactory impression is obtained.

12. Position a dial gauge as shown in Fig. 3 and using a setscrew secured to the output flange as a locating face, check backlash of mitre gears, see Data. Remove driven gear assembly and adjust shim pack as necessary until required setting is achieved.

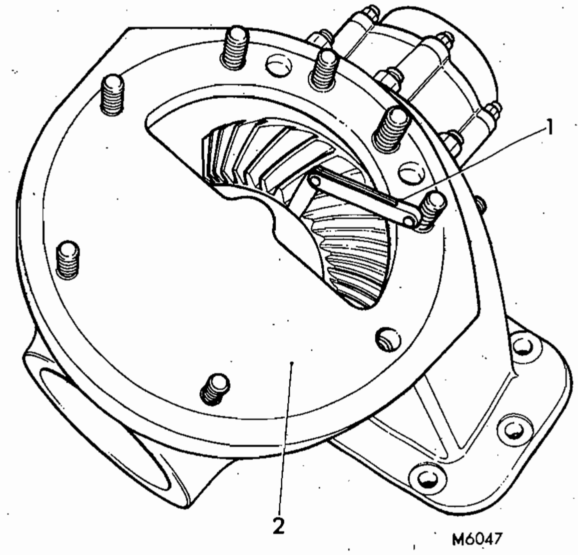


FIG. 1 APEX SETTING GAUGE APPLICATION
1. Feeler gauges 2. Gauge 2VRS-226SZ

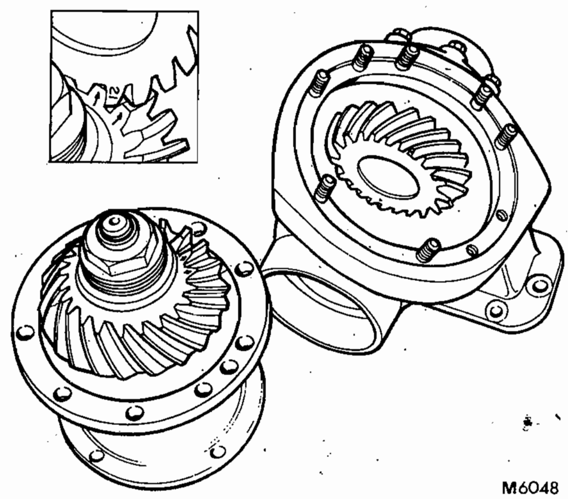


FIG. 2 TOOTH CONTACT MARKINGS

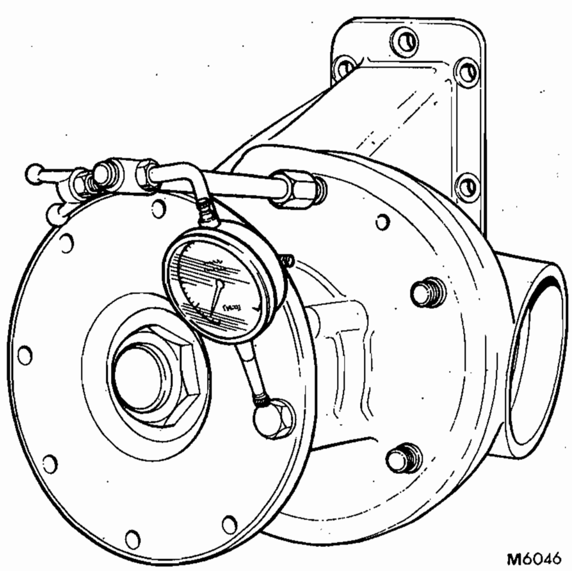
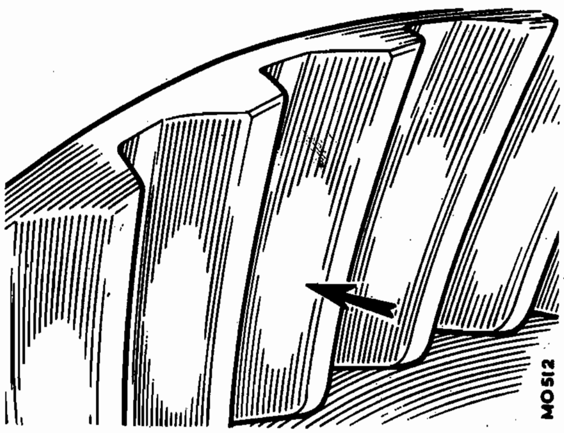


FIG. 3 CHECKING MITRE GEAR BACKLASH

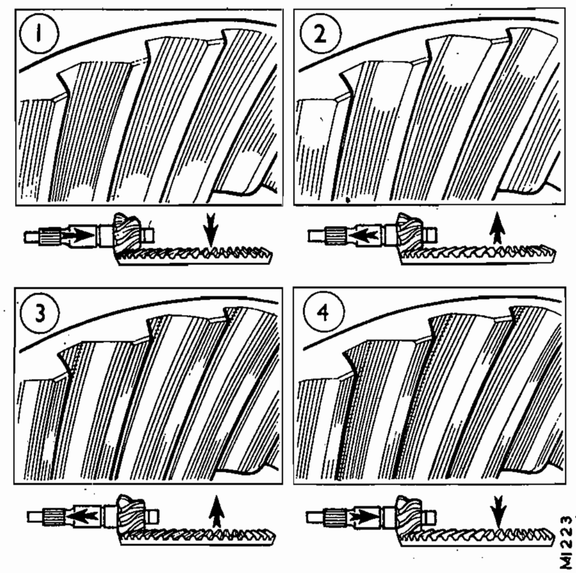
13. Remove driven gear assembly, paint teeth with a suitable marking compound, refit gear assembly and rotate gears to form an impression on the mating gear teeth. Compare the impression with Figs. 4 and 5 and adjust if necessary. Apply jointing compound to mating faces on final application.

Important: Always fit the gears with the matched teeth correctly meshed.

14. Fit signal probe and bracket and set probe to figure given in Data.



A. CORRECT TOOTH CONTACT



B. ADJUSTMENT NECESSARY

FIG. 4 TYPICAL BEVEL WHEEL TOOTH MARKINGS

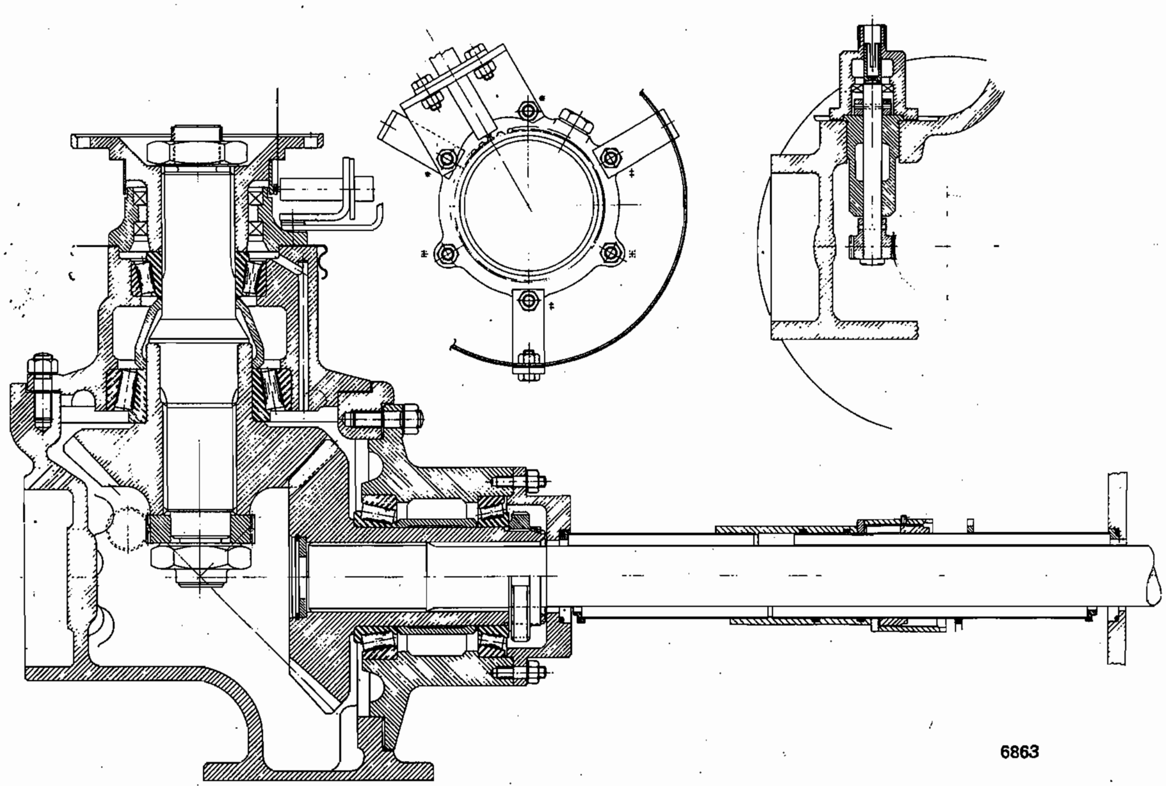


FIG. 5 SECTION THROUGH MITRE BOX

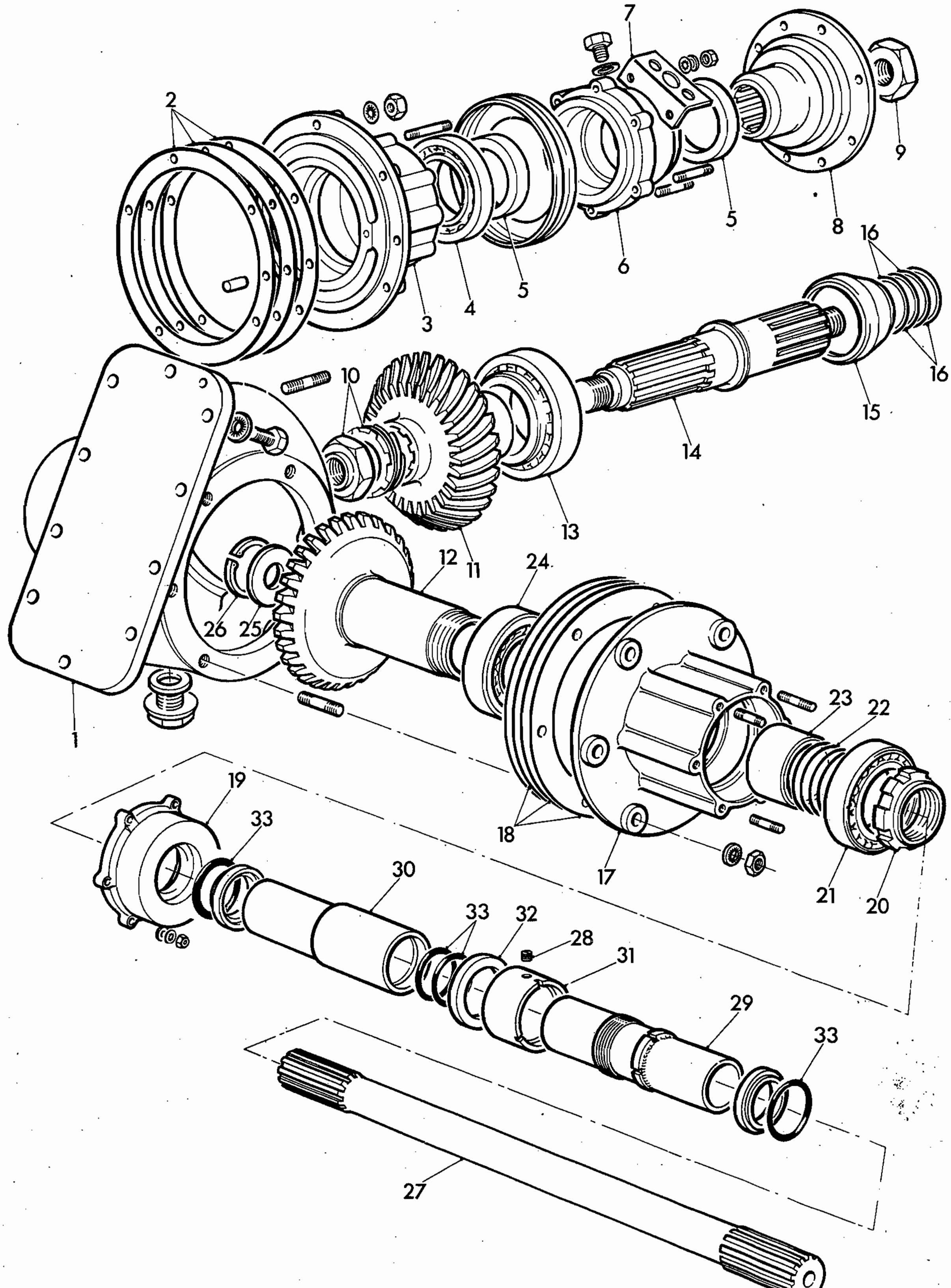


FIG. 6 EXPLODED VIEW OF MITRE BOX

1. Housing
2. Shim
3. Bearing housing
4. Outer bearing
5. Oil seals
6. End cover
7. Signal probe bracket
8. Output flange
9. Locknut, driving flange
10. Speedometer drive gear and locknut
11. Output spiral bevel gear
12. Input spiral bevel pinion
13. Inner bearing
14. Output shaft
15. Distance piece
16. Shims
17. Housing, input pinion
18. Shims
19. End cover
20. Ring nut
21. Bearing, outer
22. Shim
23. Distance piece
24. Bearing, inner
25. Abutment washer
26. Circlip
27. Drive shaft
28. Grub screw
29. Transfer drive tube, inner
30. Transfer drive tube, outer
31. Sleeve nut
32. Thrust collar
33. O-rings

Gearbox Control System

Fig. 1 shows the disposition of auxiliary reservoir and relative components which combine to form the gearbox control system. Data and a brief description is given below with reference to relevant groups in which further information is available.

1. **Auxiliary Reservoir:** Single chamber of welded steel construction.
   Capcaity 16.4 litres (1000 cu in)

2. **Pressure Regulator Valve** Group 7: Ensures that before air made available for auxiliary application, sufficient pressure is in the braking system to operate the brakes.
   Type — Westinghouse
   Operating pressure 5.6 kgf cm^2 (80 lbf in^2)

3. **Limiting Valve** Group 7: Limits the air pressure supply to gearbox operating pressure.
   Type — Westinghouse
   Settings
   Semi-automatic. — 5.6/5.95 kgf cm^2 (80/83 lbf in^2)
   Fully automatic (G2) — 4.9/5.25 kgf cm^2 (70/75 lbf in^2)

Semi-Automatic Control

4. Selector Switch Group 4 Section 5.
   Type — C.A.V.

5. Electro-pneumatic valve unit Group 8.

G2 Automatic Control System Group 8. Section 6

6. Gear Selector Switch.

7. Perception Head.

8. Performance (Kick-down) Switch.

9. Throttle Dipping Valve.

10. Low Air Pressure Protection Unit.

11. Translator.

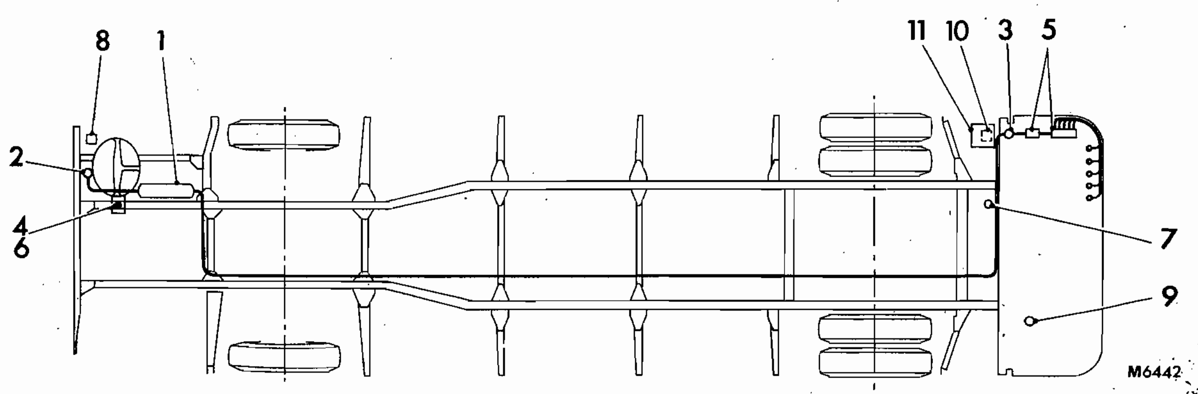


FIG. 17 DIAGRAMMATIC VIEW OF GEARBOX CONTROL SYSTEM

FRONT AXLE AND STEERING

SECTION 1A

Manual Steering

GENERAL INFORMATION

Data

Type	Burman recirculating ball
Number of steering wheel turns between axle stops	7½ approximately
Number of main nut balls	18
Number of inner column bearing balls	21 each end
Number of rocker shaft rollers	18 at each side
Rocker shaft end-float	None
Inner column bearing pre-load	11.6/16.2 kg cm (10/14 lb in)
Overall assembly pre-load	29.9/34.8 kg cm (26/30 lb in)

Torque loadings

Upper end cap mounting bolts	2.7/3.8 kgf m (20/28 lbf ft)
End cover bolts	2.7/3.8 kgf m (20/28 lbf ft)
End cover bolts	6.1/8.1 kgf m (45/60 lbf ft)

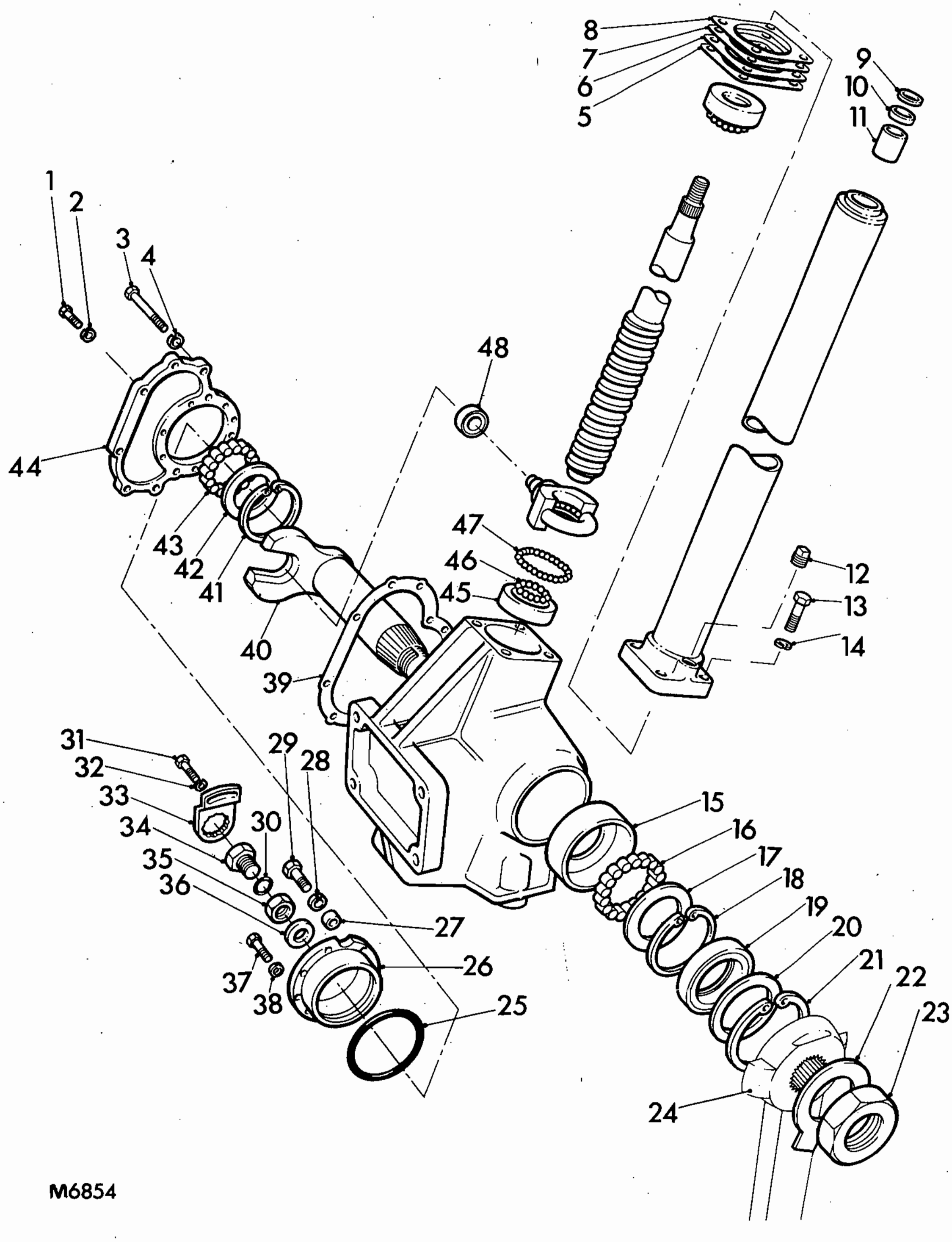


FIG. 1 EXPLODED VIEW OF MANUAL STEERING GEAR

1. Bolt
2. Washer
3. End cover retaining bolt
4. Washer
5. Shim
6. Shim
7. Shim
8. Joint
9. Washer
10. Oil seal
11. Outer tube bush
12. Oil filler plug
13. Bolt
14. Washer
15. Roller race housing
16. Rollers
17. Washer
18. Circlip
19. Oil seal
20. Washer
21. Circlip
22. Tab washer
23. Nut
24. Drop arm
25. Oil seal
26. Roller race housing
27. Washer
28. Washer
29. Bolt
30. Oil seal
31. Lock bolt
32. Washer
33. Lock ring
34. Adjuster screw
35. Nut
36. Washer
37. Bolt
38. Washer
39. Joint
40. Rocker shaft
41. Circlip
42. Roller race washer
43. Rollers
44. Cover plate
45. Adjustable ball race
46. Steel balls
47. Main nut steel balls
48. Main roller nut

REMOVAL AND REFITMENT

To Remove

1. Disconnect or isolate batteries.

2. Remove detachable panel from front of vehicle.

3. Remove split-pin and slotted nut from drag-link front ball pillar and withdraw ball pillar.

4. Carefully prise out steering wheel motif and remove retaining nut and bracket. Tap off wheel using a soft faced mallet. Replace nut and bracket.

5. Remove setscrews retaining draught excluder and sealing ring.

6. Remove horn and dipper switch arm and the two bolts securing gear selector switch assembly to its mounting bracket. Release cable connections from steering column and lower switch unit to floor. Loosen pinch bolt on mounting bracket and remove bracket from steering column.

7. Remove locking wire, set bolts and distance pieces to release steering box mounting plate.

8. Remove split pins and nuts from front mounting plate and lower steering box assembly to ground.

To Refit

Refitment is a reversal of the removal procedure.

OVERHAUL

To Dismantle

1. Mark relative positions of drop-arm and rocker shaft if not already marked, remove nut and withdraw drop arm.

2. Remove oil filling plug and drain off all oil from steering box.

3. Remove setscrews which retain side cover. Ease cover, bearing housing, and rocker shaft adjuster away from the case.

4. Remove main nut roller if this has not become detached during removal of cover.

5. Withdraw rocker shaft from case.

6. Remove four bolts and washers securing upper end cap and tube assembly. Apply hand pressure on upper end of inner column and withdraw end cap and tube assembly, paper joints and steel shims.

7. Lift inner column and remove upper bearing race and steel balls.

8. Remove inner column and main nut. Wind-off main nut from steering column and collect the steel balls from main nut track.

9. Remove steel balls from lower race.

10. Bend back corners of transfer tube retaining strap, remove bolts and strap and withdraw split tube. Extract remainder of steel balls from main nut track.

11. Remove rocker shaft oil-seal by careful levering at diametrically opposed points.

Inspection of Dismantled Parts

1. Examine the steel balls and bearing tracks of main nut and inner column. If damage to either component, in the form of pitting or grooving, is evident the component concerned must be renewed.

2. Examine the steel rollers and associated tracks of rocker shaft and detachable bearing race in side cover. Grooving or pitting on any component necessitates renewal.

   If detachable roller race requires renewal, the staked metal must be knocked back and the race tapped out. When refitting new race, position a new O-ring around periphery and tap race into position. Stake securely in three places as original.

3. Examine conical faces of main nut and rocker shaft, and bearing areas of main nut roller and side cover track. Wear, in the form of grooving or pitting; or excessive free movement between components, will necessitate renewal of components concerned.

4. Examine the steel balls and associated tracks of inner column and bearing races. Any component with grooving or pitting in evidence must be renewed.

5. Check fit of inner column upper bearing area in upper bush. If a slack fit is apparent, the sleeve should be driven out and the bush renewed. Assembly should then be driven into outer tube until sleeve abuts machined shoulder.

6. Check fit of rocker shaft journal in main case bush. If a slack fit is apparent, bush should be driven out and a new bush pressed in, see Data.

7. Check for signs of twisting of rocker shaft splines; if this fault is evident, rocker shaft must be renewed.

Note: In the interests of safety and reliability, all steering gear components must be in perfect condition.

To Reassemble

1. Refit transfer tube to main nut and secure with retaining strap, bend up corners of strap to secure bolts.

2. Smear main nut track with grease and fit steel balls.

3. Fit a new rocker shaft oil seal.

4. Fit inner lower bearing race, smear with grease and position steel balls around track.

5. Whilst holding main nut assembly in position in case, feed in inner column and engage main nut.

6. Screw inner column in a clockwise direction until main nut is approximately mid-way onto helix, and allow inner column to rest on the steel balls of lower bearing race, making sure no balls have been displaced from either main nut or lower race.

7. Smear upper bearing race with grease and position over inner column.

8. Invert complete assembly and allow inner column to rest on the ground. Take care to ensure that inner column remains in contact with steel balls of lower race to prevent these become dislodged; weight of case assembly will then hold the balls in position.

9. Load steel balls into upper race, and press race into the case. When completed return assembly to its original position.

10. Fit a new paper joint, steel shims, final paper joint, tube assembly and end cap and retaining bolts.

11. Check and adjust inner column end float as follows:

    If end float is evident, remove the tube assembly and end cap along with one shim; refit the tube and end cap and temporarily fit the steering wheel. When correct setting is obtained the steering wheel should rotate freely, but with the slightest perception of drag due to pre-loading of the bearings. The effect of a greater or lesser number of shims should be tried, each time with the tube and end cap securely tightened, until there is no end float in the steering column.

    When correct setting is obtained tighten end cap bolts to the required torque, see Data.

12. Locate rocker shaft in case and ensure that conical faces of shaft boss engage correctly with similar faces of main nut.

13. Position main nut roller on machined stub.

14. Fit new O-ring and roller face into cover plate smearing race with grease and position rollers, ensuring roller retainer and circlip are seated correctly.

15. Fit new joint to side cover mating face on case. Fit cover and screw in all bolts except the bolt which secures the locking tab for the rocker shaft adjusting screw. Tighten bolts evenly to ensure that cover is pulled up squarely. Bolts should be finally tightened to the correct torque, see Data.

16. Set steering gear to straight ahead position with the main nut in the centre of its travel along the helix. It is important to observe this instruction since conical faces of rocker shaft and main nut are machined to give more backlash at the extremity of each lock than in the straight ahead position.

    Screw up the adjuster screw to just contact the rocker shaft end face. Secure locknut in position, adjust locking plate and secure with its bolt into cover plate.

17. Refill steering box with recommended lubricant, see Group 1.

18. Fit drop arm to rocker shaft splines, ensuring the mark on the drop arm coincides with the mark on the end of rocker shaft.

19. After all adjustments have been made and drop arm has been fitted, remove steering wheel.

Power Assisted Steering

GENERAL INFORMATION

Data

Steering Gear

Type	Burman Integral unit recirculating ball
Number of steering wheel turns between axle lock stops	5¾ approximately
Number of main nut balls	28
Number of inner column bearing balls	15
Number of rocker shaft rollers	19 in each race
Rocker shaft end-float	Non-adjustable
Steering sector pre-load	0.025/0.10 mm (0.001/0.004 in)
Steering sector spacer sizes	2.25/2.9 mm (0.090/0.117 in)
Steering sector chamfered spacer sizes	2.35/2.8 mm (0.094/0.110 in)

Inner column bearing pre-load

Rocker shaft removed	2.7/4.0 kgf (6/9 lbf)	Spring balance readings see text
Rocker shaft fitted	20.4/40.8 kgf (45/90 lbf)	
Overall assembly	43.9 kgf (97 lbf)	

Torque loadings

Side cover retaining nuts End cover retaining nuts	2.4 kgf m (18 lbf ft)

Steering Pump

Type	Hobourn Eaton roller 3606/1035/59
Flow control valve setting	15.9 litres per min (3.5 galls per min)
Flow control spring tension	3.6/4.0 kg (8/9 lb) at 20.8 mm (0.82 in) long
Relief valve setting	70 kgf/cm^2 (1000 lbf/in^2)
Carrier and roller clearance	0.05 mm (0.002 in)

Torque loadings

End cover to pump body screws	2/2.2 kgf m (14/16 lbf ft)
Valve cap	4/48 kgf m (30/35 lbf ft)

HYDRAULIC OPERATION, FIGS. 1 and 2

Hydraulic oil enters the unit from the pump through the hose connection in the lower cover and passes up the bore of the inner column. From here oil enters each of the chambers formed by the valve flats, via radial drillings in valve. When the valve is in neutral position, i.e. no torque applied to steering wheel in either direction, an open circuit exists; oil entering the return hose to reservoir via chamber A, B or D, and axial oil-ways milled on outer diameter of valve, which connect with the annular chamber between valve boss and upper end cover.

When the steering wheel is turned on right lock, port 1 is cut off from oil supply, and pressure is directed to the underside of the piston from chamber A, via port 2 and the longer axial passage on the outer diameter of the inner column. In this instance oil is returning from the upper side of the piston via the shorter axial passage, port 3 in the outer sleeve, port 1 in the inner column and chamber D.

Conversely, on left lock, port 2 is cut off from the supply and pressure is directed to the upper side of the piston, from chamber A, via port 1, the shorter axial passage and port 3 in the outer sleeve. Oil then returns from the underside of the piston via the longer axial passage, port 2 in the inner column and chamber B. On either lock, chamber C merely provides hydraulic balance.

Diagnostic Testing

Checks should be carried out with hydraulic oil at normal operating temperature.

1. Connect valve block MS64, in the delivery line between pump and steering gear, ensuring that the screw down valve is fully open.

2. Top up reservoir and bleed the system by slowly turning steering from lock to lock whilst engine is idling. Repeat the operation until oil level in the reservoir remains constant.

   Note: Steering lock stops must be correctly adjusted to achieve satisfactory bleeding. Refer to Section 3 for correct procedure.

3. With the engine running at approximately 900 rev/min (fast idle) and steering set in straight ahead position, fit a spring balance to the steering wheel and pull on a line tangential with wheel rim. Apply a torque of up to 3.3 kgf m (24 lbf ft) and check oil pressure reading to either lock. Approximately 65.7 kgf/cm^2 (900 lbf/in^2) should be recorded although a lower pressure is acceptable if wheels turn before a torque of 3.3 kgf m is applied. If road wheels do not turn and pressure is low, the steering gear is suspect and should be overhauled.

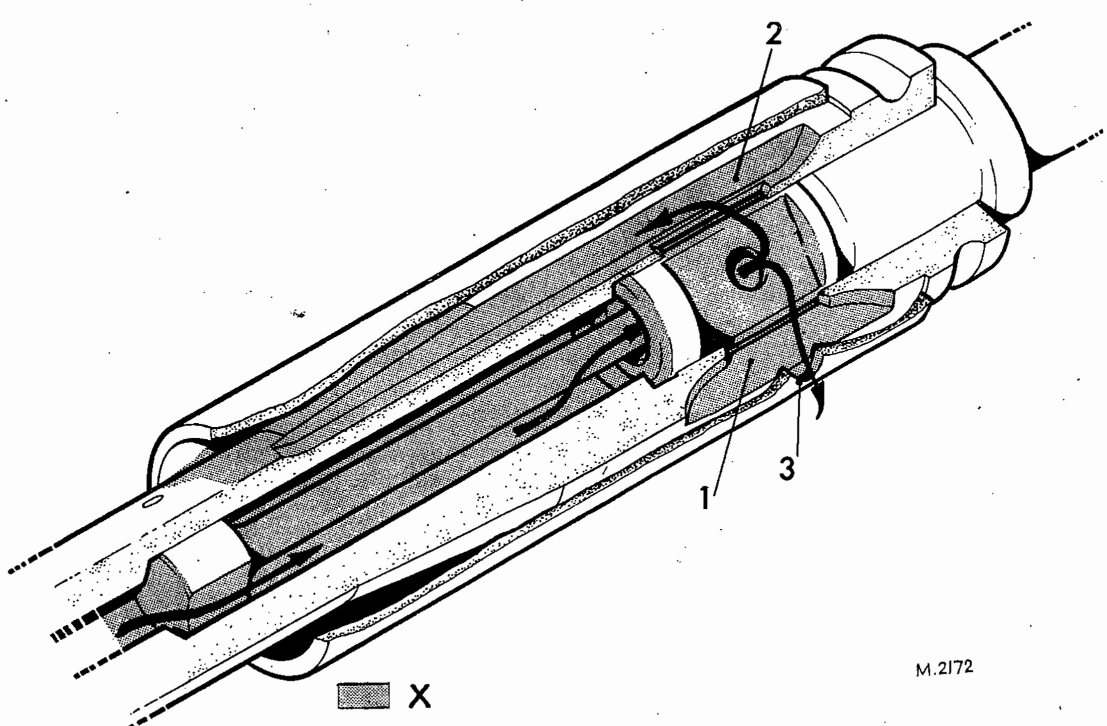


FIG. 1 CUT-AWAY VIEW OF INNER COLUMN VALVE TORSION BAR ASSEMBLY, SHOWING FLUID CIRCUIT

NOTE: THIS ILLUSTRATION SHOWS THE FLUID CIRCUIT ON BOTH LOCKS, SEE ALSO FIG. 2

1. Port 1 2. Port 2 3. Port 3

X Indicates presence of fluid

4. With the engine running at normal idling speed, slowly close the valve and note gauge reading. A figure of 65.5 to 70 kgf/cm^2 (950/1000 lbf/in^2) is satisfactory.

Important: The screw down valve must not remain closed for more than 7 seconds or damage to the pump may result. If a pressure greater than 70 kgf/cm^2 is recorded before the screw down valve is completely closed, a jammed relief valve in closed position is responsible. It is important therefore not to allow the pump to operate against a closed line or damage to both pump and gauge will occur.

If pressure does not rise to within specified limits, stop engine and carry out the following check.

5. Remove reservoir cover retaining bolt and lift off cover. With engine idling and screw down valve open, engage an assistant to turn the steering wheel from lock to lock whilst observing the oil flow in reservoir. If oil flows through the filter but no appreciable power assistance is apparent, a sticking flow control or relief valve is indicated.

6. Remove and inspect the valve assemblies, wash components in a suitable solvent. The roller type pump relief valve is not adjustable. Refit valves and re-check the pressure. Overhaul the pump if a low pressure is recorded.

7. On completion of the above checks, refit reservoir cover and if further work on the pump is not necessary, remove valve and gauge and reconnect delivery pipe. Bleed system and check for leaks.

A rough check can be made, in the absence of test equipment, to determine flow rate by rapidly turning the steering wheel from lock to lock with engine at idling speed. If power assistance is available throughout, it can be assumed that flow rate is satisfactory.

REMOVAL AND REFITMENT

Steering Gear

To Remove

1. Disconnect or isolate batteries.

2. Remove detachable panel from front of vehicle.

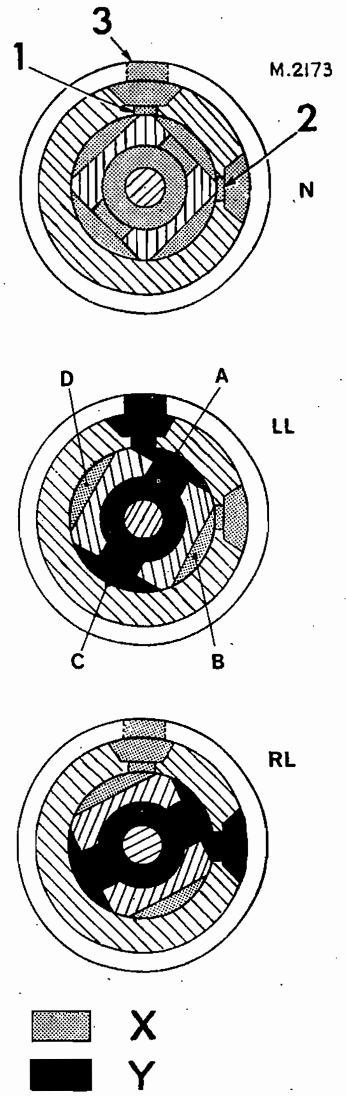


FIG. 2 SECTIONS THROUGH VALVE CHAMBERS SHOWING FLUID CIRCUIT IN NEUTRAL AND ON EACH LOCK

1. Port 1 A. Chamber A N. Neutral
2. Port 2 B. Chamber B LL. Left lock
3. Port 3 C. Chamber C RL. Right lock

X. Low pressure returning fluid, or, open circuit in neutral position.

Y. High pressure fluid

3. Position suitable container beneath the steering gear. Disconnect lower hydraulic pipe connection and allow oil to drain. To prevent ingress of foreign matter, plug both adaptor and pipe connections.

4. Remove split-pin and slotted nut from drag-link front ball pillar and withdraw ball pillar.

5. Carefully prise out steering wheel motif and remove retaining nut and bracket. Tap off wheel using a soft faced mallet and replace nut and bracket.

6. Remove setscrews retaining draught excluder and sealing ring.

7. Remove horn and dipper switch arm and the two bolts securing gear selector switch assembly to its mounting bracket. Release cable connections from steering column, and lower switch unit to floor. Loosen pinch bolt on mounting bracket and remove bracket from steering column.

8. Remove lower mounting bolts and bracket.

9. Remove the four forward plate mounting bolts and lower steering box assembly to ground.

10. Remove locking wire, set bolts and distance pieces to release steering box mounting plate.

To Refit

Refitment is a reversal of the removal procedure, paying particular attention that no pipes or wiring are trapped. After refitment the system will require bleeding in the following manner:

Jack and block steering axle.

Top up reservoir to slightly above correct level.

Start the engine and allow to idle. Slowly move steering wheel from lock to lock to ensure complete filling of control valve unit and pipelines. Re-check oil level, if level has dropped, top up again and repeat procedure until level remains constant.

Do not allow reservoir to empty.

Finally lower vehicle to ground and with engine running at approximately 1500 rev/min again turn steering from lock to lock. Re-check oil level in reservoir and check system for leaks.

Steering Pump

To Remove

1. Open engine access doors.

2. Place a suitable container beneath pump, disconnect pipes and sling from a convenient point to prevent unnecessary drainage.

3. Blank off pipes to prevent ingress of foreign matter. Allow sufficient time for pump to drain.

4. Remove retaining bolts, nuts and washers and withdraw pump from vehicle.

To Refit

Refitment is a reversal of the removal procedure. Bleed the system as directed under refitment procedure of steering gear.

OVERHAUL

Steering Gear

To Dismantle

Note: A complete set of O-rings and seals should be available before dismantling.

1. Remove bolts securing mounting bracket to box and manoeuvre bracket to allow an extractor to be applied to drop-arm. Mark relative positions of drop-arm and rocker shaft; remove nut and withdraw drop-arm.

2. Remove nuts and spring washers which secure tube housing and outer tube assembly to main casing and lift off tube.

3. Withdraw inner column extension from splined connection.

4. Remove eight nuts and spring washers securing side cover to main casing. Fit tool LC170 and remove cover taking care not to lose the rollers.

5. Ensure that rocker shaft is exactly at mid-point of its travel on main nut; tap out shaft complete with sector using a soft-faced mallet. Collect the rollers.

6. Mark relative position of lower end cover and main case. Remove bolts and spring washers and carefully tap off cover. Carefully remove sealing sleeve with fitted O-ring and coil spring from cover.

7. Temporarily refit inner column extension to splined connection and rotate assembly in an anti-clockwise direction to eject main nut and piston assembly.

   Collect the steel balls which will be ejected as inner column is screwed out of main nut track.

8. Remove upper end cover complete with bearing upper race, oil-seal and plain steel washer. Take care not to lose any steel balls from around the bearing track. Remove four O-rings from securing studs and lift off metal foil shim joints.

9. Remove internal circlip from upper bore of main nut and extract plain steel washer and O-ring carrier with fitted O-ring.

10. Remove plain steel washer from upper end cover and tap out oil-seal using a suitable drift.

11. Using a suitable brass drift inserted from lower end of main case, tap out inner column bearing lower race and O-ring carrier with fitted O-ring.

12. Remove external circlip from piston end of main nut and using suitable mandrel and support plate, press off the piston.

13. Remove rollers from side cover and carefully lever out bearing race. Remove O-ring carrier complete with fitted O-ring and loose O-ring.

14. Remove external circlip from the sector shaft and sector from the rocker shaft.

    Note: It is impractical to attempt to further dismantle the inner column/valve/torsion bar assembly, therefore, any fault or damage revealed by the following inspection procedure should be corrected by renewal of the complete assembly.

    Further dismantling of other sub-assemblies is unnecessary unless inspection reveals damage.

Inspection

1. Examine steel balls and helical bearing tracks of inner column and main nut. If damage to either component is evident, the component concerned must be renewed.

   The main nut and inner column are available only as a matched pair.

2. Examine the steel rollers and tracks on rocker shaft and on races located in main case and side cover. Any worn or damaged component must be renewed. The race in the main case can, if necessary be drifted out using a suitable soft drift applied at diametrically opposed points around the race.

3. Examine steel balls and associated tracks of inner column upper bearing. Any component with wear in evidence must be renewed.

4. Examine teeth on sector and on main nut. If excessive wear or pitting is evident the component concerned must be renewed.

5. Examine piston bore in casing; if excessive scoring or other damage is apparent, casing must be renewed.

6. Check fit of inner column extension bearing area, in upper bush. If a slack fit is apparent, sleeve should be driven out and bush renewed. The assembly should then be driven into outer tube until sleeve abuts machined shoulder.

To Reassemble

Note: All O-rings and the two piston rings must be renewed during reassembly; these parts are available in kit form.

1. Fit a new O-ring to carrier from upper end of the main case and install assembly in case recess. Drive in inner column bearing lower race above O-ring carrier.

2. Install inner column to approximately its correct position and smear steel balls and bearing tracks with petroleum jelly. Load balls around track and fit upper race to hold them.

3. Replace original shim pack over studs and fit upper end cap, minus oil seal.

4. Wrap 3 or 4 turns of fine wire or string around the input splines and attach a spring balance. Taking a direct pull at 90° to the shaft, measure pre-load. Adjust shimpack thickness as necessary to achieve correct setting, see Data.

   Note: Correct setting is essential to ensure satisfactory adjustment of latter components.

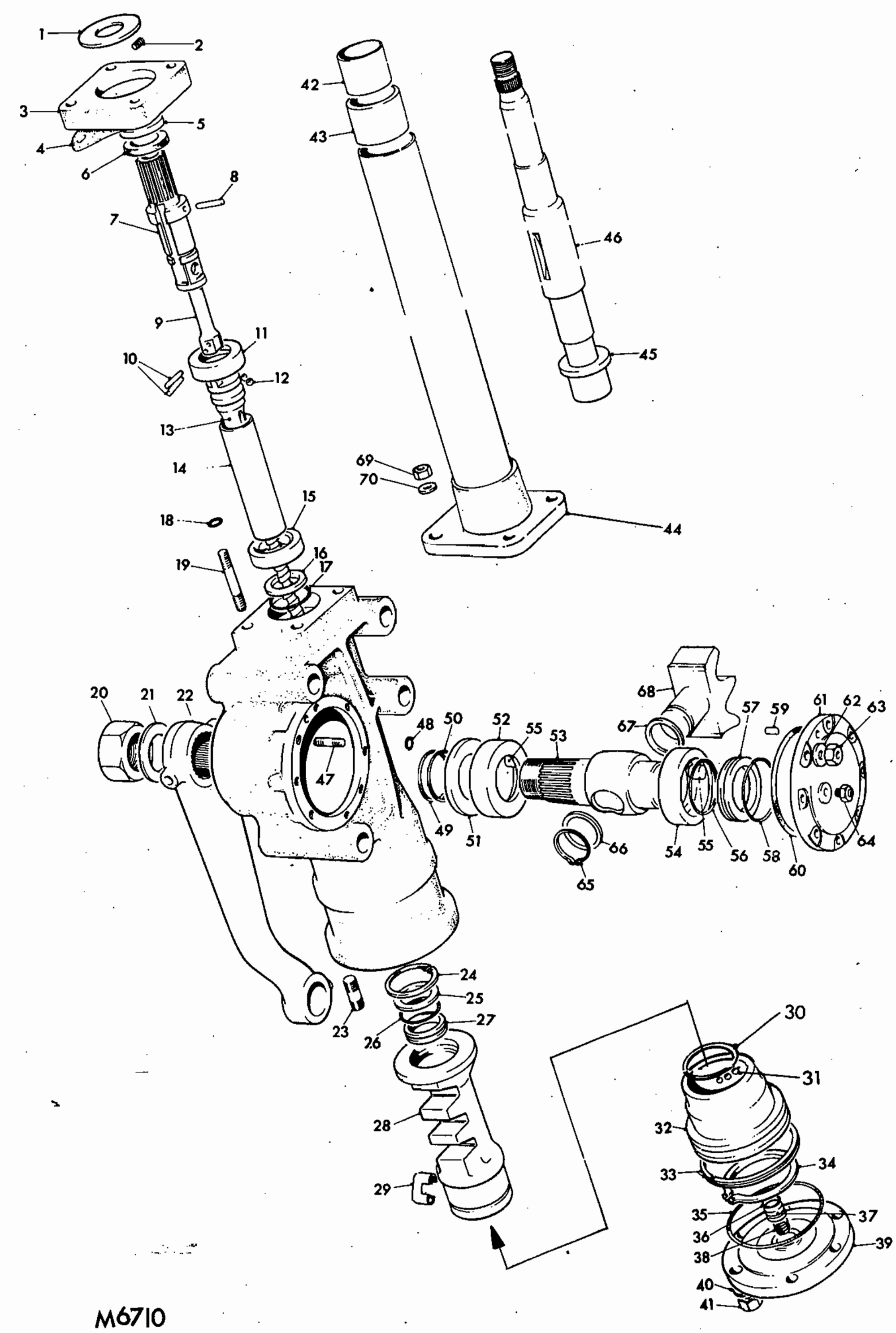


FIG. 3 EXPLODED VIEW OF INTEGRAL POWER STEERING GEAR

1. Plain washer
2. Socket head screw
3. Upper end-cap
4. Shimpack
5. Nylon backing washer—deleted on current units
6. Oil-seal
7. Valve
8. Dowel
9. Torsion bar
10. Dowels
11. Inner column bearing upper race
12. Inner column bearing balls
13. Inner column
14. Tubular sleeve
15. Inner column bearing lower race
16. O-ring carrier
17. O-ring
18. O-ring
19. Stud
20. Drop-arm retaining nut
21. Tab-washer
22. Drop-arm
23. Stud
24. Internal circlip
25. Plain washer
26. O-ring
27. O-ring carrier
28. Main nut
29. Transfer tube
30. O-ring
31. Main nut balls
32. Piston
33. Piston rings
34. External circlip
35. O-ring
36. O-ring
37. Sealing sleeve
38. Spring
39. Lower end-cover
40. Spring washer
41. Nut
42. Oilite bush
43. Sleeve
44. Pedestal mounting plate/ outer tube assembly
45. Plain washer
46. Inner column extension
47. Stud
48. O-ring
49. O-ring
50. O-ring
51. Plain washer
52. Roller race
53. Rocker shaft
54. Roller race
55. Rollers
56. O-ring
57. O-ring carrier
58. O-ring
59. Dowel
60. O-ring
61. Side cover
62. Spring washer
63. Nut
64. Relief valve
65. External circlip
66. Spacer
67. Chamfered spacer
68. Sector
69. Nut
70. Spring washer

5. Fit a new oil-seal to upper end cap taking care to ensure correct location by temporarily fitting plain steel washer, and tapping steel washer to determine the final position of oil-seal. Wrap splined valve shaft with tape and smear with hydraulic oil, fit cover and tighten socket head screw. The nuts and spacers should also be fitted and tightened to ensure that cap is held firmly when main nut is drawn into case. Remove tape ensuring that none remains.

6. Fit a new O-ring in annular groove around main nut and press on piston. Refit external circlip ensuring correct seating in groove.

7. Smear main nut track with petroleum jelly and load steel balls in track and transfer tube.

8. Fit new piston rings and position gaps diametrically opposite.

   Important: New piston rings must be of the same material as the worn rings. Do not replace cast iron rings with PTFE rings.

9. Insert smaller diameter of tool LC138 in case spigot. Smear piston rings with hydraulic oil and insert main nut assembly into case.

   Temporarily fit inner column extension and rotate to engage worm track; ensure that balls are not displaced from main nut.

   Draw main nut assembly into case until teeth are central in case side opening.

10. Fit new O-rings to side cover O-ring carrier. Smear O-rings with hydraulic oil and position assembly in cover bore. Press or drive in the roller race with open end to inside of cover. Smear race with petroleum jelly and load rollers.

11. Fit new O-rings to rocker shaft bore in main case and smear with hydraulic oil. Smear bearing race with petroleum jelly and load rollers.

12. Measure the thickness of original spacer then fit the next one down in size, with chamfer towards machined face and fit assembly to rocker shaft. Do not fit remaining spacer and circlip at this stage.

13. Temporarily fit rocker shaft and sector assembly into case; tap blank end of shaft with a soft faced mallet to ensure correct location. Note that rocker shaft and sector assembly can be fitted only with steering gear in straight ahead position.

14. Turn inner column towards either lock position and locate tool LC169, Fig. 4.

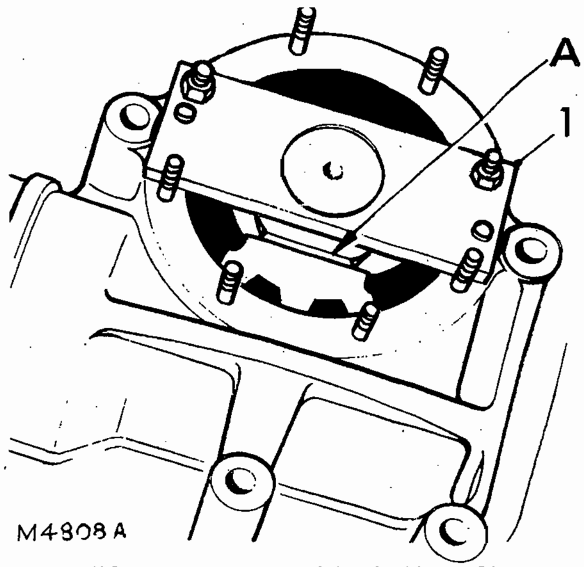


FIG. 4 APPLICATION OF SERVICE TOOL

1. Tool LC169

A. Check gap using feeler gauges

15. Using spring balance on input splines as previously described check pull required to rotate inner column. The maximum figure occurs at straight ahead position, see Data.

    Reset depth of mesh by replacing chamfered spacer until clearance between spacer and machined face of sector is between 0.0254/0.102 mm (0.001/0.004 in). Fit the next thickest spacer in the range to give a light pre-load condition.

    When correct clearance has been established select a spacer for circlip end of sector shaft, which will ensure a sector end-float, see Data.

16. Refit rocker shaft assembly.

17. Fit four new O-rings to bottom four side cover mounting studs and fit a new O-ring to periphery of side cover spigot; smear each ring with hydraulic oil.

18. Locate side cover on mounting studs, taking care to ensure that the dowel and its respective holes are aligned. Carefully tap home cover using a soft faced mallet. Tighten nuts to correct torque, see Data.

19. Fit a new O-ring to lower end cover sealing sleeve and smear with hydraulic oil. Position coil spring in cover bore and push in the sleeve, take care to ensure that the O-ring is not damaged.

20. Fit a new O-ring to periphery of end cover spigot and smear with hydraulic oil. Position cover with previously made markings aligned, and fit bolts and spring washers. Pull up cover by tightening the bolts in diametrical opposition a little at a time. Tighten bolts to correct torque, see Data.

21. Position oil-seal in upper end cap, spigot towards the seal, followed by steel washer.

    Note: Make a final check of overall pre-load using spring balance as before: the reading must not exceed the figure given in Data.

22. Fit inner column extension to splined connection and position outer tube and pedestal mounting plate assembly over studs. Fit four spring washers and nuts and tighten evenly.

Roller Type Steering Pump

Type HE3606

To Dismantle, Fig. 5

1. Clamp pump in soft jaw vice. Remove bolts (1 and 3) and withdraw suction and by-pass adaptors.

   Thread sizes and adaptor bores prevent assembly in wrong order. Do not remove Venturi flow director.

2. Remove pump driving gear and key.

3. Remove end plate.

4. Remove socket headed screws and lift off cover assembly; remove drive pin (19).

5. Tap shaft (20) and bearing (9) lightly to release from pump cover.

6. Support bearing on inner race and drive shaft through bearing.

7. Remove O-ring (16) from groove in pump body.

8. Remove rollers (15) and carrier (14) from pump body.

9. Extract cam ring (17) and lock peg (18).

10. Remove flow control valve (30) and spring (31).

11. Tap out shaft seal (10) using a drift slightly smaller than bush (13), do not damage bush.

Inspection

1. Check bushes in pump body and cover for wear, renew as necessary.

2. Inspect cam ring, roller carrier and its location in pump body. Examine rollers paying particular attention to end finish, renew if scored, damaged or eccentric.

3. Check with feeler gauges the clearance between cam surface, carrier and roller. See Data and Fig. 7.

4. Inspect shaft and bearing and renew if wear or loss of bearing lubricant is evident. Do not fit bearing to shaft at this stage.

To Reassemble

Smear all components with hydraulic oil prior to reassembly. O-rings and seals must be renewed.

1. Fit new seal in end cover using suitable mandrel. Do not damage seal lips.

2. Replace cam ring lock peg (18), install cam ring (17) with slot over peg, ensuring that ring is seated correctly against bottom face.

3. Fit tool LC172 to shaft and pass assembly through end cover, locating seal lips on machined shaft journal. Ensure positive contact at all times.

4. Remove service tool. Clamp shaft in soft jaws of vice and using suitable mandrel, drive bearing into position.

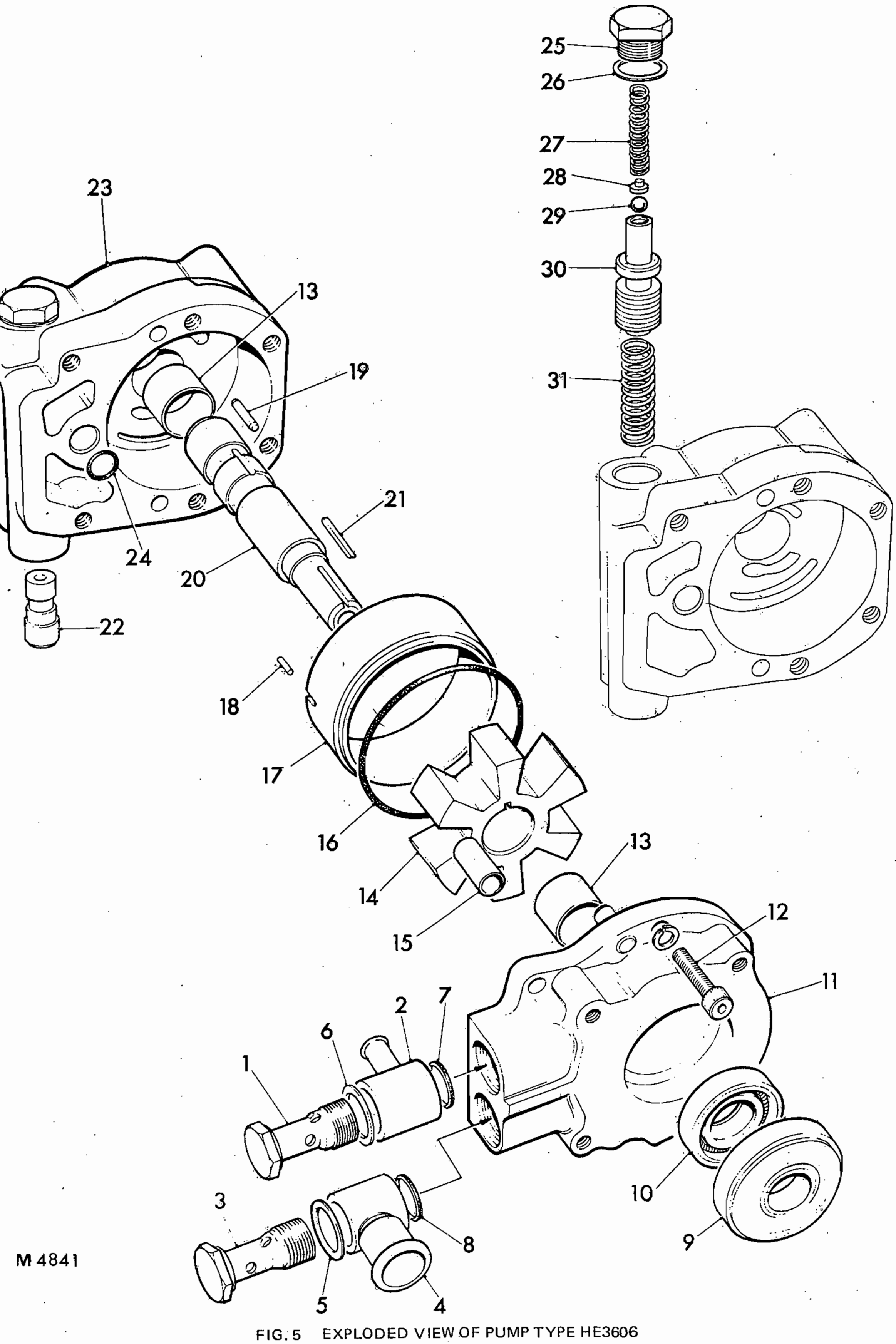


FIG. 5 EXPLODED VIEW OF PUMP TYPE HE3606

1. Bolt
2. By-pass adaptor
3. Bolt
4. Intake adaptor
5. Washer
6. Washer
7. Washer
8. Washer
9. Bearing
10. Seal
11. End cover
12. Socket head screw
13. Bush
14. Carrier
15. Rollers
16. O-ring
17. Cam ring
18. Lock peg
19. Drive pin
20. Shaft
21. Key
22. Metering orifice
23. Pump body
24. O-ring
25. Screwed cap
26. Washer
27. Spring
28. Cap
29. Ball
30. Flow control valve
31. Flow control spring

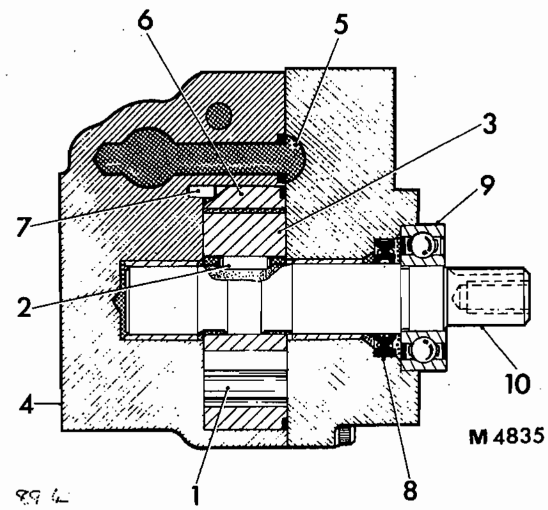


FIG. 6 SECTION THROUGH PUMP TYPE HE 3606

1. Roller
2. Roller carrier drive pin
3. Roller carrier
4. O-ring
5. O-ring
6. Cam-ring
7. Cam-ring lock peg
8. Oil seal
9. Drive shaft bearing
10. Drive shaft

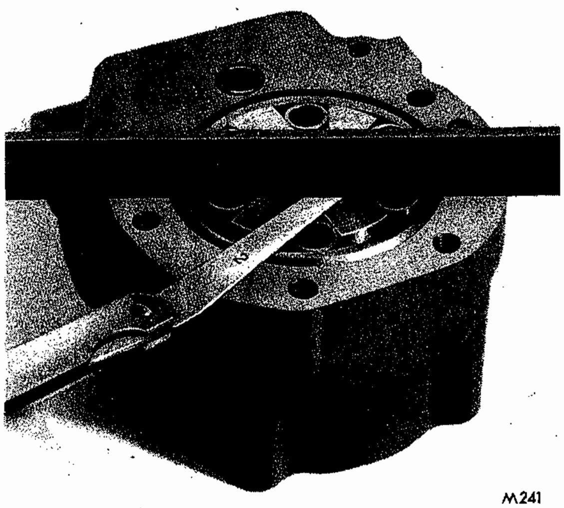


FIG. 7 CHECKING TYPICAL CARRIER AND ROLLER END-CLEARANCE

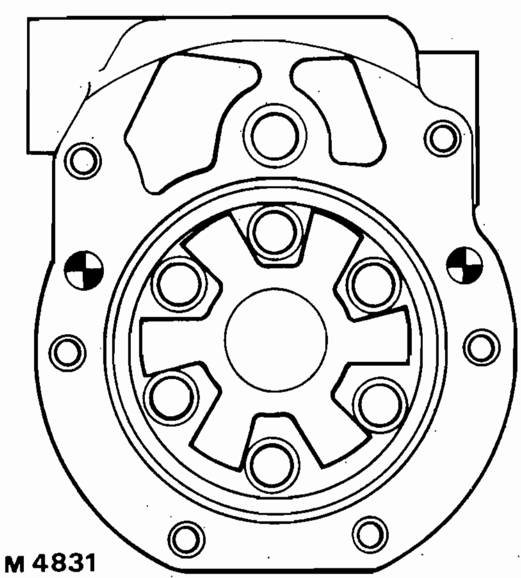


FIG. 8 SHOWING CORRECT INSTALLATION OF ROLLERS AND CARRIER

5. Fit O-rings (24) and (16).

6. Position carrier (14) and rollers as shown in Fig. 8.

7. Fit drive pin (19) to shaft. Position shaft in pump body aligning drive pin with slot in carrier and locating dowels in carrier with their respective holes in pump body.

8. Fit and tighten socket headed screws to correct torque, see Data. Check shaft for free rotation.

9. Fit flow control valve spring (31) and valve assembly (30) with ball end to outer face of port. Ensure that valve is not sticking.

10. Fit valve cap (25) with new O-ring, and tighten to correct torque, see Data.

11. Fit end plate.

12. Position key in shaft and fit driving gear. Tighten retaining nut to correct torque, see Data.

13. Replace suction and by-pass adaptors (4) and (2).

Test the unit as described under Diagnostic Testing.

SECTION 3

Front Axle and Steering Linkage

GENERAL INFORMATION

Data

Type	Parallel king pin

King pins

End-play	Zero
King pin inclination	3°

Axle Arms

Top bush internal diameter after fitting (pre-finished)	44.45 mm (1.75 in)
Bottom bush internal diameter after fitting (pre-finished)	50.8 mm (2.00 in)
Renew when diametrical clearance exceeds	0.508 mm (0.020 in)

Bearings

End play	0.10/0.24 mm (0.004/0.010 in)
Adjustment	By shims

Torque loadings

Ball pillar retaining nut	15 kgf m (110 lbf ft)
Spring clamp bolts	30 kgf m (220 lbf ft)
Hub retaining nut	40.7 kgf m (300 lbf ft)
Wheel retaining nuts	54.2 kgf m (400 lbf ft)

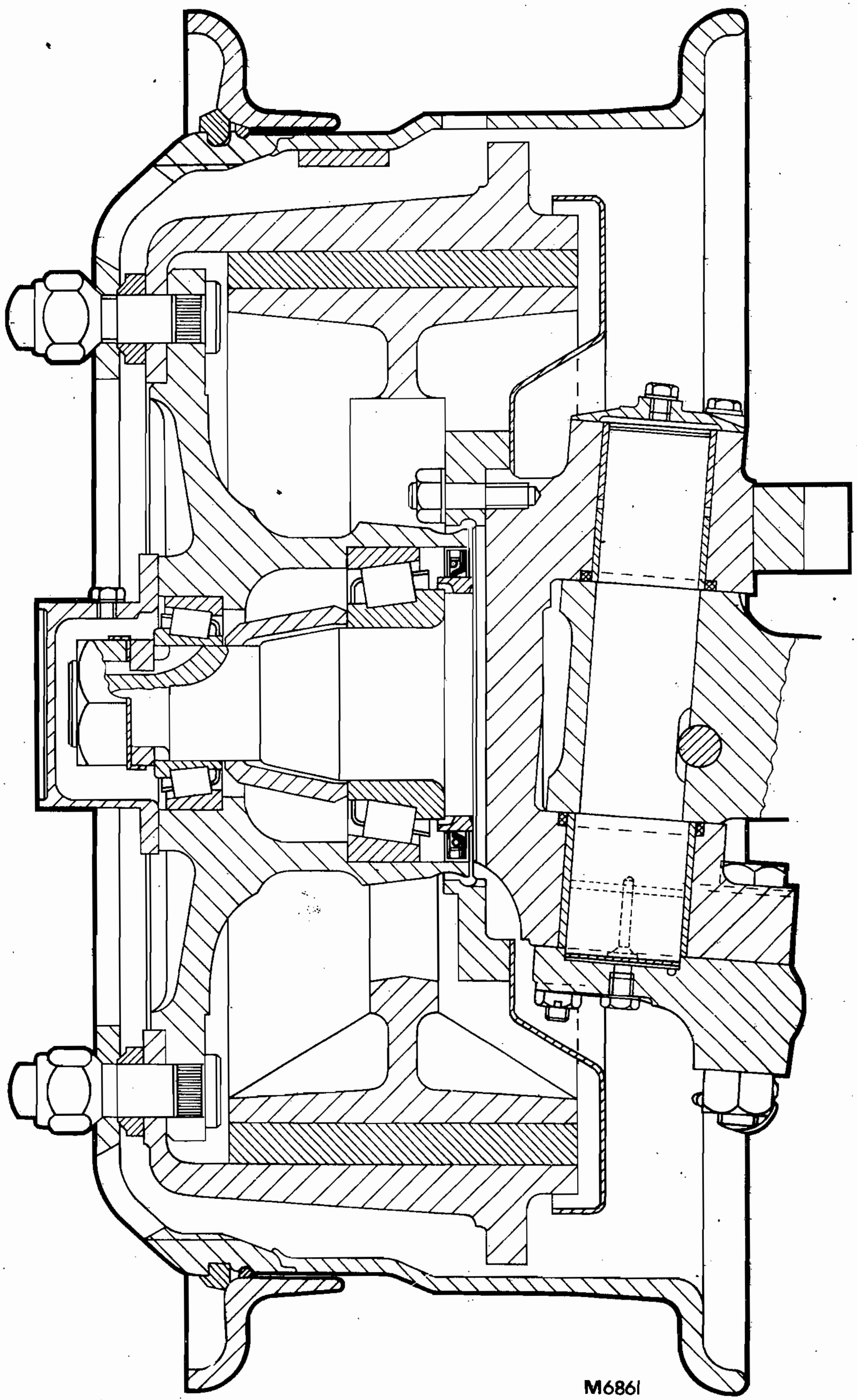


FIG. 1 SECTION THROUGH PARALLEL KING PIN AXLE ASSEMBLY

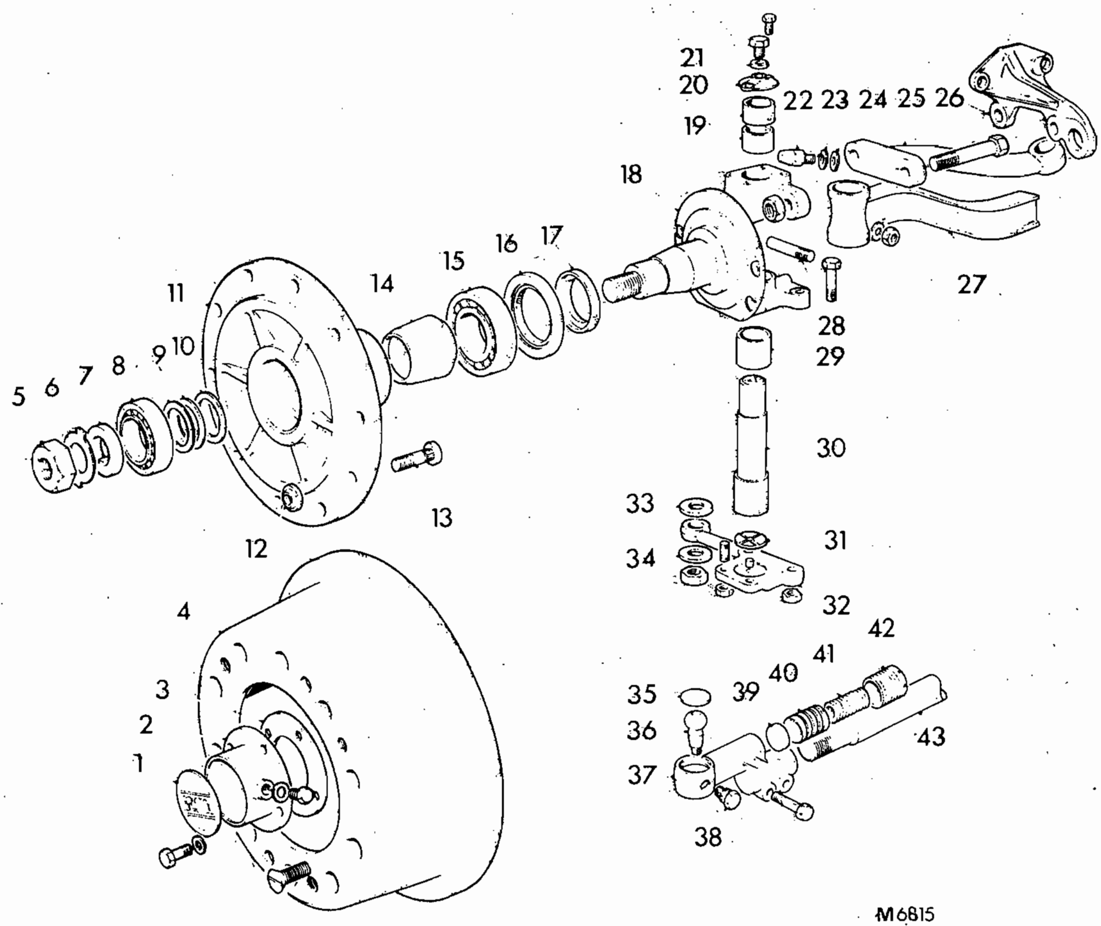


FIG. 2 EXPLODED VIEW OF PARALLEL KING PIN AXLE ASSEMBLY

1. Nameplate
2. Hub cap
3. Joint
4. Brake drum
5. Hub nut
6. Tab washer
7. Washer
8. Outer bearing
9. Shims
10. Shim
11. Hub
12. Olive
13. Wheel stud
14. Distance piece
15. Inner bearing
16. Oil seal
17. Collar
18. Stub axle
19. Upper bush
20. Cover plate
21. Washer
22. Lock stop
23. Washer
24. Washer
25. Steering arm
26. Brake chamber bracket
27. Axle beam
28. Cotter pin
29. Lower bush
30. King pin
31. Thrust pad
32. Track-rod lever
33. Felt washer
34. Washer
35. Sealing disc
36. Ball pin
37. Socket
38. Greaser
39. Ball seat (small)
40. Ball seat (large)
41. Spring
42. Socket cap
43. Track rod

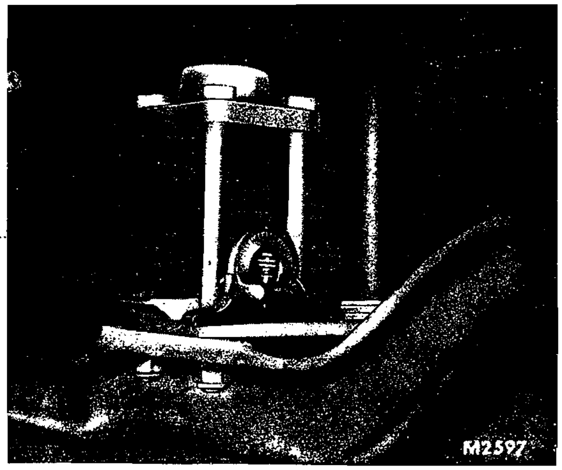


FIG. 3 CHECKING CASTOR ANGLE WITH PROTRACTOR AND LEVELLING SET

Steering Geometry Checks

The camber and castor angles are an inherent design feature and are not adjustable. They may however be checked if misalignment is suspected following a collision.

Camber Angle

Check condition of king pins and bushes, and hub adjustment as necessary. If found to be correct, misalignment of axle beam or axle arm is indicated. Replacement parts must be fitted.

Castor Angle

Position a combination protractor levelling set as shown in Fig. 3, the protractor should read 90° when spirit level is centralised.

Check tightness of spring clamp bolts and spring shackles for excessive wear as necessary. If found to be correct, misalignment of frame is indicated.

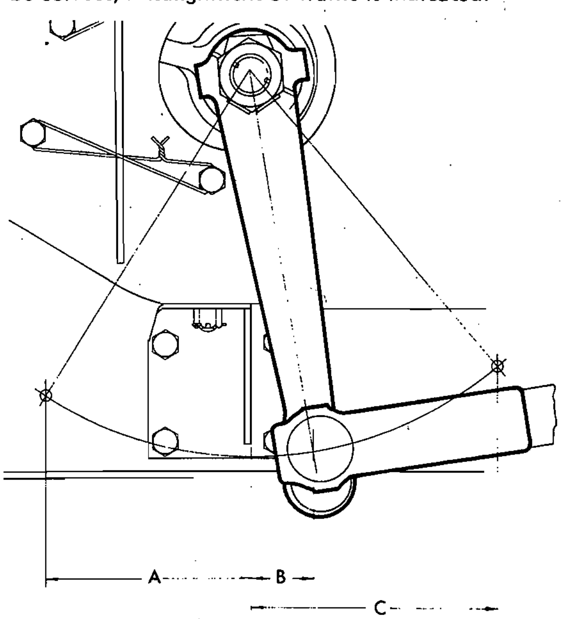


FIG. 4 DRAG-LINK SETTING

	MANUAL	POWER
A	= 177.8 mm (7.875 in)	161.9 mm (6.375 in)
B	= 95 mm (3.750 in)	38 mm (1.5 in)
C	= 241.3 mm (9.500 in)	193.7 mm (7.625 in)

Check both sides accordingly. The readings should be equal. Any slight discrepancy can be rectified by fitting tapered packing pieces between packing plate and axle beam.

Positive castor can cause heavy steering and wheel shimmy.

Negative castor can cause vehicle to wander and make directional correction at steering wheel constantly necessary.

Wheel Alignment

Check and adjust alignment in accordance with instructions given with standard workshop test equipment.

Drag Link

1. Set road wheels in straight ahead position.
2. Disconnect drag link from drop arm.
3. Check that the marks made on the drop arm and rocker shaft end-face are aligned.
4. Turn steering wheel to left lock until contact is made with the stop in the steering box.
5. Turn steering wheel back to give straight ahead position.

Note: The drop arm should be within the limits shown in Fig. 4.

6. Adjust drag link to align with the drop arm. Do not move the drop arm or the power cut-off settings will be disturbed.

REMOVAL AND REFITMENT

Axle and Steering Linkage

To Remove

1. Slacken road wheel nuts; jack and block chassis and support axle on trolley jack. Remove wheel nuts and road wheels and olives.
2. Remove split-pin, nut and washer from drag-link to steering arm pillar. Withdraw ball pillar and any automatic lubrication pipes (when fitted).
3. Release air pressure from braking system; disconnect flexible air hoses at brake chamber and plug hose and chamber inlets.

4. Remove nuts from spring clamp bolts; withdraw bolts and upper clamping plate.

5. Holding assembly steady, lower axle sufficiently to clear obstructions and withdraw from beneath the vehicle, taking care not to damage brake dustguards (when fitted).

Check axle beam for misalignment. Misalignment in the horizontal plane throughout overall beam length can be checked by passing a taut cord through king-pin centres, and any appreciable fault will become apparent.

To Refit

Refitment is a reversal of the removal procedure, ensuring that dowels on the underside of the springs locate accurately in their respective axle beam seat recess. Tighten clamp bolts and road wheels to correct torque, see Data.

Check brake adjustment and lubricate drag-link ball joint as directed in the Lubrication Chart.

Wheel Studs

To Remove

1. Slacken road wheel nuts; jack and block axle clear of ground.

2. Remove setscrews securing brake drum to hub and using same setscrews inserted in tapped holes provided, jack off the drum.

3. Remove hub from axle as described on page 5–3–6.

4. Press or drive out defective stud or studs.

Inspection

Check studs for evidence of wear around tapered shoulders. If any are grooved or worn, new studs must be fitted.

To Refit

Ensure the correct replacement stud is selected, these being stamped L or R (Left-hand or Right-hand thread) on the end face.

1. Press in new stud.

   The stud must be a force fit in the bore or slackening off in service and consequent damage to both hub and road wheel could result.

2. Refit hub and adjust bearings as described on page 5–3–7.

3. Refit brake drum.

4. Refit road wheel to correct torque, see Data, and adjust brakes, see Group 1.

Steering Ball Joints

To Remove

Note: No heat should be applied to assist in the removal of any ball joints. If heat has been applied to any heat-treated component it should be renewed.

1. Remove split pin, slotted nut and washer from ball pillar and automatic lubrication pipe (when fitted).

2. Withdraw pillar from its taper.

3. Remove split pin and release socket clamp bolts; unscrew socket noting that one end of tube is threaded right-hand the other end being threaded left-hand. Count number of turns required for removal to ensure reassembly in correct relative position. Slight adjustment will then be required to obtain correct wheel alignment.

To Refit

Drag-Link Ball Joints

1. Set steering wheel and road wheels to straight ahead position.

2. Adjust length of drag-link to align both ball pillars with their respective tapers. The sockets should be screwed on to drag-link an equal number of turns.

3. Fit ball pillars and tighten nut to correct torque, see Data. Further tighten to fit split pin. Do not back off nut to fit split pin.

4. Tighten socket clamp bolts and fit new split pin and automatic lubrication pipe (when fitted).

Track-rod Ball Joints

Refitment is a reversal of the removal procedure ensuring that ball pillar nut is tightened to correct torque, see Data. Check wheel alignment using standard workshop test equipment.

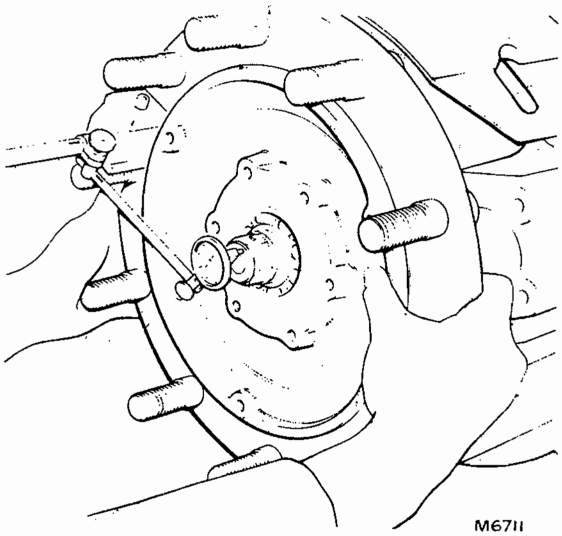


FIG. 5 CHECKING HUB END FLOAT

OVERHAUL

Front Hub

To Dismantle

Note: Unless difficulty is experienced in withdrawing hub from axle arm, the brake drum need not be detached separately. If it is found necessary to remove drum, the drum retaining screws should be inserted in the two tapped holes to jack drum from hub.

1. Slacken wheel nuts on wheel concerned.
2. Jack and block axle to leave wheel just clear of ground, remove wheel nuts, road wheels and olives.
3. Slacken the brake adjuster to maximum.
4. Remove hub cap.

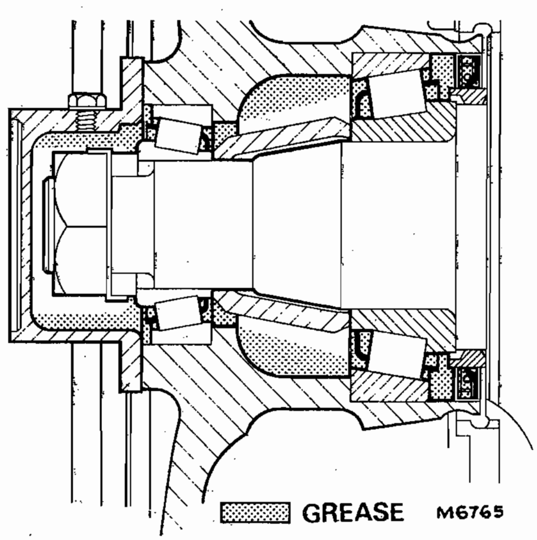


FIG. 6 HUB GREASING

5. Bend back tab washer and remove hub bearing locknut, tab washer and thrust washer.
6. Remove outer bearing and draw off hub with the complete inner bearing and oil-seal in position.
7. Extract shims, bearing distance piece, oil-seal, radius washer and inner bearing as necessary.

Inspection

1. Wash all parts except oil seals in a suitable 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.

To Reassemble

1. Press outer race of inner bearing into hub.
2. Fit inner race and radius washer.
3. Fit inner bearing cone and distance piece.
4. Fit hub shims and outer bearing cone assembly to stub axle.

Note: At this stage do not pack the hub with grease or fit new grease seal.

5. Fit thrust and tab washer to stub axle and tighten locknut to correct torque, see Data.
6. Rotate hub to obtain a correct seating position and then attach a dial test indicator to base of hub, and stylus in contact with end of stub axle. Check end-float, see Data.
7. To obtain correct end-float add or subtract shims from shim pack.
8. Remove hub and pack with grease as directed below.
9. Knead grease as specified in Group 1 well into the bearings and partly pack the cavity between the inner bearing and oil seal as shown in Fig. 6. The shaded areas in this illustration indicate where grease is to be applied.

10. Fill the hub cavity between bearings with grease, as shown, using a straight edged spatula. Also fill the hub cap to a depth of 6.0 mm (0.25 in).

11. Fit grease seal and offer hub up to the stub axle taking care not to damage seal.

12. Refit locknut and tighten to correct torque, see Data, then bend over tab washer.

13. Fit hub cap and new joint.

14. Replace road wheel and tighten nuts to correct torque, see Data.

15. Adjust brakes in accordance with the instructions in Group 1.

Axle Arm, Fig. 7

To Dismantle

Where facilities are available, the axle arms, steering arms, track rod levers and drop-arm should be crack-tested.

1. Chock rear wheels; release air pressure from service reservoir by unscrewing drain plug or by repeated applications of brakes. Disconnect spring brakes when fitted as directed in Group 7.

2. Slacken road wheel nuts on the wheel concerned.

3. Jack and block axle to leave wheel just clear of ground.

4. Remove road wheel nuts and wheel.

5. If necessary remove split-pin and castellated nut from drag-link ball pillar and withdraw pillar.

6. Disconnect brake air hoses at diaphragm chamber and plug hose and chamber inlets to prevent the ingress of foreign matter.

7. Back off the brake adjuster completely.

8. Remove the brake drum and hub as previously described.

9. Disconnect push-rod jaw-end from brake lever and remove split-pins, nuts and bolts, brake chamber, slack adjuster, brake chamber bracket and steering arm. Remove automatic lubrication pipe (if fitted).

10. Remove bolts, nuts and washers which secure brake assembly to axle arm. Remove brake assembly complete, refer to Group 7.

11. Remove split-pin from track-rod pillar, unscrew castellated nut and withdraw pillar.

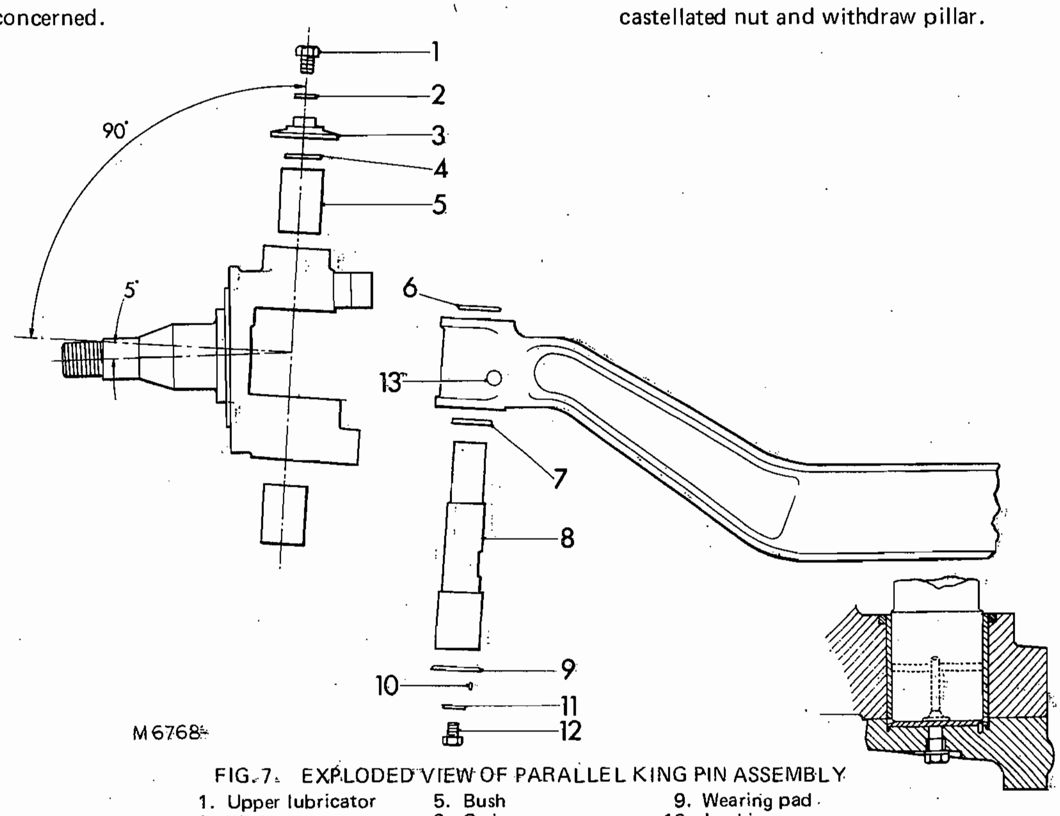


FIG. 7. EXPLODED VIEW OF PARALLEL KING PIN ASSEMBLY

1. Upper lubricator	5. Bush	9. Wearing pad
2. Washer	6. O-ring	10. Locking peg
3. Upper cap	7. Sealing ring	11. Washer
4. Seal	8. King pin	12. Lower lubricator

12. Remove setscrews securing king pin upper cover plate and withdraw cover plate. Remove automatic lubrication pipe (if fitted).

13. Remove nuts and bolts securing track rod lever and withdraw lever and thrust pad. Retain thrust pad for use on reassembly.

14. Remove cotter pin from axle beam securing king pin.

15. Using a brass or similar drift of slightly less diameter than upper diameter of king pin drive out the pin from the top.

16. Lift off axle arm assembly.

Inspection

Check axle arm for misalignment using the diagram in Fig. 7 as a guide. The arm should also be checked for cracks, particularly in the fillet radius area where the arm joins the flange.
The track-rod levers and steering levers should be removed and checked for misalignment. The levers should also be checked for cracking and enlargement of the securing bolt holes, if either faults are obvious, the levers must be renewed, together with securing bolts.

To Reassemble

1. Using suitable spigoted mandrels 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, taking care not to damage the axle arm bores.

2. Press or drive in new bushes, ensuring that:

   (a) Axle arm bores are clean and free from burrs.

   (b) Bushes enter squarely without distortion.

   Refit bearings outer races, inner bearing and oil seal, using new parts where required. Ensure that outer races are pressed or driven in squarely and that they seat correctly.

   The oil-seal should be refitted using a spigoted mandrel which is an accurate fit in the bore and on the face of the seal. If a suitable mandrel is not available the seal may be driven in using a hardwood drift. When using this method of refitment, great care should be exercised, as any damage or distortion will impair the efficiency of the seal.

3. Drive in king pin until tapered shoulder is in hard contact with the lower face of axle beam. Ensure that cotter pin location flat is in correct alignment to coincide with the hole through axle beam.

4. Fit track rod lever and thrust pad.

5. Fit king pin top cover plate, and automatic lubrication pipe (if fitted).

6. Position and secure track rod pillar fitting a new split-pin.

7. Refit brake assembly, refer to Group 7.

8. Refit steering arm, brake chamber bracket, slack adjuster, automatic lubrication pipe (if fitted) and brake chamber. Reconnect push-rod jaw end to brake lever, fitting new split-pins where necessary.

9. Lubricate and assemble hub as necessary.

10. Replace brake drum.

11. Remove plugs and connect air hoses to brake chamber.

12. Refit drag-link ball pillar.

13. Refit road wheel, see Data.

14. Check and adjust brakes as directed in Group 1.

15. Lubricate king pin bushes and ball joints as directed in Group 1.

Track Rod and Drag Link Ball Joints

To Dismantle

1. Remove split-pin retaining spring cap and using suitable screwdriver, unscrew and remove spring cup (7).

2. (a) Remove spring (6), outer ball seat (5) and withdraw ball pillar (2) through bore of socket. Inner ball seat (4) can be tapped out using a soft drift.

   (b) In case of track rod ball joints, to remove ball pillar remove spring (6), outer ball seat (5) and tap the ball pillar (2) gently, to remove the sealing washer (3) fitted in face of ball joint socket.

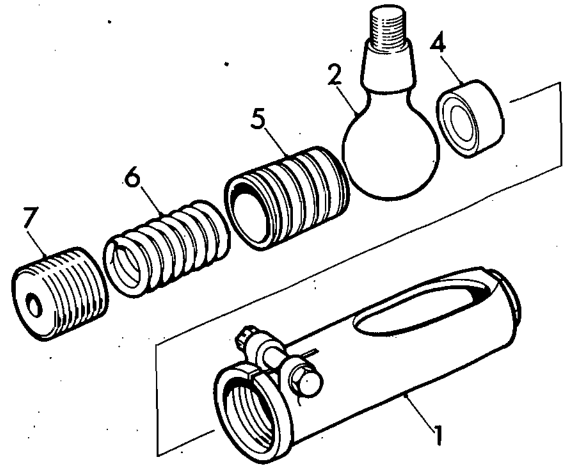
Inspection

The surfaces of the ball pillar and seats must be free from cracking or undue wear. Any part showing signs of failure must be renewed.

To Reassemble

Reverse dismantling procedure, lubricating ball pillar and seats with specified lubricant, and adjust assembly as follows:

1. Screw in spring cup to maximum; unscrew to first slots to align split pin holes. Fit new split pin, sealing washer (if fitted) and lightly grease threads of socket.



M6804

FIG. 8 EXPLODED VIEW OF DRAG-LINK BALL JOINT

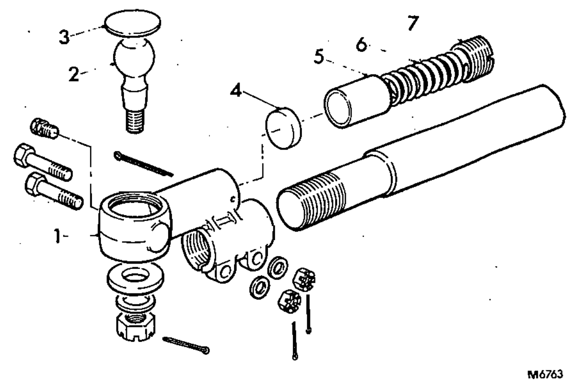


FIG. 9 EXPLODED VIEW OF TRACK-ROD BALL JOINT

GROUP 6

REAR AXLE

SECTION 1–DROPPED CENTRE AXLE | Page

SECTION 1

Rear Axle

Data

Type	Two stage reduction dropped centre axle
Ratios	3.80 :1, 4.23 : 1, 4.88 : 1, 5.37 : 1

Bearing pre-loads

Input pinion	13.8 to 28.6 kgf cm (12 to 25 lbf in)	
Spring balance reading	3.6 to 6.4 kgf (8 to 14 lbf)	
Shims	mm	in
	0.1	0.004
	0.25	0.010
	0.51	0.020
	1.02	0.040
Differential	5.7 to 11.4 kgf cm (5 to 10 lbf in)	
Spring balance reading	1.0 to 2.0 kgf (2 to 4 lbf)	
Shims	mm	in
	0.38	0.015
	0.41	0.016
	0.46	0.018
	0.51	0.020

Note: Pre-load figures are reduced by half when existing bearings are being re-used.

Backlash

Spiral bevel wheel and pinion	0.25 to 0.33 mm (0.010 to 0.013 in) or as etched on bevel wheel rim

End-float

Hubs	0.10 to 0.25 mm (0.004 to 0.010 in)

Fits and clearances

Axle Shaft Involute Splines to Spur Wheels	Initial Radial Clearance	+.0055″	+.0015″
Differential Bevel Wheel in Differential Casing Bush	Inside Diameter of Bush	Max 2.3170″	Min 2.3150″
Journal Diameter of Differential Bevel Wheel		Max 2.3110″	Min 2.3095″
Differential Bevel Pinion to Star Member	Bore Diameter of Bevel Pinion	Max .8758″	Min .8745″
Outside Diameter of Star Member Arms		Max .8725″	Min .8715″
Shaft to Oil Return Bushes	Inside Diameter of Oil Return Bushes	Max 2.3465″	Min 2.3445″
Diameter of Axle Shaft at Oil Return Bush		Max 2.312″	Min 2.307″
Central Cross Shaft Involute Splines to Spur Pinions	Initial Radius Clearance	+.006″	+.004″
End Float of Hubs		.004″	.010″

Torque Figures

Input flange retaining nut	55.2 kgf m (400 lbf ft)
Road wheel retaining nuts (dry)	55.2 kgf m (400 lbf ft)
Differential bearing cap nuts	25.6 kgf m (185 lbf ft)
Differential bearing cage nuts	8.28 kgf m (60 lbf ft)
Crown wheel securing bolts	15.21 kgf m (110 lbf ft)
Driving head to axle nuts	4.84 kgf m (35 lbf ft)
Pinion bearing housing nuts	11.06 kgf m (80 lbf ft)
Coupling flange retaining nut	55.20 kgf m (400 lbf ft)

REMOVAL AND REFITMENT

Rear Axle and Road Springs Complete

To Remove

1. Set hand control valve in PARK position; chock front road wheels; isolate batteries.

2. Slacken wheel nuts; jack up rear of vehicle and support chassis forward of rear spring brackets.

3. Take the engine and gearbox weight off their mountings using suitable blocks. Do not block under engine sump.

4. Raise road wheels clear of ground using a trolley jack. Remove wheel nuts, wheels and olives.

5. Disconnect exhaust tail pipe and exhaust shield bracket. Mark propeller shaft and axle flange to ensure correct alignment when refitting; disconnect the shaft.

6. Manually release spring brake actuators as directed in Group 7.

7. Disconnect rear clevis pins from brake rods.

8. Disconnect shock absorbers from axle and sling them clear to avoid fouling during withdrawal operation.

9. Take axle weight off both springs; remove all shackle pin retaining bolts. Drive out front shackle pins and the rear upper shackle pins.

10. Lower axle enough to clear the body and withdraw assembly through wheel arch aperture.

To Refit

1. Manoeuvre axle into position under vehicle.

2. Align spring eyes with mounting brackets and fit the shackle pins. Do not tighten the retaining bolts at this stage.

3. Fit and secure shock absorbers to the axle.

4. Align brake rod jaw-ends, fit and secure clevis pins.

5. Set spring brake actuators as directed in Group 7.

6. Fit exhaust pipe and exhaust shield.

7. Connect propeller shaft to axle flange ensuring that marks previously scribed are aligned.

8. Fit wheel olives, wheel nuts and tighten nuts to correct torque, see Data.

9. Remove blocks supporting engine and gearbox.

10. Remove the supports situated forward of the spring brackets.

11. Lower axle and take the weight of the vehicle on the spring shackle pins. Tighten the retaining bolts.

12. Remove chocks, connect batteries and test vehicle.

Nearside Transfer Gears

To Remove

1. Set hand control valve in PARK position and isolate the batteries.

2. Remove driving head and offside transfer gears as directed on page 6—1—3.

3. Remove nuts and washers securing axle drive shaft flange and remove axle shaft.

4. Pass connecting shaft through aperture in offside casing.

5. Secure tool 855SZ to cover plate and support the tool spigot in the pillar of a trolley jack.

6. Release the cover plate nuts and withdraw the transfer gear assembly.

To Refit

1. Position transfer gear assembly on tool part 855SZ.

2. Manoeuvre assembly into position in axle and secure with nuts and washers.

3. Pass connecting shaft through aperture in offside casing and locate the splines in the transfer gear.

4. Fit axle drive shaft and secure with nuts and washers.

5. Fit driving head as directed on page 6—1—3.

6. Connect batteries and test vehicle.

To Remove

Manufacture a lifting bracket see Fig. 1, to the dimensions given in Group 1, Section 4.

1. Place chocks under front road wheels and isolate the batteries.
2. Place suitable container beneath the axle to catch escaping oil, and remove small plate from offside casing.
3. Remove oil filler plug and plug housing from axle beam.
4. Disconnect propeller shaft.
5. Insert a thin bar through filler plug aperture, push connecting shaft away from driving head and out of mesh with the differential bevel gear.
6. Remove axle shaft flange securing nuts, and withdraw the shaft.
7. Remove body access panel situated above driving head.
8. Position tool made locally, as shown in Fig. 1 and using suitable lifting equipment take the weight of the driving head.
9. Remove driving head nuts, manoeuvre assembly clear of axle casing and lower to ground.

To Refit

1. Fit lifting tool and position driving head beneath vehicle.
2. Secure lifting eye to jack, raise and manoeuvre assembly into axle casing ensuring correct location of dowel in the dowel holes. Fit retaining nuts and tighten securely.
3. Insert a thin bar through the filler plug aperture and slide the connecting shaft into mesh with the differential bevel gear. Note the flange on the shaft must clear the aperture.
4. Fit filler plug housing to axle beam.
5. Fit axle shaft and tighten the flange securing nuts.
6. Fill the axle with oil as directed in Group 1.
7. Connect batteries and test vehicle.

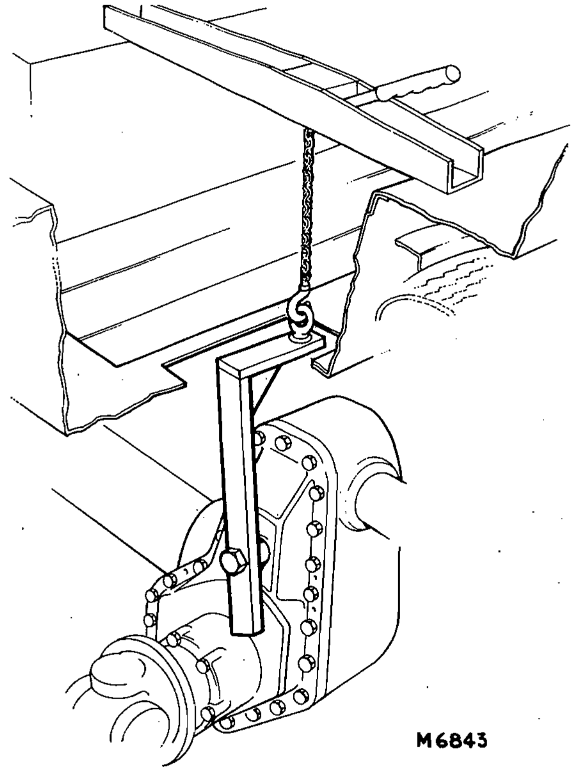


FIG. 1 LIFTING BRACKET APPLICATION

OVERHAUL

Driving Head and Offside Transfer Gears

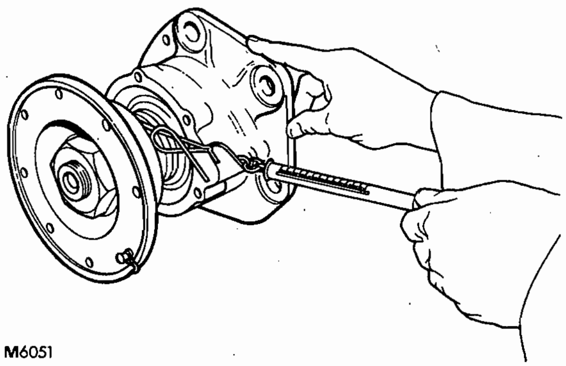
To Dismantle

Refer to Figs. 13 and 14 unless otherwise stated.

Differential assembly

1. Remove driving head assembly as directed above.
2. Remove locking tab (55) and unscrew the adjustment nut (48).
3. Remove nuts (2) and differential bearing caps.
4. Lift out the differential assembly and reduction gears. Retain all shims.
5. Separate spiral bevel gear from differential cage if necessary.

   Note: The spiral bevel gear and pinion are manufactured as a matched set. DO NOT change one without the other.
6. Bend back the tab washers; separate the differential cages and lift out the pinions (51), star member (54), thrust washers (56) and side bevel wheel (53).
7. Bend back tab washer and remove nut (60) washer and spur gear (62) from side bevel wheel shaft.



M6051

FIG. 2 CHECKING PINION BEARING PRELOAD

8. Press bevel wheel from differential cage half and remove needle roller bearing (57).

9. Draw off differential cage bearing inner races if necessary.

10. Remove roller bearings from the transfer drive gear using Sykes-Pickavant bearing separator 952 and puller 831.

Pinion assembly

1. Remove nuts securing spiral bevel pinion housing to driving head casing and drift out the complete pinion assembly.

2. Remove flange nut (34) using tool 471SZ and remove the flange.

3. Remove oil seal housing, extract and discard the seals.

4. Press pinion from housing and remove distance piece (45), shims (41), outer bearing and inner bearing outer race. Retain the pre-load shims.

5. Remove inner bearing inner race if necessary using Sykes-Pickavant bearing separator 952 with a workshop press.

6. Remove the bearing outer races from pinion housing.

TO REASSEMBLE

Refer to Data for torque figures; fit new oil seals and joints and apply gasket cement to previously treated faces. Lubricate each component during assembly to prevent initial oil starvation.

Pinion

1. Press bearing outer races into pinion housing.

2. Press inner bearing inner race onto pinion.

3. Fit distance piece (45) and shims (41) to value of 0.040 in over pinion shaft.

4. Position pinion housing over pinion followed by outer bearing inner race.

5. Temporarily fit coupling flange and tighten retaining nut to correct torque, see Data. Rotate the housing whilst tightening the nut to ensure the correct bedding of the rollers.

6. Wrap a length of string or soft wire three times around the coupling flange hub; anchor one end and attach a spring balance to the other Fig. 2; pull the balance and compare the figure recorded on the scale with the limits given in Data. Adjust the 0.040 in shim pack and repeat procedure until the correct figure is recorded on the scale. Remove coupling flange on final application.

7. Press new oil seals into housing (37), fit housing and tighten retaining bolts.

8. Fit coupling flange and tab washer, tighten to correct torque and bend over tab.

9. To prevent initial oil starvation and possible seal damage, remove plug (42) in oil seal housing and pour in ¼ pint of axle oil, see Group 1 for specification, and replace the plug.

Differential

1. Press bearing inner races onto differential cage halves.

2. Fit bronze bush (52) and side bevel wheel (53) to the differential cage half which supports the spiral bevel wheel.

3. Press needle roller (57) into other differential cage half.

4. Locate thrust washer (56) on the dowel pins.

5. Press plain roller bearing inner race onto transfer drive gear (62).

6. Assemble side bevel wheel (53) in differential cage half; fit transfer drive gear (62), nut (60), washer and tab washer. Secure nut and bend over the tab washer.

7. Position differential pinions and thrust washers (51) on star member and locate the assembly in one half of the differential cage.

8. Fit and secure both halves of differential cage, ensuring that the mating marks are aligned. Check the assembly for freedom of movement and if satisfactory, lock the nuts by bending over the tab washers.

9. Fit spiral bevel wheel (47) and wire lock the nuts.

SETTING PROCEDURE

1. Fit pinion assembly and nominal 0.040 in shim pack (44) in axle casing.

Note: The oil feed groove which supplies oil to the rear bearing, must be at the top.

2. Examine end face of pinion to determine the setting figure, this being an etched number representing thousandths of an inch, Fig. 3.

3. Position tool Part LC841SZ as shown in Fig. 4, and check with feeler gauges, the gap between pinion face and tool.

   Calculate the correct shim thickness figure as follows:

Subtract feeler gauge figure of say	0.020 in
from pinion marking figure of say	0.015 in
	−0.005 in
Nominal shim thickness	0.040 in
Minus reading obtained above	0.005 in
Shims required	0.035 in

   Remove pinion housing assembly and adjust shim pack to correct value. Set differential bearing pre-load before fitting pinion assembly.

4. Fit differential assembly adding 0.060 in of shims (63).

5. Fit bearing caps (2) and nuts; tighten nuts sufficiently to allow lateral movement of bearings.

6. Position bridge piece tool 3VRM-227-SZ Fig. 5.

7. Lock the differential by inserting a soft metal bar between the gear teeth and using C-spanner tool 850SZ, tighten the adjustment nut.

8. Check pre-load using a spring balance taking the reading from the rim of the differential cage as shown in Fig. 5.

   Mark the position of the ring nut relative to differential cage.

9. Refit input pinion assembly and shims (44).

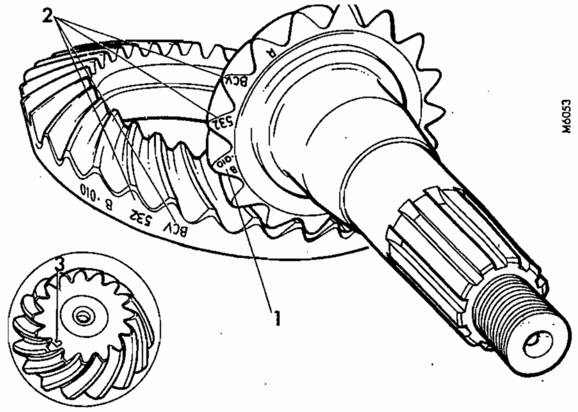


FIG. 3 CROWN WHEEL AND PINION MARKINGS
1. Backlash 2. Pairing numbers 3. Mating distance

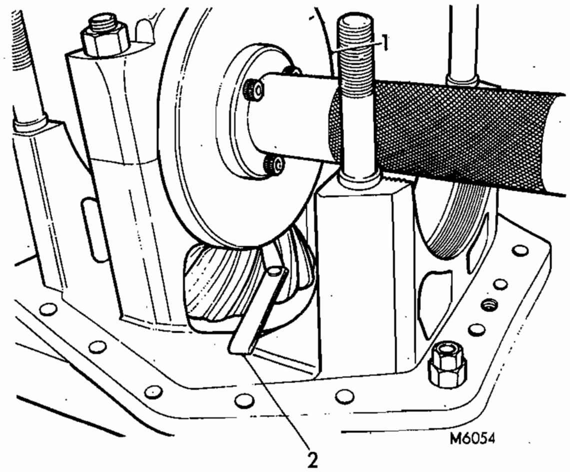


FIG. 4 SETTING PINION DEPTH
1. Tool 841SZ 2. Feeler gauges

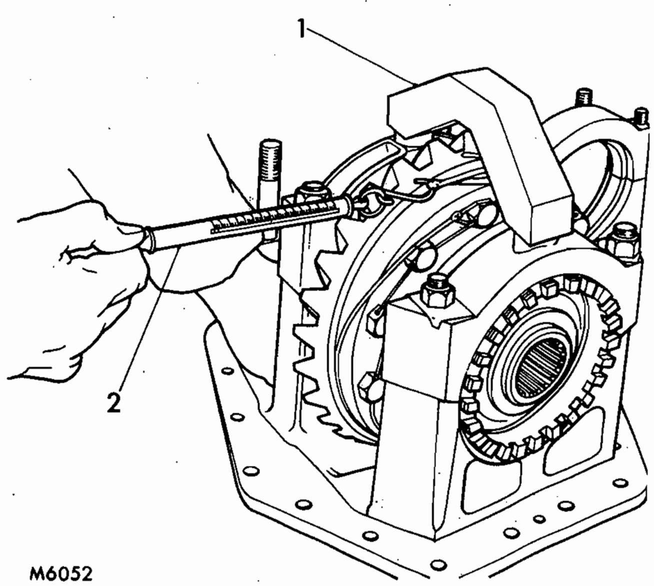


FIG. 5 CHECKING DIFFERENTIAL BEARING PRELOAD
1. Tool 3VRM-227-SZ 2. Spring balance

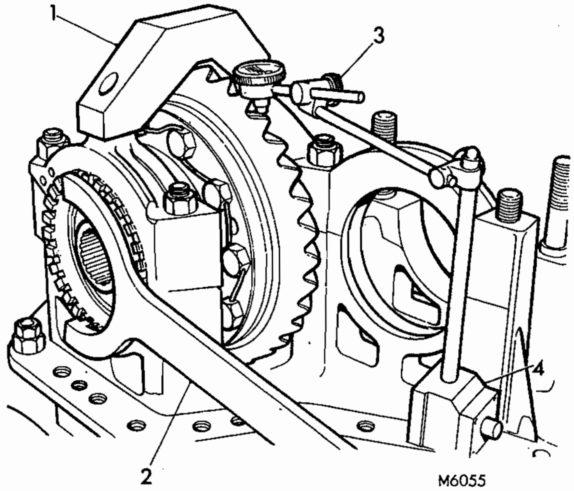


FIG. 6 CHECKING BACKLASH

1. Tool 3VRM-227-SZ
2. Tool 850SZ
3. Dial gauge
4. Magnetic base

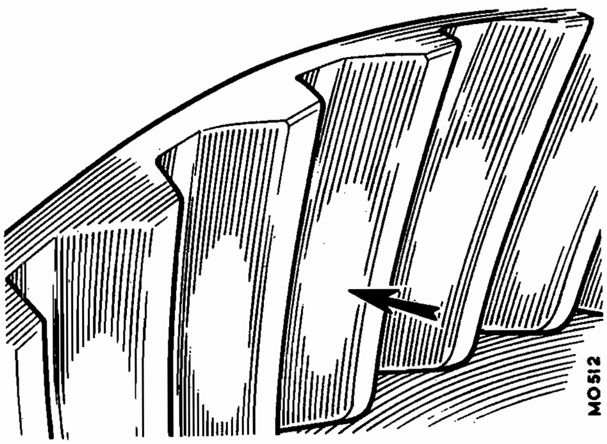


FIG. 7 CORRECT TOOTH CONTACT IMPRESSION

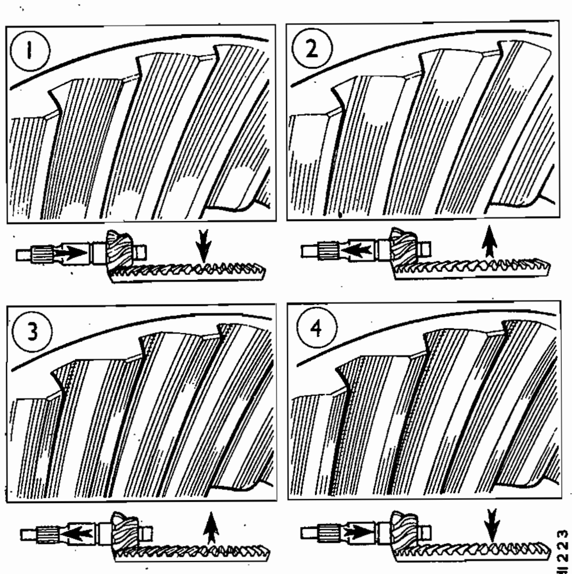


FIG. 8 ADJUSTMENT REQUIRED

10. Mount a dial gauge with magnetic base as shown in Fig. 6, and check the backlash against the figure given in Data or as etched on bevel gear. Adjust backlash as necessary by adding or subtracting shims (63) and moving ring nut by a corresponding amount, see Fig. 12 for comparison chart table.

    As a guide 0.001 in shim thickness approximates 0.003 backlash.

    Important: Care must be taken at this stage to maintain the bearing pre-load setting previously obtained.

11. Apply engineers blue to spiral bevel pinion teeth, turn the pinion and compare the tooth contact impression with Figs. 7 and 8.

12. Again mark position of ring nut in relation to differential cage; remove bridge piece tool 3VRM-227-SZ and bearing caps. Lift out differential assembly, ring nuts, and shims.

13. Fit transfer drive bearing outer race, driven gear (59), bearings (58), differential assembly shims and ring nut.

14. Fit all bearing caps and bridge piece tool. Set differential ring nut to the mark previously recorded, fit locking tab (55) and setscrew.

15. Tighten all bearing cap nuts and lock tab washers; remove bridge piece tool.

16. Fit driving head assembly to axle as directed on Page 6–1–3.

Nearside Transfer Gear

To Dismantle

1. Remove the transfer gear assembly as directed on page 6–1–2.

2. Release tab washers, remove bearing caps and nuts.

3. Lift out the gears and bearings.

4. Drive or press the bearings from the gears.

To Reassemble

1. Press bearing inner races onto the gears.

2. Locate gears and outer races in transfer gear cover, fit bearing caps and secure with nuts and tab washers.

3. Fit transfer gear assembly to axle as directed on page 6–1–2.

To Dismantle, Fig. 14

1. Chock front road wheels and isolate the batteries.

2. Slacken road wheel retaining nuts, jack wheels clear of the ground and fit axle stands.

3. Remove road wheels.

4. Release the air pressure by opening the reservoir drain taps.

5. Manually release the spring brake actuator as directed in Group 7.

6. Remove countersunk headed screws securing brake drum to hub; remove wheel stud olives and withdraw brake drum.

7. Remove axle shaft flange nuts and withdraw flange and shaft.

8. Release tab washer and remove hub bearing retaining nut using tool 836SZ.

9. Remove bearing thrust washer.

10. Withdraw hub complete with bearings and oil seal.

11. Remove axle tube collar (5).

12. Remove bearing inner race and drift or press out the oil seal and bearing outer races.

Inspection

Remove all existing grease and wash the hub and bearing in a clean solvent. Renew any component showing signs of damage, fatigue or wear beyond the limits quoted in Data.

Inspect the surface finish of the collar (5) and renew the oil seal.

To Assemble

1. Press both bearing outer races into hub.

2. Apply a layer of Lithium based high melting point grease approximately 13 mm (0.5 in) thick in recess between bearing outer races.

   Important: DO NOT completely fill this cavity with grease, a gap must be left to allow for expansion, see Fig. 9.

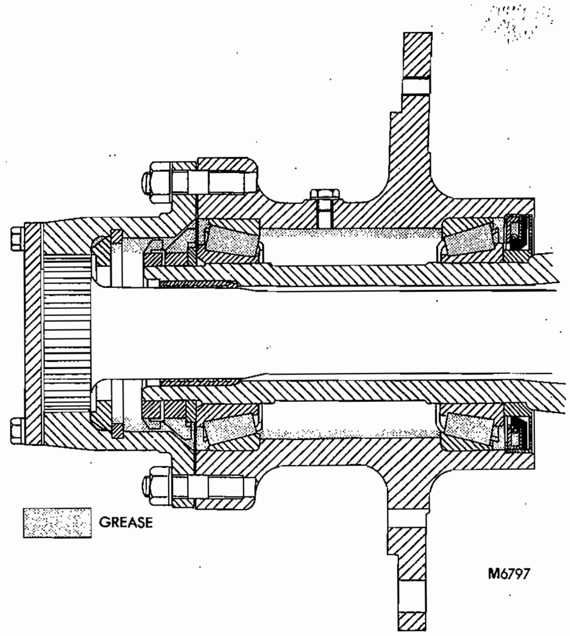


FIG. 9 HUB GREASING

3. Fit inner bearing inner race in hub.

4. Press new oil seal in hub; note the position of the seal and fit correctly.

5. Pack with grease the cavity between bearing and oil seal; knead grease well into spaces between rollers.

6. Feed on hub taking care not to damage seal, and fit outer bearing inner race.

7. Fit washer (18), locknuts (15 and 17) and lockwasher (16).

8. Mount a dial gauge as shown in Fig. 10; rock hub and adjust the inner locknut until the required end-float is recorded on gauge, see Data.

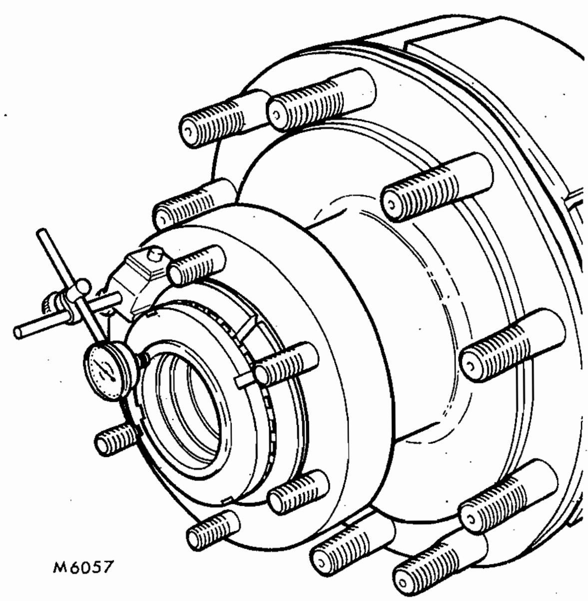


FIG. 10 CHECKING HUB BEARING END FLOAT

9. Bend the locking tab over to secure inner locknut.

10. Tighten outer locknut and bend over locking tab.

11. Apply a layer of grease approximately 13 mm (0.5 in) thick to inner face of axle flange; fit flange together with axle shaft, and securely tighten flange nuts.

12. Fit and secure brake drum using the countersunk headed screws.

13. Fit an olive to each wheel stud; position road wheels on the studs and fit and partially tighten the wheel nuts.

14. Lower wheels to ground and tighten wheel nuts in sequence to correct torque, see Data.

15. Charge air system and re-set spring brake actuator as directed in Group 7.

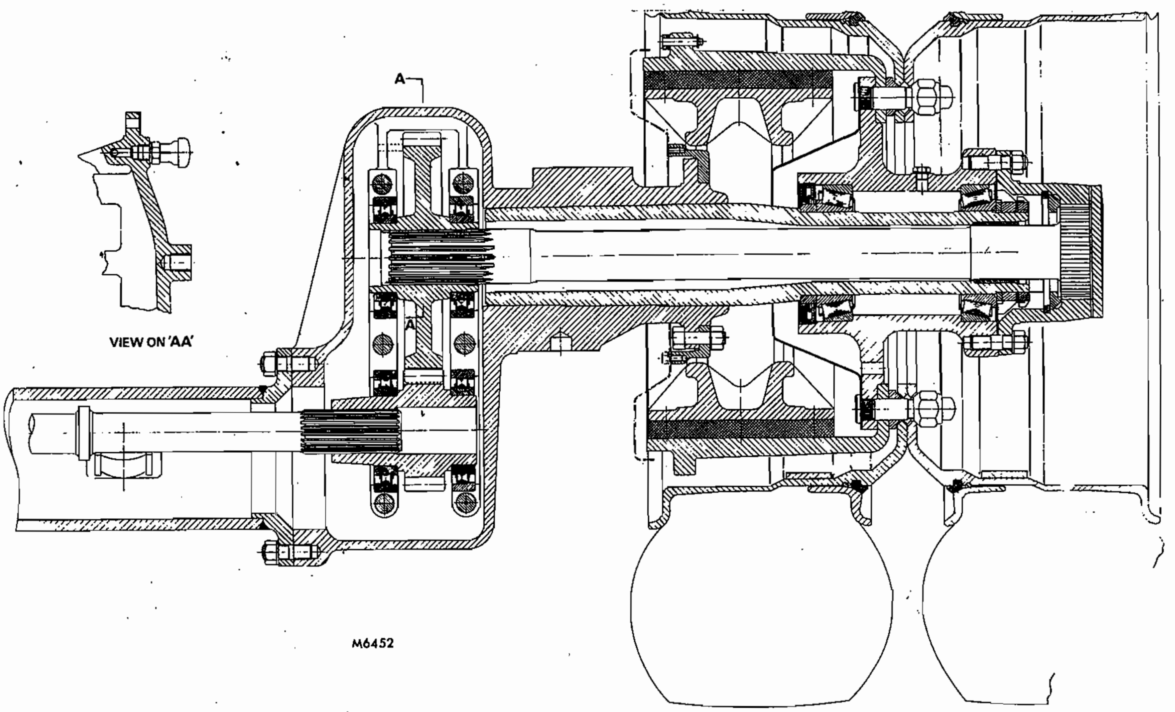
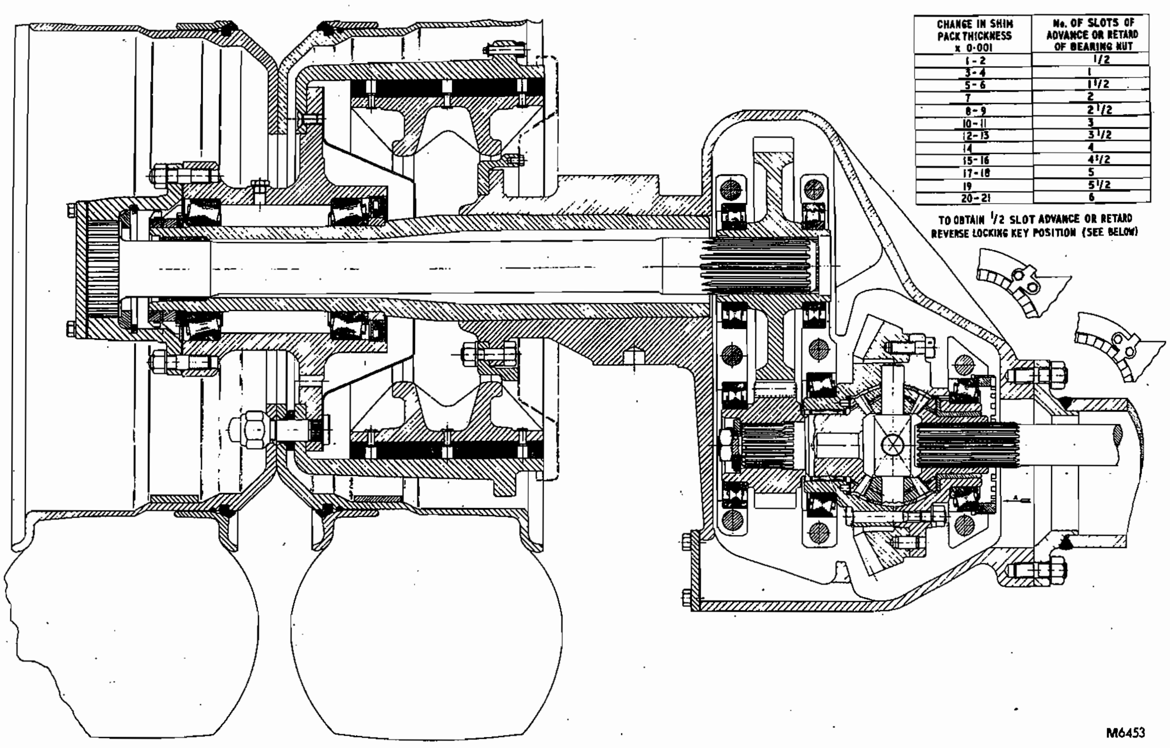


FIG. 11 SECTION THROUGH AXLE–NEARSIDE



CHANGE IN SHIM PACK THICKNESS x 0·001	No. OF SLOTS OF ADVANCE OR RETARD OF BEARING NUT
1 - 2	1/2
3 - 4	1
5 - 6	1 1/2
7	2
8 - 9	2 1/2
10 - 11	3
12 - 13	3 1/2
14	4
15 - 16	4 1/2
17 - 18	5
19	5 1/2
20 - 21	6

TO OBTAIN 1/2 SLOT ADVANCE OR RETARD REVERSE LOCKING KEY POSITION (SEE BELOW)

FIG. 12 SECTION THROUGH AXLE–OFFSIDE

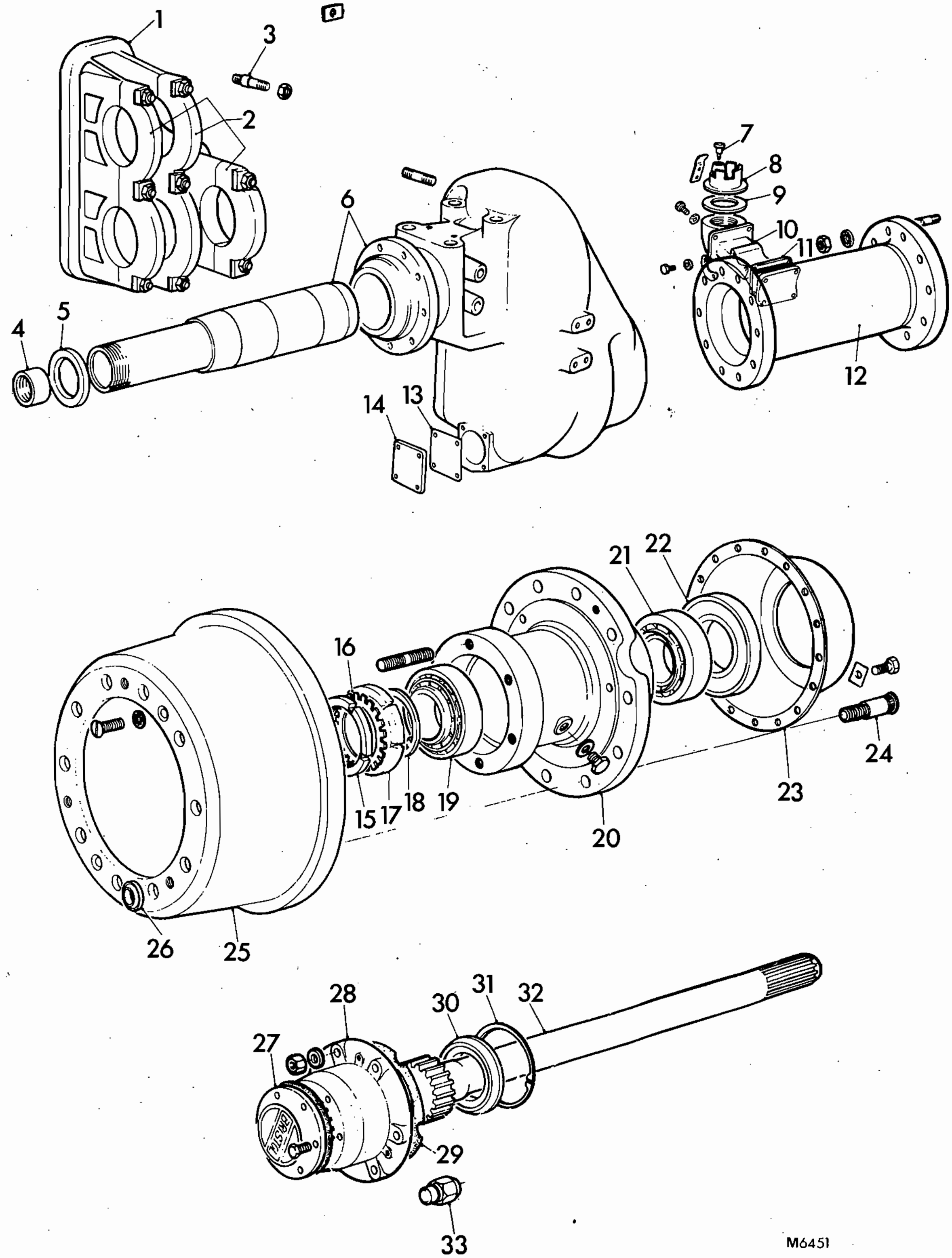


FIG. 13 EXPLODED VIEW OF HUB AND AXLE CASING

1. Driving head
2. Bearing caps
3. Stud
4. Oil return bush
5. Collar
6. Axle casing and tube
7. Dipstick
8. Oil filler cap
9. Washer
10. Oil filler
11. Joint
12. Beam
13. Joint
14. Plate
15. Locknut
16. Tab washer
17. Locknut
18. Washer
19. Outer taper roller bearing
20. Hub
21. Inner taper roller bearing
22. Oil seal
23. Oil shield
24. Wheel stud
25. Brake drum
26. Wheel olive
27. Hub cap
28. Axle shaft flange
29. Joint
30. Retaining ring
31. Circlip
32. Axle drive shaft
33. Wheel nut

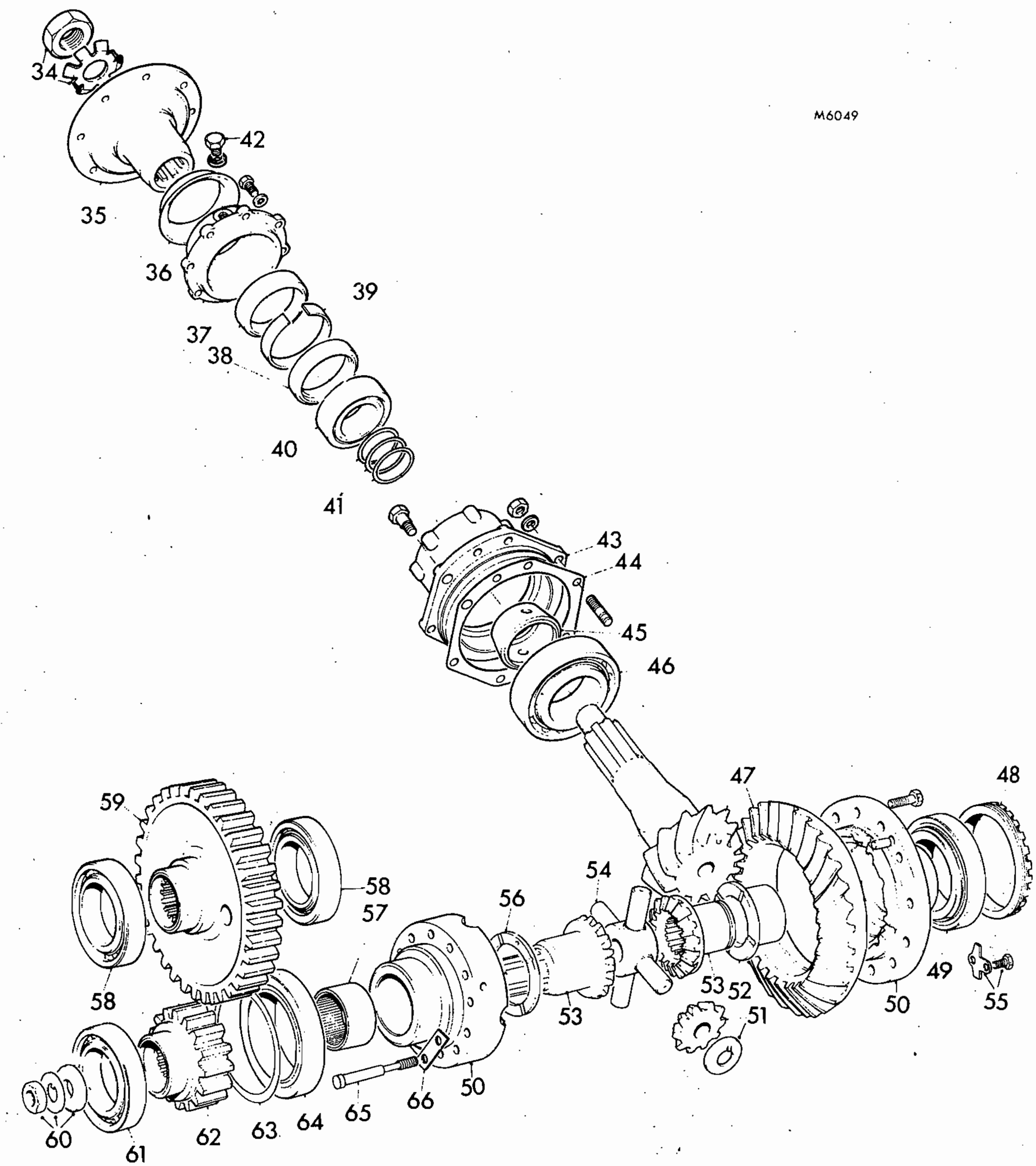


FIG. 14 EXPLODED VIEW OF DRIVING HEAD AND OFFSIDE TRANSFER GEARS

34. Nut and tab washer
35. Driving flange
36. Dust shield
37. Oil seal housing
38. Oil seal
39. Distance piece
40. Outer taper roller bearing
41. Shim
42. Plug
43. Bearing housing
44. Shims
45. Distance piece
46. Inner taper roller bearing
47. Spiral bevel gear and pinion
48. Adjustment nut
49. Differential cage bearing
50. Differential cage halves
51. Bevel pinions and thrust washers
52. Bush
53. Side bevel wheel
54. Star member
55. Locking tab and setscrew
56. Thrust washer
57. Needle bearing
58. Roller bearings
59. Spur gear
60. Washer, tab washer and nut
61. Roller bearing
62. Spur pinion
63. Shim
64. Taper roller bearing
65. Differential cage bolts
66. Tab washer

GROUP 7

BRAKES

SECTION 1N

General Information

DATA

Braking system	Air pressure operated with Clayton Dewandre or Bendix Westinghouse equipment
Unloader valve	
Cut-out pressure	8,4 kgf/cm² (120 lbf/in²)
Cut-in pressure	6,6 kgf/cm² (95 lbf/in²)
Low pressure indicator	
Operating pressure	4,1 to 5,0 kgf/cm² (59 to 71 lbf/in²)
Stop light switch	
Operating pressure	0,5 kgf/cm² (7 lbf/in²)
Pressure protection valve	
Opening pressure	4,2 kgf/cm² (60 lbf/in²)

SERVICE EXCHANGE UNITS

The following units cannot be overhauled and must be renewed with a service exchange unit at the manufacturer's prescribed intervals

Safety valve	Every year or 80 000 km (50 000 miles)
Pressure regulating valve PR2	Every year or 80 000 km (50 000 miles)
Non-return valve	Every two years or 160 000 km (100 000 miles)
Pressure reducing valve RV1	Every year or 80 000 km (50 000 miles)

The air test detailed below should be carried out at the periods shown in Group 1.

AIR PRESSURE SYSTEM TEST

1. Ensure that the brakes are correctly adjusted.
2. Chock the road wheels, release all pressure from the air system.
3. Operate the starter switch to the auxiliary circuits position.
4. Start the engine to charge the air system and note that:
   a. The brake warning buzzer should cease sounding and the brake warning light should extinguish at 3,5 to 4,2 kgf/cm² (50 to 60 lbf/in²).
   b. There should be a pause in the rising air pressure at 5,6 to 5,9 kgf/cm² (80 to 85 lbf/in²) and the gearbox auxiliary light should extinguish.
   c. When the air pressure reaches 8,4 kgf/cm² (120 lbf/in²) an audible cut-off of the unloader valve should be heard. Ensure the air pressure readings rise in unison; a maximum tolerance of 0,35 kgf/cm² (5 lbf/in²) being permissible.
5. Stop the engine and apply the foot brake. Using a soap solution check all connections for leakages.

6. Release the foot brake and start the engine. Operate the foot brake several times and check that the unloader valve cuts-in at 6,6 kgf/cm^2 (95 lbf/in^2) and cut-outs at 8,4 kgf/cm^2 (120 lbf/in^2).

7. Stop the engine and disconnect the delivery between the unloader valve and the dual brake reservoir; check the brake reservoir non-return valves for leakage. Connect the delivery pipe.

8. Disconnect the delivery pipe to the hand brake/gearbox reservoir between the take-off main feed pipe and pressure regulating valve. Check the regulating valve for leakage. Connect the delivery pipe.

9. Operate the hand control valve and check the spring brake actuators for correct operation.

10. Operate the foot brake until the brake warning buzzer sounds and the brake warning light illuminates; the air pressure gauge reading should be 4,1 to 5,0 kgf/cm^2 (59 to 71 lbf/in^2).

    Continue the brake application until the system is depleted; the air pressure gauge reading should be zero.

11. Start the engine and charge the system. Check all connections that were disconnected during inspection.

12. Stop the engine. Move the hand control valve to the 'OFF' position and apply the foot brake for 20 minutes, after this period the pressure drop must not exceed 0,7 kgf/cm^2 (10 lbf/in^2).

    Note: Ignore the initial pressure drop which occurs with the application of the hand control valve.

13. Release the brakes and charge the air system to the unloader cut-out pressure.

14. Stop the engine and move the hand control valve to the 'PARK' position and release the foot brake. After 20 minutes the pressure drop must not exceed 0,35 kgf/cm^2 (5 lbf/in^2).

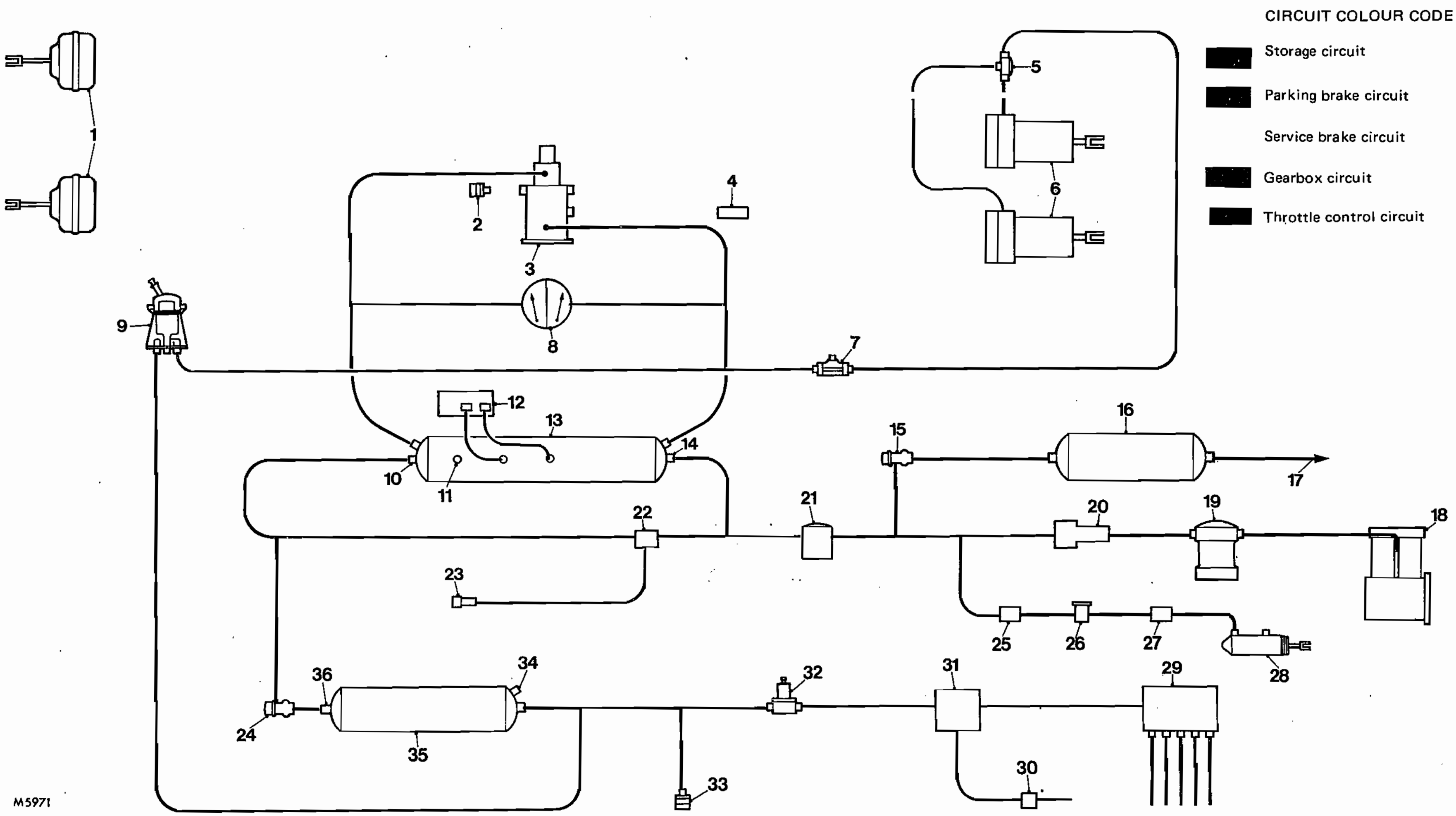


FIG. 1 DIAGRAMMATIC LAYOUT OF THE AIR SYSTEM

1. Brake chambers
2. Stop-light switch
3. Footbrake valve
4. Stop-light switch
5. Quick release valve
6. Spring brake actuators
7. Double check valve
8. Dual pressure gauge
9. Hand control valve
10. Non-return valve
11. Safety valve
12. Low pressure switches
13. Dual brake reservoir
14. Non-return valve
15. Pressure regulator valve
16. Auxiliary reservoir (when fitted)
17. Air operated doors/automatic lubrication
18. Compressor
19. Condenser
20. Unloader valve
21. Pressure protection valve.
22. Air line coupling
23. Towing air coupling (when fitted)
24. Pressure regulator valve
25. Door interlock EP unit
26. Throttle control cylinder
27. Throttle dip switch (G2 transmission only)
28. Throttle cylinder
29. 5-way EP valve
30. Reverse light switch
31. EP valve
32. Limiting/reducing valve
33. Low pressure switch (G2 transmission only)
34. Low pressure switch
35. Gearbox/handbrake reservoir
36. Non-return valve

Brake Assemblies

REMOVAL AND REFITMENT

Brake Shoes, Front and Rear

To Remove

1. *Front brake shoes:* Chock the rear road wheels, set the hand control valve to the 'PARK' position and isolate the batteries.

   Rear brake shoes: Chock the front road wheels, isolate the batteries and set the hand control valve to the 'OFF' position, if no air supply is available manually release the spring brake actuators.

   WARNING: Do not work beneath the vehicle with the jack as sole means of support; position additional supports beneath the vehicle chassis.

2. Slacken the road wheel retaining nuts; jack the wheel clear of the ground and fit axle stands.

3. Remove the road wheels.

4. Remove the countersunk setscrews securing the brake drum to the hub; remove the wheel stud olives and detach the brake drum

5. Using a strong wire hook and bar, inserted in the aperture in the brake shoe, release the tension from the return spring and withdraw the anchor pin.

6. Release the tab washer and remove the setscrew and locking plate from the fulcrum pin.

7. Extract the fulcrum pins, using a ½ in UNF withdrawal bolt inserted in the ends of the fulcrum pins, and detach the brake shoes.
   Note the positions of the leading and trailing brake shoes.

To Refit

1. Position the brake shoes with their leading and trailing edges in the correct position. Smear the fulcrum pins with oil and insert them into the brake carrier and brake shoes, ensuring that the tapped withdrawal holes in the fulcrum pins face away from the hub.

2. Renew the tab washer and fit the locking plate and setscrew.

3. Using a strong wire hook and bar, inserted in the aperture in the brake shoe, tension the return spring and fit the anchor pin.

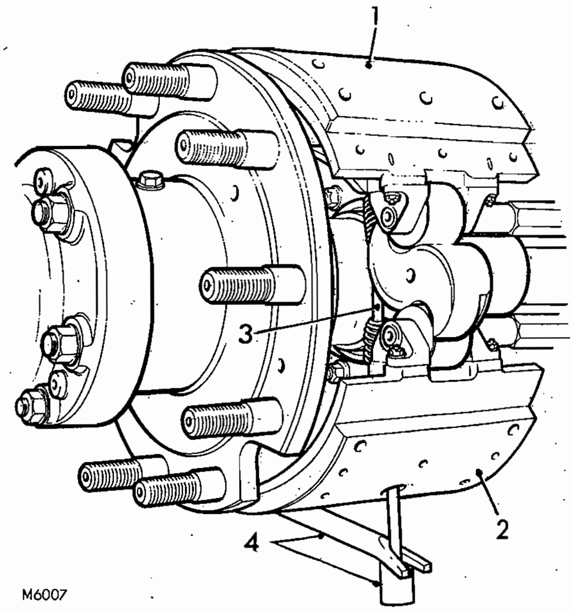


FIG. 1 RELEASING TENSION FROM RETURN SPRING

1. Trailing brake shoe
2. Leading brake shoe
3. Return spring
4. Bar and hook

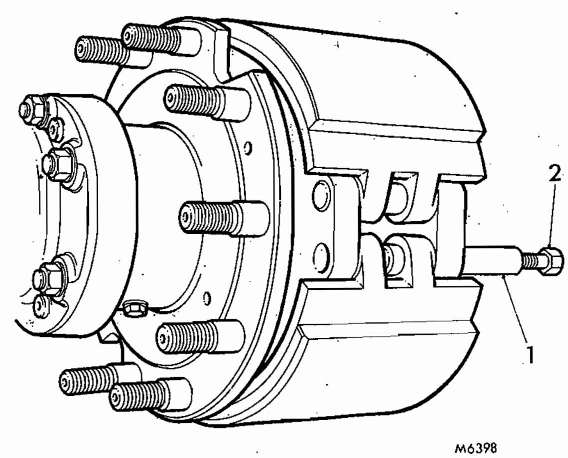


FIG. 2 REMOVAL OF FULCRUM PINS

1. Fulcrum pin
2. Withdrawal bolt

4. *Front brake shoes:* Fit the nut and a new split pin to the anchor pin.

5. Fit the brake drum and the wheel stud olives; secure the brake drum to the hub with the countersunk setscrews.

6. Fit the road wheels; do not tighten the wheel nuts.

7. Remove the axle stands and lower the vehicle to the ground. Torque tighten the wheel nuts to 28,12 kgf cm (400 lbf ft) in the sequence shown in Group 1.

8. Adjust the running clearance between the brake shoes and drum as described in 7–4C–3.

Brake Camshafts

To Remove

1. Remove the hubs, refer to Group 5 or 6.

2. Remove the slack adjusters as described on page 7–4C–1.

3. Using a strong wire hook and bar, inserted in the aperture in the brake shoe, tension the return spring and remove the anchor pin.

4. Note the sequence of the seals and felt washers and withdraw the camshaft from the brake carrier.

To Refit

1. Renew the felt washers and seals, smear the camshaft with grease and insert the camshaft into the brake carrier.

2. Tension the return spring and fit the anchor pin.

3. Fit the hubs, refer to Group 5 or 6.

4. Fit the slack adjusters as described on page 7–4C–2.

SAB Automatic Slack Adjuster

OPERATING TESTS

Check operation of the slack adjuster as follows:

1. Start the engine and fully charge the air brake system. Check that the clearance between brake shoe lining and brake drum is approximately 0,41 mm (0.016 in).

2. Apply and release brakes and note that push-rods move smoothly and promptly without binding.

3. Check the push-rod stroke. The correct free travel should be between 12,7 mm (0.50 in) and 19,0 mm (0.75 in) for a slack adjuster leverage of 166 mm (6.5 in) to 203 mm (8 in).
   If the push-rod free travel is not within the limits, check the following items:
   (a) Apply and release brakes and ensure the camshaft rotates freely.
   (b) Check that brake chamber push-rod returns to the fully released position.
   (c) Check the brake shoes for sticking, for example anchor pin seized, return spring broken.
   (d) Check that the brake shoe eccentric adjusters are secure.
   (e) Check that the control arm is secured to the anchor bracket.
   (f) Check that the anchor bracket is secured to the axle.
   (g) If either the control arm or anchor bracket is loose check the fixing screws for tightness and renew as necessary. Reset slack adjuster to operation 7 onwards, as described under To Refit, reference 7–4C–2.

4. If checks (a) to (f) prove satisfactory check that each adjuster is functioning correctly as follows:
   (a) Manually release the brakes by turning each adjusting screw in an anti-clockwise direction to give an approximate clearance of 1,5 mm (0.065 in) between brake shoe linings and the brake drum.
   (b) Apply and release the foot brake and each adjusting screw will be seen to turn on the release stroke. If no movement is observed the adjuster will have to be removed for overhaul.
   (c) If movement of adjusting screw is correct re-adjust the running clearance between linings and drum to 0,41 mm (0.016 in).

Note: When turning the adjusting screw anti-clockwise considerably more effort is required than when turning clockwise, this is also a further check that the adjuster is operating correctly. A loud clicking noise will be heard when releasing the brakes and approximately 4,15 kgf m (30 lbf ft) torque is required.

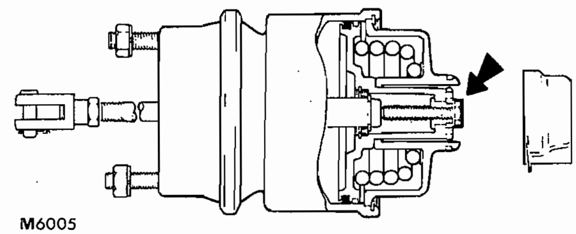


FIG. 1 BRAKE ACTUATOR RELEASE BOLT

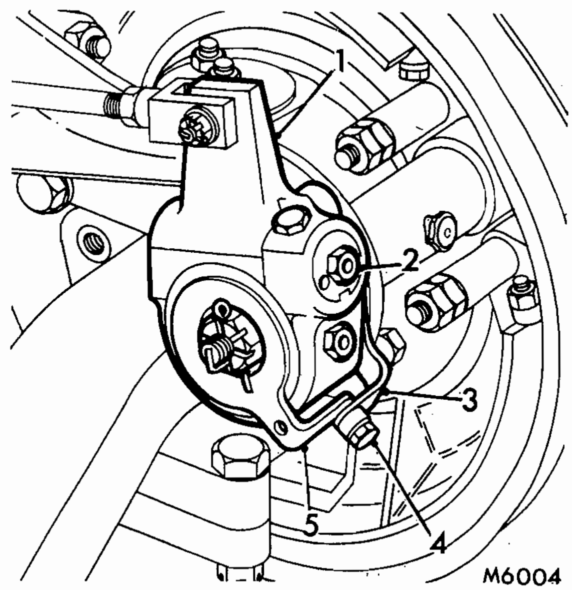


FIG. 2 VIEW OF FRONT SLACK ADJUSTER

1. Slack adjuster
2. Adjusting screw
3. Anchor bracket
4. Locking screw
5. Control arm

REMOVAL AND REFITMENT

To Remove

1. Chock the road wheels.

2. Charge the air system to the unloader cut-out pressure and set the hand control valve to the 'OFF' position or, with no air supply available, manually release the spring brake actuators (see Fig. 1) and remove the jaw-end pin.

3. Remove the split pin and nut securing the slack adjuster to the camshaft.

4. Remove the anchor locking screw and locknut securing the control arm.

5. Rotate the adjusting screw on the slack adjuster until the slack adjuster is clear of the jaw-end.

6. Lever the slack adjuster from the camshaft splines; do not hammer the slack adjuster.

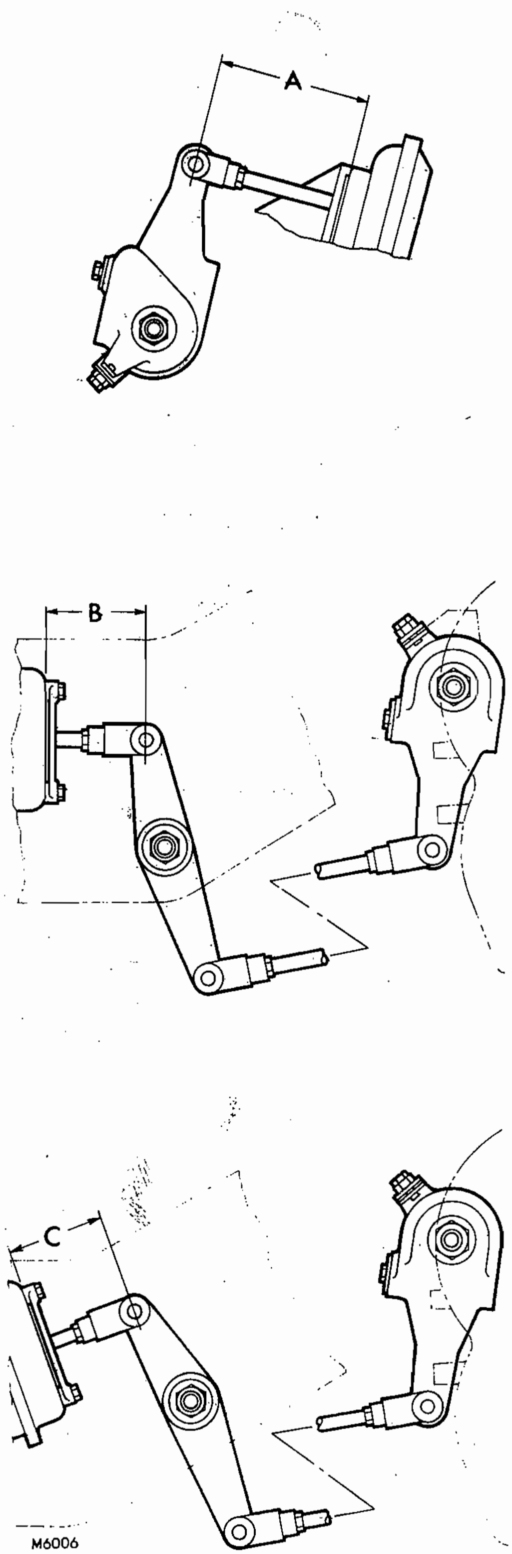


FIG. 3 ADJUSTING BRAKE CHAMBER PUSH-RODS

A = 168,2 mm (6.625 in)
B = 114,3 mm (4.50 in)
C = 123,8 mm (4.875 in)

To Refit

If the spring brake actuators have been held off by air pressure ensure the push-rods are fully back, that is, in the released position.

a. Check the air pressure reading in the driver's compartment; re-charge the air system to the unloader valve cut-out pressure.

b. Ensure that the hand control valve is in the 'OFF' position.

1. Ensure that the camshaft rotates freely without binding or sticking.

2. Ensure that the camshaft is in the normal released position and that both eccentric adjusters are at their lowest position of lift.

3. Adjust the brake chamber push-rods to the following dimensions, see Fig. 3.
Front brakes: Dimension 'A'.
Rear brakes–high frame chassis: Dimension 'B'.
Rear brakes–low frame chassis: Dimension 'C'.

4. Fit the slack adjusters to the camshaft splines, ensuring that the arrow on the slack adjuster points in the direction of the brake application. Fit the end nut and split pin.

5. Front brakes:
   a. With the brake chamber push-rods in the fully released position, rotate the adjusting screw on the slack adjuster until the slack adjuster brake lever and push-rod jaw holes are aligned; fit the securing pin.

   Important: The slack adjuster control arm must be rotated in the rotational direction of the arrow to ensure the correct operation of the slack adjuster.

   b. Rotate the slack adjuster control arm in the rotational direction of the arrow as far as it will go and fit the locking screw. If the control arm and anchor bracket holes do not align, adjust, as necessary the push-rod jaw end.

Rear brakes:

   a. With the brake chamber push-rods in the fully released position, rotate the adjusting screw of the slack adjuster. Ensure that the jaw end holes in the slack adjusters are approximately 9,5 mm (0.375 in) forward of the shock absorber bracket boss.

Important: The slack adjuster control arm must be rotated in the rotational direction of the arrow to ensure the correct operation of the slack adjuster.

b. Rotate the slack adjuster control arm in the rotational direction of the arrow as far as it will go and fit the locking screw. If the control arm and anchor bracket holes do not align, rotate the adjusting screw on the slack adjuster until the holes align; rotate the slack adjuster control arm in the rotational direction of the arrow as far as it will go and fit the locking screw.

c. Fit the brake rod to the push-rod and transfer lever.

6. Manually apply each spring brake actuator and fit the breather cap (arrow facing downwards).

7. Charge the brake system to release the spring brakes; rotate the adjusting screw on the slack adjuster to give an approximate clearance of 1,5 mm (0.065 in) between the brake shoe linings and the brake drum.

8. Check the operation of the slack adjusters by applying the brakes and noting that the adjusting screws rotate slightly at the release of the brakes.

9. Re-set the running clearance between the brake shoe linings and the brake drum to 0,41 mm (0.016 in). Ensure that both brake shoe lining clearances are equal and, if necessary, rotate the eccentric brake adjusters to achieve equal lining clearances.

Note: This clearance is important whenever new brake linings have been fitted. Failure to obtain this clearance between the linings and drum with the camshaft in the normal released position could result in the push-rod becoming fully extended.

OVERHAUL

The manufacturers recommended overhaul period is 160 000 km (100 000 miles) or 2 years.

Special Tools

When dismantling or assembling the slack adjuster it is essential that SAB special adjuster tool 407 is available, see Fig. 4 and Group 1.

A controlled turning motion of the screwed cover is necessary to accurately pre-load the spring assembly acting on the wormscrew.

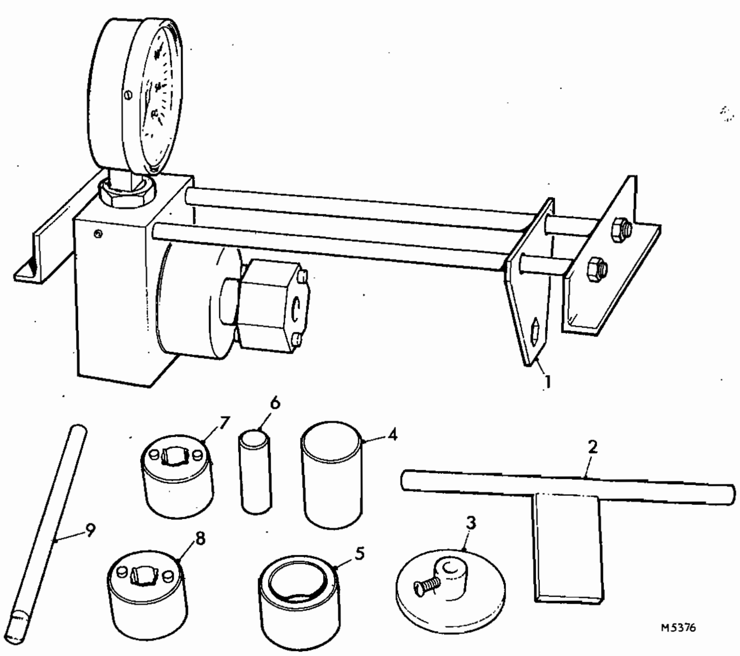


FIG. 4 SAB SPECIAL TOOLS

1. Tool 407 for setting and adjusting
2. Tool 008
3. Tool 004 for holding clock gauge
4. Tool 003
5. Tool 011
6. Tool 001
7. Tool 010 peg spanner
8. Tool 009 peg spanner
9. Tool 005 for compressing springs

To Dismantle, Fig. 5

Remove the slack adjuster from the vehicle and clean the unit in a suitable solvent before dismantling.

Note: Early type slack adjusters can be modified to the latest specification by renewing the interchangeable items shown in Fig. 5.

1. Remove the screws (31) and detach the control unit (28, 29, 30) and joint (27).
2. Remove the rack (32).
3. Release the Welch plug (24) and detach the return springs (23).
4. *Early type:* Extract the rivet (19) and remove the rear screw cover (18) using peg spanner 009. Detach the needle bearing (17), pressure disc (16) and Belleville washer assembly (15).
   Latest type: Extract the rivet (19) and remove the rear screw cover (20). Detach the coil spring (21) and pressure disc (22).
5. Extract the rivet (1) and remove the front screw cover (2) using peg spanner 009. Detach the needle bearing (3) and clutch assembly (4, 5, 6).
6. Press out the worm screw (9 or 10) and bearing (7) (in the direction of the arrow embossed on the housing) using adaptors 002 and 011.
7. Detach the worm wheel (26) and remove the 'O'-rings (25) from the worm wheel.
8. Remove the grease nipple (13) (if fitted).

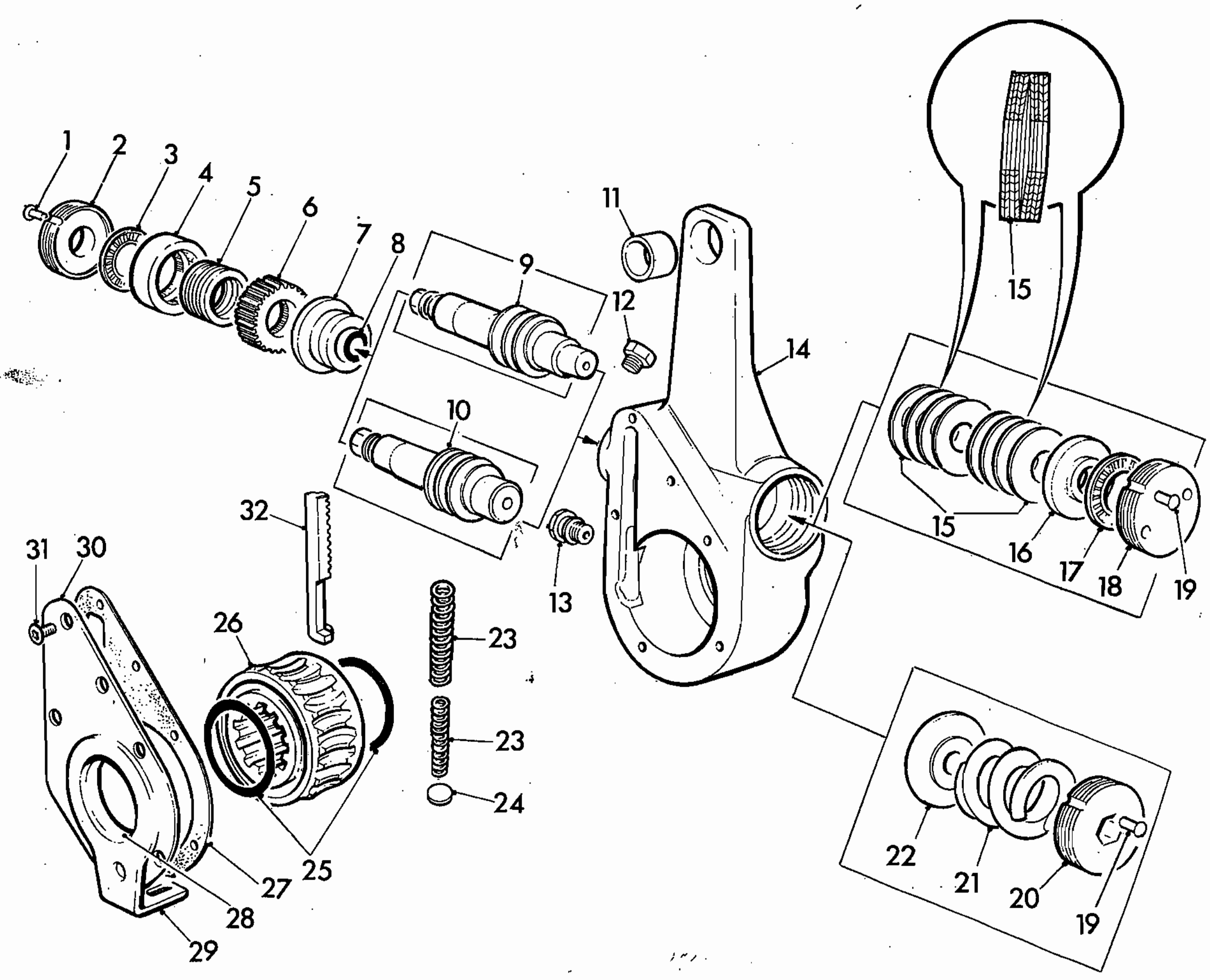


FIG. 5 EXPLODED VIEW OF SAB AUTOMATIC SLACK ADJUSTER

1. Rivet	9. Worm screw	17. Needle bearing	25. 'O'-ring
2. Front screw cover	*10. Worm screw	18. Rear screw cover	26. Worm wheel
3. Needle bearing	11. Bush	19. Rivet	27. Joint
4. Clutch ring	12. Plug	*20. Rear screw cover	28. Control disc
5. Clutch spring	13. Grease nipple	*21. Coil spring	29. Control arm
6. Clutch gear	14. Housing	*22. Pressure disc	30. Control cover
7. Bearing	15. Belleville washer assembly	23. Return spring	31. Screw
8. 'O'-ring	16. Pressure disc	24. Welch plug	32. Rack

* Latest models

To Inspect

Clean all parts thoroughly in a suitable cleaning solvent. Inspect parts and renew those that are worn or damaged.

Renew the one-way clutch assembly (4, 5, 6), 'O'-rings (8, 25), joint (27), return springs (23), Welch plug (24), rivets (1, 19) and Belleville washer assembly (15).

Special attention should be given to the following items:

1. **Housing (14)**
   Check the worm wheel housing bore for wear or damage. Renew the complete slack adjuster if the housing bore is damaged or its internal diameter exceeds 62,2 mm (2.44 in).
   Ensure the grease channels are clean and unobstructed.

2. **Worm wheel (26) and worm screw (9, 10)**
   If the teeth on one section of the worm wheel are worn it is still serviceable if turned 180°. Renew worm wheel and screw (26) and (9, 10); clutch assembly (4, 5, 6), needle bearings (3 or 17) and grease nipple (13) when applicable.
   Check the tooth height on the conical clutch, minimum height should read 0.08 mm (0.003 in).

3. **Rack (32)**
   Check the toe for wear. Excess wear will affect the running clearance. Renew as necessary.

To Reassemble, Fig. 5

Prior to assembly all components should be liberally lubricated. For correct grade of lubricant see Group 1.

1. Fit the 'O'-rings (25) to the worm wheel. Insert the worm wheel, with the step uppermost, into the housing.
2. Fit the bearing (7) over the worm screw and position in the housing. Rotate the worm screw to engage the worm wheel and press the bearing into the housing using tool 003.
   Note: Ensure the bearing seats correctly against the recess in the housing and the worm wheel is free to rotate.
3. Assemble the one-way clutch (4, 5, 6) on the worm wheel, ensuring the clutch ring (4) and clutch gear (6) are in contact with each other.
4. Fit the 'O'-ring (8), needle bearing (3) and front screw cover (2) to the worm screw and housing. Tighten the front screw cover to a torque load of 5,0 kgf m (36 lbf ft). Ensure that the one-way clutch assembly has not been compressed by rotating the worm wheel.

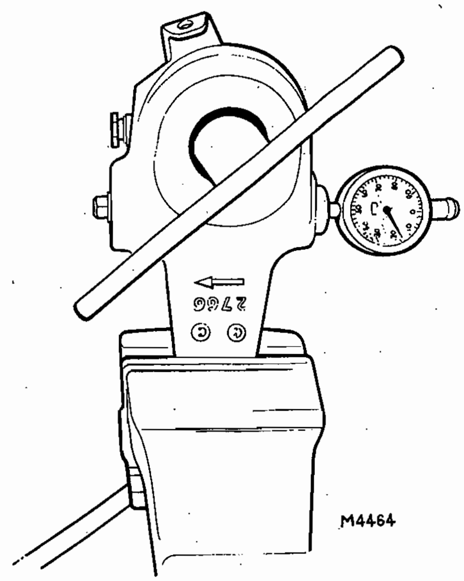


FIG. 6 CHECKING END-FLOAT OF WORM SCREW WITH SPECIAL INDICATOR GAUGE

5. Check the worm screw end-float using a dial test indicator, adaptor 004 and special tool 008, see Fig. 6. The end-float must not exceed 0,6 mm (0.024 in) or be less than 0,15 mm (0.006 in). If the end-float is not within the tolerances renew the worm screw.
6. Insert the new springs (23) in the housing and, using tool 005, compress the springs and fit the rack (32). Ensure the rack is correctly located in the housing and that the springs are correctly located on the recess of the rack. Fit a new Welch plug.
7. Using a new joint (27), fit the control unit (28, 29, 30) to the housing, ensuring the toe of the rack engages the cut out in the control disc (28).
8. Check the tooth height of the worm screw clutch using tools 008 and 004, see Fig. 6. Rotate the worm wheel in a clockwise direction and set the dial test indicator to register zero. Rotate the worm screw, using a 12 mm spanner, to record the clutch tooth height; minimum height 0,08 mm (0.0032 in).
9. Lock the front screw cover (2) with a new rivet (1).
10. *Early type:* Smear each Belleville washer (15) with grease and assemble the Belleville washers in the correct order, see inset Fig. 5. Insert the Belleville washer assembly, pressure disc (16) and needle bearing (17) into the housing. Fit the rear screw cover (18).
    Latest type: Insert pressure disc (22) and coil spring (21) into the housing. Fit the rear screw cover (20).
11. Pre-stress load the slack adjuster spring assembly, see To Adjust.
12. Fit the grease nipple (if fitted).

To Adjust

To ensure correct operation of the slack adjuster, the spring assembly must be pre-stress loaded to 400 kgf (885 lbf) using special tool 407, see Fig. 7.

1. Place tool 407 in a vice and attach peg type 009 or hexagon type 021 adaptor (depending on slack adjuster model) to tool 407.
2. Position the slack adjuster in tool, ensuring the adaptor (009 or 021) locates in the rear screw cover and that the hexagon head of the worm screw is locked in position by the moveable plate, see Fig. 7.
3. Rotate the vice handle to load the slack adjuster until the pressure gauge registers 10 kp/cm^2. Rotate the control arm in a clockwise direction to its full stroke (the rack will then be fully depressed).
4. Rotate the vice handle to load the slack adjuster until the pressure gauge registers 30 to 32 kp/cm^2 (i.e. the gauge pointer is within the black area on the gauge); the control arm should return to its original starting position.

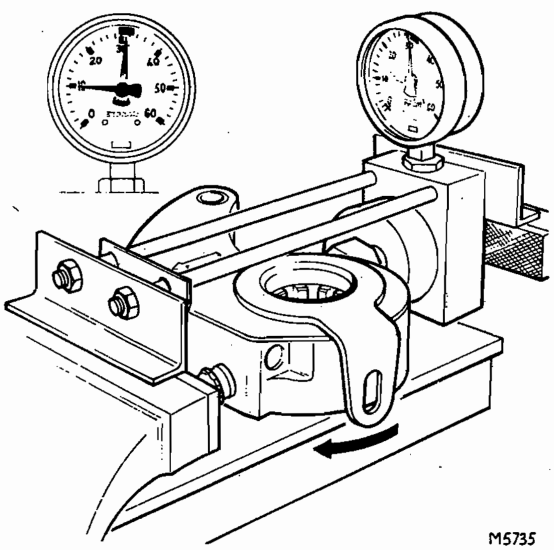


FIG. 7 PRE-STRESS LOADING THE AUTOMATIC SLACK ADJUSTER IN SAB TOOL

Note: Slight hand pressure may be required to assist the control arm overcome the drag imposed by the new 'O'-rings.

5. If the force required to return the control arm to its original position is greater or less than 30 to 32 kp/cm^2 (i.e. the gauge pointer is outside the black area on the gauge) adjust the spring assembly tension as follows:
   a. Rotate the vice handle to completely release the load from the slack adjuster.
   b. Rotate the adaptor (009 or 021) in the appropriate direction using a 32 mm spanner.
   c. Repeat operations 3 and 4 until the correct reading is obtained.
   Note: Repeat these operations twice to verify the gauge readings.
6. Remove the slack adjuster from the tool and lock the rear screw cover with a new rivet.
7. Fill the slack adjuster with grease.

Hand Control Valve

REMOVAL AND REFITMENT

To Remove

1. Chock the road wheels and release all air pressure from the air system.
2. Remove the side access panel.
3. Remove the circlip, washer and handle. Remove the circlip and extract the spring and locking sleeve from the hand control valve.
4. Disconnect the air pipes noting their relative positions and protect the ends of the pipes and the unit against the ingress of dirt and grime.
5. Remove the setscrews, nuts and washers and detach the valve from the vehicle.

To Refit

1. Fit the valve to the vehicle.
2. Connect the air pipes to their original positions.
3. Fit the locking sleeve, spring, circlip, handle, washer and circlip to the hand control valve.
4. Charge the air system and carry out the Operating and Leakage tests as described in this section.
5. Fit the side access panel.

OVERHAUL

The manufacturer's recommended overhaul period is every year or 80 000 km (50 000 miles).

A service repair kit must be obtained before dismantling the unit.

To Dismantle, Fig. 1

1. Remove the circlip (1), washer (2) and handle (3). Remove the circlip (4) and extract the spring (5) and locking sleeve (6).
2. Reference mark the top cover (7), pivot plate (8) and body to facilitate correct assembly. Remove screws and detach the top cover.
3. Remove the screws (9) and extract the handle and piston assembly. Remove and discard the piston 'O' ring (10).
4. Remove the circlip (11) and withdraw the spring retainer (12). Extract and discard the spring (13), inlet/exhaust valve (14) and 'O' ring (15).

Note: If a press and suitable adaptors are not available a new shaft and piston assembly must be fitted.

5. Compress the pivot plate and piston and drive out the pin (16) and detach the roller (17). Separate the assembly and remove and discard the seal(s) (18).

Note: Do not apply pressure to the small diameter of the piston.

Inspection

1. Clean all components in a suitable solvent and dry thoroughly.
2. Examine all components for wear, damage or distortion; renew as necessary.
3. Examine the locking sleeve and the slot in the top cover for appreciable wear or damage; renew as necessary.
4. Examine the piston bores for wear, scores or ovality; renew the valve body as necessary.
5. Examine the springs for corrosion or distortion; renew as necessary.

To Reassemble

1. Renew all items as supplied in the repair kits.
2. Grease the 'O' rings (10 and 15), seal(s) (18) and piston bores with Bendix Westinghouse Grade A grease.
3. Fit the 'O' ring (15), inlet/exhaust valve (14) and the spring (13) into the body. Insert the spring retainer (12) and fit the circlip (11).
4. Fit the seal (18) on the piston, ensuring the seal lip faces away from the piston return spring (19). Pairs of seals (when fitted) must be fitted back to back.

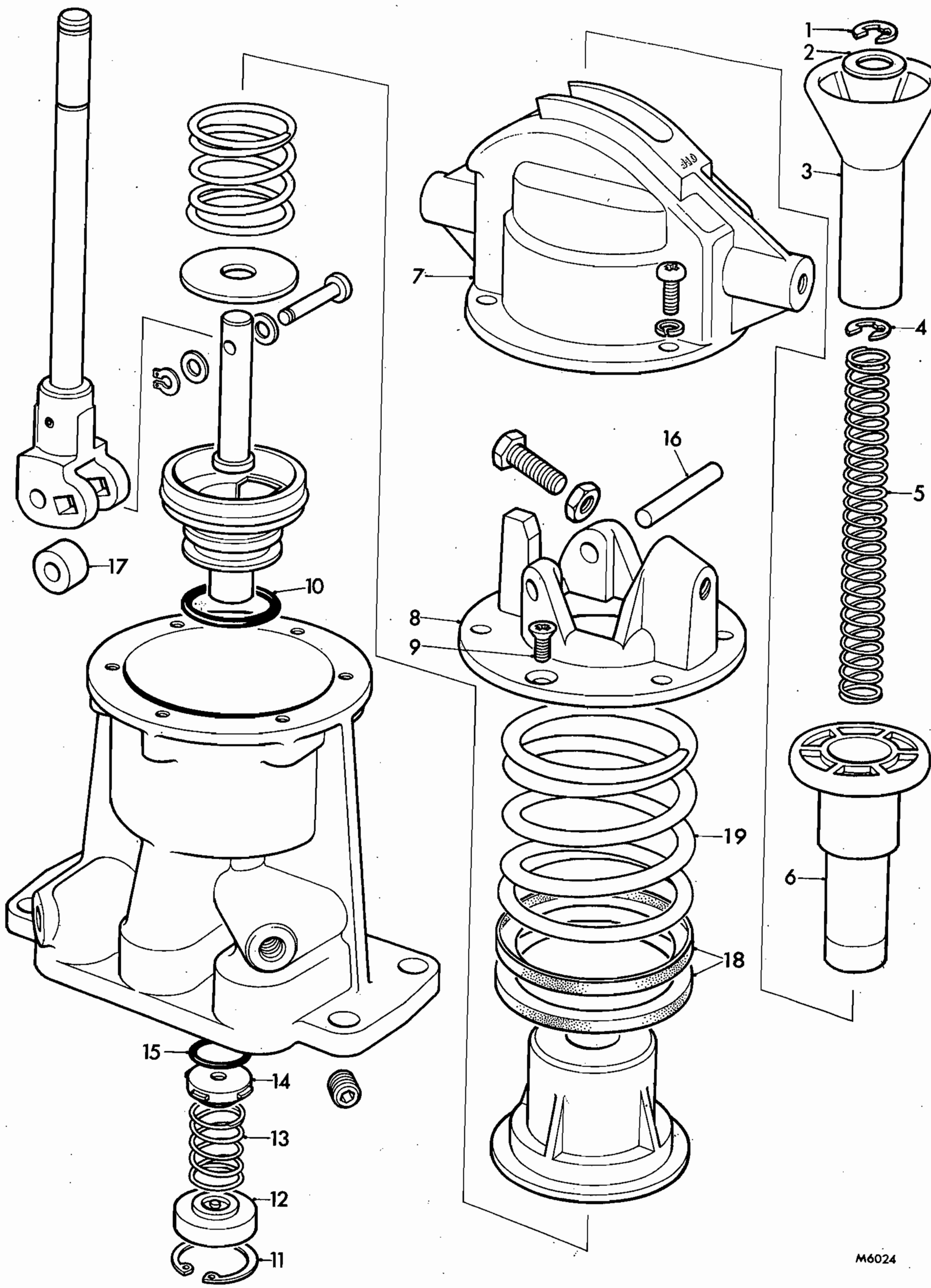


FIG. 1 EXPLODED VIEW OF HAND CONTROL VALVE

1. Circlip
2. Washer
3. Handle
4. Circlip
5. Spring
6. Locking sleeve
7. Top cover
8. Pivot plate
9. Screw
10. O-ring
11. Circlip
12. Spring retainer
13. Spring
14. Inlet/exhaust valve
15. O-ring
16. Pin
17. Roller
18. Seal
19. Piston return

5. Position the piston return spring (19) on the piston and compress the pivot plate and piston assembly, using a press and suitable adaptors, and fit the roller (17) and pin (16).

   Note: Do not apply pressure to the small diameter of the piston.

6. Insert the pivot plate and piston assembly into the body and align the reference marks made during dismantling. Secure the pivot plate to the body.

7. Fit the top cover, ensuring that the reference marks made during dismantling align.

8. Fit the locking sleeve, spring, circlip, handle, washer and circlip to the shaft.

9. Carry out the Operating and Leakage tests.

TESTING, Fig. 2

Operating Tests

Note: Examine the top cover to determine the correct pressure setting. The pressure setting will either be 8,92 kgf/cm^2 (127 lbf/in^2) (marked on the top cover) or 7,03 kgf/cm^2 (100 lbf/in^2) (top cover unmarked).

1. Connect the supply port (1) to an air supply source which is fitted with a pressure gauge Admit air to the correct test pressure:

Pressure setting	Test pressure
7,03 kgf/cm^2 (100 lbf/in^2)	8,08 kgf/cm^2 (115 lbf/in^2)
8,92 kgf/cm^2 (127 lbf/in^2)	9,84 kgf/cm^2 (140 lbf/in^2)

2. With the hand control valve handle in the 'OFF' position, ensure that air discharges from the delivery port (2). Move the handle to the 'PARK' position to cut off the air flow.

3. If necessary, rotate the setscrew (3) in the appropriate direction to adjust the delivery air pressure setting.

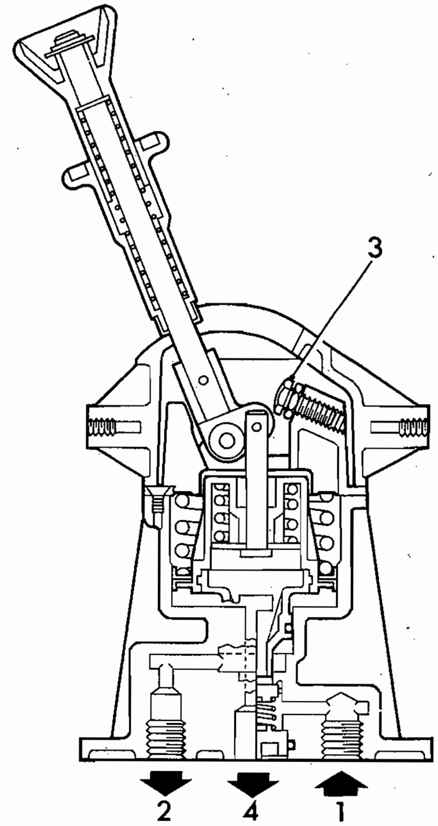


FIG. 2 SECTION THROUGH HAND CONTROL VALVE

1. Supply port
2. Delivery port
3. Setscrew
4. Exhaust port

Leakage Tests

1. Chock the road wheels and charge the system to the unloader valve cut-out pressure.

2. Fit a blanking plug to the delivery port (2) and move the valve handle to the 'PARK' position. Check the inlet valve for leakage by applying a soap solution to exhaust port (4); leakage is not permissible.

3. Move the valve handle to the 'OFF' position and check the exhaust valve for leakage by applying a soap solution to the exhaust port (4); leakage is not permissible.

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 requires 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 valves and seats.
5. Broken or weak valve springs.
6. Air leakage in system.
7. Defective unloader valve.

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 in) from the delivery port for 10 seconds and 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. If the oil carry-over test is negative, remove the compressor cylinder head and connect a separate air line of 7,03 kgf/cm^2 (100 lbf/in^2) 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. Remove the compressor as instructed on page 7–6H–3.

   Note: The cylinder liners should be held in position whilst removing the cylinder head to avoid breaking the crankcase seal.

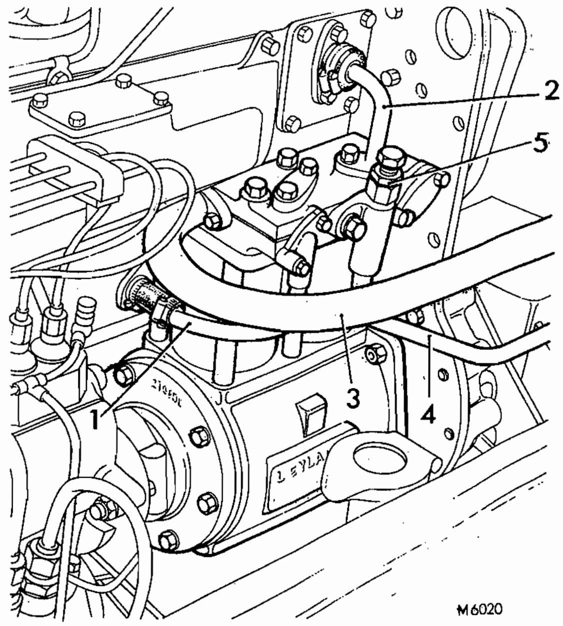


FIG. 1 COMPRESSOR IN POSITION ON ENGINE

1. Water inlet
2. Water outlet
3. Air inlet
4. Air delivery
5. Safety valve

2. Remove the cylinder head nuts and tap the cylinder head to break the joint and detach the cylinder head from the compressor.

To Refit

1. Ensure that the valves are not seized and that they are held centrally on their seats by the valve springs.
2. Renew each ring joint between the cylinders and cylinder head.
3. Fit the cylinder head and torque tighten the cylinder head nuts evenly to 2,2 kgf m (16 lbf ft).
4. Fit the compressor as instructed on page 7–6H–3.

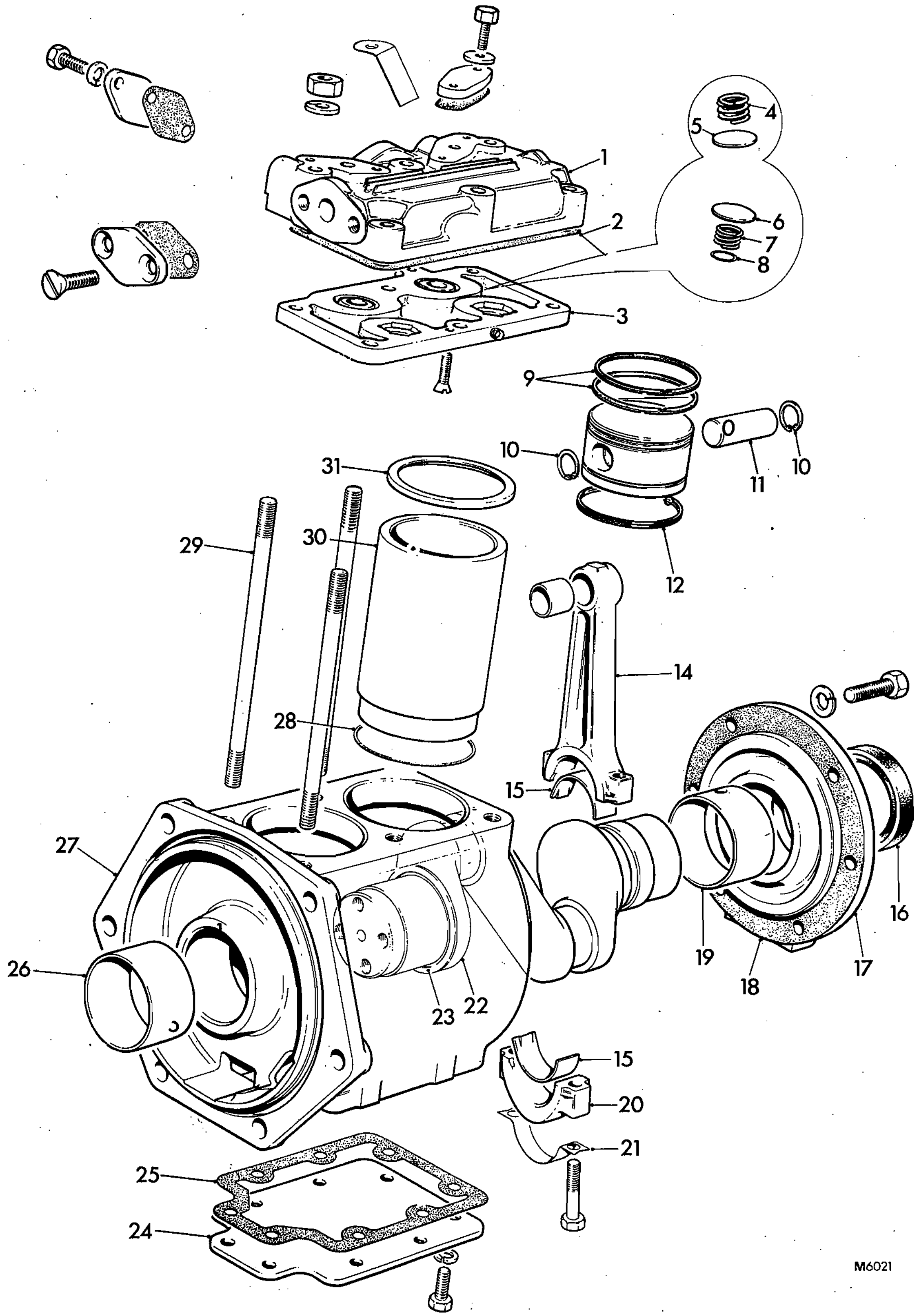


FIG. 2 EXPLODED VIEW OF COMPRESSOR

1. Cylinder head
2. Gasket
3. Base plate
4. Valve spring
5. Valve disc.
6. Valve disc
7. Valvé spring
8. Shim
9. Compression ring
10. Circlip
11. Gudgeon pin
12. Scraper ring
13. Small-end bush
14. Connecting rod.
15. Big-end bush.
16 Oil seal.
17. End cover
18. End cover joint
19. End cover bush
20. Big-end bearing cap
21. Locking strap
22. Crankshaft
23. Thrust washer
24. Base plate
25. Base plate joint
26. Crankcase bush
27. Crankcase
28. O-ring
29. Stud
30. Cylinder
31. Cylinder joint

To Remove the Compressor

1. Chock the road wheels and release all air pressure from the air system.

2. Remove the engine access panel.

3. Drain the engine cooling system.

4. Disconnect the fuel injection pump pipes and compressor pipes. Protect each bore against the ingress of dust and grime.

5. Disconnect the oil feed pipe from the compressor.

6. Remove the fuel injection pump and coupling, Group 2.

7. Remove the access cover from the timing case end of the engine and remove the bolts securing the compressor drive gear.

8. Remove the nuts and washers securing the compressor to the engine. Lever the drive gear from the compressor and lift the compressor clear.

   Note: The crankshaft must not be rotated unless the drive gear is held in mesh using special tool LC144, Group 2.

To Refit

1. Ensure that the oil return hole in the end of the compressor is clear.

2. Remove special tool if fitted to the compressor drive gear.

3. Fit gasket to compressor crankcase and fit compressor to engine. Secure compressor drive gear to crankshaft and torque tighten drive gear bolts to 10,23 kgf m (74 lbf ft).

4. Fit access cover to engine timing case.

5. Fit fuel injection pump and coupling, Group 2.

6. Fit fuel injection pump pipes and compressor pipes.

7. Connect oil feed pipe to the compressor.

8. Refill water cooling system to the correct level, Group 1.

9. Re-time the fuel injection pump, Group 2.

10. Fit engine access panel.

11. Remove the chocks and road test vehicle.

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).

A service repair kit, piston rings and cylinder liners must be obtained before dismantling the unit.

To Dismantle, Fig. 2

1. Reference mark the cylinder head, crankcase, end-cover and bottom plate to facilitate correct assembly.

2. Remove the nuts and washer and detach the cylinder head; remove and discard the cylinder sealing joints.

3. Remove the retaining screws and separate the cylinder head and remove the valve assemblies.

4. Support the pistons and withdraw and discard the cylinders from the crankcase. Remove and discard the O-ring seals.

5. Remove bottom cover and joint.

6. Rotate the crankshaft until each piston is at the bottom of its stroke and reference mark the bearing caps. Release the locking tabs and remove the connecting rod bolts and detach the bearing caps.

7. Reference mark and withdraw the connecting rod and piston assemblies from the crankcase.

8. Remove the crankcase end cover and discard the 'O'-ring and withdraw the crankshaft.

9. Remove and discard piston rings from the pistons.

10. Reference mark the pistons and connecting rod assemblies and remove the circlips and press out the gudgeon pin.

Inspection

1. Remove all traces of jointing compound from mating surfaces and loosen any carbon deposits or foreign matter on the components.

2. Ensure that the oil passages in the crankshaft and end cover are free from obstruction.

3. Clean all components and flush all oil passages with a suitable cleaning solvent and dry with compressed air.

4. Examine pistons for wear, scores, cracks or damage; renew as necessary.

5. Examine the valves and valve seats for pitting or damage; regrind the valves and seats or renew the valves/springs/seats as necessary or renew the cylinder head.

6. Test the gudgeon pin clearance in the small end bush; the clearance should not exceed 0,038 mm (0.0015 in). Renew the small end bush as necessary.

7. Inspect the crankshaft journals for scores, wear or distortion. If scored or oval more than 0,038 mm (0.0015 in) the crankshaft must be renewed.

8. Examine the crankcase, base plate, end cover, and connecting rods for cracks, damage or distortion; renew as necessary.

9. Examine the crankshaft plain bearings for wear or damage; renew as necessary.

To Reassemble, Fig. 2

1. If a new small end bush is to be fitted, drill the oil hole through the bush from the top of the connecting rod before reaming.

2. Fit thrust washer (23) to crankshaft with the white metal face towards the crankshaft. Fit a new 'O'-ring to the crankcase end cover. Insert the crankshaft into the crankcase and fit the end cover to the reference mark made during dismantling, ensuring a new joint is fitted. Check crankshaft end-float is within 0,076 to 0,539 mm (0.003 to 0.022 in). Renew thrust washer as necessary.

3. Fit each gudgeon pin to its original piston and connecting rod assembly and secure with circlips.

4. Fit the new scraper ring (12) and compression rings (9) to each piston with internal recesses or the word 'TOP' facing upwards to the piston crown. Space each piston ring gap approximately 120° to each other. Avoid positioning the gaps in line to the ends of the gudgeon pin.

5. Using new locking straps (21) and big-end bearings (15) fit the connecting rod and piston assemblies to their original positions on the crankshaft. Torque tighten the connecting rod bolts evenly to 1,40 to 1,66 kgf m (10 to 12 lbf ft) and secure each pair of bolts with the locking strap.

6. Renew the O-rings (28) and slide the new cylinder over its piston assembly and into the crankcase.

7. Renew the cylinder head gasket (2) and assemble the cylinder head, ensuring that the reference marks made during dismantling align. Ensure the valves are not trapped between the mating faces of the cylinder head, and that they are held centrally on their seats by the valve springs. Torque tighten the securing screws on the underside of the cylinder head evenly to 0,96 kgf m (7 lbf ft).

8. Fit new cylinder joints on the cylinders and correctly position head on the studs. Torque tighten the cylinder head nuts evenly to 2,2 kgf m (16 lbf ft)

9. Rotate the crankshaft and apply clean engine oil over the crankshaft and cylinder bores. Pour sufficent oil into the crankshaft to provide splash lubrication during the initial build-up of the oil pressure. For the correct grade of oil, Group 1.

10. Renew joint to the base cover and torque tighten the setscrews evenly to 1,4 kgf m (10 lbf ft).

Air Compressor — Gardner Engines

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 requires 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 valves and seats.
5. Broken or weak valve springs.
6. Air leakage in system.
7. Defective unloader valve.

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 and 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. If the oil carry-over test is negative, remove the compressor cylinder head and connect a separate air line of 7,03 kgf/cm^2 (100 lbf/in^2) 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. Chock the road wheels and release all air pressure from the air system.
2. Remove the engine access panel.
3. Drain the engine cooling system.

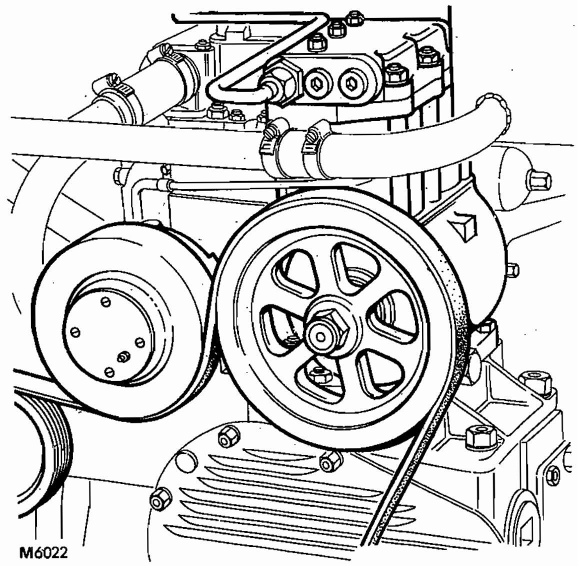


FIG. 1 COMPRESSOR IN POSITION ON ENGINE

4. Disconnect the air and water pipes from the cylinder head. Protect each bore against the ingress of dust and grime.

   Note: The cylinder liners should be held in position whilst removing the cylinder head to avoid breaking the crankcase seal.

5. Remove the cylinder head nuts and tap the cylinder head to break the joint and detach the cylinder head from the compressor.

To Refit

1. Ensure that the valves are not seized and that they are held centrally on their seats by the valve springs.
2. Renew each ring joint between the cylinders and cylinder head.
3. Fit the cylinder head and torque tighten the cylinder head nuts evenly to 2,2 kgf m (16 lbf ft).
4. Connect the air and water pipes to the cylinder head.
5. Refill the cooling system to the correct level, Group 1.
6. Fit the engine access panel.
7. Remove the chocks and road test the vehicle.

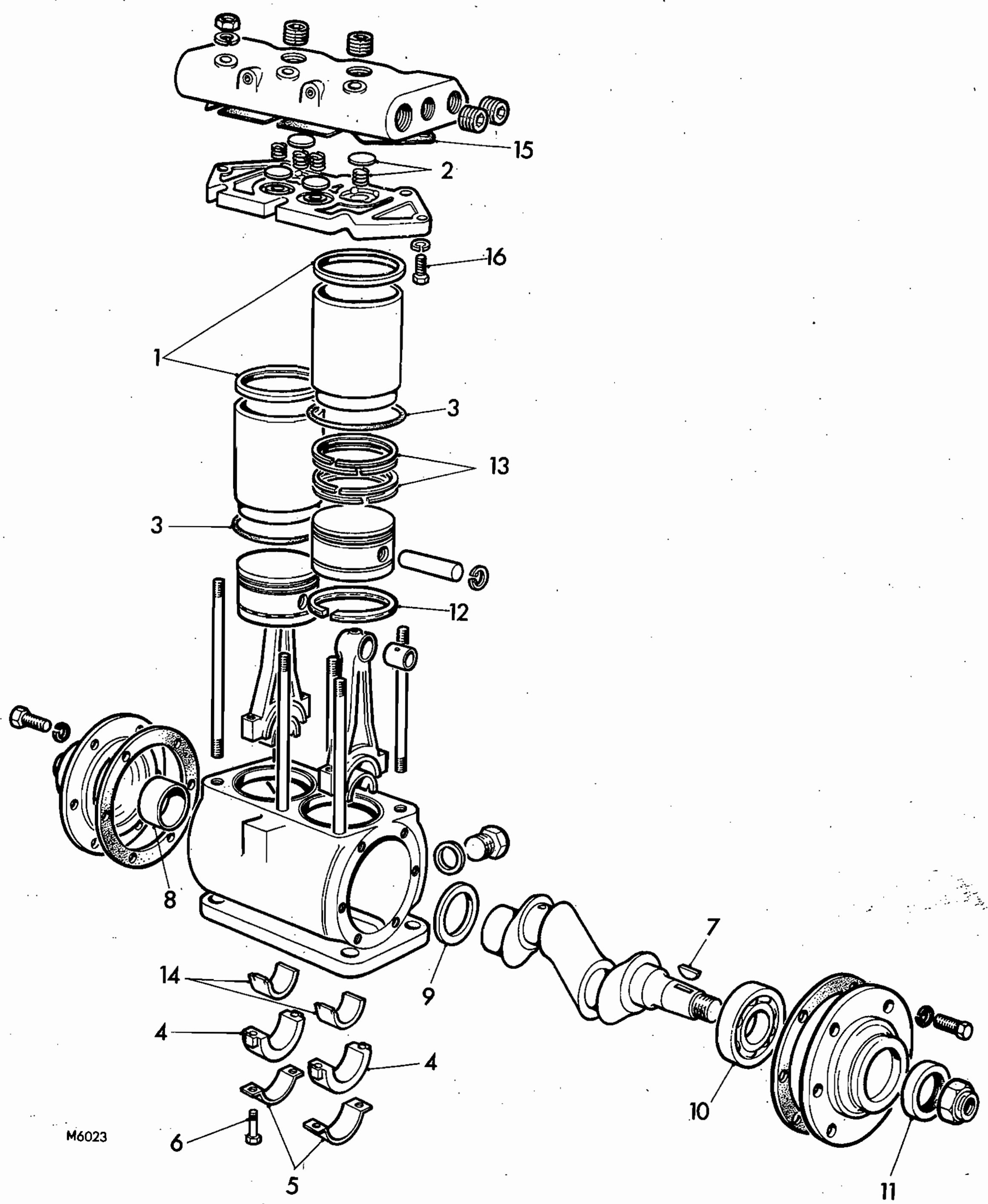


FIG. 2 EXPLODED VIEW OF COMPRESSOR

1. Sealing joints
2. Valve assemblies
3. O-ring seals
4. Bearing caps
5. Locking tabs
6. Connecting rod bolts
7. Woodruff key
8. Plain bearing
9. Thrust washer
10. Ball race
11. Oil seal
12 Scraper ring
13 Compression ring
14. Big-end bearings
15. Gasket
16. Screw

REMOVAL AND REFITMENT

To Remove the Compressor

1. Chock the road wheels and release all air pressure from the air system.
2. Remove the engine access panels.
3. Drain the engine cooling system.
4. Release the drive belt tensioner and detach the drive belt.
5. Remove the compressor drive pulley.
6. Disconnect the air and water pipes from the cylinder head. Protect each bore against the ingress of dirt and grime.
7. Disconnect the oil feed pipe from the compressor.
8. Remove the securing nuts and detach the compressor from the engine.

To Refit

1. Remove all traces of jointing compound from the mating surfaces of the compressor and compressor mounting bracket. Ensure that the mounting bracket oil holes are free from obstructions.
2. Using a new gasket fit the compressor to the engine.
3. Connect the oil feed pipe to the compressor.
4. Connect the water and air pipes to the cylinder head.
5. Fit the compressor drive pulley.
6. Fit the drive belt and, using the belt tensioner, adjust the belt tension until there is no appreciable deflection under normal hand pressure at the centre of the longest run.
7. Refill the cooling system to the correct level, Group 1.

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).

A service repair kit, piston rings and cylinder liners must be obtained before dismantling the unit.

To Dismantle, Fig. 2

1. Reference mark the cylinder head, crankcase and end-covers to facilitate correct assembly.
2. Remove the nuts and washers and detach the cylinder head; remove and discard the cylinder sealing joints (1).
3. Remove the retaining screws and separate the cylinder head and remove the valve assemblies (2).
4. Support the pistons and withdraw and discard the cylinders from the crankcase. Remove and discard the O-ring seals (3).
5. Rotate the crankshaft until each piston is at the bottom of its stroke and reference mark the bearing caps (4). Release the locking tabs (5), remove the connecting rod bolts (6) and detach the bearing caps.
6. Reference mark and withdraw the connecting rod and piston assemblies from the crankcase.
7. Remove the Woodruff key (7) from the crankshaft.
8. Remove the crankcase end covers and withdraw the crankshaft.
9. Remove the plain bearing (8), thrust washer (9) and ball race (10) from the crankshaft.
10. Remove the oil seal (11) from the end cover.
11. Remove the crankcase end covers and withdraw the crankshaft.
12. Remove and discard piston rings from the pistons.
13. Reference mark the pistons and connecting rod assemblies and remove the circlips and press out the gudgeon pin.

Inspection

1. Remove all traces of jointing compound from mating surfaces and loosen any carbon deposits of foreign matter on the components.
2. Ensure that the oil passages in the crankshaft and end cover are free from obstruction.
3. Clean all components and flush all oil passages with a suitable cleaning solvent and dry with compressed air.
4. Examine pistons for wear, scores, cracks or damage; renew as necessary.

5. Examine the valves and valve seats for pitting or damage; regrind the valves and seats or renew the valves/springs/seats as necessary or renew the cylinder head.

6. Test the gudgeon pin clearance in the small end bush; the clearance should not exceed 0,038 mm (0.0015 in). Renew the small end bush as necessary.

7. Inspect the crankshaft journals for scores wear or distortion. If scored or oval more than 0,038 mm (0.0015 in) the crankshaft must be renewed.

8. Examine the crankcase, end covers, and connecting rods for cracks, damage or distortion; renew as necessary.

9. Examine the crankshaft plain bearing and ball race for wear, damage or distortion; renew as necessary.

10. Examine the end-cover oil seal for damage or distortion; renew as necessary.

To Reassemble, Fig. 2

1. If a new small end bush is to be fitted, drill the oil hole through the bush from the top of the connecting rod before reaming.

2. Press the ball race (10) and end-cover on the crankshaft.

3. Fit the thrust washer (9) to the crankshaft with the white metal face towards the crankshaft. Insert the crankshaft into the crankcase and fit the plain bearing (8) and end-cover, ensuring the reference marks made during dismantling align and that new joints are fitted. Check that the crankshaft end-float is within 0,076 to 0,559 mm (0.003 to 0.022 in); renew the thrust washer as necessary.

4. Fit the oil seal (11) to the end-cover and fit the Woodruff key (7) to the crankshaft.

5. Fit each gudgeon pin to its original piston and connecting rod assembly and secure with circlips.

6. Fit the new scraper ring (12) and compression rings (13) to each piston with internal recesses or the word 'TOP' facing upwards to the piston crown. Space each piston ring gap approximately 120° to each other. Avoid positioning the gaps in line to the ends of the gudgeon pin.

7. Using new locking straps (5) and big-end bearings (14) fit the connecting rod and piston assemblies to their original positions on the crankshaft. Torque tighten the connecting rod bolts (6) evenly to 1,40 to 1,66 kgf m (10 to 12 lbf ft) and secure each pair of bolts with the locking strap.

8. Renew the O-rings (3) and slide the new cylinder over its piston assembly and into the crankcase.

9. Renew the cylinder head gasket (15) and assemble the cylinder head, ensuring that the reference marks made during dismantling align. Ensure the valves are not trapped between the mating faces of the cylinder head, and that they are held centrally on their seats by the valve springs. Torque tighten the securing screws (16) on the underside of the cylinder head evenly to 0,96 kgf m (7 lbf ft).

10. Fit new cylinder joints on the cylinders and correctly position head on the studs. Torque tighten the cylinder head nuts evenly to 2,2 kgf m (16 lbf ft).

11. Rotate the crankshaft and apply clean engine oil over the crankshaft and cylinder bores. Pour sufficient oil into the crankshaft to provide splash lubrication during the initial build-up of the oil pressure. For the correct grade of oil, Group 1.

Unloader Valve

REMOVAL AND REFITMENT

To Remove

1. Release all air pressure from the system.

2. Brush away dirt from air line connections. Disconnect air lines from the unit and take precautions to prevent dirt from entering the valve and air lines.

3. Remove valve from its mounting.

To Refit

1. Remount valve and connect air lines as originally fitted.

2. After refitting, it may be necessary to adjust the valve as described under Adjustment.

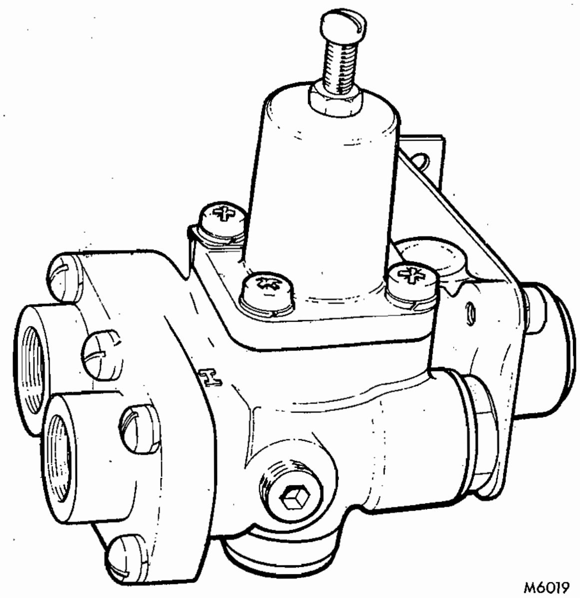


FIG. 1 GENERAL VIEW OF LINE TYPE UNLOADER VALVE

OVERHAUL

The manufacturer's recommended overhaul period is every year or 80 000 km (50 000 miles).

A service repair kit must be obtained before dismantling the unit.

To Dismantle, Fig 2

1. Before dismantling unloader valve, scribe lines across valve body and covers to ensure correct reassembly.

2. Holding valve in a vice fitted with soft jaw inserts, slacken locknut and unscrew adjusting screw (24) from top cover.

3. Holding the cover against tension of spring in a vice, progressively slacken the four retaining setscrews (23), then remove top cover complete with setting spring (20).

4. Withdraw spring and seat from the top cover, taking care to avoid losing the spacing washer, if fitted. Examine the spring for signs of corrosion or distortion and renew if necessary.

5. Withdraw diaphragm assembly from valve body, unscrew self locking nut (28) from plunger stem (31), and remove the spring guide, diaphragm followers, fabric washer and O-ring from plunger stem.

6. Unscrew retaining screw from governor exhaust check valve; remove the plate and discard valve.

7. Unscrew exhaust nut (1) and carefully remove spring and valve assembly from body.

8. Progressively slacken the six setscrews retaining unloader valve end cover (42), and remove the screws, washers, cover, joint, spring and spring guide.

9. Withdraw inlet filter element (35) from valve body.

10. Unscrew the large hexagon plug at the other end of unloader plunger chamber, and remove and discard sealing ring.

11. Holding unloader plunger with a screwdriver unscrew the self locking nut from plunger stem, remove the unloader valve disc, nut and washer. Discard unloader valve disc and self-locking nut.

12. Withdraw plunger from valve body and remove and discard the plunger sealing ring.

13. Remove the two setscrews securing end cover and bracket to body.

14. Separate cover and bracket and discard sealing rings.

15. Withdraw circlip (7) securing the check valve assembly (6) and remove and discard check valve.

To Reassemble

1. Before assembly it is advisable to renew all rubber components. Clean all metal parts in a suitable solvent and blow dry with compressed air.

2. Smear all the working surfaces, plunger bores and O-rings with grease, see Group 1.

3. Fit a new check valve assembly in the valve body and fit the circlip, ensuring that the circlip is correctly located in its groove.

4. Fit new sealing rings between valve body and bracket and between bracket and end cover.

5. Align the marks made before dismantling and fit bracket and end cover to valve body.

6. Refit the two setscrews and tighten securely.

7. Fit a new sealing ring on unloader valve plunger and fit plunger in the valve body.

8. Place a new unloader valve rubber on plunger stem with the smooth face towards the seat in valve body.

9. Fit the washer and new self-locking nut on plunger stem, hold plunger with a screwdriver, and tighten self-locking nut.

10. Place a new sealing ring on hexagon plug and screw plug into unloader chamber.

11. If the inlet filter element is clean and undamaged, position it in its housing in valve body. Otherwise fit a new element.

12. Place spring and spring guide over unloader valve, fit a new joint and fit cover, taking care to observe the alignment marks.

13. Fit the six setscrews and tighten evenly and securely.

14. Using a new inlet exhaust valve, fit valve assembly in the body.

15. Fit the washer and exhaust nut and tighten securely.

TESTING

Operating Tests

1. Start the engine and note pressure registered by the air gauge when unloader valve cuts out and further compression of air ceases. If there is a marked difference between the pressure registered by the air gauge and the required pressure, see DATA, check the actual pressure by using a test gauge.

2. With the engine running, slowly reduce air pressure in system and note pressure when the unloader valve cuts-in and compression of air is resumed.

   Note: The pressure difference between the cut-out and cut-in settings is fixed and cannot be adjusted. This pressure difference varies between 0.84 and 1.34 kgf/cm^2 (12 and 18 lbf/in^2) according to the pressure setting of the particular valve.

Leakage Tests

Note: In operations 2, 5 and 6, leakage in excess of a one inch (25 mm) soap bubble in five seconds is not permissible.

1. Charge air system to just below unloader valve cut-out pressure and then stop engine. Coat the entire unloader valve and air line connections with soap solution to test for air leakage.

2. Leakage from governor exhaust check valve indicates that one or more of the following parts is defective: governor inlet valve, inlet valve seat, governor plunger sealing ring or unloader plunger sealing ring. Leakage from the unloader exhaust indicates that the unloader valve or seat is defective.

3. Air leakage from any other part of the valve, or from the air line connections, is not permissible. Leakage from the vent in the top cover indicates that the diaphragm has ruptured.

4. Start engine to charge the reservoir to unloader valve cut-out pressure. After valve has unloaded, stop engine.

5. Coat governor exhaust check valve with soap solution to test governor exhaust valve or seat for air leakage.

6. Coat unloader exhaust check valve with soap solution to test non-return valve and unloader plunger sealing ring for leakage.

7. Coat valve body and plugs with soap solution; leakage is not permissible.

8. If the tests indicate defective parts or loose connections, these must be rectified.

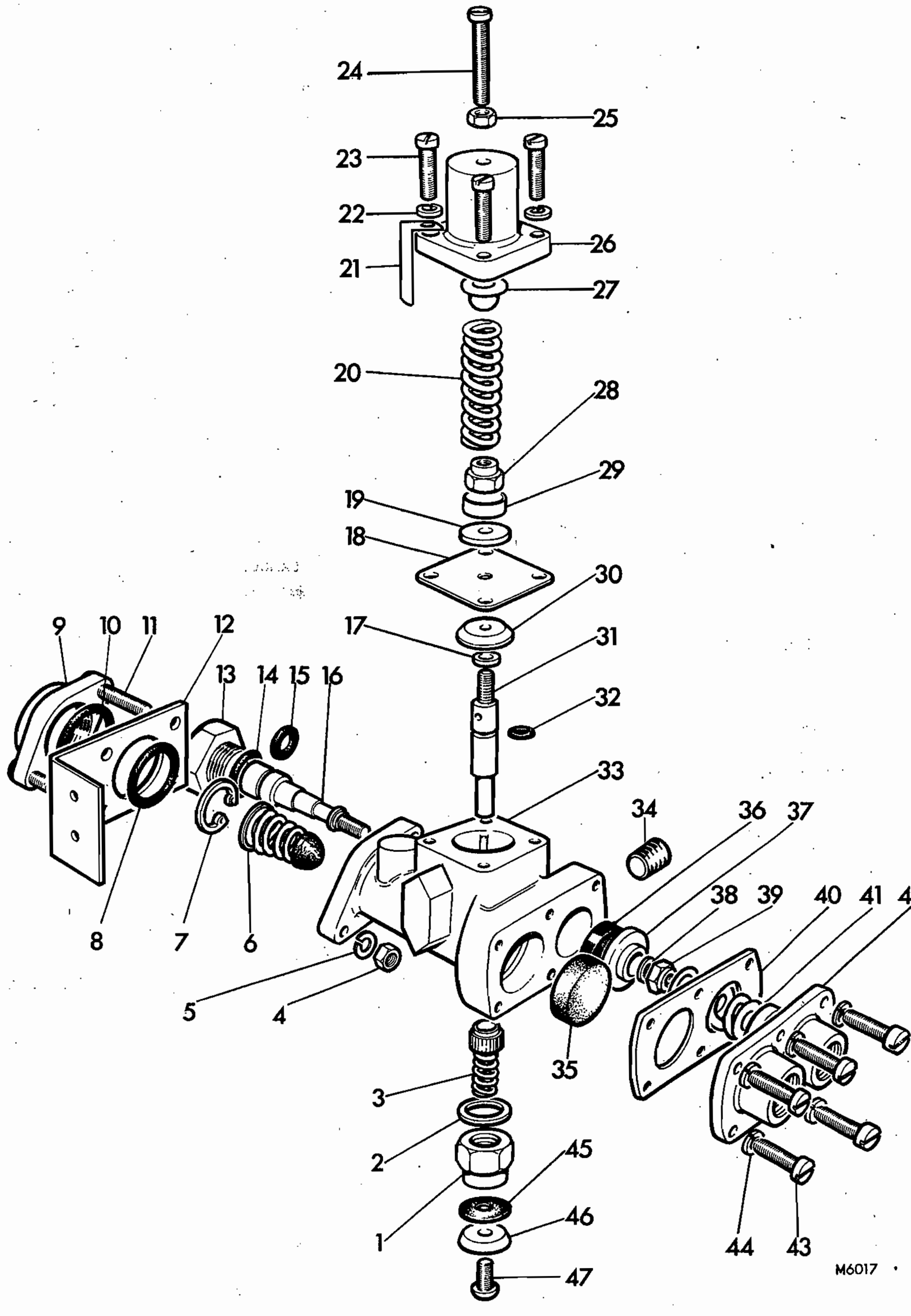


FIG. 2 EXPLODED VIEW OF UNLOADER VALVE

1. Exhaust nut
2. Washer
3. Inlet/exhaust valve assembly
4. Nut
5. Washer
6. Check valve assembly
7. Circlip
8. Sealing ring
9. End cover
10. Sealing ring
11. Setscrew
12. Bracket
13. Plug
14. Sealing ring
15. O-ring
16. Unloader valve plunger
17. Fabric washer
18. Diaphragm
19. Diaphragm follower
20. Setting spring
21. Identification tag
22. Spring washer
23. Setscrew
24. Adjusting screw
25. Locknut
26. Top cover
27. Spring seat
28. Self locking nut
29. Spring guide
30. Diaphragm follower
31. Governor plunger
32. O-ring
33. Valve body
34. Plug
35. Inlet filter element
36. Unloader valve disc
37. Unloader spring guide
38. Washer
39. Self locking nut
40. Joint
41. Unloader spring
42. End cover
43. Setscrew
44. Spring washer
45. Governor exhaust check valve
46. Retainer
47. Retainer setscrew

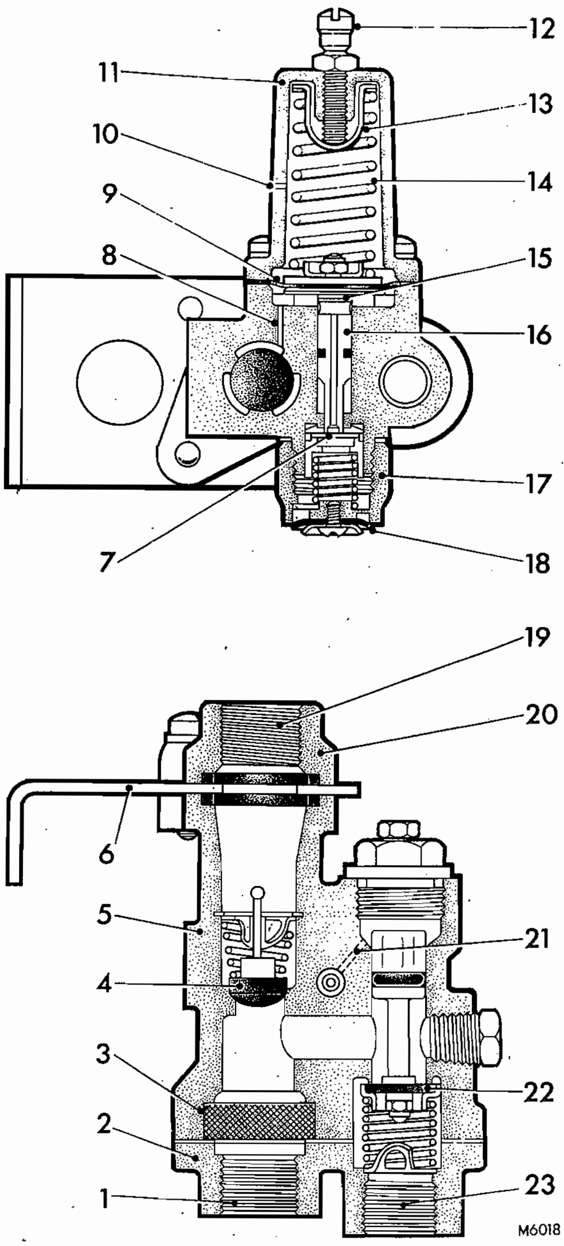


FIG. 3 SECTIONS THROUGH A TYPICAL VALVE

1. Inlet port
2. Cover
3. Filter
4. Check valve
5. Body
6. Mounting bracket
7. Inlet-exhaust valve
8. Air passage to governor
9. Diaphragm
10. Vent
11. Cover
12. Adjuster screw
13. Spring seat
14. Pressure setting spring
15. Fabric washer
16. Governor plunger
17. Exhaust nut
18. Governor exhaust diaphragm
19. Delivery port
20. End cover
21. Air passage to unloader plunger
22. Unloader valve
23. Exhaust port

Adjustment after Testing

1. The unloader valve does not normally require maintenance between overhauls but if at any time the pressure gauge gives a reading in excess of maximum cut-out pressure, as detailed in Group 1, then the unloader requires adjustment which should be carried out as follows:

2. Run engine and allow the pressure to build up.

3. When unloader cuts out, note pressure registered on the air gauge.

   If gauge reading is below minimum cut-out pressure, keep engine running, slacken locknut on adjusting screw and turn screw clockwise until gauge shows required cut-out pressure then hold screw and tighten locknut.

   If pressure is above maximum, stop the engine and exhaust pressure in system by repeated applications of the brake valve.

4. Slacken locknut and turn adjusting screw anti-clockwise one complete turn.

5. Start up the engine and let it run until unloader valve opens.

   Note pressure indicated on the air gauge.

   If it still exceeds maximum cut-out pressure, then the operation must be repeated as before.

   If, however, the gauge reads less than minimum cut-out pressure then adjusting screw should be turned clockwise, with engine running, until the gauge shows correct pressure.

6. When required pressure is attained, hold adjusting screw and tighten locknut securely.

7. Should pressure in the system fail to rise, and a continuous leak from the unloader valve be noted, then it is advisable to remove the valve for service or exchange.

Dual Concentric Footbrake Valve

REMOVAL AND REFITMENT

To Remove

1. Chock the road wheels and release all air pressure from the air system.

2. Remove the front detachable panel.

3. Note the relative positions and disconnect the air pipes from the valve and protect the ends of the pipes and the ports in the valve from the ingress of dirt and grime.

4. Note the relative positions and disconnect the electrical connections from the stop light switch.

5. Note the relative positions and remove the unions, elbows and stop light switch from the valve.

6. Remove the securing nuts and detach the valve from the vehicle.

7. Drive out the tension pin and withdraw the hinge pin to separate the brake treadle from the valve.

To Refit

1. Reverse the procedure in 1 to 7, noting the following:
   a. Ensure all air and electrical connections are in their original positions.
   b. Carry out the Operating and Leakage Tests.

OVERHAUL

The manufacturer's recommended overhaul period is every year or 80 000 km (50 000 miles).

A service repair kit must be obtained before dismantling the unit.

To Dismantle, Fig. 1

1. Reference mark the mounting plate (1) and valve body to facilitate correct assembly.

2. Remove the rubber gaiter (2) and withdraw the plunger (3) from the mounting plate.

3. Remove the setscrews (4) and separate the mounting plate and valve body.

CAUTION: The piston is spring-loaded and, therefore, care must be taken when removing the stop-bolt.

4. Remove the stop-bolt (5) from the valve body.

5. Grip the tie-bolt (6) and extract the valve carrier and piston assembly.

6. Remove the circlip (7) from the valve carrier.

7. Remove the nut (8) from the tie-bolt and detach the perforated disc (9), valve guide (10), spring (11), valve retainer (12), inlet/exhaust valve (13), valve carrier (14), spring (15), piston (16), rubber spring (17) and washer (18).

8. Extract the piston (19) and spring (20) from the valve body.

9. Remove the screw (21), diaphragm washer (22) and diaphragm (23).

10. Remove the circlip (24) and extract the washer (25), valve guide (26), spring (27), valve retainer (28) and inlet/exhaust valve (29).

Inspection

1. Clean all components in a suitable solvent and dry thoroughly.

2. Examine the valve body and mounting plate for cracks, damage or distortion; renew as necessary.

3. Examine internal bores and working surfaces for wear, scores or distortion; renew as necessary.

4. Examine the exhaust seats on the upper and lower pistons, valve body and valve carriers for burrs, pitting or nicks; lightly lap with a suitable surfacing tool or renew as necessary.

5. Examine the springs for corrosion or distortion; renew as necessary.

To Reassemble, Fig. 1

1. Renew all items as supplied in the repair kit.

2. Grease all working and bearing surfaces, springs and sealing rings with CDS 156 grease (Clayton recommendation).

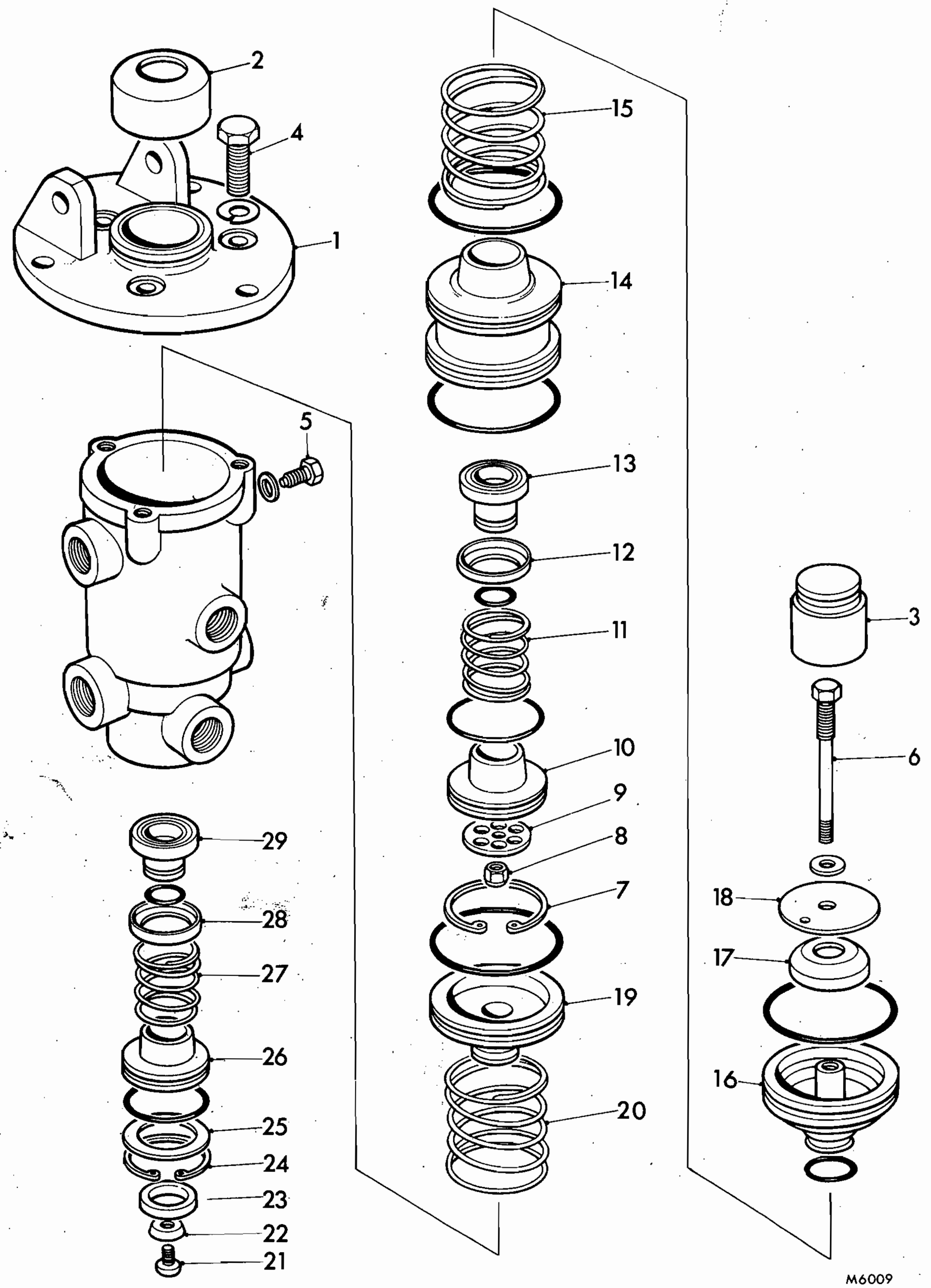


FIG. 1 EXPLODED VIEW OF FOOTBRAKE VALVE

1. Mounting plate
2. Rubber gaiter
3. Plunger
4. Setscrew
5. Stop bolt
6. Tie-bolt
7. Circlip
8. Nut
9. Perforated disc
10. Valve guide
11. Spring
12. Valve retainer
13. Inlet/exhaust valve
14. Valve carrier
15. Spring
16. Piston
17. Rubber spring
18. Washer
19. Piston
20. Spring
21. Screw
22. Diaphragm washer
23. Diaphragm
24. Circlip
25. Washer
26. Valve guide
27. Spring
28. Valve retainer
29. Inlet/exhaust valve

3. Fit the inlet/exhaust valve (29), valve retainer (28), spring (27), valve guide (26), washer (25), and circlip (24).

4. Fit the diaphragm (23), diaphragm washer (22) and screw (21).

5. Insert the spring (20) and piston (19) into the valve body.

6. Assemble the rubber spring (17) into the piston (16) recess (with the concave face of the rubber spring towards the piston), and fit the washer (18) over the rubber spring. Slide the tie-bolt through the piston assembly.

7. Fit the spring (15) valve carrier (14), inlet/exhaust valve (13), valve retainer (12), spring (11), valve guide (10) and perforated disc (9) to the tie-bolt and screw the nut (8) a few turns onto the tie-bolt.

8. Fit the circlip (7) to the valve carrier.

Note: The inlet/exhaust valve clearance must be accurately set to ensure correct functioning of the footbrake valve.

9. Adjust the inlet/exhaust valve clearance (see Fig. 2) as follows:

   a. Using three suitable blocks of wood, position blocks A and B at the fixed jaw of the vice and support the valve carrier and block C between the jaws of the vice.

      NOTE: Ensure at least two thirds of the diameter of the valve carrier is supported between the jaws of the vice. Ensure that the blocks of wood do not obstruct the free movement of the tie-bolt and perforated disc.

   b. Attach a suitable probe to a dial test indicator (D.T.I.) and clamp the D.T.I. to an adjustable magnetic block. Insert the probe into one of the holes in the perforated disc, until it abuts the stem of the inlet/exhaust valve.

   c. Screw in the vice and observe the D.T.I. movement when the inlet/exhaust valve is opened. Slacken the vice until the D.T.I. movement ceases. Insert a 1,70 mm (0.067 in.) feeler gauge, (preferably cut to a 'C' shape to fit around the tie bolt), between the base of the nut and the perforated disc, ensuring that the perforated disc is flat against its seat in the valve guide.

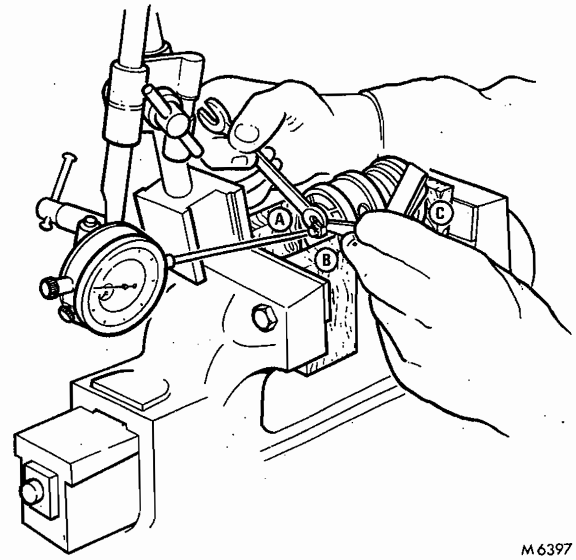


FIG. 2 ADJUSTING INLET/EXHAUST VALVE CLEARANCE

   d. Apply screw locking compound on the threads of the tie-bolt. Screw the nut so that it tightens against the gauge and observe the first signs of movement on the D.T.I. Immediately movement is noticed, back the nut off half a turn and remove the feeler gauge. Remove the assembly from the vice.

10. Insert the valve carrier and piston assembly into the valve body and fit the stop-bolt (5).

11. Fit the mounting plate (1) to the valve body, ensuring that the reference marks made during dismantling align.

12. Insert the plunger (3) in the mounting plate and fit the gaiter (2).

13. Carry out the Operating and Leakage Tests as described in this section.

TESTING

Operating Test

1. Chock the road wheels and release all air pressure from the air system.

2. Connect air pressure gauges to the front and rear service brake lines as close to the valve as practicable.

3. Charge the system to the unloader valve cut-out pressure.

   NOTE: If the valve has been overhauled or is a service exchange unit, operate the valve several times to evenly distribute the grease on the internal components.

4. Lightly depress the brake treadle and note when the gauge, connected to the bottom half of the valve, registers 0,35 to 0,49 kgf/cm^2 (5 to 7 lbf/in^2), the gauge connected to the lower half of the valve should start to register pressure. If the second stage fails to open by the time the first stage has delivered 0,35 to 0,49 kgf/cm^2 (5 to 7 lbf/in^2) renew the valve.

5. Gradually raise the delivery pressure, stopping at intervals of 1,40 kgf/cm^2 (20 lbf/in^2) and check that both gauge readings rise in unison; a maximum tolerance of 0.14 kgf/cm^2 (3 lbf/in^2) being permissible.

6. Increase the pressure to 6,32 kgf/cm^2 (90 lbf/in^2) and, with the brake treadle stationary, check the air gauges in the vehicle; a falling pressure indicates incorrect seating of the inlet/exhaust valves.

7. Gradually release the brake treadle and check for pressure balance and severe leakage at 6,32 kgf/cm^2 (90 lbf/in^2).

8. When the brake treadle is released, check for rapid, total exhausting of air pressure from the air lines and actuators. Slow exhausting indicates a partially seized valve or linkage.

9. Apply and release the valve several times, moving the brake treadle to its full application position each time, check for any lag in applying or releasing.

Leakage Test

1. Chock the road wheels and charge the system to the unloader cut-out pressure.

2. Apply a soap solution around the exhaust outlet and observe any leakage; no leakage is permissible.

3. Depress the brake treadle and note that brake line delivered pressure rises smoothly.

4. Allow the pressure delivered to the brake to rise to 6,32 kgf/cm^2 (90 lbf/in^2) and while holding the brake treadle stationary, apply a soap solution to the exhaust valve; leakage must not exceed a 1cm soap bubble in 5 seconds.

5. Apply the brakes and coat the exhaust and all pipe connections to the valve; leakage from the exhaust must not exceed a 2 cm soap bubble in 5 seconds and no leakage is permissible from the valve body or pipe connections.

Single Diaphragm Brake Chambers

REMOVAL AND REFITMENT

To Remove

1. Prevent the vehicle from moving by applying the hand control valve.

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 refitment.

3. Disconnect air line and take care to prevent dirt from entering the brake chamber or air line.

4. Remove push rod jaw-end pin and gaiter, slacken the locknut and unscrew the jaw-end.

5. Unscrew nuts on mounting studs and remove the brake chamber.

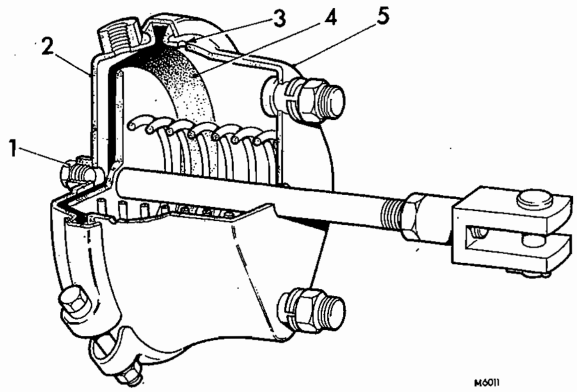


FIG. 1 CUT-AWAY VIEW OF DIAPHRAGM BRAKE CHAMBER

1. Air inlet port
2. Pressure plate
3. Breather hole
4. Diaphragm
5. Non-pressure plate

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 unit 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 on to 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.

9. Unbalanced operation may be caused by unmatched diaphragm or incorrect springs.

10. After testing, smear jaw-end pins with grease and connect each jaw-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.

OVERHAUL

The manufacturer's recommended overhaul period is every year or 80 000 km (50 000 miles).

Note: A new diaphragm must be ordered before dismantling the unit.

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 re-assembled.

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 vice-grip pliers, or a similar tool, Fig. 3. This will relieve the tension of the spring on the pressure plate.

4. Extract clamp ring nuts and bolts, and remove clamp ring from the body halves.

5. Separate pressure plate, non-pressure plate and the diaphragm.

6. Carefully release the vice-grip 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 are apparent.

3. Ensure that the breather holes are not obstructed before reassembly.

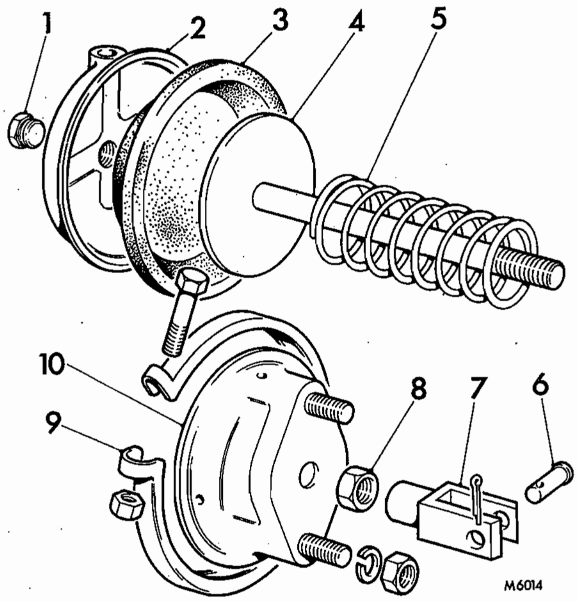


FIG. 2 EXPLODED VIEW OF DIAPHRAGM BRAKE CHAMBER

1. Plug
2. Pressure plate
3. Diaphragm
4. Push rod
5. Spring
6. Pin
7. Jaw end
8. Locknut
9. Clamp ring
10. Non-pressure plate

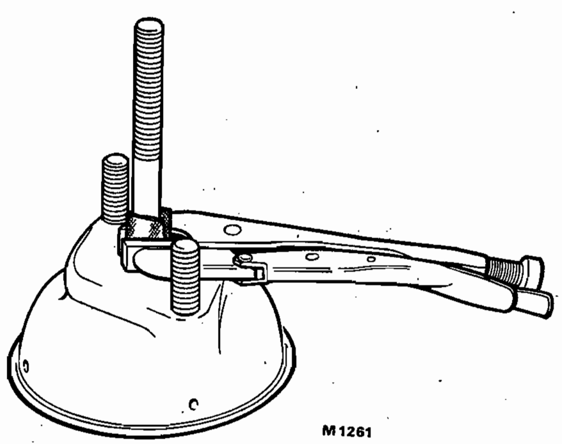


FIG. 3 METHOD OF CLAMPING THE PUSH ROD PRIOR TO REASSEMBLY

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. Rest push rod on flat surface and place 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 vice-grip pliers taking precautions to avoid damaging the push rod.

3. Position new diaphragm centrally on pressure plate and centre non-pressure plate and push rod on diaphragm. Loosely install the clamp ring and true up all parts using a hide faced hammer.

4. Tighten the clamp ring and release the vice-grip pliers.

   Note: Due to the rubber bead on the diaphragm having a tendency to 'bed-in', the clamp ring should be re-tightened after a few hours to prevent bead movement causing leakage and fretting.

TESTING

Operating Tests

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.

2. Apply and release the brakes and note that the push rods move smoothly and promptly without binding.

Leakage Tests

1. First prevent the vehicle from moving by applying 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

If pressurised air is not available to release the brakes, the spring brakes can be released (to allow the vehicle to be towed) by unscrewing the release bolt at the end of the spring brake chamber.

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 PARK 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.

To Refit

1. Remount the actuator on the vehicle. Tighten mounting stud nuts to a torque of 11,04 kgf m (80 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, Reference 7—4C—2.
6. Carry out the Operating and Leakage Tests.

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 re-mounting the chamber on the vehicle as this will make fitting extremely difficult.

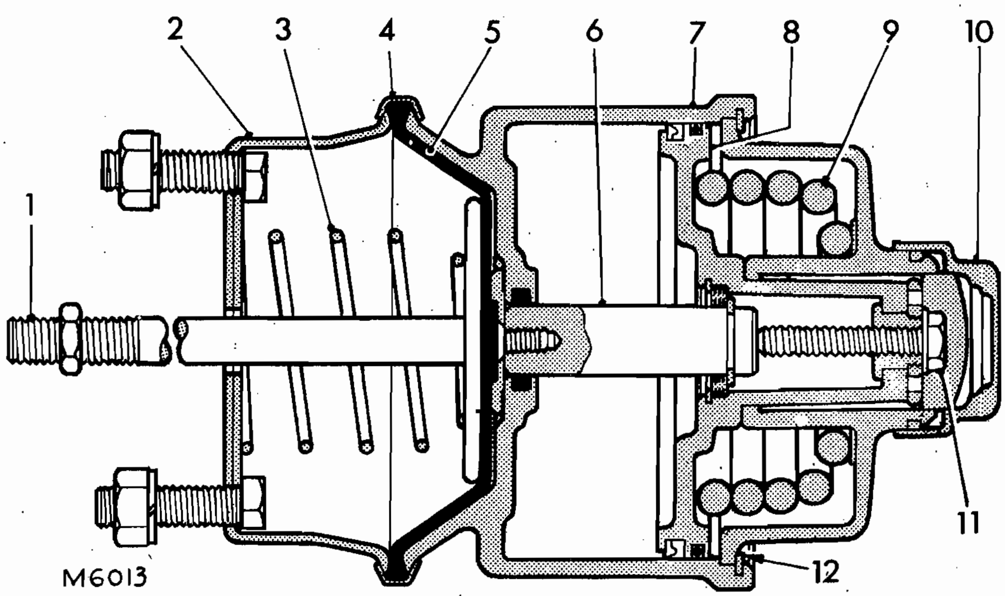


FIG. 1 TYPICAL SPRING BRAKE ACTUATOR
(In normal driving position— showing service footbrake and handbrake in the OFF or released position)

1. Service brake push-rod
2. Service brake chamber
3. Service brake spring
4. Clamp ring
5. Diaphragm
6. Handbrake push-rod
7. Handbrake chamber
8. Handbrake piston
9. Handbrake spring
10. End cap, with filter
11. Release bolt
12. Circlip

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 must 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 MS61 and adaptor set WH61-5.

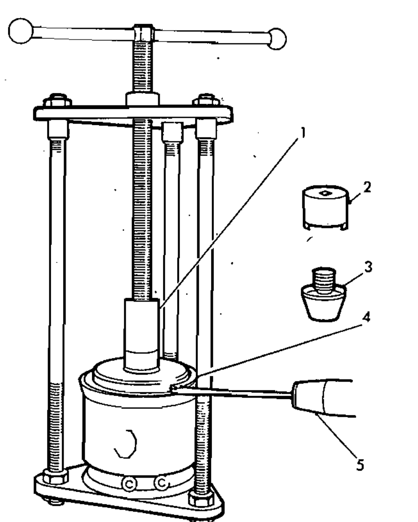


FIG. 2 TYPICAL SPRING BRAKE ACTUATOR HELD IN BASIC TOOL MS61 SHOWING CIRCLIP REMOVAL

1., 2., 3. Adaptor set WH61-5
4. Circlip
5. Lever

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 centralise. 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.

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.

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 centralise 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.

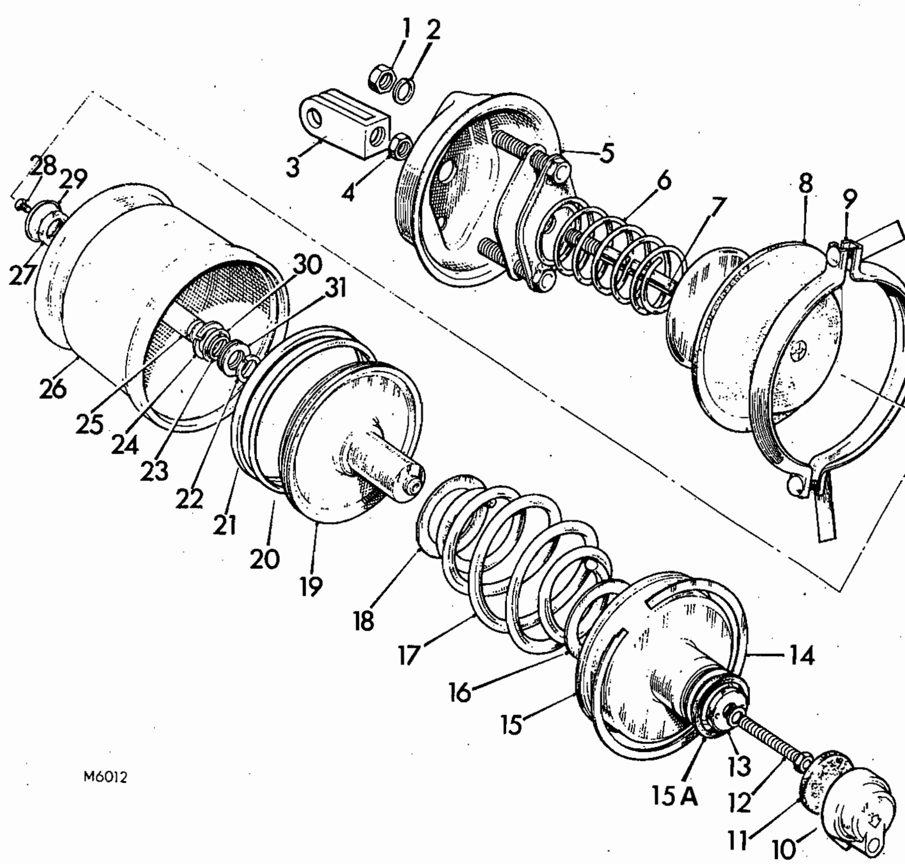


FIG. 3 EXPLODED VIEW OF TYPICAL SPRING BRAKE ACTUATOR

1. Nut
2. Washer, spring
3. Jaw-end
4. Locknut
5. Non-pressure plate
6. Spring
7. Push-rod
8. Diaphragm
9. Clamp ring
10. Breather cap
11. Filter element
12. Release bolt
13. Anti-explosion washer
14. Circlip
15. Chamber head
15a. O-ring seal
16. Thrust washer
17. Spring
18. Thrust washer
19. Piston
20. Wiper
21. Piston seal
22. Snap ring
23. O-ring seal
24. Circlip
25. Push-rod
26. Chamber
27. Push-rod seal
28. Screw, socket head
29. Push-plate
30. O-ring seal
31. Collar

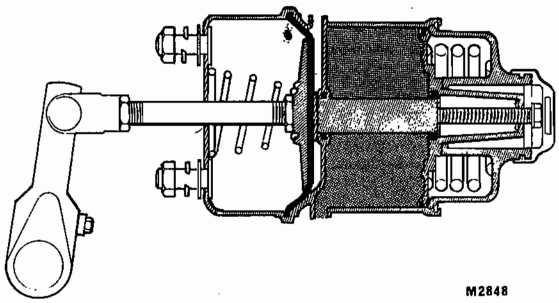


FIG. 4 NORMAL DRIVING – SERVICE AND SPRING BRAKES RELEASED

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 1 hour.
17. Refit the warning tags and lock nuts. Refit the actuator to the vehicle, Reference 7—11E—1.

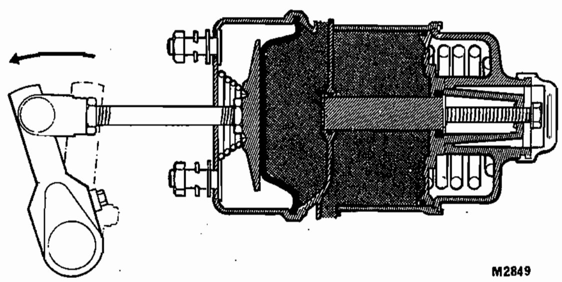


FIG. 5 SERVICE BRAKES APPLIED

TESTING

Operating Test

Operate the spring brake 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.

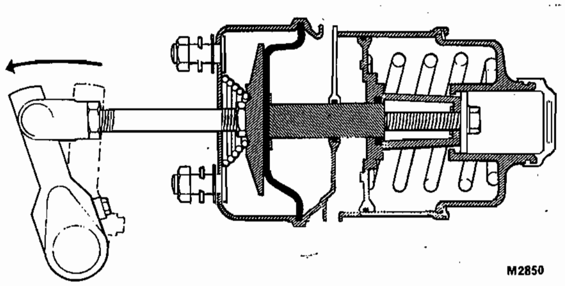


FIG. 6 EMERGENCY OR PARK POSITION SPRING BRAKES APPLIED

Leakage Test

Operate the spring brakes by means of the hand control valve and carry out the following tests:

Slight frothing is permissible.

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.

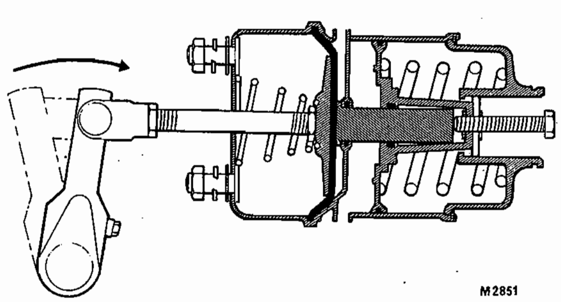


FIG. 7 SPRING BRAKES MANUALLY RELEASED

Stop-Light Switch

REMOVAL AND REFITMENT

To Remove

1. Chock the wheels and release all air pressure from the braking system. Note the positions and disconnect the electrical connections from the stop light switch.

2. Brush away dirt from the switch and remove it from its mounting. Take precautions to prevent dirt from entering the switch and its mounting port in the foot brake valve.

To Refit

1. Screw the unit into position and tighten only sufficiently to prevent air leakage.

2. Connect the electrical connections 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).

A repair kit must be obtained before dismantling the unit.

To Dismantle

1. Remove grease and dirt from the exterior of the unit.

2. Unscrew the setscrews and separate the parts of the unit.

3. Discard the diaphragm, contact strip, cover and contact assembly.

Inspection

1. Wash all parts in a suitable solvent and blow dry with compressed air.

2. Examine the body and piston for cracks and damage. Examine the sliding surfaces of the piston for scores and excessive wear.

3. Check the spring for corrosion and distortion.

4. Examine all threads for damage.

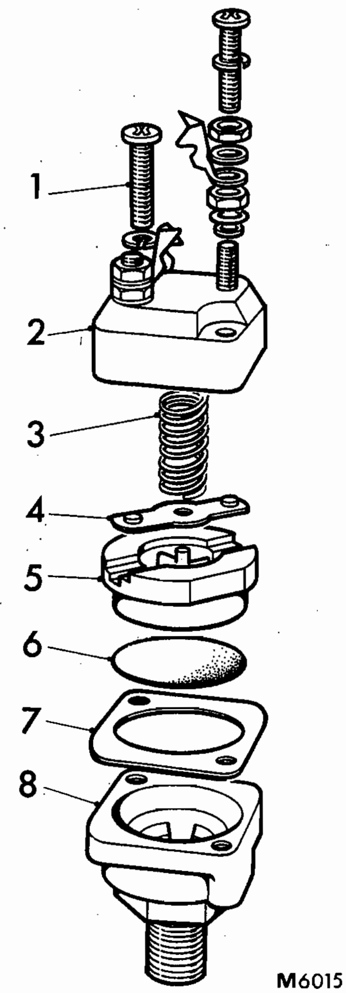


FIG. 1 EXPLODED VIEW OF STOP LIGHT SWITCH

1. Setscrew
2. Cover
3. Spring
4. Contact strip
5. Piston
6. Diaphragm
7. Joint
8. Body

To Reassemble

1. Renew all parts found to be defective during 'Inspection'.

   Lightly smear the sliding surfaces of the piston and switch assembly with C.D.S. 156 grease. (Clayton recommendation).

2. Insert the diaphragm in the body, flat side uppermost. Insert the piston into the body and locate the contact strip and spring on the piston. Fit the cover ensuring a new joint is used.

TESTING

Air leakage test:

1. Chock the wheels. Charge the vehicle braking system to the unloader valve cut-out pressure and stop the engine. Apply the brakes and apply soap solution to the body and to the joint between the body and switch assembly. Bubbles indicate leakage which is not permissible. Leakage from the joint indicates that the diaphragm is defective.
2. If the test indicates that the diaphragm is defective, or that the unit is insecurely mounted, these must be rectified.

Operating test

1. With the braking system charged, slowly apply the brakes and check that the stop lights are switched on as soon as the brake valve operates. Release the brakes and check that the stop lights are switched off.

Low Pressure Switch

REMOVAL AND REFITMENT

To Remove

1. Chock the road wheels and release all air pressure from the air system.

2. Remove the rubber gaiter and, noting their positions, disconnect the electrical connections.

3. Brush dirt away from the switch and remove the switch from its mounting. Take precautions to prevent the ingress of dirt and grime into the switch and its mounting port in the system.

To Refit

1. Fit the switch into position and only tighten sufficiently to prevent air leakage.

2. Connect the electrical connection to their original positions and fit the rubber gaiter.

3. Carry out the Operating and Leakage Tests as described in this section.

OVERHAUL

The manufacturer's recommended overhaul period is every two years or 160 000 km (100 000 miles).

A service repair kit must be obtained before overhauling the unit.

To Dismantle, Fig. 1

1. Remove grease and dirt from the exterior of the unit.

2. Remove the cover and withdraw the spring, contact disc and shim(s) (when fitted).

3. Withdraw the contact plate assembly, piston and rubber diaphragm from the body.

Inspection

1. Clean all parts in a suitable cleaning solvent and dry thoroughly.

2. Examine the body and cover for cracks or damage; renew as necessary.

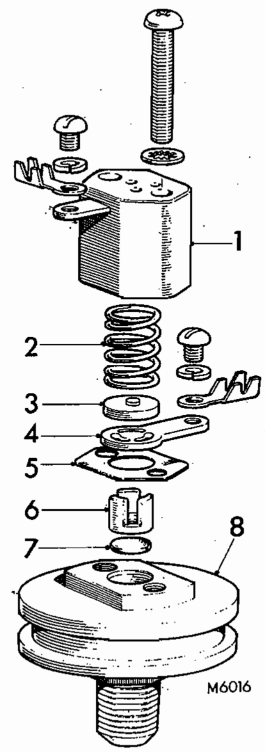


FIG. 1 EXPLODED VIEW OF LOW PRESSURE SWITCH

1. Cover
2. Spring
3. Contact disc
4. Contact plate
5. Joint
6. Piston
7. Diaphragm
8. Body

3. Examine the contact points for pitting or wear; the contact use can be extended by turning over the contact disc and contact plate.

4. Examine the control spring for corrosion and tension; renew as necessary.

To Reassemble

1. Renew all items as supplied in the repair kit.

2. Smear the piston housing with CDS 156 grease (Clayton recommendation).

3. Insert the rubber diaphragm (flat side uppermost), piston and contact plate assembly in to body.

4. Insert the shim(s), (when fitted) spring and contact disc into the cover. Fit the cover to the body.

5. Carry out the Operating and Leakage Tests as described in this section.

TESTING

Operating Test

1. Chock the road wheels and charge the air system to the unloader valve cut-out pressure and stop the engine.

2. Gradually reduce the air pressure and check that the low pressure switch operates the brake warning buzzer and brake warning light when the reservoir pressure has fallen to 4,1 to 5,0 kgf/cm^2 (59 to 71 lbf/in^2).

3. If necessary, adjust the low pressure switch pressure setting by increasing or decreasing the shims in the unit.

Leakage Test

1. Chock the road wheels and charge the air system to the unloader valve cut-out pressure.

2. Coat the unit with a soap solution; no leakage is permissible.

Non-Return Valve

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.

OVERHAUL

The manufacturer recommends that the non-return valves are renewed every two years or 160 000 km (100 000 miles).

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.

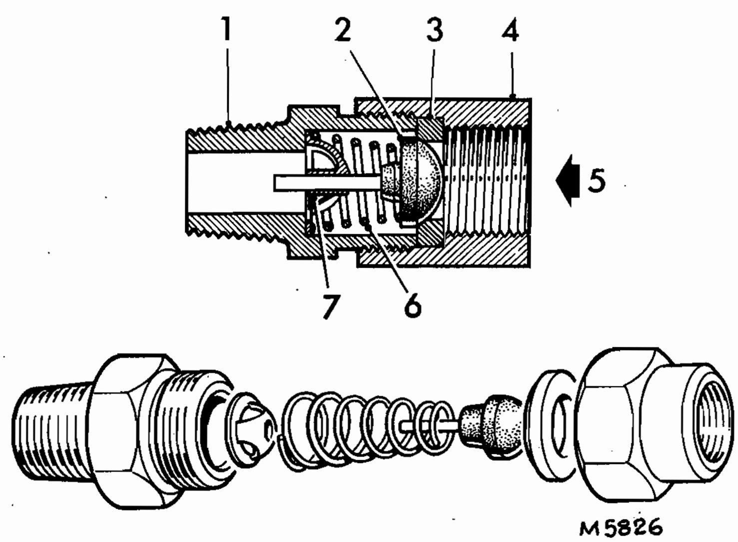


FIG. 1 NON-RETURN VALVE

1. Body
2. Valve
3. Valve seat
4. Screw cap
5. Direction of air flow
6. Spring
7. Spring guide

Condenser and Drain Valve

REMOVAL AND REFITMENT

To Remove

1. Chock the road wheels and release all air pressure from the braking system.

2. Note the positions of the air lines relative to the unit. Disconnect the air lines and take precautions to prevent dirt from entering the unit and air lines.

3. Remove the nuts from the securing studs and the unit from the chassis.

To Refit

1. Fit the unit to the vehicle.

2. Connect the air lines to the unit as originally fitted.

3. Carry out the Operating and Leakage tests as described in this section.

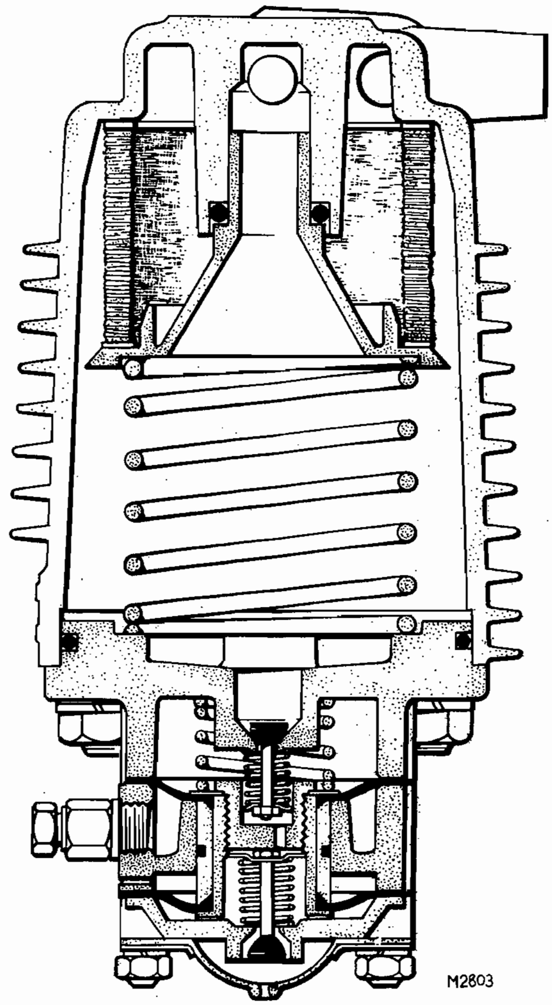


FIG. 1 SECTION VIEW OF CONDENSER AND DRAIN VALVE

OVERHAUL

The manufacturer's recommended overhaul period is every six months or 80 000 km (50 000 miles).

A service repair kit must be obtained before dismantling the unit.

To Dismantle, Fig. 2

1. Reference mark the cylinder, cylinder base plate and drain valve body to facilitate correct assembly.

2. Remove the bridge pipe from the unit, ensuring that no dirt or grime enters the pipe or condenser parts.

   Caution: The drain valve body holds the filter retaining spring in tension, therefore the drain valve body must be carefully removed to release the tension from the filter retaining spring.

3. Remove securing nuts and detach drain valve body from the cylinder.

4. Remove filter retaining spring, filter retainer and filter from the cylinder.

5. Remove sealing rings from filter retainer and cylinder base plate.

6. Remove securing nuts and detach bottom cover and drain valve assemblies.

7. Release valve centre guide from diaphragm retainer and remove diaphragm washer and the upper and lower diaphragms from the drain valve body.

8. Withdraw piston from drain valve body and remove piston sealing ring.

9. Remove securing nuts from the upper and lower valve stems and detach valves, springs and spring seat.

10. Discard all items which will be renewed from the repair kit.

Inspection

1. Clean all components in a suitable solvent and blow dry with compressed air.

2. Inspect all threads for damage and the springs for corrosion or distortion and renew as necessary.

3. Check the sliding surfaces of the diaphragm retainer and the piston for excessive wear or scores and renew as necessary.

4. Check all components for wear, damage or distortion and renew as necessary.

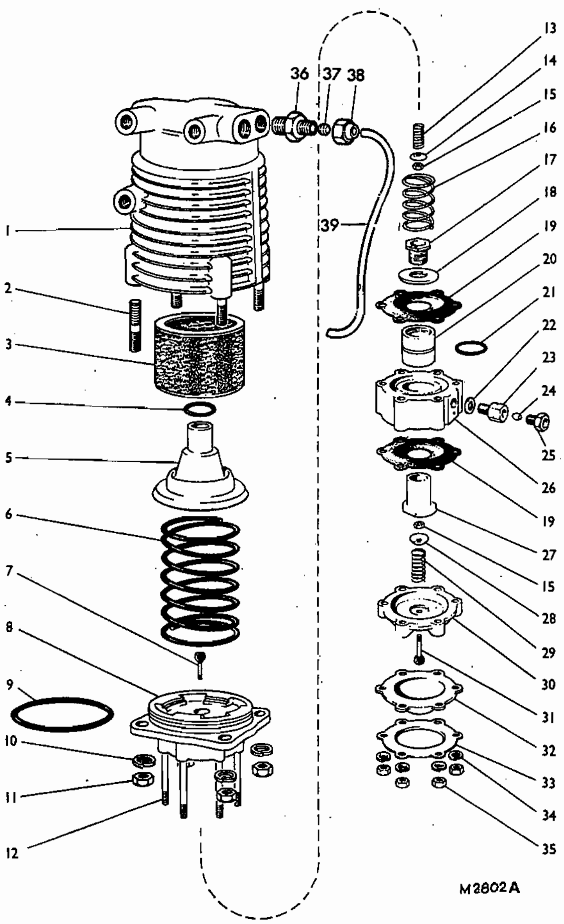


FIG. 2 EXPLODED VIEW OF CONDENSER AND DRAIN VALVE

1. Condenser body
2. Stud
3. Filter
4. Sealing ring
5. Filter retainer
6. Filter retaining spring
7. Upper valve
8. Base plate
9. Sealing ring
10. Spring washer
11. Nut
12. Stud
13. Upper valve spring
14. Seat
15. Nut
16. Return spring
17. Valve centre guide
18. Diaphragm washer
19. Diaphragm
20. Piston
21. Piston sealing ring
22. Washer
23. Adaptor
24. Nipple
25. Pipe nut
26. Drain valve body
27. Diaphragm retainer
28. Seat
29. Lower valve spring
30. Bottom cover
31. Lower valve
32. Drain cap
33. Drain disc
34. Spring washer
35. Nut
36. Adaptor
37. Nipple
38. Pipe cut
39. Bridge pipe

5. Examine the valves and their seats for wear and renew as necessary.

6. Ensure that the breather vent in the drain body and the vent in the valve centre guide are clean and unobstructed.

To Reassemble

1. Smear all sliding surfaces with CDS 156 (Rocol E1/A) grease (Clayton recommendation).

2. Insert the smaller valve through the top cover/cylinder base plate and ensure that the head of the valve locates in the seat.

   Note: Smear the threads of the valve stem with 'Loctite Screw Lock' before screwing on the nut.

3. Fit the smaller valve spring and guide on the stem and secure with the nut.

4. Similarly assemble the larger valve, spring and seat in the bottom cover.

5. Position one of the diaphragms on the diaphragm retainer and ensure that the flat side of the diaphragm is against the retainer flange.

6. Fit the sealing ring on the piston and slide the centre body over the piston (breather hole end first).

7. Position the other diaphragm on the diaphragm retainer so that the bead fits into the chamfered end of the piston.

8. Position the diaphragm washer on the diaphragm so that the rounded edge is against the diaphragm.

9. Fit the valve centre guide and tighten to a torque of 1,25 kgf m (9,0 lbf ft) taking care not to distort the diaphragm.

10. Position the piston return spring in the top cover/cylinder base plate and fit the diaphragm assembly over the studs ensuring that the port control is towards the top cover/cylinder base plate.

11. Fit the bottom cover and valve assembly to the diaphragm so that the rubber valve head faces outwards.

12. Fit the drain cap and disc with the rounded inner cup of the disc facing outwards.

13. Depress the drain cap and fit the nuts and washers and tighten diametrically opposite nuts progressively to a torque of 0,7 kgf m (5.0 lbf ft).

14. Fit sealing rings to the cylinder base plate and filter retainer.

15. Place the filter on the retainer and insert into the bore of the cylinder and fit the retainer spring on the cylinder base plate.

16. Position the base plate and cylinder to the reference marks made during dismantling and tighten the securing nuts to a torque of 2,2 kgf m (16 lbf ft).

17. Connect the bridge pipe to the unit.

18. Fit the unit to the vehicle and test as described under Operating and Leakage Tests.

TESTING

Operating Test

1. Apply the hand control valve to the 'PARK' position and chock the road wheels.

2. Reduce the pressure in the air system by applying and releasing brakes.

3. Charge the system to the unloader valve cut-out pressure (see DATA) and note when the unloader valve 'cuts-out' the condenser drain valve exhausts a small quantity of air/water/oil.

Air Leakage Test

Note: The condenser must be drained of all condensate before testing for leakages.

1. Apply the hand control valve to the 'PARK' position and chock the road wheels.

2. Release all air pressure from the system by applying and releasing the brakes.

3. Disconnect the bridge pipe from the cylinder and fit a blanking plug.

4. Charge the system to approximately 7,0 kgf/cm^2 (100 lbf/m^2) and while the pressure is rising, coat the drain port with a soap solution and observe any leakage. Leakage in excess of a 0,5 cm soap bubble in five seconds indicates a faulty inlet valve or seat.

5. Start the engine and charge the system to the unloader valve cut-out pressure (see DATA) and stop the engine. Remove the blanking plug and connect the bridge pipe.

6. Operate the brake valve to reduce the air in the system to a pressure below the unloader valve cut-in pressure (see DATA). Charge the system, to just below the unloader valve cut-out pressure, this will ensure that the condensing cylinder contains compressed air when testing the unit for air leakage.

7. Coat the breather hole and drain port with a soap solution, slight leakage from the breather hole indicates a defective piston sealing ring, excessive leakage indicates a ruptured lower diaphragm. Leakage from the drain hole in excess of a 1 cm soap bubble in five seconds is not permissible, excessive leakage indicates a ruptured upper diaphragm.

Quick Release Valve

REMOVAL AND REFITMENT

To Remove

1. Release all air pressure from system, disconnect air pipes at the valve and remove the mounting nuts or bolts.

To Refit

1. Refitment is a reversal of the removal procedure.

2. Carry out the Operating and Leakage tests.

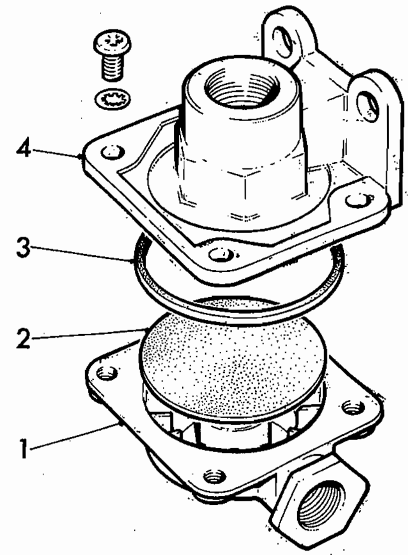


FIG. 1 EXPLODED VIEW OF A TYPICAL QUICK RELEASE VALVE

1. Valve body
2. Diaphragm
3. Sealing ring
4. Cover

OVERHAUL

The recommended overhaul period is every year or 80 000 km (50 000 miles).

To Dismantle

1. Scribe a line across body and cover to ensure correct reassembly.

2. Remove the four setscrews, separate body and cover, and remove diaphragm and sealing ring.

To Reassemble

1. Reassembly is a reversal of the dismantling procedure ensuring a new diaphragm and sealing ring are fitted.

TESTING

Operating and Leakage Tests

1. Fully charge the air system.

2. Apply and release the brakes and check for prompt action of the brake chambers.

3. When the brakes are released check that air pressure is exhausted through the exhaust port at the base of the valve.

4. With the brakes applied, coat the exhaust port with soap solution. Leakage in excess of a one inch soap bubble in five seconds is not permissible.

Double Check Valve

REMOVAL AND REFITMENT

To Remove

1. Release all air pressure from the system.

2. Disconnect air lines from the valve and unscrew the valve from the relay valve adaptor.

To Refit

1. Refitment of the valve is a reversal of the removal procedure.

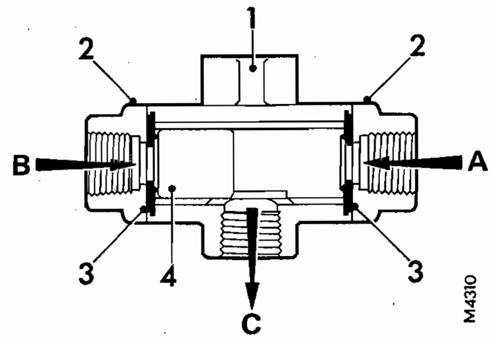


FIG. 1 SECTION THROUGH DOUBLE CHECK VALVE

A. & B. Inlet ports	1. Body	3. Seal
C. Outlet port	2. End plate	4. Shuttle

TESTING

When reassembled, the valve should be tested as follows:

1. Connect an air supply, which can be varied between 0.703 to 7.03 kgf/cm^2 (10 to 100 lbf/in^2) to ensure perfect sealing under all conditions, first to connection 'A' Fig. 1, and note that a free flow is obtained at connection 'C'. The latter should then be plugged and all joints and connection 'B' should be tested for leakage with soap and water.

2. The test should be repeated with the air supply connection to 'B', testing all joints, and connection 'A'.

3. Leakage 'A' or 'B' will indicate faulty seals.

OVERHAUL

It is recommended that the valve is overhauled every year or 80 000 km (50 000 miles).

To Dismantle

1. Remove the two nuts and washers and separate the end plates from the body.

2. Remove the two end seals and the shuttle.

Inspection

1. Wash all parts thoroughly and dry with compressed air.

2. Check scuttle and bore for excessive scoring and if necessary renew.

3. Renew the end seals.

To Reassemble

1. Reassembly is a reversal of the dismantling procedure ensuring the shuttle is thoroughly clean and lightly greased. The shuttle should be moved backwards and forwards several times to ensure free movement.

M4299

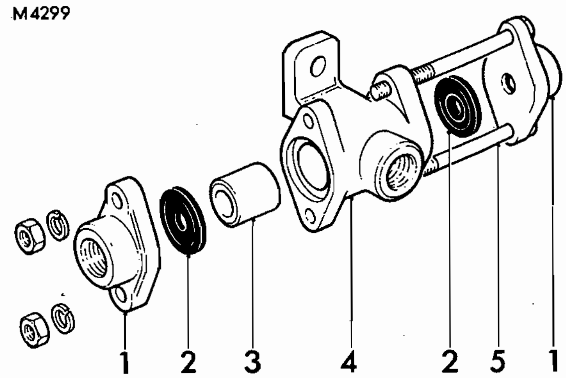


FIG 2 EXPLODED VIEW OF DOUBLE CHECK VALVE

1. End plate
2. Seal
3. Shuttle
4. Body
5. Bolt

Pressure Protection Valve

REMOVAL AND REFITMENT

To Remove

1. Chock the road wheels and release all pressure from the air system.
2. Reference mark the valve in relation to its mounting, disconnect air pipes noting their relative positions, and protect the ends of the pipes against the ingress of dirt.
3. Remove the two mounting bolts, nuts and washers and detach the valve from the vehicle.

To Refit

NOTE: If the valve is a replacement, duplicate the reference marks made on the old valve on to the new valve to ensure correct location.

1. Refit the two mounting bolts, nuts and washers and tighten securely.
2. Connect the air pipes as previously noted and charge the air system.
3. Carry out the Operating and Leakage test as described in this section.

OVERHAUL

The manufacturers recommend overhaul period is every year or 80 000 km (50 000 miles).

A service repair kit must be obtained before dismantling the unit.

To Dismantle

1. Loosen the locking ring, unscrew the adjuster cap and remove the graduating spring.
2. Remove the stop bolt from the body, tap the open end of the body against the hand to release the piston and valve assembly.
3. Remove the screws and detach the spring seat.
4. Withdraw the valve rubber from the stem and separate the piston, valve spring, guide and the valve stem.
5. Discard all items which will be renewed from the repair kit.

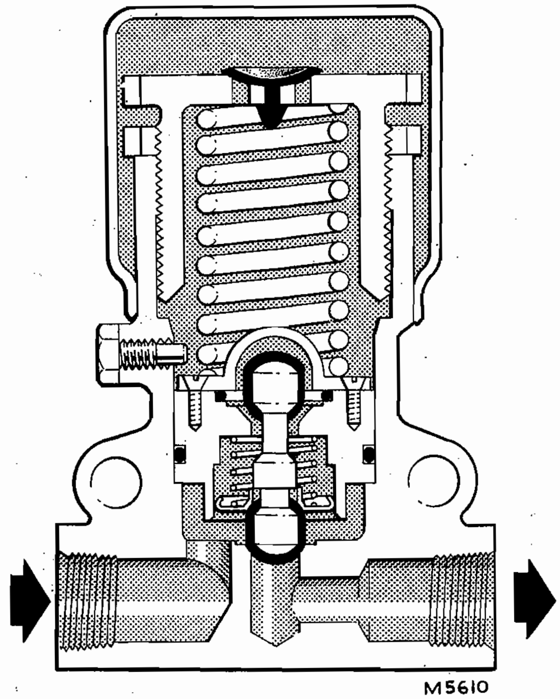


FIG. 1 SECTION OF PRESSURE PROTECTION VALVE

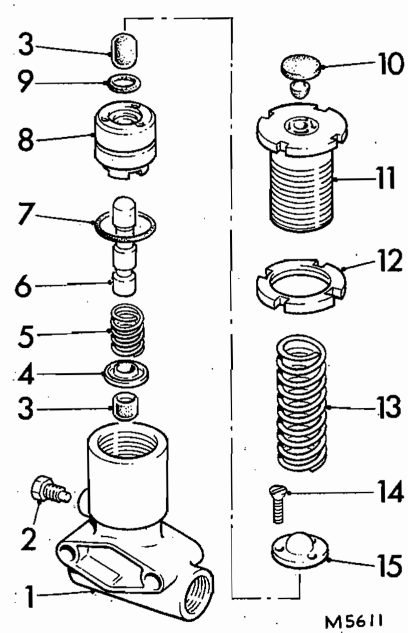


FIG. 2 EXPLODED VIEW OF PRESSURE PROTECTION VALVE

1. Valve body
2. Stop bolt
3. Valve rubber
4. Valve guide
5. Valve spring
6. Valve stem
7. Sealing ring
8. Piston
9. Sealing ring
10. Diaphragm
11. Adjuster cap
12. Locking ring
13. Graduating spring
14. Screw
15. Spring seat

Inspection

1. Clean all components in a suitable solvent and blow dry.
2. Examine the sliding surfaces of the piston and its bore for excessive wear or scores.
3. Check the body and adjuster for damage, particularly the threads.
4. Any springs not included in the repair kit should be checked for corrosion or distortion, renew if necessary.

To Reassemble

NOTE: Lightly smear all sliding and load bearing surfaces, sealing rings, and springs with C.D.S. 156 grease.

1. Place a valve rubber on the shorter leg of the valve stem.
2. Fit the valve guide on the stem so that the rounded edge abuts the valve rubber, place the spring on the guide.
3. Fit the long leg of the valve stem through the hole in the piston ensuring that the tapped holes in the piston are outermost.
4. Fit a sealing ring in the piston recess and place the spring seat on the piston, screw in the countersunk screws.
5. Fit the other sealing ring to the piston, and slide the piston into the body, so that the domed spring seat faces outwards.
6. Screw in the stop bolt, ensuring the dowelled end clears the spring seat before tightening.
7. Place the graduating spring in the body and screw in the adjusting screw cap, complete with locking ring.

TESTING

Testing and Adjusting Rebuilt Valve

1. Connect an air line, fitted with a reducer valve to the input port.
2. Connect the supply port to a small reservoir with attached pressure gauge, calibrated from 0 to 10,55 kgf/cm^2 (0 to 150 lbf/in^2).
3. Screw in the adjuster cap and pressurise the air supply line.
4. Operate the reducer valve until the pressure in the supply line is the same as the opening pressure of the protection valve, see DATA.
5. Unscrew the adjuster slowly, and secure the locking ring when the reservoir gauge registers on injection of compressed air.
6. Release the pressure from the input side of the valve and note that approximately 0,21 kgf/cm^2 (3 lbf/in^2) is left in the reservoir connected to the outlet port.

Operating Test

1. Chock the road wheels and release all pressure from the air system.
2. Using a suitable adaptor, connect a pressure gauge calibrated from 0 to 10,55 kgf/cm^2 (0 to 150 lbf/in^2) in the supply line to the throttle control valve.
3. Start the engine and note that the first available air is supplied to the gauge in the throttle supply line.
4. When the opening pressure of the pressure protection valve is attained, see DATA, the service reservoirs will then be charged, and will register on the dual air gauges in the driving compartment.
5. If the opening pressure of the pressure protection valve shows a discrepancy of ± 0,35 kgf/cm^2 (± 5 lbf/in^2) the valve should be adjusted.
6. Release all pressure from the air system and loosen the locking ring, adjust the screw cap until the correct pressure is obtained, tighten the locking ring after adjustment.

Air Leakage Test

1. Charge the system to the unloader valve cut out pressure.
2. Brush a soap solution on the breather diaphragm (situated under the rubber gaiter), the valve body and connections; no leakage is permissible from the valve body or connections.
3. Leakage from the breather must not exceed a 1 cm bubble in 10 seconds.

GROUP 8

ELECTRICAL

START INHIBIT CIRCUIT—ELECTRO-PNEUMATIC

Operation, Fig. 1.

Upon selection of 'Start' (1), current is fed via circuit breaker (2) neutral contacts (3) of gear selector through the engine canopy micro-switch (5) to one side of the starter push-button (6).

Depression of button completes the circuit to interlock relay (10) coil—the negative return being through the closed contacts of oil pressure switch (8). Starter relay (9) which feeds starter motor solenoid (7), is energised via interlock relay contacts 9 and 10.

Whilst engine is cranked, relay (10) is 'latched in' by contacts 3 and 4.

Thus circuit is inoperative with engine running.

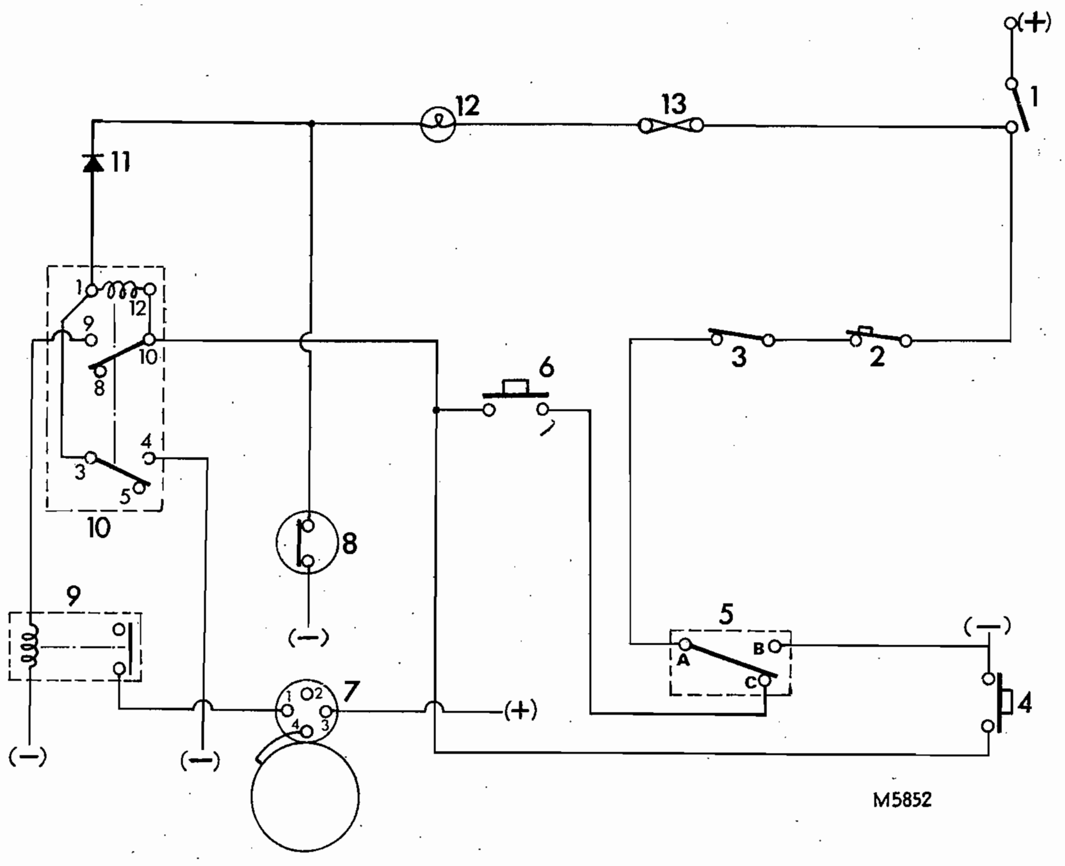


FIG. 1. START INHIBIT CIRCUIT DIAGRAM—ELECTRO-PNEUMATIC

1. Start, switch
2. Circuit breaker — 10 Ampere
3. Neutral position — gear selector switch
4. Start push-button — rear
5. Switch-micro, engine canopy
6. Start push-button — front
7. Starter motor
8. Switch, low oil pressure
9. Relay, starter
10. Relay, interlock
11. Diode
12. Lamp — low oil pressure warning
13. Fuse

START INHIBIT CIRCUIT–G2 TRANSMISSION

Operation, Fig. 2.

Upon selection of 'Start' (1), current is fed via the gear selector switch neutral position (4) through the engine canopy micro-switch (7) via the normally closed contacts 8 and 10 of sequence relay (9) to one side of the starter push button (6). Closing of the push button contacts completes the circuit to the interlock coil (5) – the negative return of which is through the closed contacts of the oil pressure switch (12). The starter relay (11), which in turn delivers a feed to the starter motor solenoid, is energised via interlock relay contacts 9 and 10.

During engine cranking, relay (5) is 'latched in' by contacts 3 and 4.

Operation of the engine stop button energises – in addition to the stop solenoid – the sequence relay coil (which is then 'latched in' via contacts 3 and 4) contacts 8 and 10 of which are opened to interrupt the circuit previously explained. Opening of the start switch de-energises the sequence relay and contacts 8 and 10 are re-made.

This circuit, as implied, ensures that the correct starting sequence is followed.

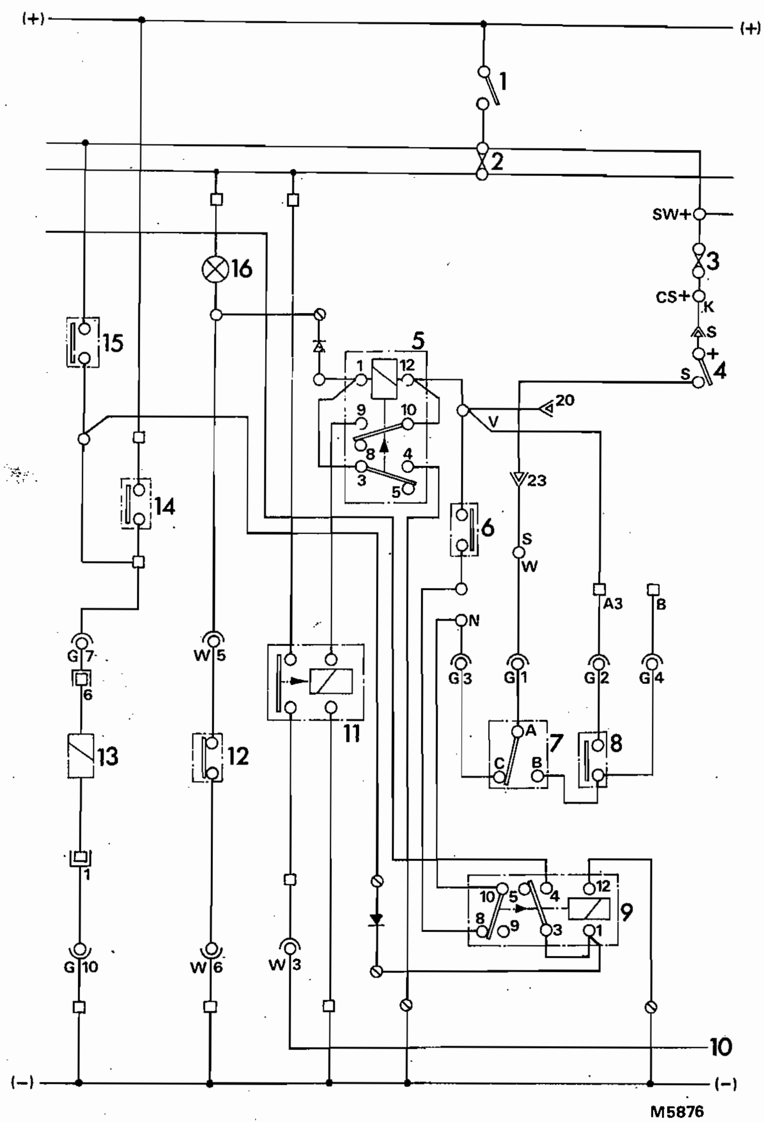
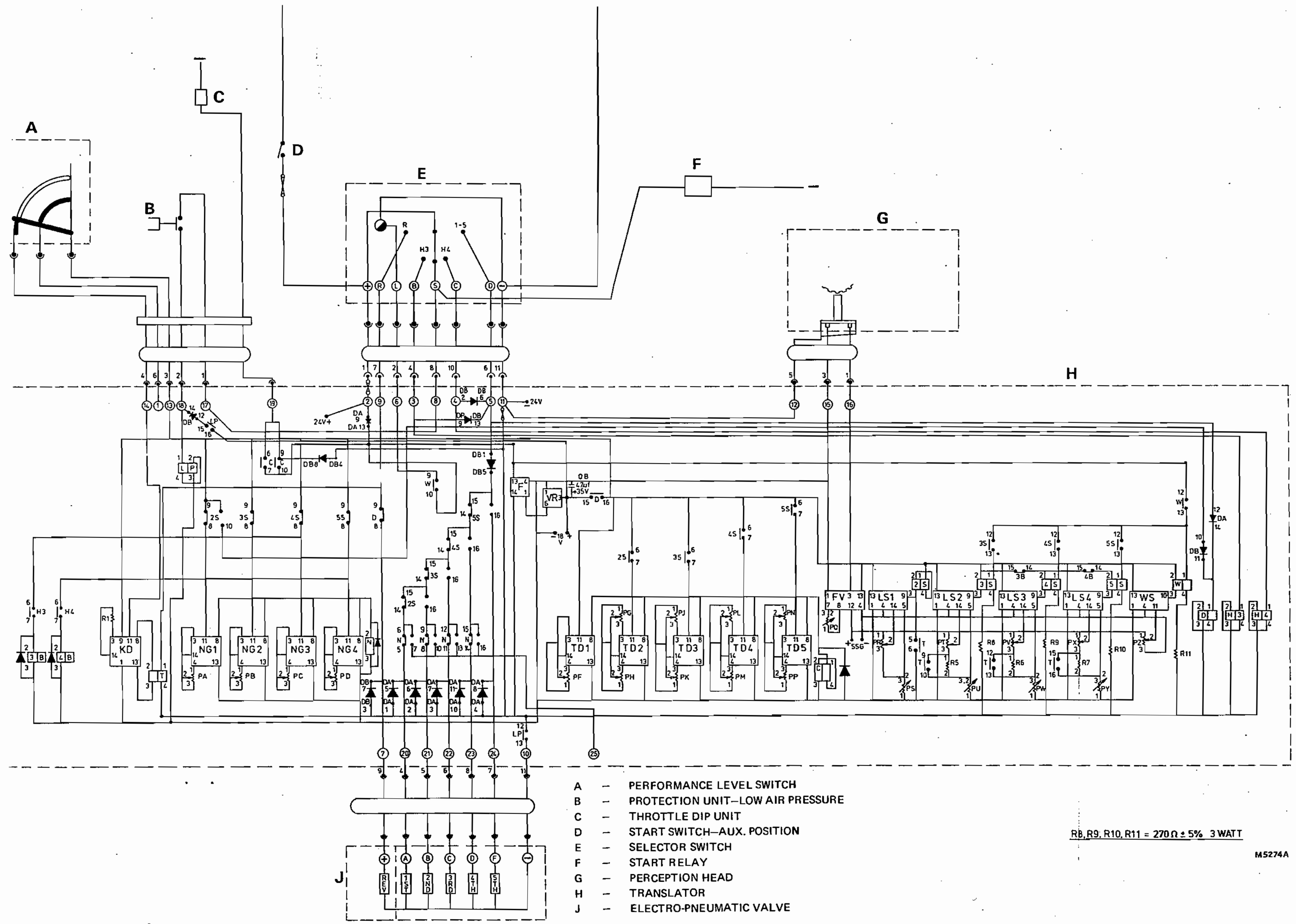


FIG. 2. START INHIBIT CIRCUIT DIAGRAM–G2 TRANSMISSION

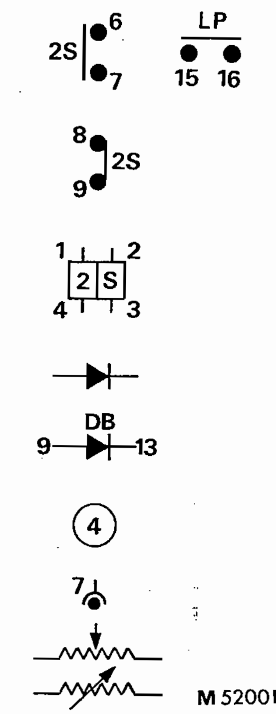
1. Start switch
2. Fuse – 10 Ampere
3. Line fuse – 2 Ampere
4. Gear selector switch – neutral
5. Relay – interlock
6. Starter push button – front
7. Micro-switch, engine canopy
8. Starter push button – rear
9. Relay – start sequence
10. To starter motor solenoid
11. Relay starter
12. Switch – oil pressure
13. Solenoid – engine stop
14. Push button – emergency engine stop
15. Push button – engine stop
16. Warning lamp – low oil pressure



A – PERFORMANCE LEVEL SWITCH
B – PROTECTION UNIT–LOW AIR PRESSURE
C – THROTTLE DIP UNIT
D – START SWITCH–AUX. POSITION
E – SELECTOR SWITCH
F – START RELAY
G – PERCEPTION HEAD
H – TRANSLATOR
J – ELECTRO-PNEUMATIC VALVE

R8, R9, R10, R11 = 270Ω ± 5% 3 WATT

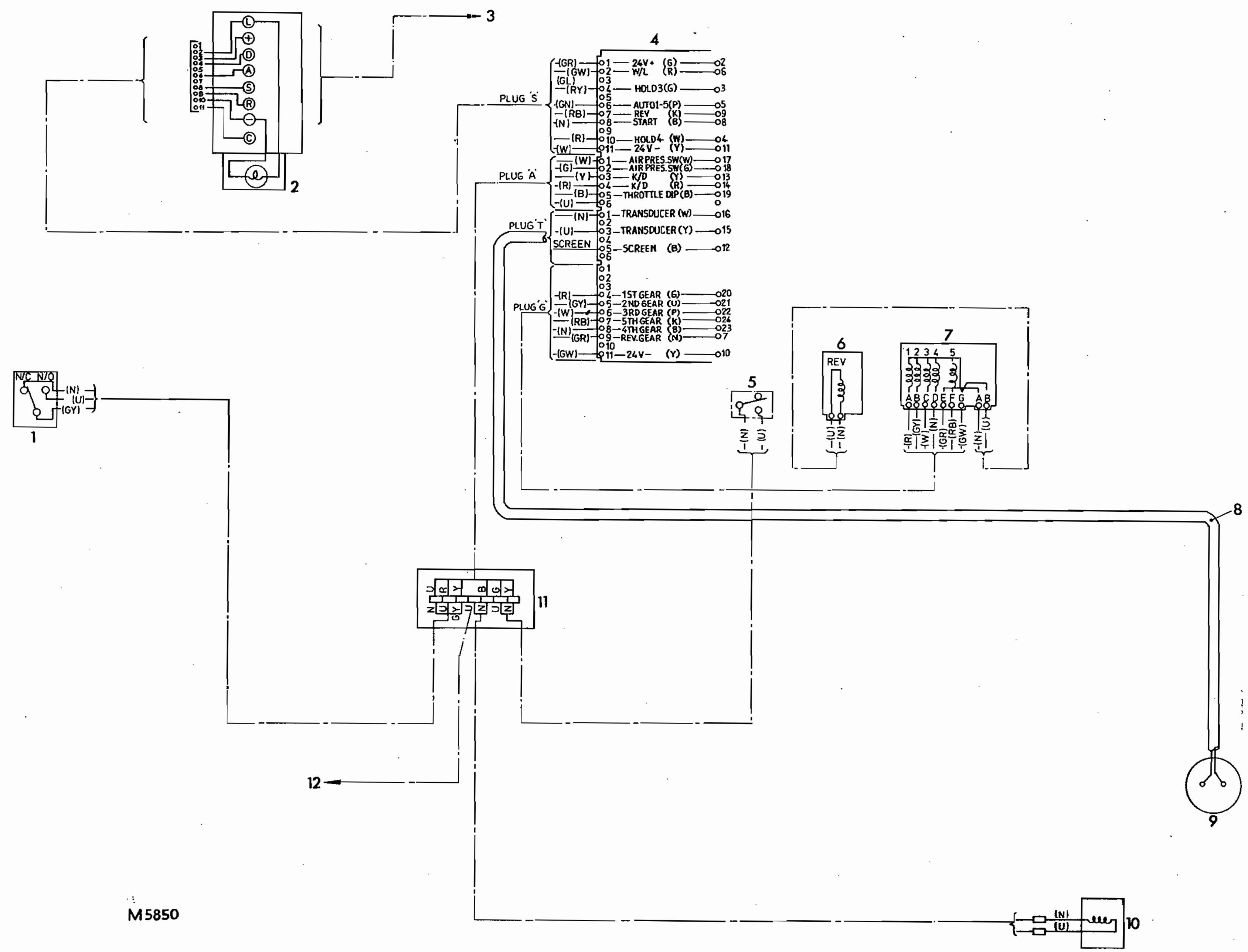
M5274A



Secondary Relay Contacts	6–7, 9–10, 12–13 and 15–16 Normally Open. Relay contacts 2S 6–7 and LP 15–16 shown.
Secondary Relay Contacts	6–5, 9–8, 12–11 and 14–15 Normally Closed. Relay contacts 2S 9–8 shown.
Secondary Relay Coils	Relay coil 2S shown (both coils 1–4 and 2–3 used).
'Free Diode'	
Diode in Module (DB) Between pins 9–13	
Terminals	
Pins in Multi-pin Sockets	
Control Potentiometers	

M 5200B

AUTOMATIC CONTROL CIRCUIT DIAGRAM

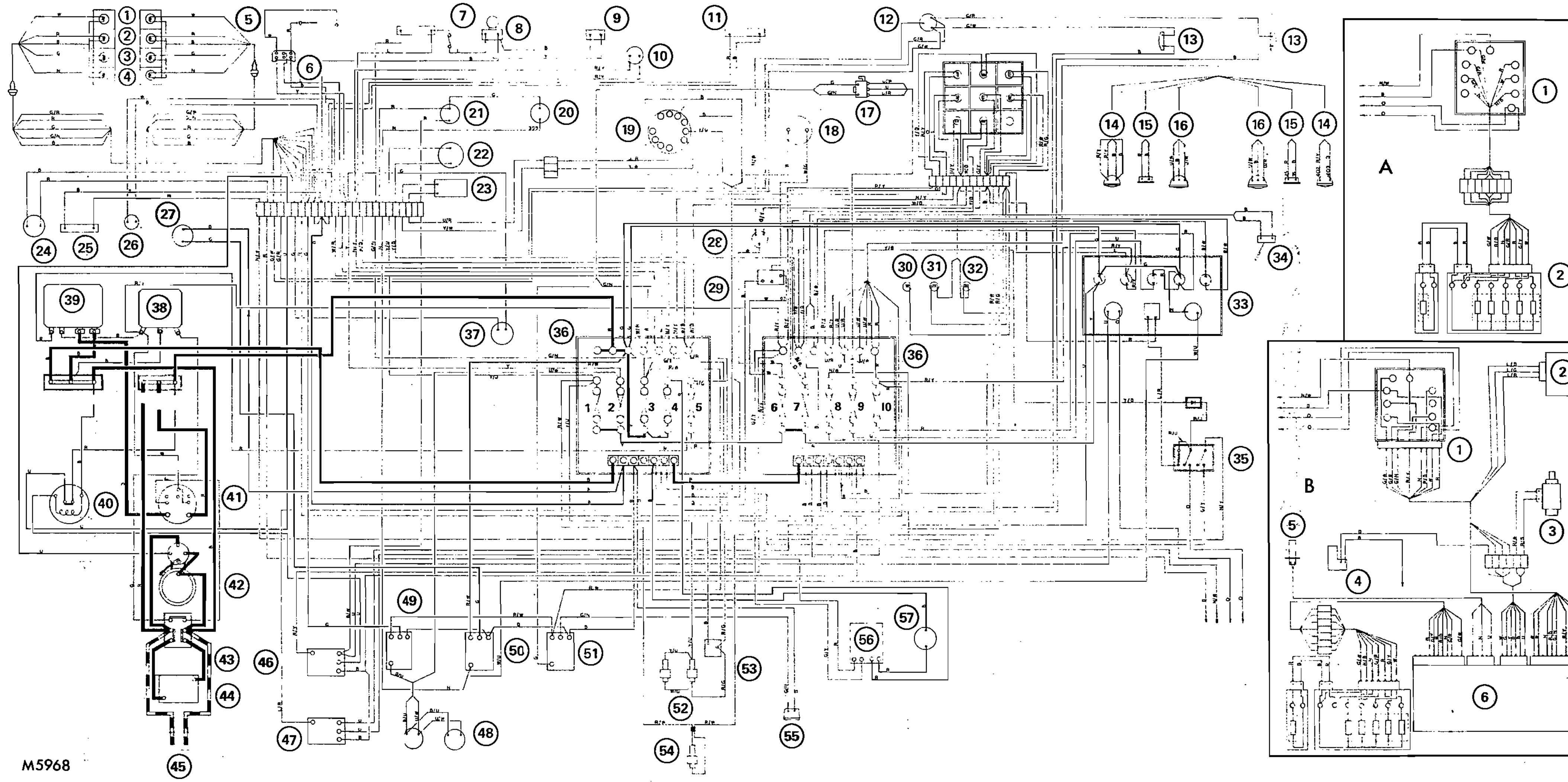


M5850

AUTOMATIC CONTROL SYSTEM CIRCUIT DIAGRAM

AUTOMATIC CONTROL SYSTEM CIRCUIT DIAGRAM

1. Switch, performance level
2. Switch, selector
3. Connection, see vehicle Wiring Diagram
4. Pins, translator terminals
5. Switch, low air pressure
6. E.P. Valve 1-way
7. E.P. Valve 5-way
8. Cable co-axial 2-core
9. Transducer
10. Throttle dip valve
11. Terminal box
12. Vehicle negative connection



M5968

KEY TO WIRING DIAGRAM

1. Rear direction indicator light
2. Tail light
3. Stop light
4. Reversing light
5. Header tank probe
6. 'Radolarm' unit
7. Engine door warning light switch
8. Engine compartment light
9. Engine compartment socket
10. Emergency door warning light
11. Rear registration panel
12. Direction indicator switch
13. Front direction indicator light
14. Fog light
15. Side light
16. Headlight
17. Horn push and dipswitch
18. Temperature gauge
19. Speedometer
20. Engine stop switch
21. Engine start switch
22. Oil pressure switch
23. Speedometer pulse generator
24. Fan thermal switch
25. Cold start thermostart
26. Temperature transmitter
27. Engine stop solenoid
28. Direction indicator unit
29. Voltage stabilizer
30. Speedometer light
31. Air gauge light
32. Temperature gauge light
33. Switch panel
34. Windscreen wiper
35. Cold start relay
36. Fusebox:
    1. Aux. – 10 amp
    2. Aux. – 10 amp
    3. Aux. – 10 amp
    4. Fan – 25 amp
    5. Speedo – 5 amp
    6. Aux. – 10 amp
    7. Aux. – 10 amp
    8. Gearbox – 5 amp
    9. Head – 10 amp
    10. Side/tail and fog – 10 amp
37. Reverse light switch
38. Regulator
39. Reverse polarity relay and pulse clipper
40. Starter relay
41. Alternator
42. Starter motor
43. Battery isolation switch
44. Batteries
45. Assisted starter socket (when fitted)
46. Starter protection relay
47. Starter inhibition relay
48. Stop light switches
49. Stop light relay
50. Engine stop relay
51. Horn relay
52. Low pressure switches
53. Low pressure buzzer
54. Gearbox low pressure switches
55. Horn
56. Fan relay
57. Fan motor

A – SEMI-AUTOMATIC TRANSMISSION CIRCUIT

1. Gear selector switch
2. E.P. valves

B – FULLY AUTOMATIC TRANSMISSION CIRCUIT

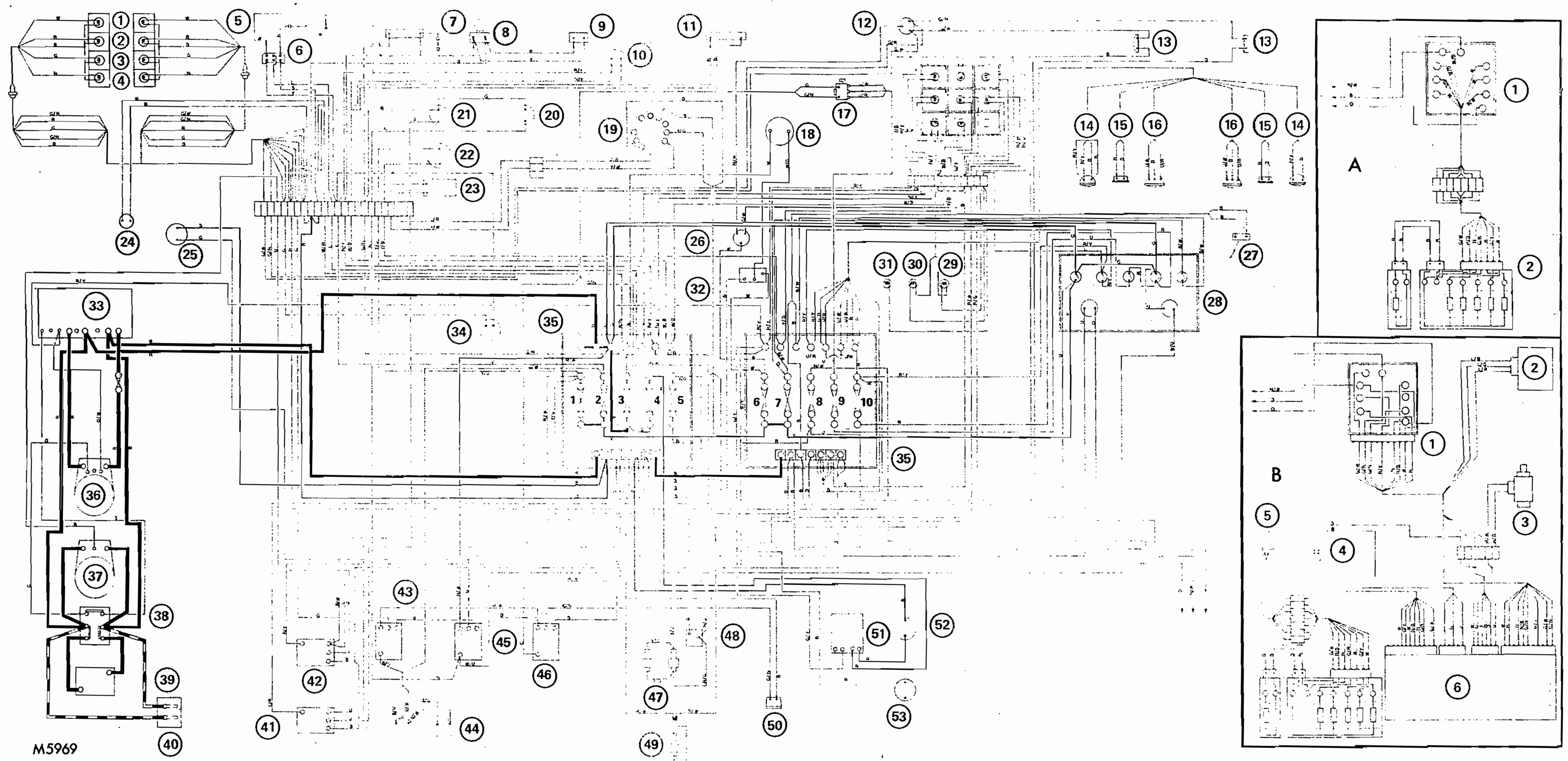
1. Gear selector switch
2. Performance level switch
3. Low air pressure switch
4. Throttle dip E.P. valve
5. Road speed transducer
6. Translator

CABLE COLOUR CODE

N.	Brown	Y.	Yellow
U.	Blue	B.	Black
R.	Red	S.	Slate
G.	Green	L.	Lilac
W.	White	O.	Orange

When a cable has two colour code letters the first denotes the main colour and the second denotes the tracer colour

WIRING DIAGRAM – BUTEC EQUIPMENT



M5969

KEY TO WIRING DIAGRAM

1. Rear direction indicator light
2. Tail light
3. Stop light
4. Reversing light
5. Head tank probe
6. 'Radolarm' unit
7. Engine door warning light switch
8. Engine compartment light
9. Engine compartment socket
10. Emergency door warning light switch
11. Rear registration panel
12. Direction indicator switch
13. Front direction indicator light
14. Fog light
15. Side light
16. Head light
17. Horn push and dip switch
18. Temperature gauge
19. Speedometer
20. Engine stop switch
21. Engine start switch
22. Oil pressure switch
23. Speedometer pulse generator
24. Temperature transmitter
25. Engine stop solenoid
26. Direction indicator unit
27. Windscreen wiper
28. Switch panel
29. Temperature gauge light
30. Air gauge light
31. Speedometer light
32. Voltage stabilizer
33. Control board
34. Reverse light switch
35. Fusebox:
    1. Aux. – 10 amp
    2. Aux. – 10 amp
    2. Aux. – 10 amp
    4. Fan – 25 amp
    5. Speedo – 5 amp
    6. Aux. – 10 amp.
    7. Aux. – 10 amp.
    8. Gearbox – 5 amp.
    9. Head – 10 amp.
    10. Side/tail and fog – 10 amp.
36. Alternator
37. Starter motor
38. Battery isolation switch
39. Batteries
40. Assisted starter socket
41. Starter inhibition relay
42. Starter protection relay
43. Stop light relay
44. Stop light switches
45. Engine stop relay
46. Horn relay
47. Low pressure switches
48. Low pressure buzzer
49. Gearbox low pressure switches
50. Horn
51. Fan relay
52. Fan motor
53. Fan thermal switch

A. – SEMI-AUTOMATIC TRANSMISSION CIRCUIT

1. Gear selector switch
2. E.P. valves

B. – FULLY AUTOMATIC TRANSMISSION CIRCUIT

1. Gear selector switch
2. Performance level switch
3. Low air pressure switch
4. Throttle dip E.P. valve
5. Road speed transducer
6. Translator

COLOUR CABLE CODE

N.	Brown	Y.	Yellow
U.	Blue	B.	Black
R.	Red	S.	Slate
G.	Green	L.	Lilac
W.	White	O.	Orange

When a cable has two colour code letters the first denotes the main colour and the second denotes the tracer colour.

WIRING DIAGRAM – C.A.V. EQUIPMENT

Batteries

PREPARATION FOR SERVICE (Unfilled batteries)

1. **Mixing the Electrolyte**
   Battery electrolyte is usually available at the required specific gravity, but if this is not the case if acid of a higher specific gravity will have to be diluted with water to the required strength.

   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 glass, glazed earthenware, hard rubber or lead. Care must be exercised if using glass containers as the heat of mixing may crack them.

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.

2. **Filling–Dry Uncharged Batteries**
   Before charging remove any seals which may be fitted to vent orifices and fill each cell slowly with pure dilute sulphuric acid of correct strength.

   After filling, allow the battery to stand for 6 to 12 hours.

   During this period the electrolyte level will probably have fallen and it must be restored before charging.

3. **Precautions to be observed during charging**
   (i) Always break the charging circuit at the main switch. Never remove batteries from a live circuit because of the risk of sparks and explosions.

   (ii) 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.

   (iii) Keep the charging point, batteries and connections as clean and dry as possible.

   (iv) Protect the batteries from direct sun-rays. Maintain a clear space of at least one inch around each battery.

   (v) 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.

   (vi) Floors must be insulated. Concrete floors which are difficult to keep dry are not considered absolutely non-conducting.

4. **Initial Charges**
   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.

Table 1. 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

Charge at the initial rate quoted on the manufacturer's label attached to the battery.

Charging should continue until voltage and specific gravity show no increase over five successive hourly readings and each cell is gassing freely.

If the acid temperature reaches 43.5°C (110°F) the charging current should be reduced and the time increased proportionally, or the charge suspended until the battery has had time to cool.

CARE OF BATTERIES IN SERVICE

If the batteries require topping-up more frequently than once every two weeks, 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.

DIAGNOSTIC TESTING

If trouble with the batteries is encountered, tests may be undertaken to ascertain whether they are merely out of condition or reaching the end of their life.

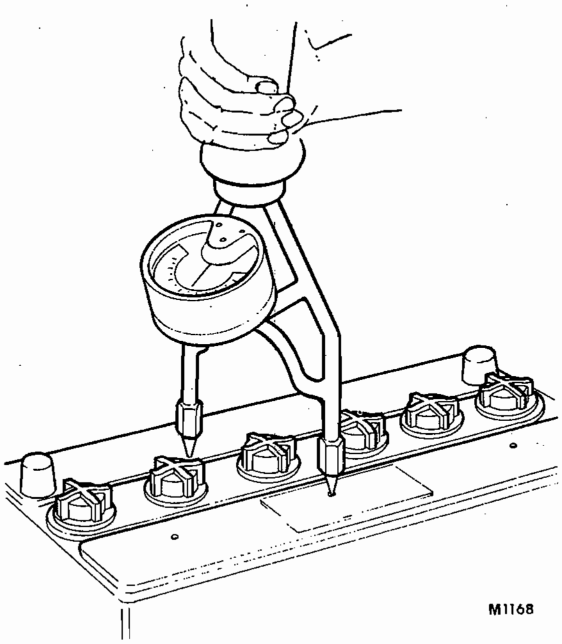


FIG. 1. THE HEAVY DISCHARGE TEST

Assuming other electrical equipment is in order the following may be taken as signs of failing batteries:

1. Starter motor sluggish in operation.
2. Lights fail after a short period of parking.
3. Continuously high rate of charge when alternator is running under 'no load' condition.

High-rate Discharge Test, Fig. 1

The high-rate discharge test is a timed on-load voltage check applied to each individual cell. Good cells will maintain constant readings for ten seconds when the prongs of a suitably rated test meter are applied to adjacent intercell connections or terminals. A weak cell will show a falling voltage.

If readings are uniform but low, it may be assumed the battery is in a healthy condition though partially discharged, and a hydrometer will determine the exact state of charge.

Should a cell give a reading appreciably lower than the remainder or display a rapid fall-off in voltage during a five second period, a failing cell is indicated.

Erratic readings with several cells showing a falling voltage indicate the battery has almost reached the end of its life, which will be confirmed if these cells have specific gravities very much lower than the remainder. Each cell should be at least 70% charged before testing, but if the vehicle has just completed a journey the batteries should be slightly discharged by operating the starter or leaving on the headlights for a few minutes – to remove surface charge.

Failure to do this may result in falsely high readings on the high-rate discharge test.

Hydrometer Test

The hydrometer measures the state of charge of a battery by determining the acid specific gravity. This varies with temperature, and whatever reference temperature used, the correction is always seven points (.007) of specific gravity for each 10°C variation.

Fast Charging

Fast charge equipment should be used with discretion and only regarded as an emergency measure for a discharged but otherwise sound battery.

Trickle charging is always preferable. Frequent need for 'boosting' indicates failure in the vehicle charging system which should be immediately investigated.

When using fast charging equipment, instructions issued by the makers should be closely followed and the electrolyte temperature kept below 43.3°C (110°F). This method must never be used for initial charging.

SECTION 3A

The BUTEC Charging System

DATA

Alternator

Type	A24AB
Maximum rated output	28V, 60A
Cooling	Surface cooled (built-in fan)
Rectification	Built-in silicon diodes
Stator phase resistance	0.126 to 0.140 ohms
Weight (without pulley)	12,6 kg (27.8 lb)

Regulator

Type	R1

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.

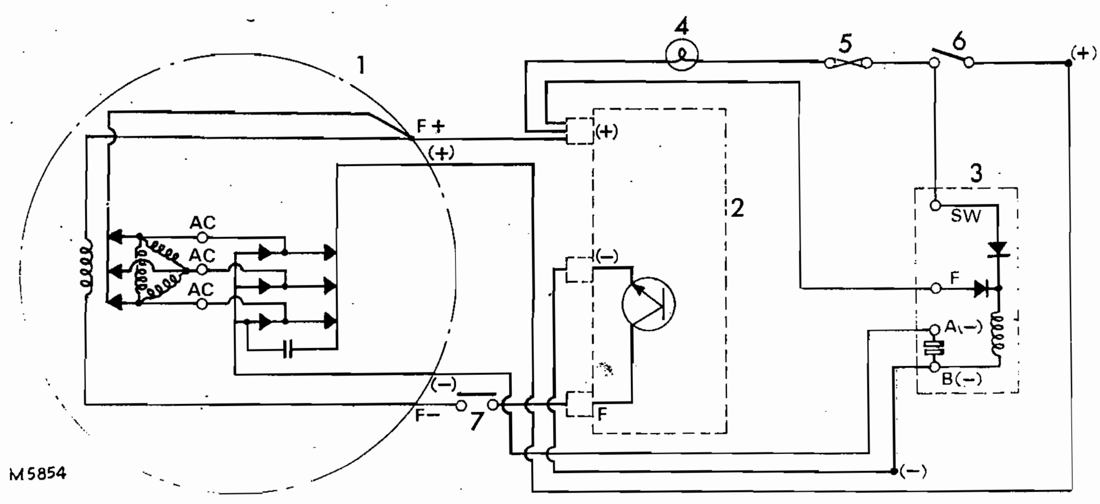


FIG. 1. TYPICAL CHARGING CIRCUIT

1. Alternator
2. Voltage regulator
3. Relay — reverse polarity
4. Lamp — no charge warning
5. Fuse
6. Switch, auxiliary — start
7. Contacts — field isolator

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
- Regulator faulty

REMOVAL AND REFITMENT

Alternator

To Remove

1. Rotate the isolator switch to the 'OFF' position.
2. Open the engine access panel.
3. Note the positions and disconnect the electrical connections from the alternator.
4. Slacken the alternator drive belt adjuster; remove the drive belts and the bolt securing the adjuster to the alternator cradle.
5. Swing the cradle down and remove the setscrews securing the alternator. Detach the alternator from the engine.

To Refit

1. Reverse the procedure 1 to 5 noting,
   a. Adjust the alternator drive belt tension as described in Group 1, Reference 1–2–14.
   b. Ensure that all electrical connections are in their original positions.

MAINTENANCE

The bearings are packed with lubricant during manufacture and further lubrication is therefore unnecessary.

1. The exterior of the alternator must be kept clean.

2. Check all mounting bolts for security and terminal connections for cleanliness and security.

3. At regular intervals inspect the brushes — minimum brush length is 47.6 mm (0.187 in) — their spring tension and the slip-rings. Should the slip-rings and brush holders be fouled with grease or dirt, the unit should be removed from the engine. After removing the brush housing, the slip-rings, brushes and brush holders should be thoroughly cleaned.

ALTERNATOR – FAULT DIAGNOSIS

Should the charging system not function properly, the following tests may be conducted whilst the alternator is mounted on the vehicle and should indicate whether the unit is defective.

Remove encapsulated field diodes (1) Fig. 3 before taking tests.

1. **Stator Earth Test**
   Check any stator phase for earth to the alternator frame as shown in Fig. 4. A 110 or 230 volt test lamp is used for this test. A circuit should not be indicated. This is a delta connected stator so if one phase shows earth, all phases will be earthed.

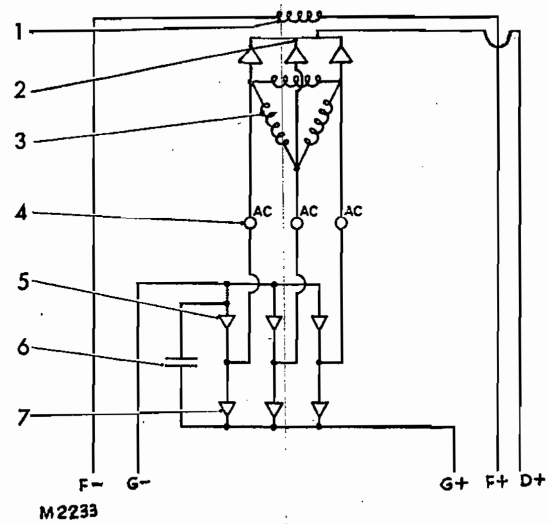


FIG. 2. A24AB ALTERNATOR CIRCUIT DIAGRAM

1. Rotor (field) coil
2. Positive (+) sensing diode
3. Stator winding
4. A.C. terminals
5. Negative (–) diodes
6. Capacitor
7. Positive (+) diodes

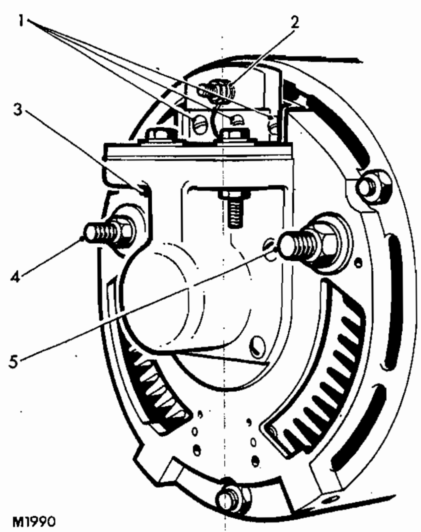


FIG. 3. A24AB ALTERNATOR TERMINALS

1. A.C. output tappings
2. Sensing diode terminal
3. Field terminal
4. Negative D.C. terminal
5. Positive D.C. terminal

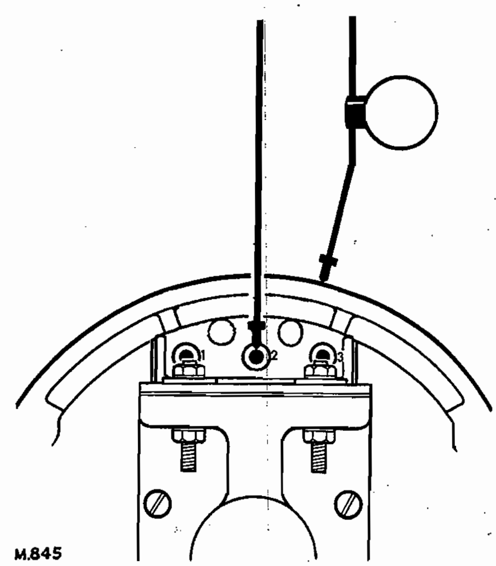


FIG. 4. STATOR EARTH TEST

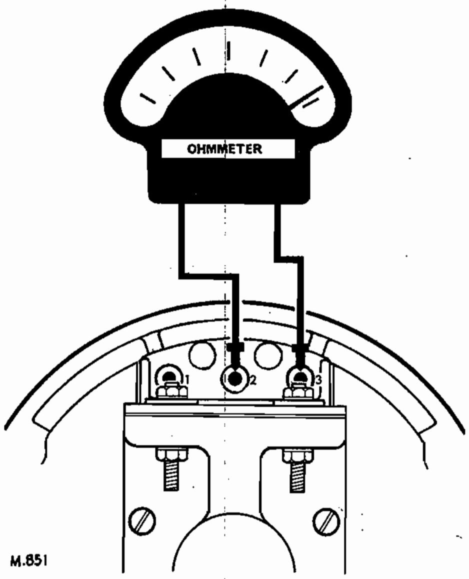


FIG. 5. STATOR CONTINUITY TEST

2. Stator Winding Continuity Test

With an ohmmeter check the continuity of each of the three phases of the stator winding as shown in Fig. 5.

Three similar readings should be obtained.

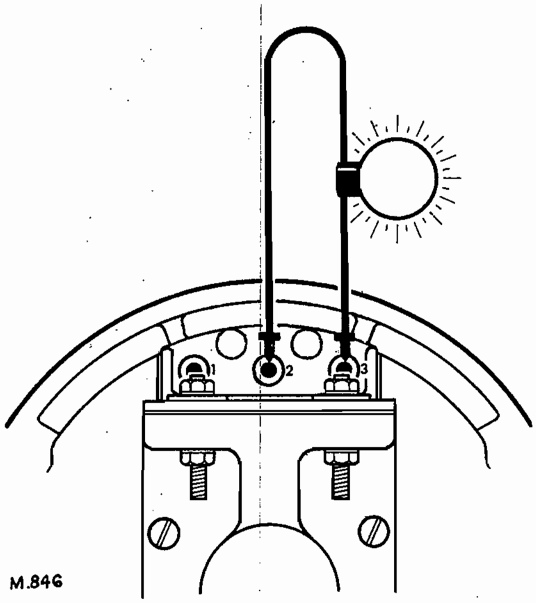


FIG. 6. PHASE TEST

3. Alternator Phase Test

Start the engine and run the alternator at 1,000 rev/min. Connect an A.C. Voltmeter, or test lamp of the same voltage rating as the system between two of the three A.C. terminals in turn, Fig. 6.

Voltage or lamp brilliance should be the same across phases 1-2, 2-3 and 1-3. A pronounced difference in voltmeter reading or lamp brilliance indicates shorted or earthed stator windings.

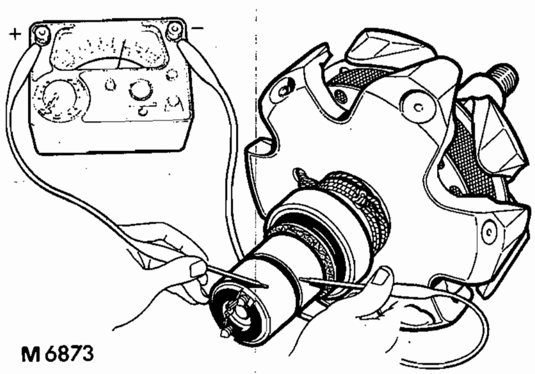


FIG. 7. TESTING ROTOR COIL RESISTANCE

4. Rotor Coil Resistance Test

Position the Avometer test prods on each slip ring, ensuring good electrical contact is made, see Fig. 7. The rotor coil resistance should be 13.6 to 15.1 ohms.

Lack of resistance indicates a possible open circuit condition of the rotor coil.

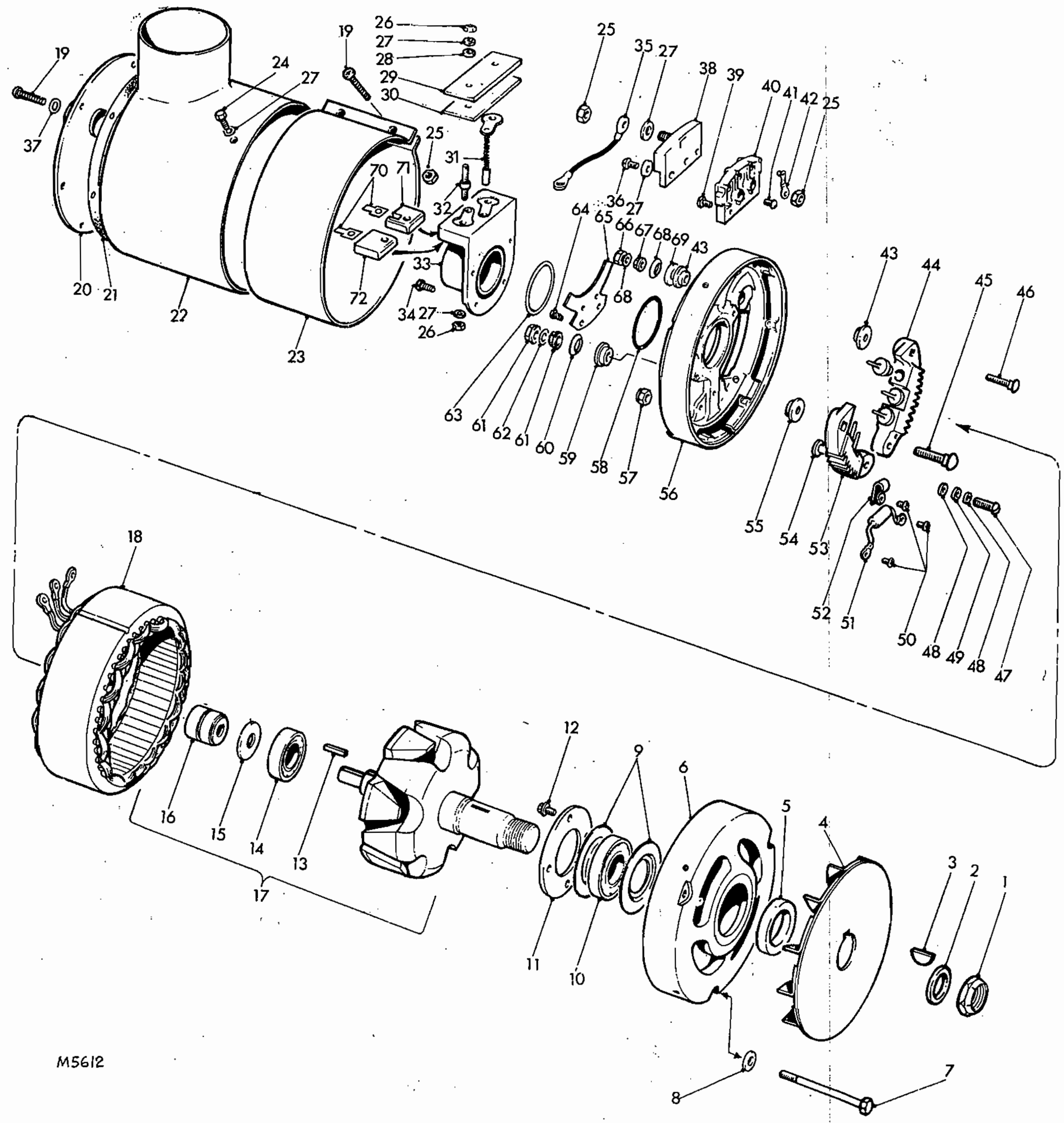


FIG. 8. EXPLODED VIEW OF TYPICAL ALTERNATOR

1. Nut
2. Washer plain
3. Key
4. Fan assembly
5. Spacer
6. Housing drive-end
7. Bolt
8. Washer belleville
9. Seal
10. Bearing drive-end
11. Retainer bearing
12. Screw
13. Wedge slot
14. Bearing slip-ring end
15. Washer insulation
16. Slip-ring assembly
17. Rotor and slip ring assembly
18. Stator assembly
19. Screw
*20. Insulator and cover assembly
*21. Gasket
*22. Cover assembly
*23. Band
*24. Screw
25. Nut lock
26. Nut
27. Washer lock
28. Washer plain
29. Cover terminal
30. Gasket
31. Brush assembly
32. Screw
33. Housing brush holder
34. Screw
35. Lead assembly
36. Screw
37. Washer
38. Capsule diode – positive
39. Screw
40. Insulator
41. Screw
42. Jumper
43. Bush insulation
44. Rectifier assembly – negative
45. Screw terminal
46. Screw terminal
47. Screw
48. Washer plain
49. Washer insulation
50. Screw
51. Capacitor assembly
52. Clamp
53. Rectifier assembly positive
54. Bush insulation
55. Bush insulation
56. Housing slip-ring end
57. Nut
58. O-ring
59. Bush insulation
60. Washer belleville
61. Nut Tenz
62. Washer lock
63. O-ring
64. Rivet
65. Plate identification
66. Nut Tenz
67. Washer lock
68. Washer beleville
69. Washer plain
*70. Terminal field
*71. Inhibitor field
*72. Inhibitor field

* Where fitted

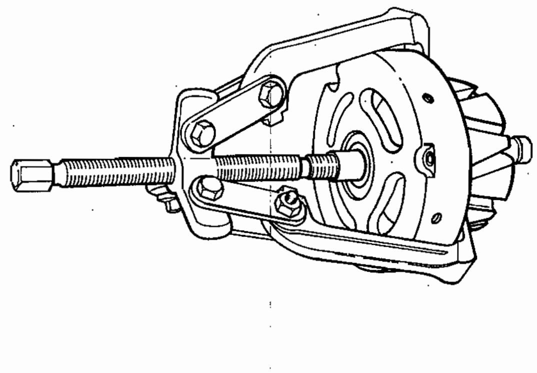


FIG. 9. REMOVING ROTOR

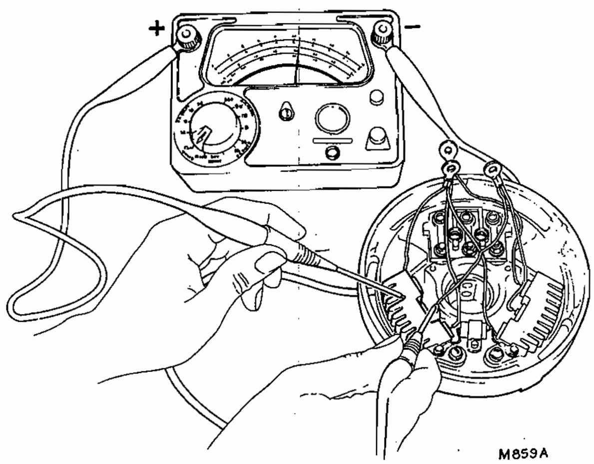


FIG. 10. DIODE TEST – USING AVOMETER

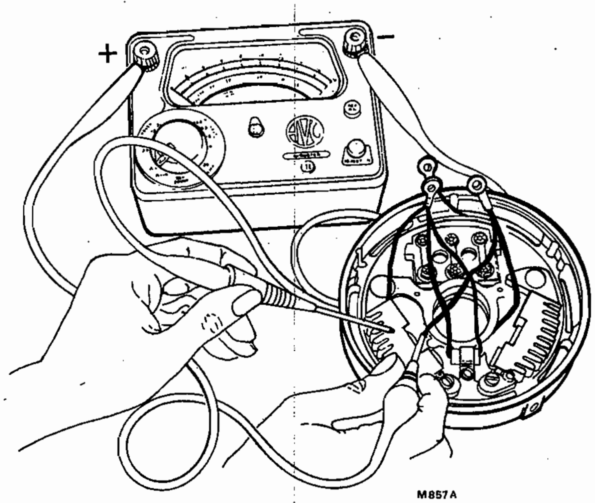


FIG. 11. DIODE TEST (PRODS REVERSED)

OVERHAUL

To Dismantle, Fig. 8

1. Unscrew the shaft nut. Remove the washer, coupling and fan assembly, then the drive key.

2. Remove the brushes together with washers, insulator cover, and cork gasket after unscrewing the two insulator cover retaining nuts.

3. Remove the plastic brush housing after releasing the four screws.

4. Remove three Nyloc nuts, the through bolts and three special washers holding the unit together. Hold a brass drift against the slip-ring end of the rotor shaft; gently tap the drift with a hammer or mallet and part the slip-ring end housing and stator.

5. To disconnect the stator from the slip-ring end housing, remove the three A.C. terminal nuts and stator connections, then separate the components using a lead or hide mallet.

6. Use a gear puller – Fig. 9 – or an arbor type press to remove the rotor from the drive-end housing.

The diodes are carried in two heat sinks – one of positive polarity and the other negative. The positive consists of three cathode based diodes – the negative having three anode based diodes. These diodes are not individually replaceable, but supplied for service purposes already assembled to heat sinks.

Rectifier Testing – Method 'A'

The following rectifier tests should be made when it is indicated that they are not functioning correctly:

Note: To determine which lead of an ohmmeter is positive (+) or negative (–) an ordinary flashlight battery may be used. With one prod of the ohmmeter touching the carbon end of the battery and the other touching the case, a high resistance reading indicates that the prod at the carbon end is positive (+), no resistance is an indication that the lead at the carbon end is negative (–).

The instrument shown in illustrations Fig. 10 and 11 is an Avometer model 12 which has been specially designed for automotive use.

If an ohmmeter or Avometer is not available, see alternative method 'B'.

Test 1 – Positive (+) Diodes

(a) With the negative prod of an ohmmeter (or Avometer) on the diode terminal and the positive prod on the associated heat sink – pointer should deflect. Fig. 10. If no deflection – diode is open circuit.

(b) Reverse meter prods – positive to diode terminal – negative to heat sink. Meter pointer should not deflect. Fig. 11.

Deflection indicates a short circuit condition.

Each of the positive (+) diodes should be checked in this manner.

Test 2 – Negative (–) Diodes

Each of the negative diodes should be checked in a similar manner to Test 1.

With the meter positive prod on the negative diode terminal and the negative on the heat sink – pointer deflection should occur.

If it does not – diode is open circuit.

Reverse the prods – meter pointer should not deflect.

Pointer deflection indicates a short circuit condition.

Rectifier Testing – Method 'B' (Alternative)
If an Avometer or ohmmeter is not available a 12 volt battery and lamp may be used to test the silicon rectifiers – see Fig. 12. This test is basically the same as method 'A' with the battery and lamp replacing the Avometer shown in Fig. 10 and Fig. 11.

The results of the preceding test can be as follows:

1. If the lamp lights in one direction only, the rectifier diode is satisfactory.
2. If the bulb lights in both directions the rectifier diode is 'shorted'.
3. If the bulb does not light in either direction, the rectifier is 'open'.

Any diode failing the foregoing tests will entail renewal of the complete rectifier assembly concerned.

Rectifier Assembly Renewal
When it is determined which diode or diodes are defective, it is recommended that one or both rectifier assemblies be renewed. To renew, proceed as follows:

1. Remove the two screws which secure the capacitor leads to the rectifier assemblies.
2. Cut the three flexible leads of one or both rectifier assemblies concerned at the crimped terminals.
3. Remove the screws, nuts, washers and ceramic insulators which secure the rectifier assembly to the slip-ring end housing.
4. Fit new rectifier assembly, **ensuring it is of the same polarity** and that both the ceramic insulators and fibre washers are in their correct relative positions, Fig. 13 and 14.
5. Remove the three A.C. terminal nuts and connect the rectifiers.
6. Re-connect the capacitor leads.

Test 3 – Diode Capsule – Positive Sensing

A. With the negative (–) prod of an ohmmeter on the terminal post and the positive (+) prod on each other terminal in turn, the meter should indicate a low resistance, Fig. 15.

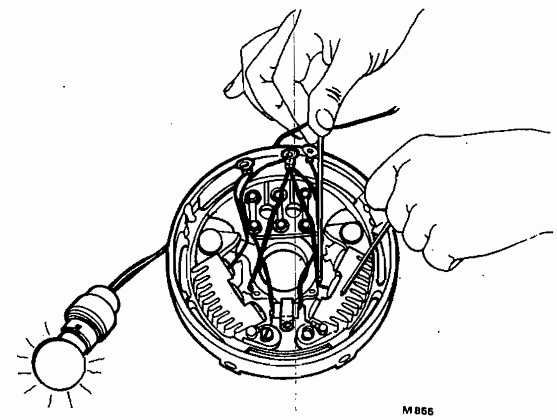


FIG. 12. DIODE TEST – USING LAMP

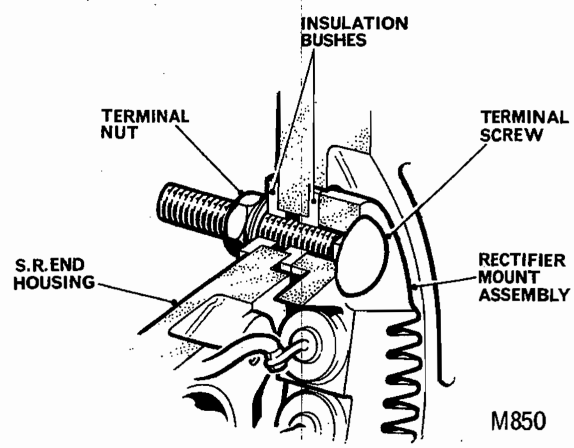


FIG. 13. SECTION THROUGH SLIP-RING END HOUSING

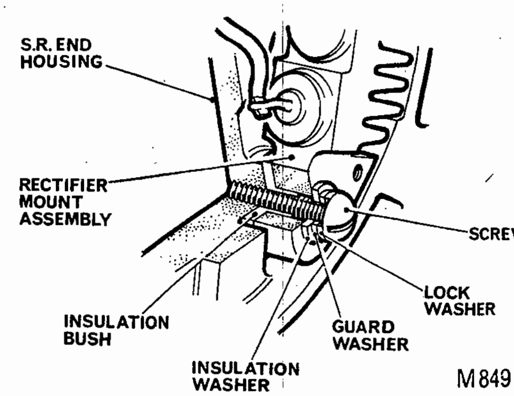


FIG. 14. SECTION THROUGH SLIP-RING END HOUSING

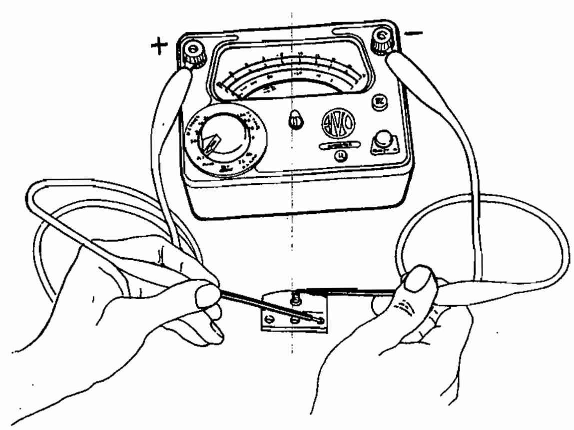


FIG. 15. TESTING FIELD DIODES

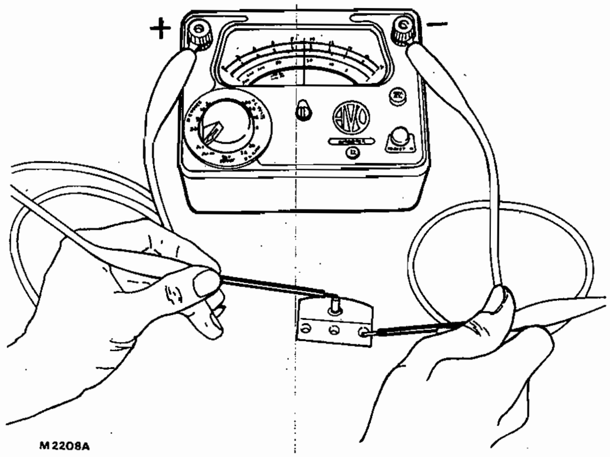


FIG. 16. TESTING FIELD DIODES (PRODS REVERSED)

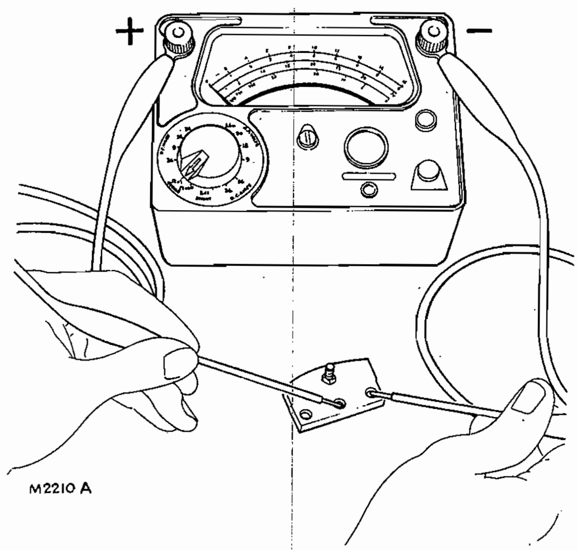


FIG. 17. TESTING FIELD DIODES

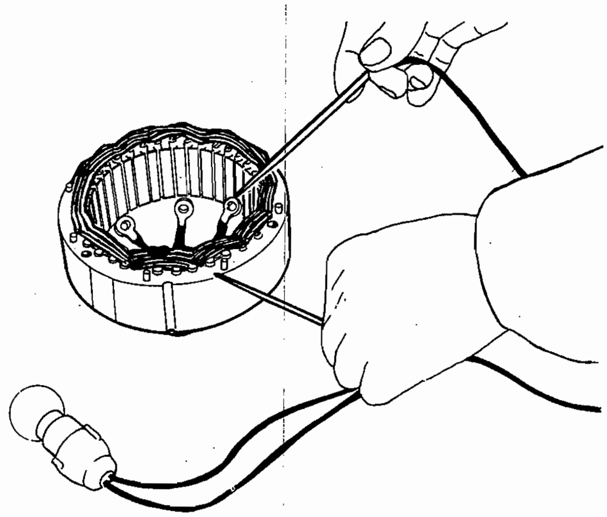


FIG. 18. TESTING INSULATION

B. With the positive (+) prod of an ohmmeter on the terminal post and negative (–) prod on each other terminal in turn, meter should indicate a high resistance, Fig. 16.

C. Apply test prods between two of the three diodes in turn. No reading should be obtained, Fig. 17.

Overhaul (Stator and Housing)

1. Check the stator windings to ensure the wires are not burned, broken or insulation damaged, see Fig. 18. If the windings appear to be in good condition, use an air hose to blow out any dirt or carbon dust. Clean the stator with a suitable solvent and dry thoroughly. Check each A.C. terminal to each of the other two terminals using a bridge tester; they should all make a complete circuit and a reading of 0.454 to 0.494 ohms should be recorded, see Fig. 19.

2. If the bearing is worn it should be renewed. Remove the four screws and bearing retainer plate from the drive-end housing and press out or tap out the old bearing. Apply pressure on outer race only when pressing in the new bearing.

Overhaul (Rotor)

If the rotor bearing, slip-rings and coil are in good condition, further dismantling is unnecessary. But if the rotor coil is open circuit, earthed or does not have the specified resistance, the rotor is beyond repair and a service replacement rotor assembly must be obtained.

Renewing Slip Rings

Worn or scored slip-rings should be renewed.

With a soldering iron, remove the wire which connects the rotor coil to the outer slip-ring. Bend the wire so that it is parallel to the shaft and unsolder the wire from the inner slip-ring. With a gear puller, pull off the slip-rings and insulating washer. Alternatively, an arbor type press may be used, placing suitable fixture plates behind the slip-rings. A new insulation washer should always be fitted.

The new slip-ring assembly should be kept in a warm place so that it will press on the shaft easily without cracking. Ensure the slots in the slip-ring align with the slot in the shaft carrying the wires from the rotor coil and then press on the slip-ring to the shoulder. Solder the coil leads to the new slip-ring.

Place the rotor assembly in a lathe and take a light smooth cut, preferably with a diamond tool, from the face of the slip-rings to ensure perfect concentricity with the bearing surfaces of the shaft which should be within 0.050 mm (0.002 in) total indicator reading.

Renewing Rotor Bearings

A worn rotor bearing may be removed after the slip-rings using a puller — Fig. 20 — or alternatively an arbor press. Pressure should be applied to the inner race only when fitting a new bearing.

Reassembling the Alternator

1. Place the slip-ring end of the shaft on a flat plate in an arbor press and assemble the rotor and drive end housing, using a tube or pipe to press on to the inner race of bearing only.

2. Place the stator over the rotor and line up the bolt holes to match those in the drive end housing. Secure the stator connections to the insulator (40) Fig. 8 — in the slip-ring end housing, then place the housing assembly into position using the bolts (7) to align the housing with the stator. Apply pressure to the top of slip-ring end housing in arbor press. Tighten the through bolts to a torque loading of 0.76/0.95 kgf m (5.5/7.0 lbf ft).

3. Refit brush housing, renewing if necessary the rubber O-ring.

4. Insert brushes — if worn below the minimum serviceable length of 4.76 mm (0.187 in) they should be renewed — allowing them to rest on the slip-rings. Fit a new cork gasket, the insulator cover, washers and retaining nuts.

5. Refit the sensing diode capsule and reconnect the lead wire to the field terminal.

6. Fit the shaft key, fan and coupling flange and finally the washer and shaft nut. Tighten the nut to a torque of 7.0 kgf m (50 lbf ft). Spin the rotor by hand to ensure free rotation.

7. Refit the alternator to chassis and test per system diagram. If a test block is used instead, 1,000 rev/min must not be exceeded or damage to the alternator will result.

Warning: If welding or soldering is necessary in the vicinity of the alternator, precautions must be taken to ensure that heat is not transmitted to the diodes, otherwise irreparable damage will be caused.

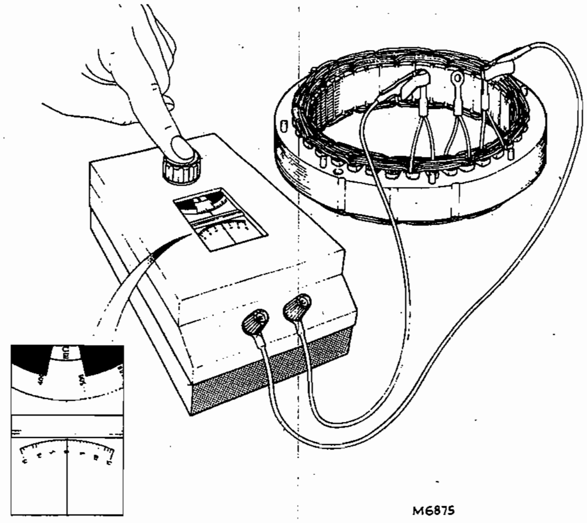


FIG. 19. CHECKING CONTINUITY

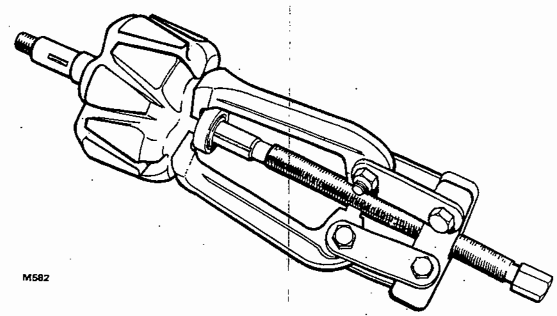


FIG. 20. REMOVING ROTOR BEARING

REGULATOR — TYPE R1

DESCRIPTION

The R1 Regulator is fully transistorised, has no moving parts, needs no maintenance and is repairable. The components are fixed upon a printed circuit base in a sealed aluminium case which is suitably finned for heat dissipation. The field adjustment screw is located beneath a socket plug.

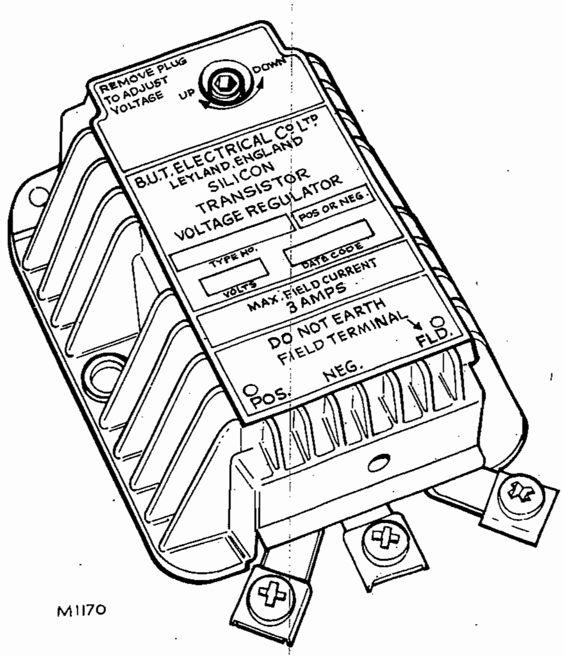


FIG. 21. R1 REGULATOR

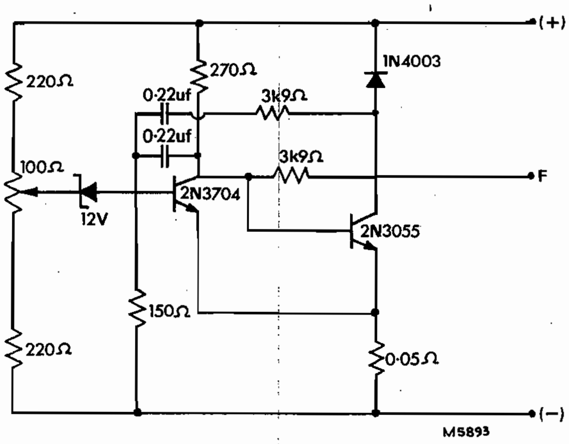


FIG. 22. CIRCUIT DIAGRAM

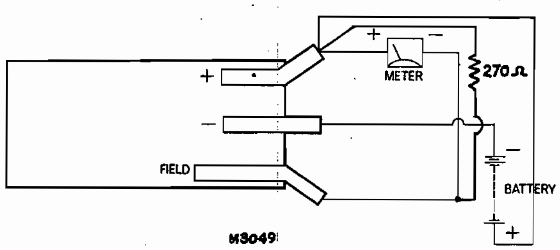


FIG. 23. TEST CIRCUIT DIAGRAM

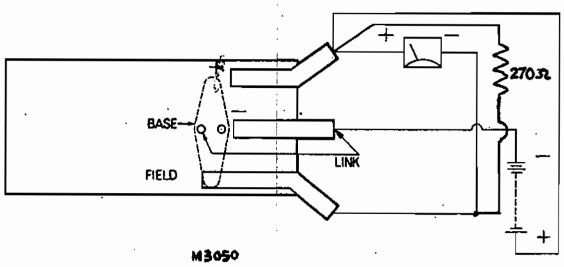


FIG. 24. TESTING OUTPUT TRANSISTOR AND FIELD DISCHARGE RECTIFIER

FAULT DIAGNOSIS

The purpose of this section is to instruct service personnel in the correct test procedures which, using common test equipment, quickly diagnose the exact source of trouble. It is emphasised that the recommended methodical checks be carried out so that only the defective component is repaired or replaced.

It is essential to ensure, in fault cases, that the regulator unit, prior to disconnection, is faulty and not due to a wiring error, loose connection, the alternator, or, simply a blown fuse.

Disconnecting the batteries whilst the alternator is running or reversing the battery connections will cause damage to semi-conductors in both regulator and alternator.

Before testing the regulator in detail because of low voltage output, first remove both the negative and field leads from the regulator and join them together; do not use the regulator terminals to join the field and negative together as a short circuit may exist inside the unit. This enables the alternator to run full field and should the fault persist, a faulty alternator is indicated.

Tests in Vehicle

Assuming the fault persists, check the voltage adjustment setting.

1. On normal load check that a voltage at least equal to battery voltage exists between positive (+) and negative (—) at the regulator terminals.

2. The control potentiometer may be incorrectly set; adjust to 28 volts on load.

3. Note setting of control potentiometer, rotate fully clockwise and measure voltage between field and negative (—) terminals; this must be less than 1.5 volts. If so, the regulator is operating correctly; reset to original position.

If the above tests confirm that the regulator is faulty, it must now be removed for further testing.

The batteries must first be disconnected before attempting removal of the unit from the vehicle in order to undertake the following bench tests.

Bench tests

Connect a 24 volt battery to the positive and negative terminals of regulator. Connect a voltmeter (30 volts scale) and a 270 ohm resistor between positive and field terminals. An Avometer or similar instrument is ideal. Positive of meter to positive terminal, Fig. 23.

Note: All diagrams show the underside of the regulator.

Alternatively, if a voltmeter is not available, connect a 24 volt, 6 watt bulb in the meter position — the 270 ohm resistor will not then be required. Illumination of the bulb indicates the same circuit condition as the full battery voltage reading on the meter.

1. **Field Discharge Rectifier 1N4003 and Output Transistor 2N3055.**

   With the regulator control at its normal setting, the voltmeter will read battery voltage. If the reading is below 2 volts, rotate the control potentiometer screw fully anti-clockwise. The voltmeter should now read battery voltage.

   Using a shorting link wire, join the negative terminal of the regulator to the base of the 2N3055 transistor. Fig. 24.

   The voltmeter will now fall to within 2 volts of zero and removal of the link will again allow a rise in voltage.

   These tests ensure that the field discharge rectifier is not short-circuited and that the 2N3055 output transistor is switching correctly.

2. **Driver Transistor**

   Connect a 200 ohm resistor between the potentiometer slider tag and positive, Fig. 25.

   To avoid damaging the regulator, the resistor should be held in the circuit for a brief period only — just sufficient to obtain a meter reading. The voltmeter should now drop to within 2 volts of zero. Remove the resistor. This test proves correct function of the driver transistor.

3. **Potentiometer and Zener Diode**

   Connect a fully charged battery (24.6 volts or more) as shown in Fig. 26.

   Rotate the potentiometer adjustment screw clockwise (DOWN direction on cover). Voltmeter should read 24 volts approximately. Rotate adjuster screw anti-clockwise (UP direction on cover). Reading obtained should be 2 volts or less.

This check shows correct operation of the potentiometer and Zener diode.

From the foregoing tests 1, 2 and 3, it is possible to diagnose any incorrect operation of a stage or component.

Before proceeding further it is necessary to remove the printed circuit base from the housing and then remove the components from the base.

REMOVAL OF PRINTED CIRCUIT BOARD

Using a box spanner, remove five No. 8 UNF screws holding the board, also the nuts and cross recessed head screws securing the output transistor 2N3055.

A soldering iron not exceeding 25 watts dissipation should be used on all joints, together with a solder puller, such as supplied by Sealab Electronics, Havant, Hampshire.

Remove solder from around the base and emitter pins of 2N3055 transistor.

The printed board can now be lifted from the housing. Take care not to lose or damage the mica washer or screw insulating inserts when the output transistor is removed.

COMPONENT TESTING

No attempt should be made to take these measurements whilst the components are attached to the printed circuit base; this would result in false measurements and wrong conclusions due to shunt circuits on the base. Always unsolder the components as detailed above, being careful not to use excessive heat.

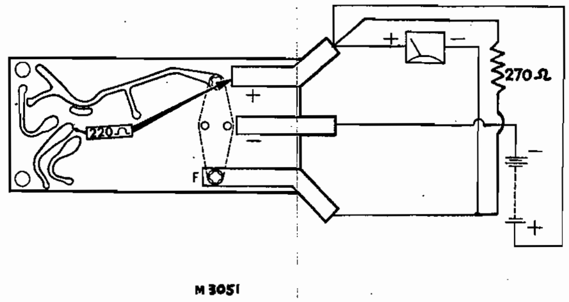


FIG. 25. TESTING DRIVER TRANSISTOR

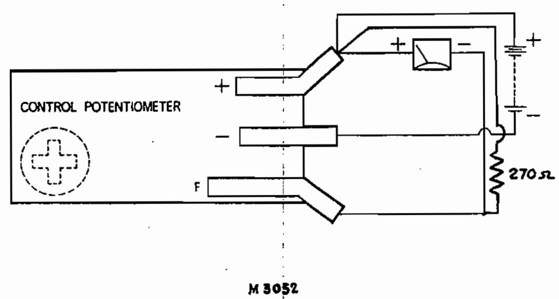


FIG. 26. TESTING POTENTIOMETER AND ZENER DIODE

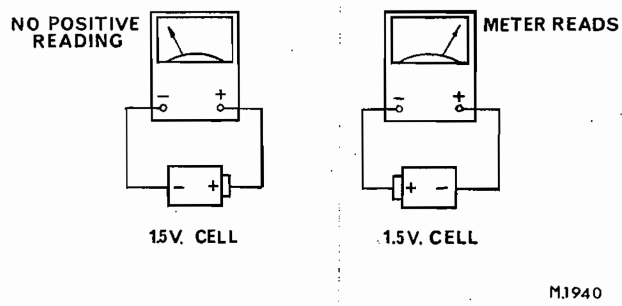


FIG. 27. CHECKING METER POLARITY

Transistor testing

An ohmmeter is required for the test to be described and it is most important that correct polarities are observed. The polarity of an ohmmeter internal battery can quickly be ascertained and noted for future use.

Connect a 1.5 volt cell as shown in Fig. 27. If the readings are as shown, then the ohmmeter battery polarity will be as indicated.

This test is particularly important with combination instruments such as an Avometer, where the positive terminal may well be the negative of an internal battery.

Method of Testing

(a) Connect positive voltage terminal of ohmmeter to Base lead wire. Touch negative terminal lead to Emitter and then to Collector; these readings will be approximately equal and of low resistance.

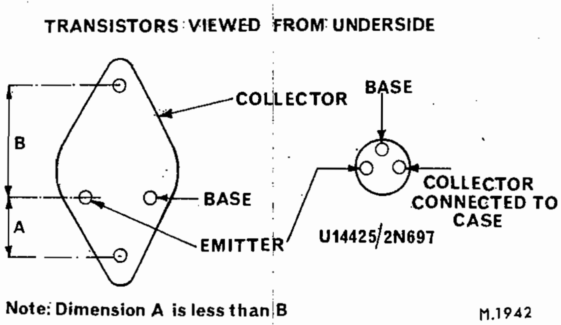


FIG. 28. TRANSISTOR CONNECTIONS

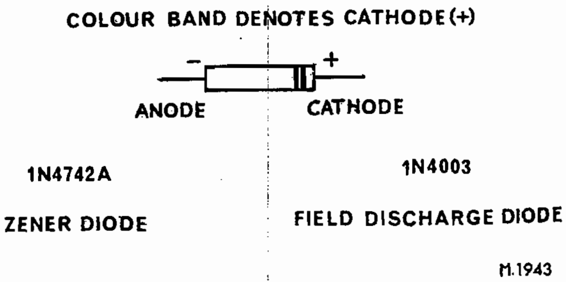


FIG. 29. DIODES USED IN BUTEC REGULATOR

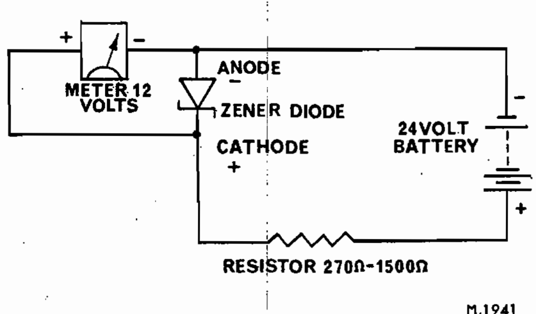


FIG. 30. ZENER VOLTAGE TEST

(b) Connect negative terminal of ohmmeter to Base lead wire. Touch positive terminal lead to Emitter then to Collector; the readings should be of considerably higher resistance in this case.

Fig. 28 shows the transistor connections viewed from the underside.

Note:
No specific readings for resistance are given, only High and Low.

The actual value will depend upon the type of ohmmeter used and its internal battery voltage. Since the tests are essentially PASS/FAIL, if in doubt, renew the transistor.

Diode Testing
The diodes used in the regulator are illustrated in Fig. 29. Again using the ohmmeter, connect the positive of the meter to the diode anode and the negative to the cathode; the meter should read LOW resistance. Negative to anode should obtain a HIGH resistance reading.

It is unimportant if the meter scale will not accommodate the HIGH reading, for the test is aimed to show a large difference when reversing polarity. Differences of at least 100 : 1 are normal.

Zener Voltage Test
This test enables the Zener diode to be checked for actual breakdown voltage.

Connect a 24 volt battery, the diode and any resistor between 270 and 1500 ohms as shown in Fig. 30 together with a D.C. voltmeter reading to 12 volts.

If the Zener is satisfactory it will read approximately 12 volts. However, unless the resistor chosen is of a greater value than 500 ohms, the components should not be left connected for more than a few minutes.

REASSEMBLY

The 2N3055 transistor is mounted in the housing and secured by two screws, and insulated from the housing by a mica washer and two bushes. Always refit the mica washer and ensure that the mounting surface is clean and free from burrs. Since the washer is very thin to obtain maximum heat transfer to the housing, any burrs or metal particles may punch through and cause a short circuit to the mounting surface. Silicone grease, applied to both surfaces of the washer, will improve heat transference.

Use only resin core solder and ensure that no particles of solder are left in the unit after repair.

SECTION 3B

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
- Regulator faulty

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.

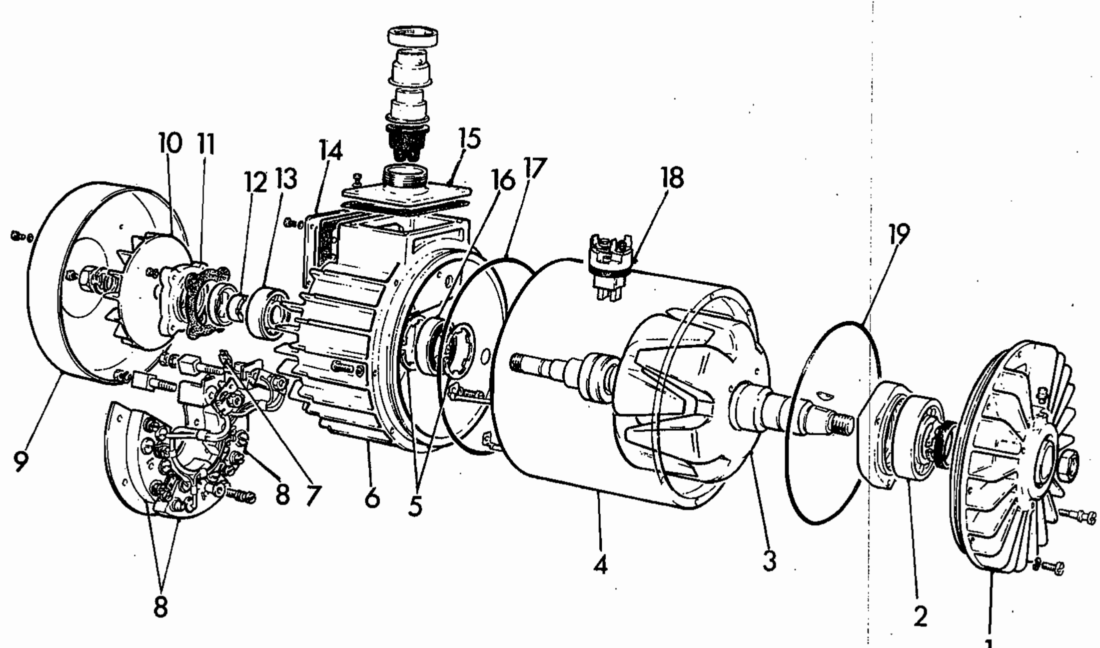


FIG. 1. EXPLODED VIEW OF ALTERNATOR

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	

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.

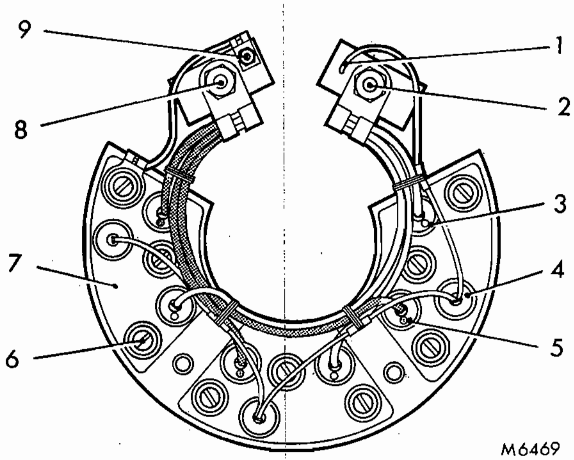


FIG. 2. HEAT SINK RENEWAL

1. 'A' lead
2. Output terminal (+)
3. Red spot main diode
4. Auxiliary diode
5. Black spot main diode
6. Fixing screws
7. Heat sink
8. Output terminal (−)
9. 'R' terminal

   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:

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.

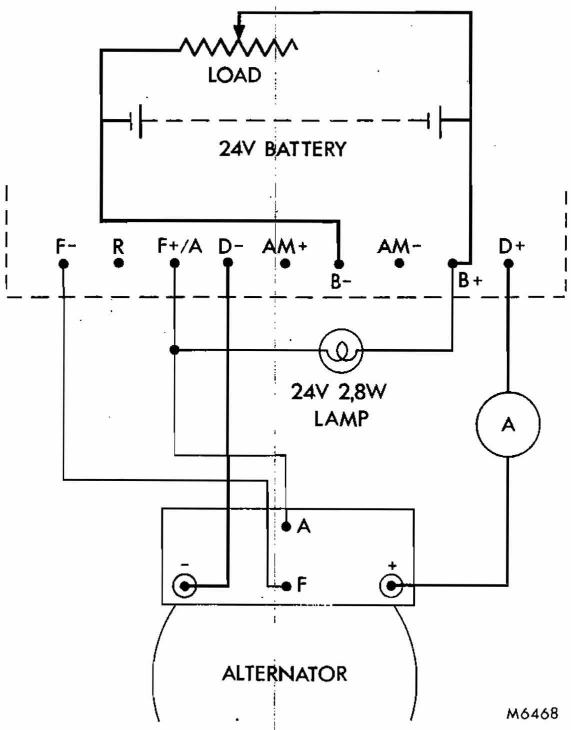


FIG. 3. TEST BENCH CIRCUIT

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 ±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.

Starter Motor – BUTEC

DATA

Type	MS1A/40
Weight	27,2 kg (60 lb)
Output	9.5 horsepower
Lock torque	10.2 kgf m (74.0 lbf ft) with 1 350 amperes 11.6 terminal volts
Light running current	490 amperes at 2 200 rev/min

DIAGNOSTIC TESTING

Fault	Rectification
Starter fails to operate	Check: State of charge of batteries. That all cables and connections are clean and secure. Solenoid switch.
Solenoid operates bringing 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 properly engage in flywheel ring gear.	Check: Pinion for wear. Flywheel ring gear for wear. Shift lever and shaft 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.
   CAUTION: Do not support the starter motor by the external solenoid.

4. With the starter motor adequately supported, remove the nuts and washers and withdraw the starter motor from the engine.

To Refit

1. Reverse the procedure 1 to 4, ensuring that all electrical connections are in their original positions.

OVERHAUL

Starter Motor

To Dismantle, Fig. 1

1. Index all housings in relation to the field ring and each other by punch marks or other means before dismantling.

2. Slacken brush opening band securing screws then slide off band complete with cork gasket. Remove eight brush tab securing screws and using a suitable tool, lift up the brush springs – then remove the brushes. The brushes must not be lifted by their flexible leads. Remove the screws and lockplates securing the field connections. After unscrewing four retaining bolts the commutator end housing together with brush holders may be withdrawn.

3. Using tool CET55/60 remove six socket head screws from nose housing and slide housing from armature shaft, revealing the drive assembly.

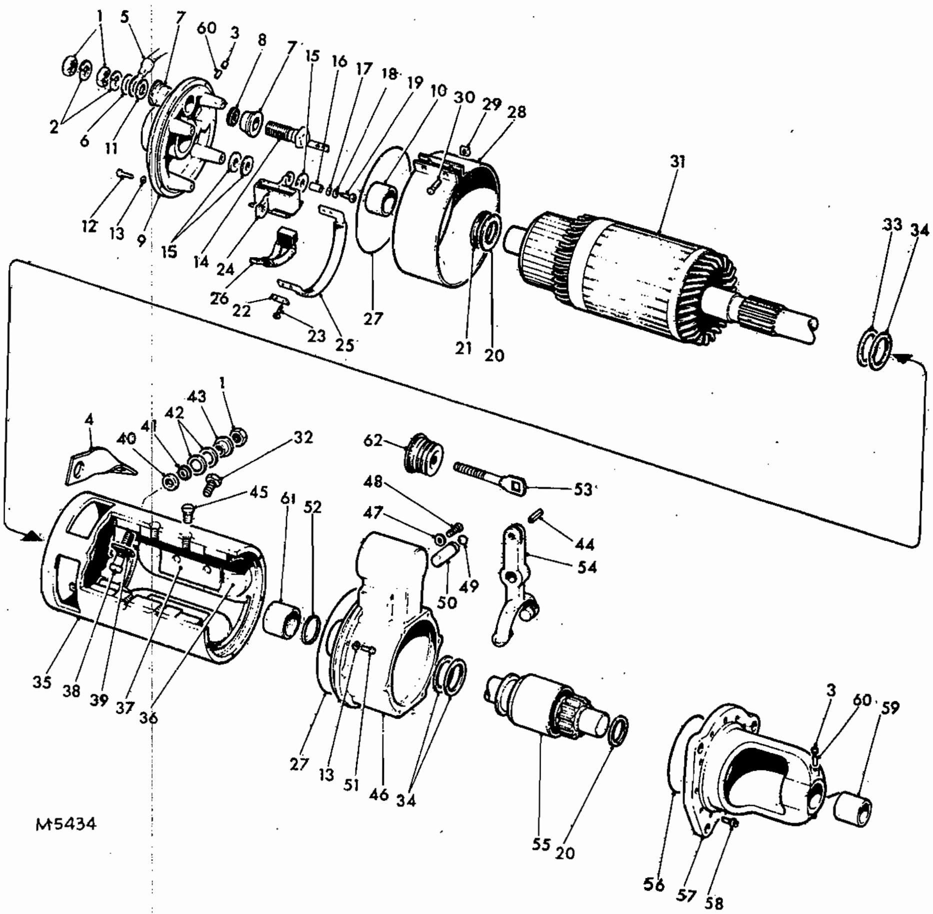


FIG. 1. TYPICAL STARTER MOTOR ASSEMBLY

1. Nut
2. Lockwasher
3. Plug
4. Jumper, field
5. Lead assembly
6. Washer
7. Insulation bush
8. Sealing ring
9. Housing – commutator end
10. Bush
11. Washer
12. Screw
13. Lockwasher
14. Jumper assembly
15. Washer
16. Insulation bush
17. Washer
18. Lockwasher
19. Screw
20. Washer
21. Washer
22. Lockplate
23. Screw
24. Brush holder
25. Jumper assembly
26. Brush assembly
27. O-ring
28. Band assembly
29. Nut
30. Screw
31. Armature assembly
32. Screw
33. Washer
34. Washer
35. Field ring assembly
36. Coil and jumper assembly
37. Pole piece
38. Screw
39. Insulator
40. Insulation bush
41. Sealing ring
42. Washer
43. Insulation bush
44. Pin
45. Screw
46. Housing, shift
47. Washer
48. Screw
49. O-ring
50. Shaft
51. Screw
52. Seal
53. Link screw
54. Lever assembly
55. Pinion assembly
56. O-ring
57. Housing, nose
58. Screw
59. Bush
60. Bush
61. Bush
62. Seal

4. Remove socket head retaining screw and washer, withdraw shift lever shaft and pinion assembly – followed by shift lever arm assembly.

5. Withdraw armature from field ring assembly.

6. On removal of five socket head screws, shift housing may be lifted off field ring.

Inspection

1. Inspect shift housing, commutator end housing, field ring and solenoid switch shell and brackets for cracks, breaks, damaged threads or other defects.

2. Examine commutator surface of armature. A satisfactory condition is indicated by an even, highly burnished, dark copper colour. If the contact surface is rough, pitted, scored, burnt or coated with hard carbon, or oil, the commutator must be re-surfaced, provided it is of course in good electrical and mechanical condition.

3. Inspect shaft splines for wear or damage and renew if either condition exists.

4. Check the armature for short circuits using a growler, see Fig. 2. Place the armature in the growler and hold a thin strip of metal, such as a hacksaw blade, approximately 1 to 1.5 mm away from the armature core. Whilst holding the steel strip in position, rotate the armature slowly in the growler. A short circuit will pull the steel strip tightly against the armature core and cause the strip to vibrate; renew the armature if this occurs.

5. Check the armature for earth, using a 230 V test light, see Fig. 3. If the light illuminates; renew the armature.

6. Inspect armature shaft alignment and commutator for eccentricity using a lathe or V-block and dial indicator. If shaft run-out exceeds 0.13 mm (0.005 in), renew armature. Should commutator eccentricity exceed 0.08 mm (0.003 in), refinish commutator. Minimum commutator diameter is 52.39 mm (2.062 in), minimum brush length 15.8 mm (0.625 in).

7. Check the armature for continuity using a growler, see Fig. 4, and test all commutator bars. If the light illuminates the armature is earthed and must be renewed.

8. Check the brush gear insulation using a flash tester set a 500V, see Fig. 5, and check the following:
   a. between each brush holder and commutator end housing.
   b. between each brush holder.

   Should a circuit exist on either test, the brush gear should be dismantled and new insulation bushes and washers fitted. Re-test the brush gear insulation.

9. Clean the ring field assembly, ensuring the field coils are free from dirt and oil. Examine the field coils for corrosion or burning. Using a flasher tester set on 500 V, see Figs. 6 and 7, determine if the windings are earthed or shorted to the field ring or pole pieces. If the coils are earthed or shorted, renew the coil assembly.

10. Inspect shift lever for wear on cams, the shaft for wear and for burrs in the seal area. Examine nylon locking insert in screwed portion of shaft. Renew either if necessary.

11. Carefully examine pinion assembly and renew if worn or damaged.

Reassembly

1. All sealing O-rings should be lubricated with glycerine and bearing bushes smeared with clean S.A.E. 5W/20 oil prior to assembly. Fibre thrust washers and felt wicks should be soaked in S.A.E. 5W/20 oil.

2. Refit shift lever housing and field ring.

3. Place shift lever and linkage assembly into shift housing and index drive collar—lubricated with light graphite grease—into shift lever.

4. Slide steel thrust washer and fibre washer on to armature shaft and insert armature into field ring. Before sliding shaft through pinion, fit two fibre washers.

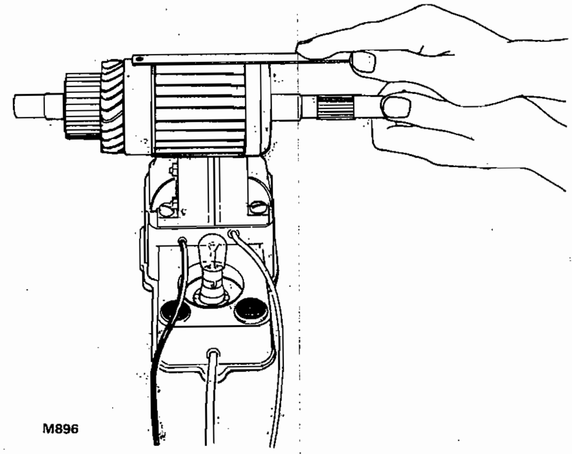


FIG. 2. CHECKING ARMATURE FOR SHORT CIRCUITS

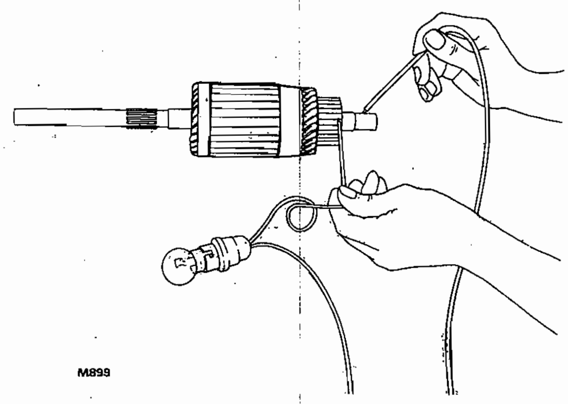


FIG. 3. CHECKING ARMATURE FOR EARTH

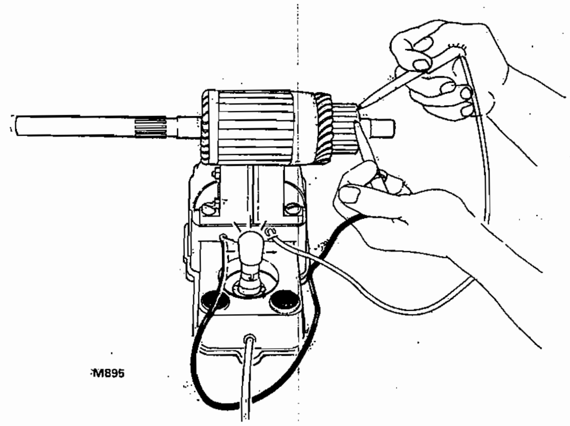


FIG. 4. CHECKING ARMATURE FOR CONTINUITY

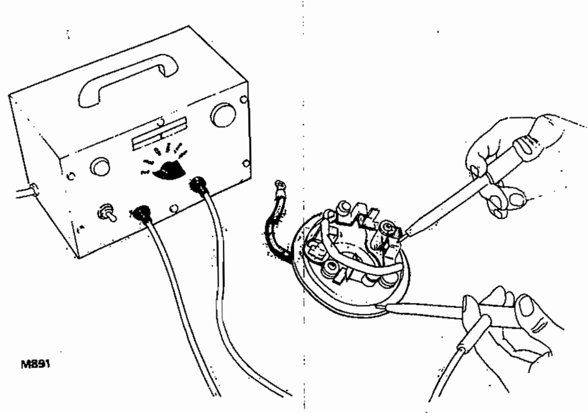


FIG. 5. CHECKING BRUSH GEAR INSULATION

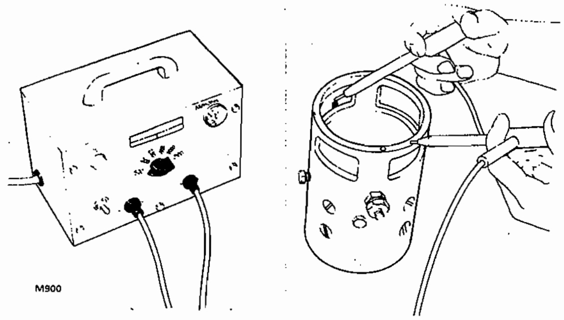


FIG. 6. CHECKING FIELD COIL INSULATION

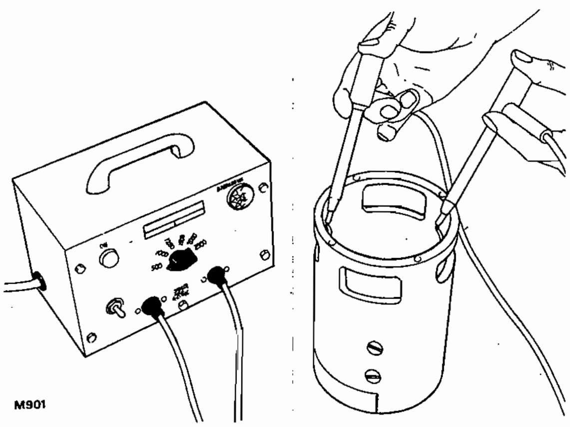


FIG. 7. CHECKING FIELD COIL CONTINUITY

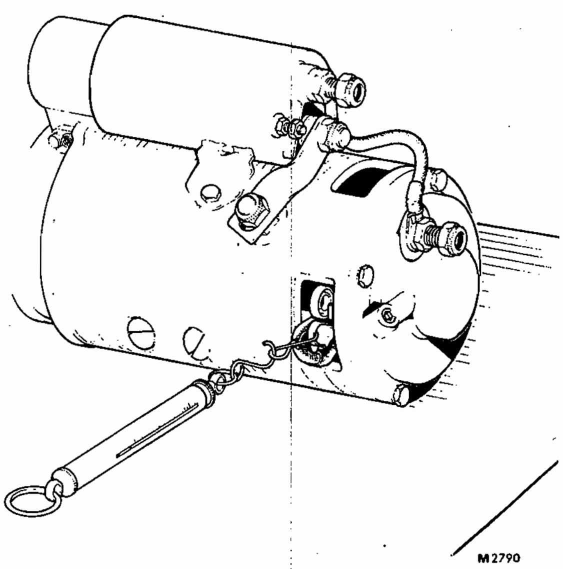


FIG. 8. CHECKING BRUSH SPRING TENSION

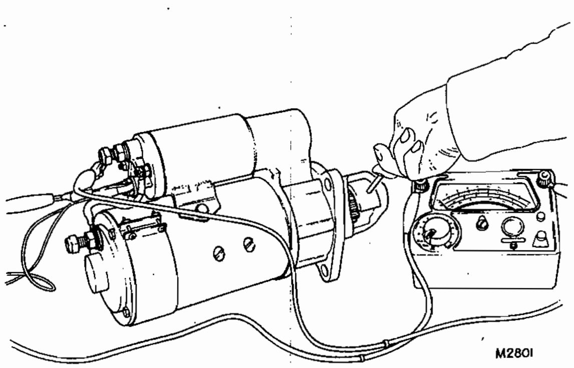


FIG. 9. ABUTMENT TEST

5. Apply light graphite grease to shift lever shaft and after assembling into housing, secure with washer and socket screw.

6. Fit steel thrust washer followed by fibre washer onto the commutator end of armature shaft and assemble housing to field ring.

7. Fit a steel thrust washer to armature shaft then assemble nose housing.

8. Install the brushes in their respective holders. Replacement brushes, which should be fitted in sets of eight, must be bedded to the commutator prior to use. Ensure brushes are free to move in their holders and also that flexible leads are clear of any obstruction likely to impede movement. Brush spring pressure, 1.42 – 1.68 kg (50 – 59 oz) may be verified by means of a spring balance – Fig. 8.

   Re-connect two field terminals.

9. Coat cover band gasket with glycerine and assemble on motor so that ends of band are over a rib section of field ring to ensure a watertight joint.

Testing

1. Test solenoid switch for correct operating sequence by placing tool CEG 14/3 on armature shaft to retain pinion assembly in rest position. With an Avometer connected to terminals 2 and 3 and 24 volt DC supply to terminal 1 and 3 a reading should not be observed, see Fig. 9.

2. Refit starter to engine and check operational efficiency.

SOLENOID SWITCH

To Remove

1. Disconnect jumper lead from solenoid terminal (4).

2. Unscrew nut (1) on motor field terminal, securing locknut beneath jumper (4) to prevent stud from turning. Remove jumpers after unscrewing switch terminal nut.

3. Remove rubber plug (25) Fig. 10, to gain access to timing shaft.

4. Insert adjusting tool CET55/105 into switch aperture and engage with timing shaft – unscrew anti-clockwise to release plunger from arm and shaft assembly.

5. Remove the screws securing switch to motor.

6. Switch can then be removed from motor.

To Refit

1. Insert link screw (53) Fig. 1 into rubber seal (62) and align with tapped hole in plunger. Insert tool No. CET55/105 into switch base and turn shaft clockwise until it bottoms. Back off counter clockwise approximately five turns, then enter switch into switch housing. Assemble and tighten mounting screws securely.

2. A 24 volt DC supply should now be connected to switch terminal numbers 1 and 3. With the solenoid switch energised, gently push back the pinion assembly against the shift arm cams and check spacing between face of pinion and thrust washer using gauge No. CEG 14/1.
   The final adjustment is accomplished by turning tool CET55/105 clockwise or counter clockwise until gauge is a sliding fit between pinion and thrust washer – Fig. 12.

   CAUTION: This adjustment must be made with switch de-energised. Never leave switch energised longer than 30 seconds.

3. Refit rubber plug in switch aperture.

4. Refit flexible jumper lead and motor field jumper.

5. Add a few drops of clean S.A.E. 5W/20 oil to the three wick lubricators.

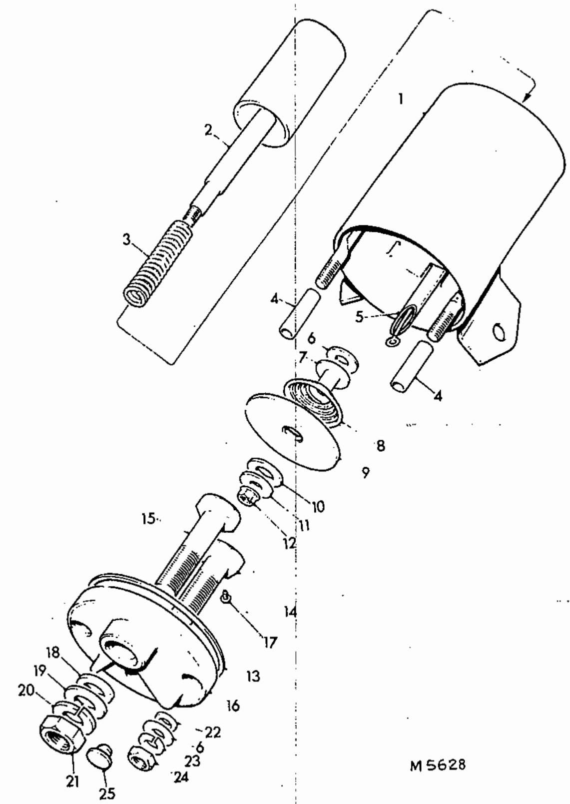


FIG. 10. SOLENOID SWITCH ASSEMBLY

1. Magnet assembly
2. Plunger and shaft assembly
3. Spring, return
4. Insulator
5. Guard, wire
6. Washer
7. Bush, insulation
8. Spring, contactor
9. Contactor
10. Washer, insulation
11. Washer
12. Nut, lock
13. Ring, sealing
14. Screw, contact
15. Screw, contact
16. Base
17. Screw
18. Ring, sealing
19. Washer, thrust
20. Washer, lock
21. Nut
22. Ring, sealing
23. Washer, lock
24. Nut
25. Plug, sealing

OVERHAUL

To Dismantle, Fig. 10

1. Remove nuts (24), washers (23) (6), sealing rings (22) from both terminals.

2. Partially withdraw base (16) and disconnect coil lead by releasing screw (17).

3. Remove base and sealing ring (13).

4. Unscrew nut (12), remove washers (11) (10), contactor (9), spring (8), bush (7) and washer (6).

5. The plunger and shaft assembly (2) together with return spring (3) can then be removed from opposite end of switch after removing seal (62) see Fig. 1.

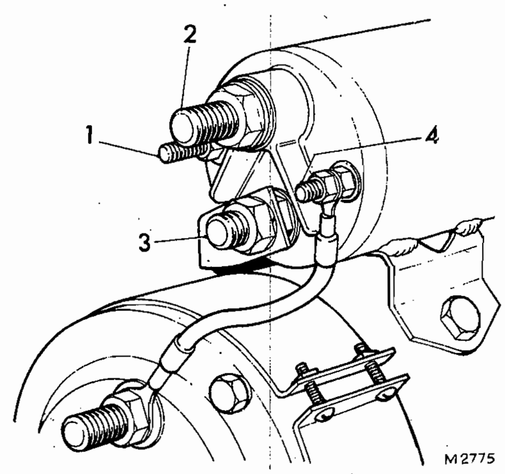


FIG. 11. SOLENOID SWITCH TERMINALS

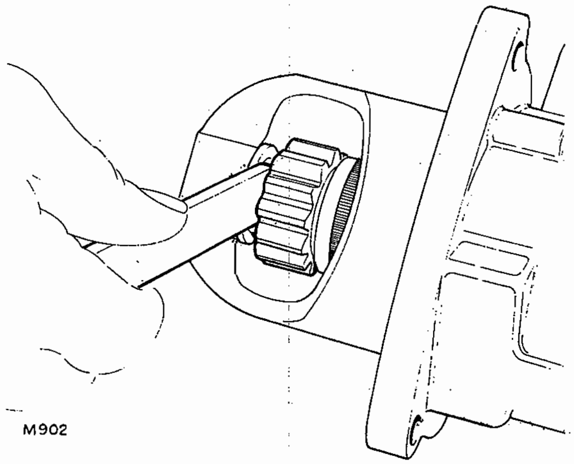


FIG. 12. CHECKING PINION CLEARANCE

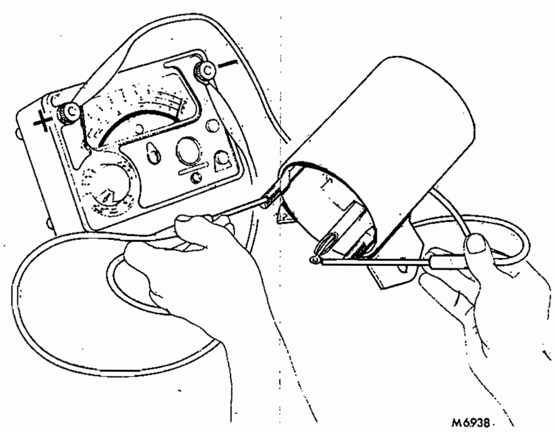


FIG. 13. TESTING PULL-IN COIL

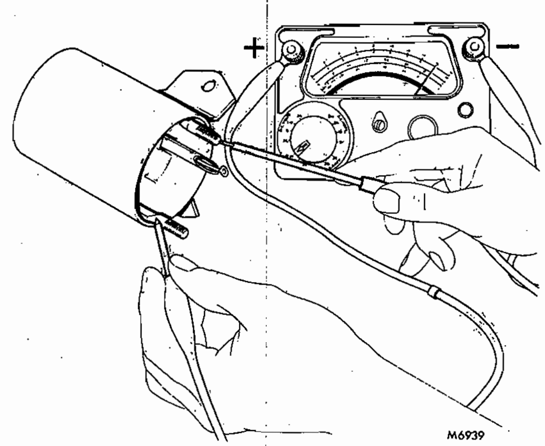


FIG. 14. TESTING HOLD-IN COIL

Testing

1. Using an Avometer check the following:
   a. The resistance between terminals 1 and 3 or the pull-in coil, see Fig. 13: a resistance of 1.29 to 1.40 ohms should be recorded.
   b. The resistance between terminals 1 and 4 of the hold-in coil, see Fig. 14: a resistance of 2.49 to 2.75 ohms should be recorded.

   Should the coils be earthed or shorted; renew the magnet assembly.

To Reassemble

1. Re-assembly is a reversal of the dismantling procedure, nut (12) and seals (13) (22) (62) should be renewed. Main contacts (14) (15) must be in perfect condition.

Starter Motor – CAV

DATA

Type U6/24B/13

Weight . . . . 27,2 kg (60 lb)

Test (with 154AH battery)	Battery Voltage	Current (Amps)	Speed (Rev/min)	Torque	
				kgf m	lbf ft
Lock torque	24	1240-1320	–	8.7	63
Running torque	24	620-680	1400	3.8–4.3	28–31
Light running torque	24	70	4200	–	–

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. Shift lever and shaft 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.

To Refit

1. Reverse the procedure 1 to 4, ensuring that all electrical connections are in their original positions.

OVERHAUL

To Dismantle, Fig. 1

1. Remove the nuts (28) and detach the commutator end cover (29) and dust seal.
2. Remove the brush lead screws (27), lift the brush springs and detach the brushes from their holders. Note the positions of the copper field connectors linking brushes of the same polarity to facilitate correct assembly.
3. Identify the leads to the brush gear and solenoid switch to facilitate correct assembly.
4. Remove the plunger nut (20) and washer.
5. Remove the main securing bolts (37). Tap the drive-end shield (38) gently away from the yoke (15) with a hide or wooden mallet. Withdraw the shield complete with armature (35).

6. With the armature secured in a suitable soft jawed vice, remove the lubrication plug (5) and spring (4) from the drive-end shield.
   Note: On some starters the spring is fitted on the opposite side of the casting to the lubrication plug and cannot be removed at this stage.

7. Remove the split pin (41), nuts (40 and 1) and washers (2 and 3) from the front end of the pinion (39), and slide the pinion and drive end shield off the armature shaft.

8. Remove the pinion spring (7).

9. Detach the clutch inner race (8), clutch plates (10), shim washers (11), back plate (12) and pressure plates (13) from the clutch assembly.
   Note: The clutch plates should be tied together in the order of their removal to ensure that they can be refitted to their original positions in the clutch.

10. Extract the shim(s) (6) and rubber sealing ring (when fitted) from the bore of the pinion.

11. Remove the armature plunger retaining nut (33) and withdraw the armature plunger from the bore of the armature.

12. Remove the screws (24, 22 and 26) and, noting their positions, release the positive terminal connector, main field coils and auxiliary field connections from the solenoid switch.

13. Using a hide or wooden mallet carefully separate the commutator-end shield from the yoke.

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.

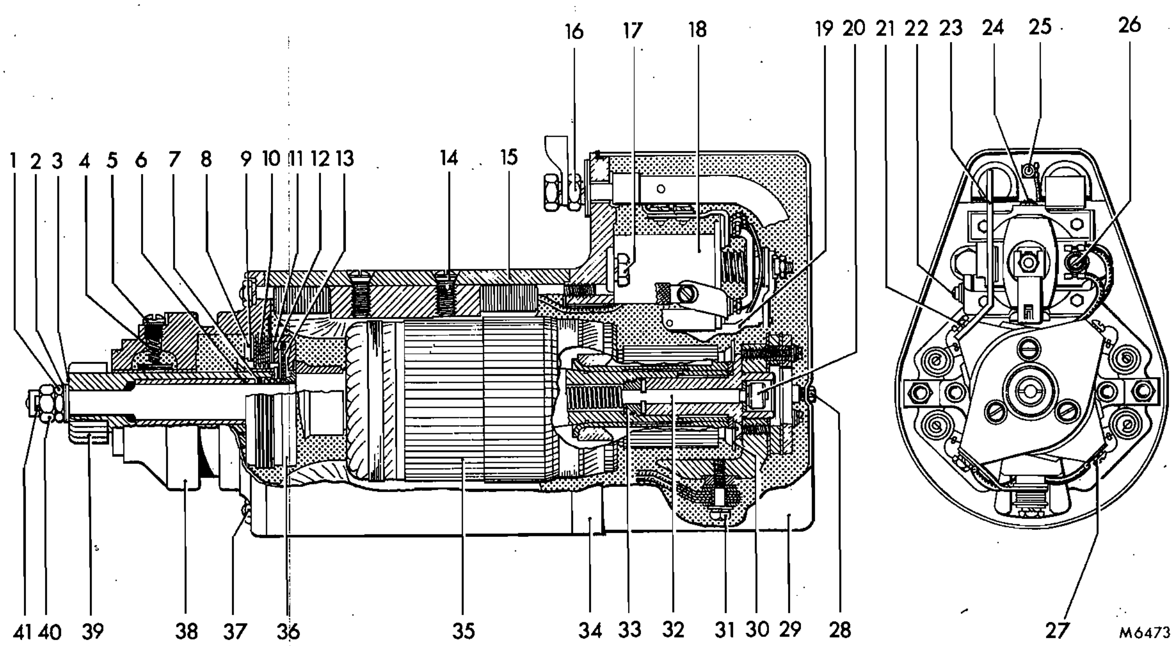


FIG. 1. SECTIONAL VIEW OF C.A.V. STARTER MOTOR

1. Nut
2. Washer
3. Shim
4. Spring
5. Lubricating plug
6. Shim
7. Pinion spring
8. Clutch inner race
9. Clutch springs
10. Clutch plates
11. Shim washers
12. Back plate
13. Pressure plates
14. Countersunk screws
15. Yoke
16. Terminal
17. Hexagon screw
18. Solenoid switch
19. Trigger
20. Nut
21. Hexagon screw
22. Screw
23. Negative connector
24. Screw
25. Solenoid connector
26. } Screws
27. }
28. Nuts
29. Cover
30. Tripping disc
31. Hexagon screw
32. Plunger
33. Nut
34. Commutator-end shield
35. Armature
36. Clutch outer race
37. Bolts
38. Drive-end shield
39. Pinion
40. Nut
41. Split pin

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. 2).

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. 3). 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).

   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.

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.

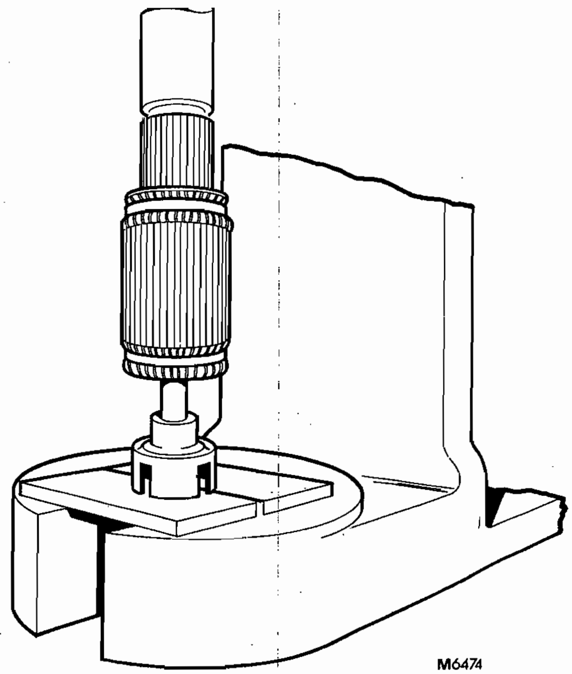


FIG. 2. PRESSING ON THE CLUTCH OUTER RACE

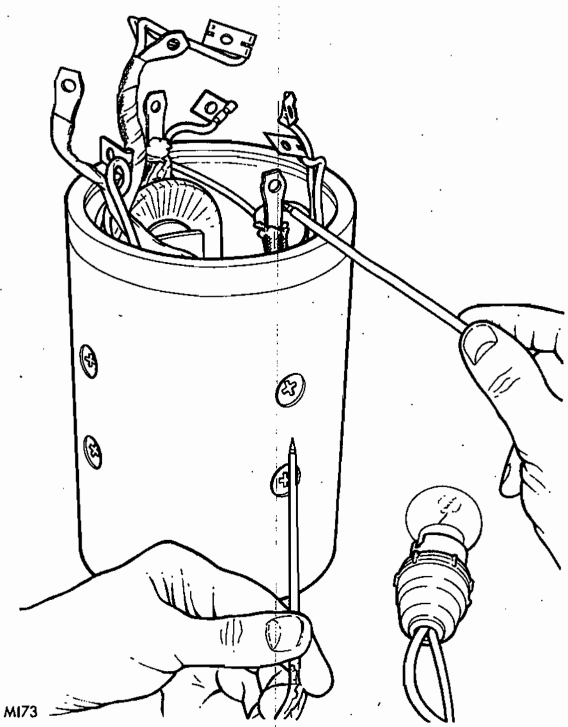


FIG. 3. CHECKING THE FIELD WINDINGS FOR SHORT CIRCUITS

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. 4).
   b. The positive brush holder and the frame (Fig. 5).
   c. The negative brush holder and the frame (Fig. 6).

   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. 1

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. 7).
7. Grease the pinion spring (7) and slide it onto the armature shaft.
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.

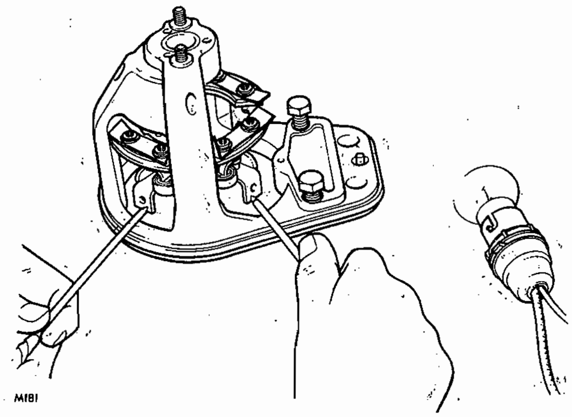


FIG. 4. CHECKING THE BRUSH GEAR (a)

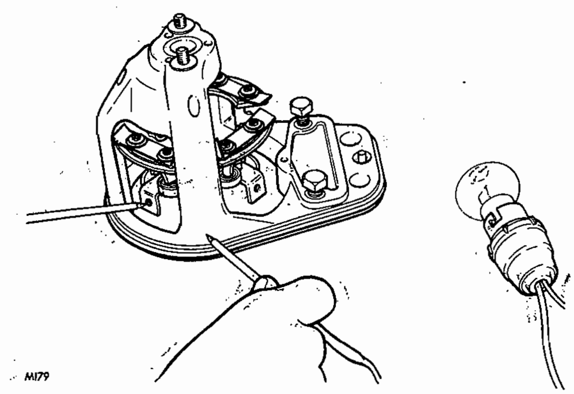


FIG. 5. CHECKING THE BRUSH GEAR (b)

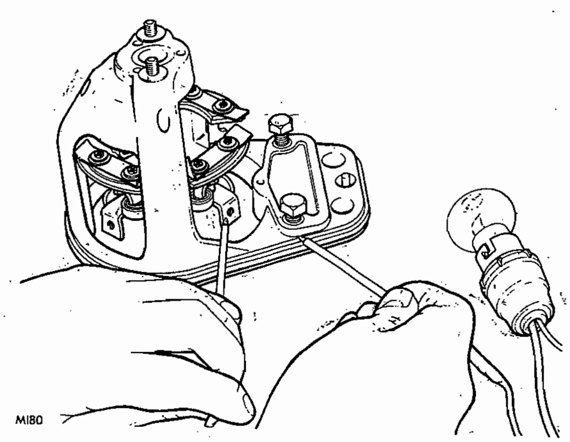


FIG. 6. CHECKING THE BRUSH GEAR (c)

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.

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.

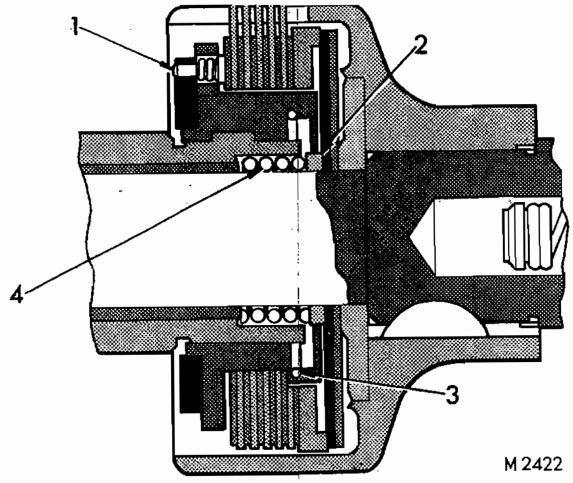


FIG. 7. SECTION THROUGH CLUTCH ASSEMBLY
1. Guide pin
2. Spacing ring
3. Spring ring
4. Pinion spring

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.

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.

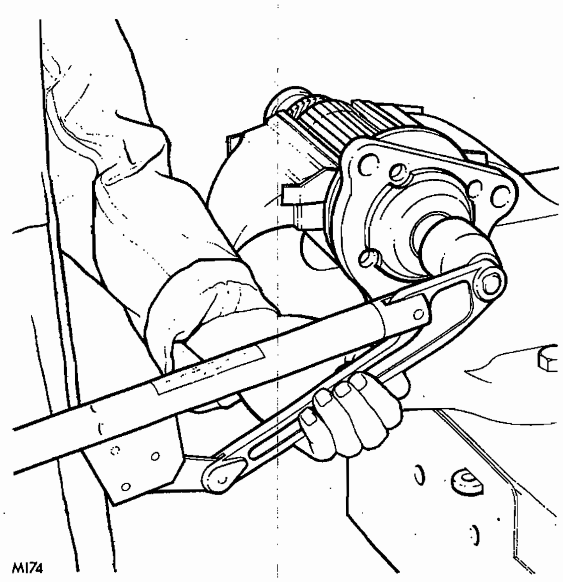


FIG. 8. ADJUSTING CLUTCH SLIP TORQUE

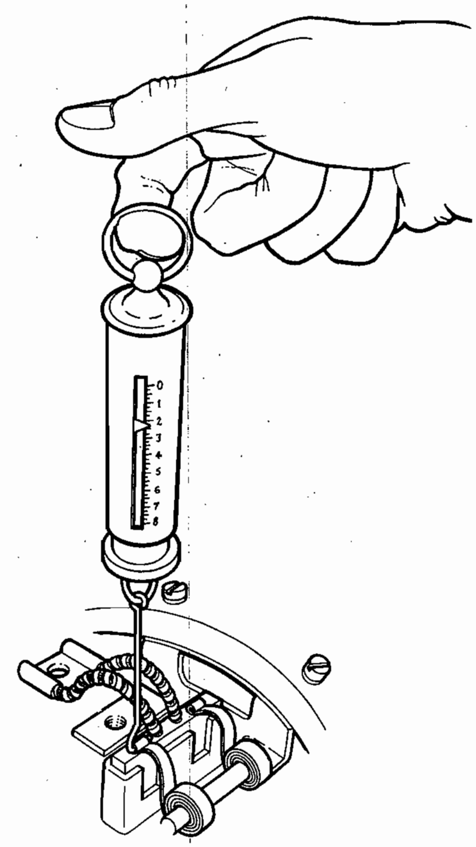


FIG. 9. CHECKING SPRING BRUSH PRESSURE

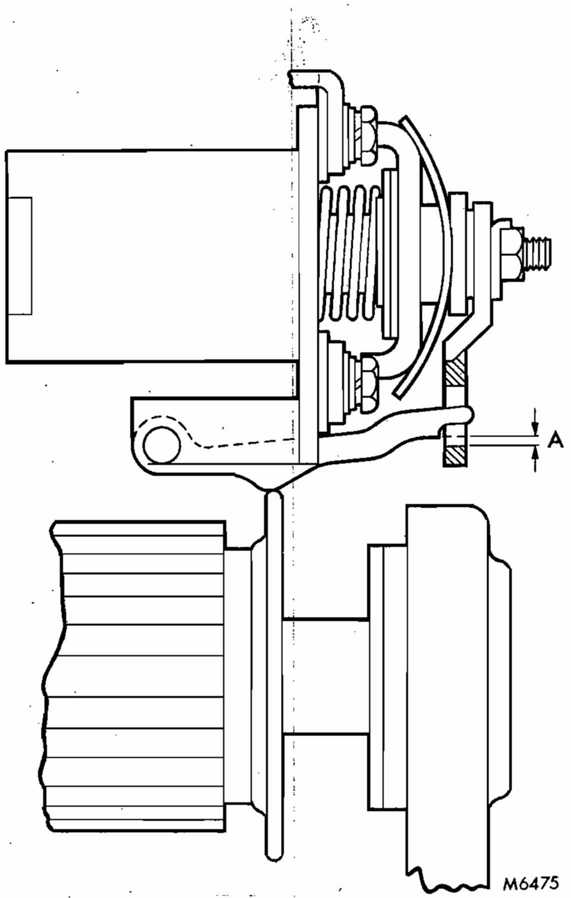


FIG. 10. RELATIONSHIP BETWEEN TRIGGER AND TRIPPING DISC

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. 9). 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. 10). The dimension 'A' between the shoulder on the trigger and the bottom of the slot should be $2 \pm 0{,}1$ mm (0.078 ± 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.

3. When the performance tests have been completed fit the sealing ring and commutator end cover and carry out the Insulation Test.

Insulation Test, Fig. 11

1. Using test probes connected to a mains supply (not exceeding 110V) and in series with a 15 W bulb between the following:

   a. The positive terminal and frame.

   b. The negative terminal and frame.

If the bulb illuminates during any of the tests the insulation is faulty.

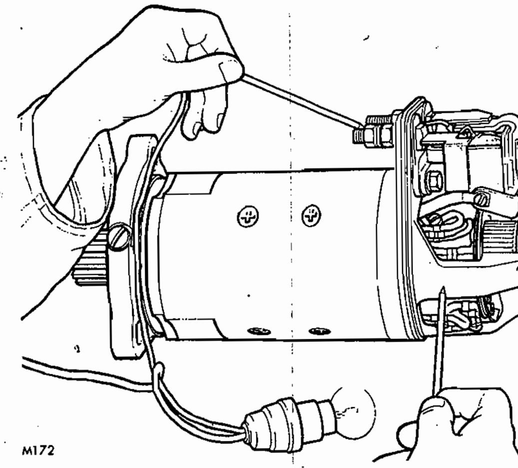


FIG. 11. INSULATION TEST

OVERHAUL

Solenoid Switch

To Dismantle, Fig. 12

1. Release the lock washer (2) and remove the nut (1).
2. 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).
3. Remove the trigger spring (12).

Inspection

1. Clean all components in a suitable solvent and dry thoroughly.
2. 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. 13) 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.
3. 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.
4. Examine the solenoid winding for breakages or damage; renew as necessary.
5. Examine the catch plate and trigger for excessive wear; renew as necessary.

To Reassemble, Fig. 12

1. 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.
2. Fit the return spring (7), ensuring that it locates over the lip on the periphery of the switch bore.
3. Fit the trigger spring (12).
4. Assemble the insulating washer (6), adjusting washers (5), moving contact (4), contact spring (17), contact guide (8) and catch plate (9).

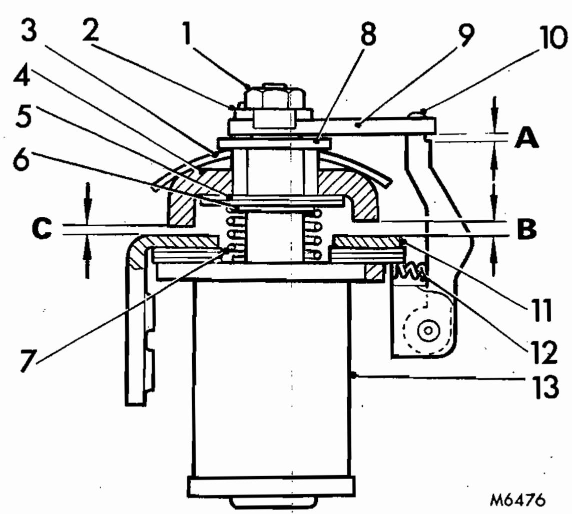


FIG. 12. SOLENOID SWITCH

1. Nut
2. Lockwasher
3. Leaf spring
4. Moving contact
5. Washers
6. Insulating washer
7. Return spring
8. Contact guide
9. Catch plate
10. Trigger
11. Fixed contacts
12. Trigger spring
13. Coil

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 ± 0,1	0.079 ± 0.004
'B'	3,8 ± 0,3	0.15 ± 0.012
'C'	1,0 ± 0,1	0.39 ± 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:

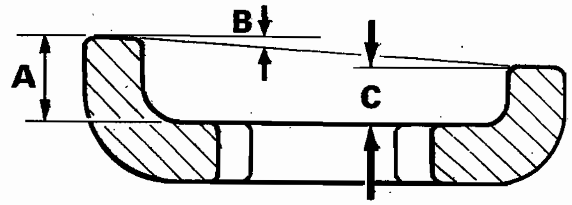


FIG. 13. MOVING CONTACT

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.

SECTION 5

Miscellaneous Equipment

REVERSE POLARITY RELAY AND PULSE CLIPPER

DATA

Earth polarity	Negative
Nominal voltage	28V
Relay pull-in voltage	17V (cold)
Relay contact rating	60 amperes at 70°C (158°F) ambient temp.
Maximum voltage drop between terminals (1) and (2) at 70 amperes	120 mV
Transient voltage clipping level	55V approx. (27V above DC level)
Limitations	To be used with 9 diode systems only

WARNING
When the connections at the vehicle's batteries are reversed, the six main rectifier diodes in the alternator are forward biased — virtually applying a short circuit across the supply lines. Depending upon the current sharing, one or more of the diodes will be irreparably damaged and the system rendered unserviceable.

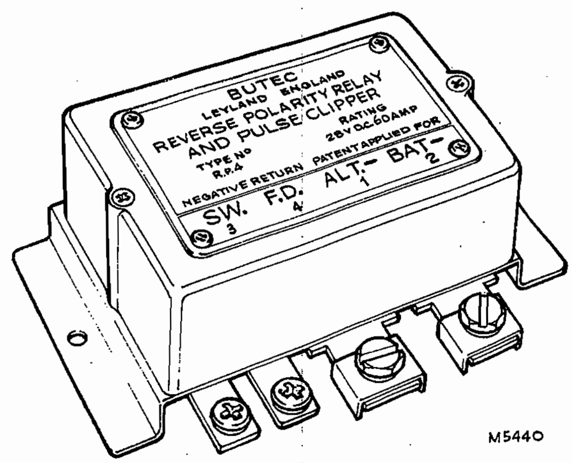


FIG. 1. TYPE RP4 RELAY AND PULSE CLIPPER

The protection circuit incorporates a polarity diode in series with the relay coil, the contacts of which break the main negative (—) line between the batteries and the alternator.

Operation — Relay Circuit
A relay with large current capacity contacts, whose coil is series connected with diode D1, Fig. 2, opens the main negative (—) lead from the alternator — protecting the rectifier diodes should the leads of the batteries be inadvertently reversed. Diode D2 provides a second route for the relay coil current whilst the alternator is generating — ensuring the contacts do not open until the output voltage has diminished to a relatively low level. Diode D3 affords protection to the voltage regulator in the reversed polarity mode.

The unit will safeguard the system under these conditions thus increasing overall reliability.

Immediately the batteries are correctly connected the system returns to a fully operational state.

M3254

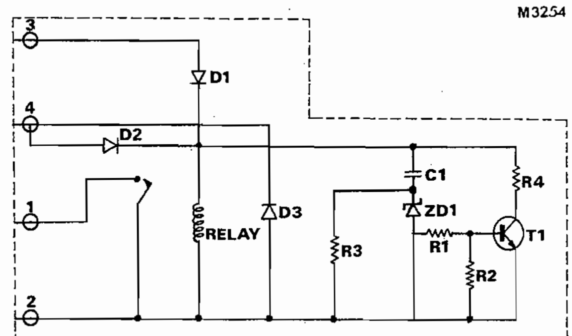


FIG. 2. INTERNAL WIRING DIAGRAM

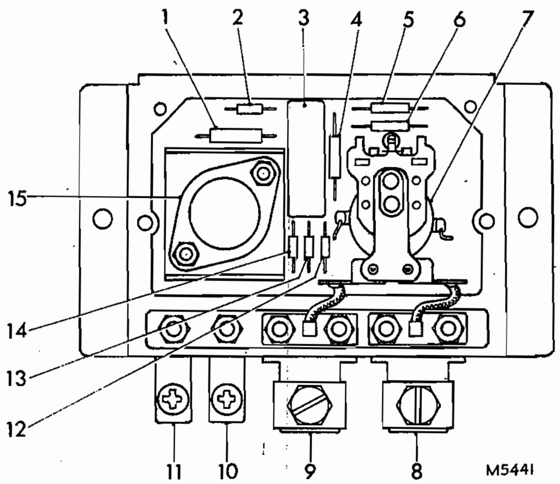


FIG. 3. INTERIOR VIEW

1. Resistor
2. Zener diode
3. Capacitor
4. Resistor
5. Resistor
6. Resistor
7. Relay
8. Terminal (2) batteries (–)
9. Terminal (1) alternator (–)
10. Terminal (4) field diodes
11. Terminal (3) start switch
12. Diode
13. Diode
14. Diode
15. Transistor

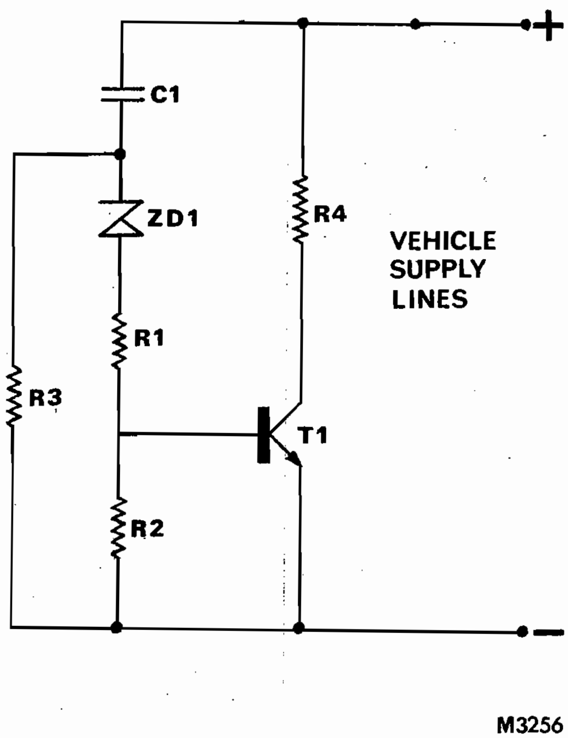


FIG. 4. PULSE CLIPPER CIRCUIT

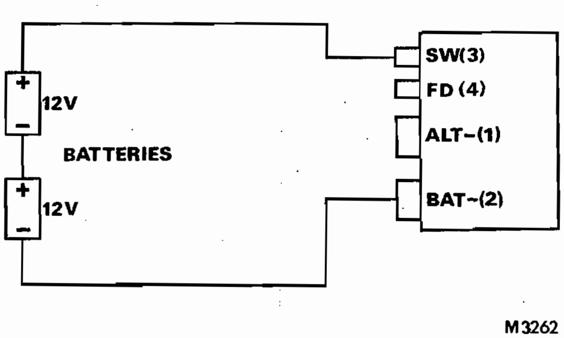


FIG. 5. RELAY COIL TEST

Operation – Pulse Clipper Circuit

Another hazard to transistors and diodes are voltage transients. These can be generated by switched inductive circuits and intermittent connections carrying heavy currents – particularly when the batteries are disconnected or semi-discharged. 200-300 volts – well in excess of normal component rating, can be generated.

The clipper circuit will suppress this voltage to a safe level, whilst the normal operation of the system remains unaffected.

Under normal conditions, capacitor C1, Fig. 2 is fully charged to the supply line voltage with zero volts across resistor R3. When a voltage surge or 'spike' occurs, C1 charges further through R3 and Zener diode Z1. If the voltage is greater than the Zener reference value, current flows into transistor T1 base, which then switches and conducts sufficiently to load and therefore limit the supply line.

The clipping level is approximately equal to the Zener reference voltage plus the DC supply line voltage. Under extreme conditions, several hundred watts are dissipated in resistor R4. Diodes D1 and D2 are low impedance forward conducting in normal circuit operation.

SERVICING

Relay Circuit

1. Remove the unit from installation and lift off the cover after releasing retaining screws.

2. Inspect the relay contacts – ensuring they are open.

3. Connect a 24V DC supply between terminals 2 and 3, Fig. 5, and confirm contacts close. Non-closure indicates an open circuit condition of either diode D1 or relay coil.

   Renew the defective component.

4. Detach lead at terminal SW (3) and reconnect to terminal FD (4), Fig. 6.

   Relay contacts should again close.

   Check circuit continuity between terminals (1) and (2) using an Avometer switched to resistance range, or alternatively by connecting a 24V bulb between terminals (1) and (4) – Fig. 6.

5. Finally, connect the circuit as in Fig. 7 – reverse polarity.

Relay contacts must not close. If they do close diode D1 is short circuit, and must be changed.

CAUTION

Under no circumstances must the supply be connected in reverse polarity between terminals (4) and (2).

The relay is retained by cross-recessed headed screws.

When renewing diodes do not apply excessive heat.

Pulse Clipper Circuit

1. Connect the circuit as shown in Fig. 8.

2. The meter should register approximately 14V. If the meter reads lower than this either (a) the capacitor is short circuited or (b) the transistor has failed. In order to differentiate between the two, reduce the applied voltage to 12V. If meter still reads less than the applied voltage – a faulty transistor is indicated. Conversely – if meter now reads 12V – a leaky capacitor is probable.

3. Connect a test circuit as shown in Fig. 9. With the capacitor 'shorted' externally, meter reading should be 12.7V approximately. If the voltage is substantially different from this value – the Zener diode is faulty and must be renewed.

Repair Note

When renewing Zener diode or capacitors take care not to apply excessive heat.

A soldering iron not exceeding 25 watts dissipation should be used on joints – together with a solder puller – such as supplied by Sealab Electronics, Havant, Hants, England.

Use only resin cored solder and ensure there are no loose particles remaining in the unit on completion of repairs.

If the cork sealing gasket is not in perfect condition it should be renewed.

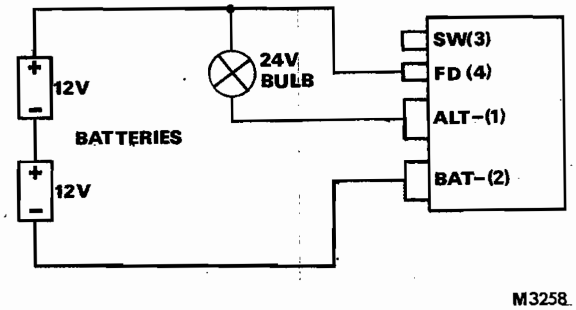


FIG. 6. RELAY CONTACTS TEST

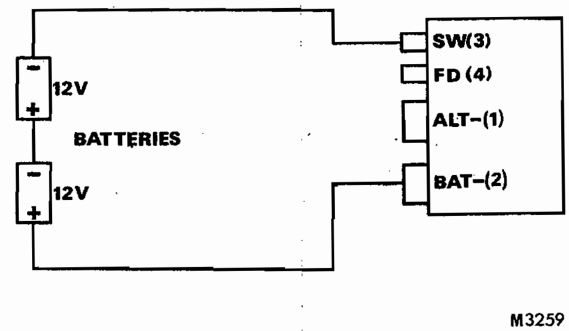


FIG. 7. RELAY TEST – POLARITY REVERSED

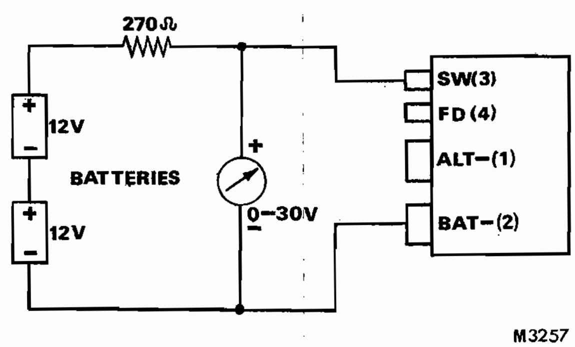


FIG. 8. TRANSISTOR/CAPACITOR TEST

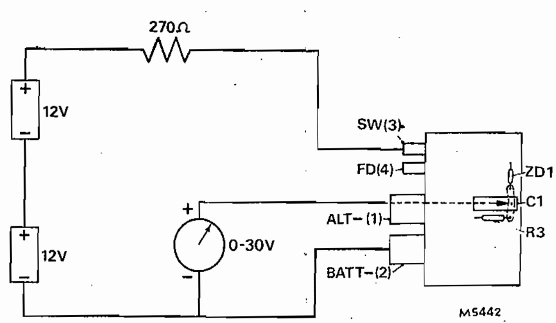


FIG. 9. ZENER DIODE TEST

ENGINE STOP SOLENOID

WARNING

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.**

REMOVAL AND REFITMENT

To Remove

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.

Note: If it is necessary to remove the plunger, note distance between locknuts, dimension 'A' Fig. 10, first. Plunger can then be released by slackening locknut (4) and unscrewing plunger using an open ended spanner on hexagon (1)

To Refit

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.

OVERHAUL

To Dismantle

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; renew as necessary.

Clean the terminals with a suitable cleaning solvent.

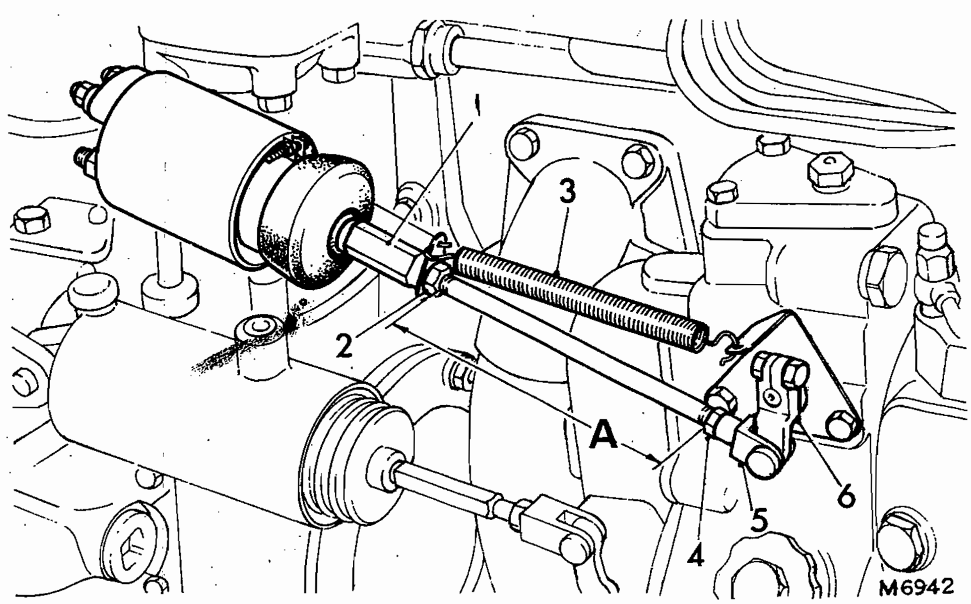


FIG. 10. ENGINE STOP SOLENOID AND LINKAGE

1. Plunger
2. Locknut
3. Return spring
4. Locknut
5. Jaw—end
6. Pump lever

To Reassemble

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:

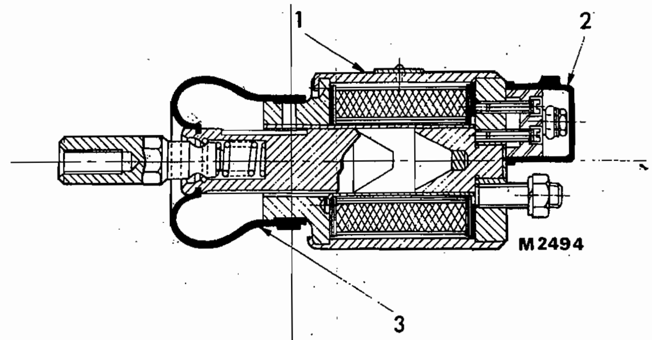


FIG. 11. SECTION THROUGH SOLENOID

1. Body 2. Terminal cover 3. Bellows

1. Check that fuel pump lever, Fig. 10, 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.

G2 Automatic Transmission Control

DATA

a)	Input Voltage	22.5–30.5 V
b)	Ripple Voltage	3.0 V peak to peak
c)	Maximum due to a) and b)	32.0 V
d)	Minimum due to a) and b)	21.0 V
e)	Maximum short term over voltage (10% duty cycle)	40.0 V for 500 milliseconds

Transducer/toothed wheel air gap . . . . 0.13–0.4 mm (0.005–0.015 in)

Principal Units of the System

1. **Gear Selector Switch, Fig. 1**
'A' – In this position all forward gears will be engaged automatically during normal running, dependent on the road speed of the vehicle.

'H3' (hold third) – In this position the automatic gear changes are limited to third gear ratio.

'H4' (hold fourth) – In this position the automatic gear changes are limited to fourth gear ratio.

'R' (Reverse) – To select reverse gear, stop the vehicle, pull locking plunger on the selector outwards with one hand whilst selecting the reverse position with the other hand.

A red warning light incorporated in the selector body is illuminated when a malfunction occurs in the signal circuit or when fierce braking locks the rear wheels.
See Section 7 for further details.

2. **Perception Head, Fig 2**
This comprises a multi-toothed disc coupled to the gearbox output shaft and a flange mounted radially disposed magnetic transducer which transmits a periodic signal of frequency proportional to shaft speed.

3. **Performance (Kick-down) Switch, Fig. 3**
A switch, Fig. 3, located beneath the hand control valve, which if actuated:
(a) from stationary, engages first gear, or
(b) whilst second gear is engaged, below a pre-determined road speed, results in an immediate down-change to first gear. Furthermore, upward changes occur at higher speeds than normal – nearer maximum engine power.

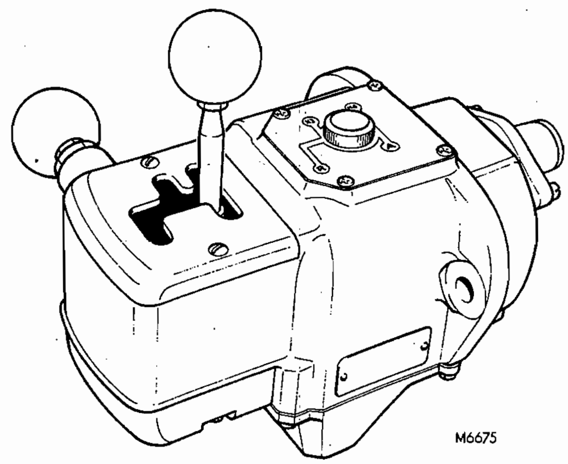


FIG. 1. SELECTOR SWITCH

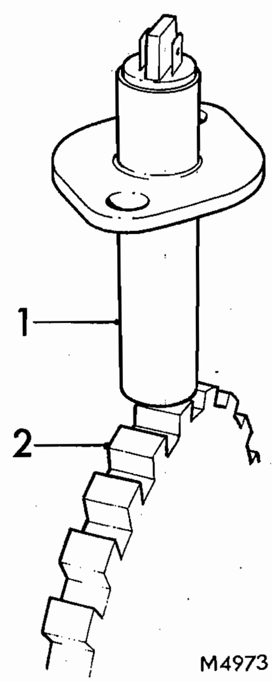


FIG. 2. PERCEPTION HEAD

1. Transducer 2. Toothed Wheel–30T

4. **Electro-Pneumatic Valve Unit, Fig. 2**
This contains a set of six solenoid operated air valves connected by pipes to the brake-band operating cylinders in the gearbox.

5. **Throttle Dipping Valve, Fig. 3**
An electro-pneumatic unit which momentarily reduces the engine fuel supply via the governor — therefore minimising gearbox brake-band wear and assuring smooth gearshifts.

6. **Low Air Pressure Protection Unit, Fig. 3**
Prevents the engagement of a starting gear until adequate air system pressure is reached.

7. **Translator, Fig. 3**
A solid state electronic unit of sensing and switching circuits, the G2 translator analyses incoming signals from the gear selector, performance switch and perception head, subsequently energising the appropriate solenoids in the electro-pneumatic valve unit.

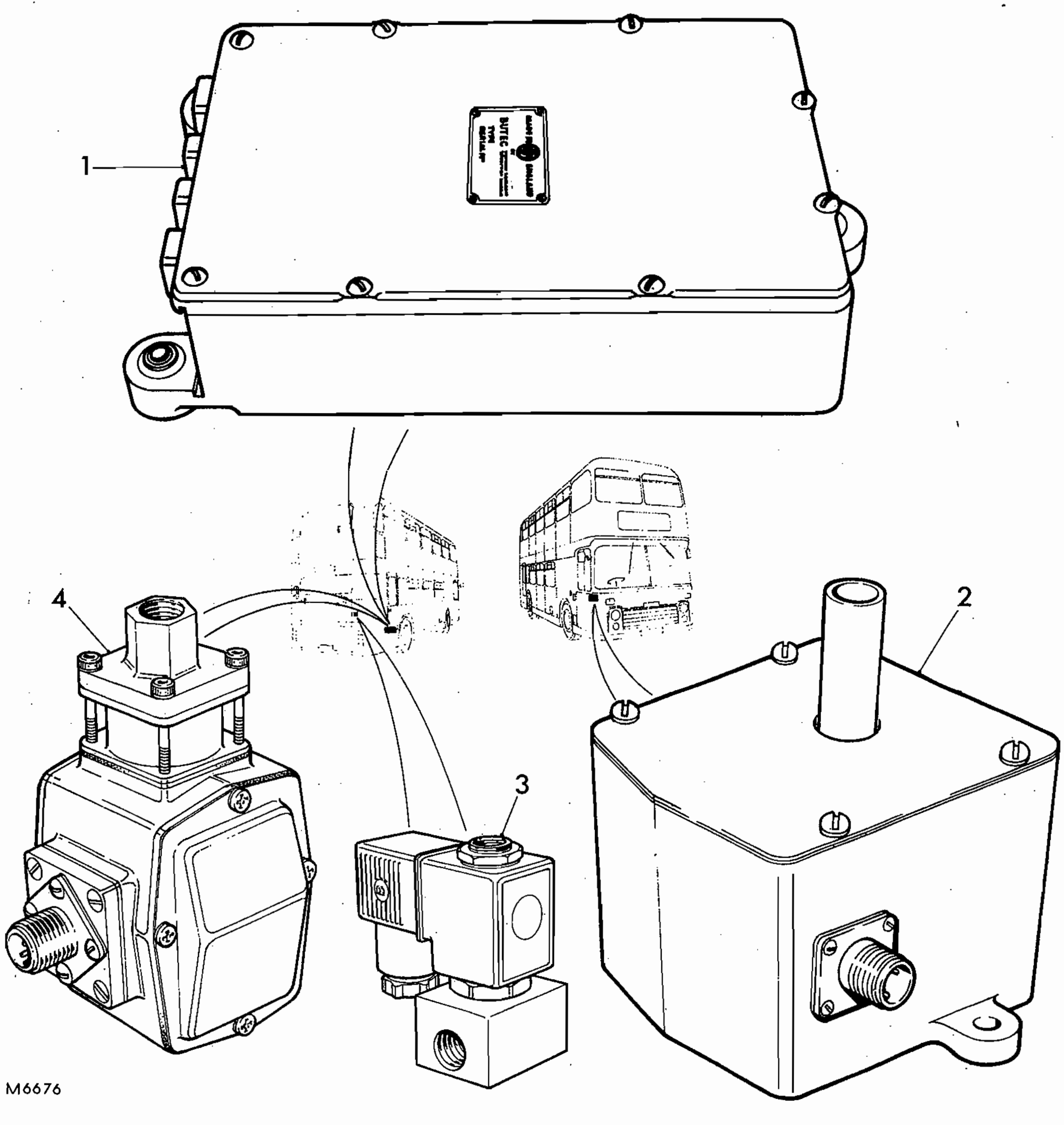


FIG. 3. G2 AUTOMATIC TRANSMISSION CONTROLS

1. Translator
2. Performance switch
3. Throttle dip valve
4. Low air pressure switch

SYMPTOM	POSSIBLE CAUSE	TEST No.	TEST PROCEDURE	ACTION
1. All gears unobtainable	Correct start procedure has not been followed	1		Refer to relevant instruction manual
	Air pressure inadequate	2	Monitor vehicle air pressure. Reservoir should be fully charged before selecting 'Automatic' Always fully charge air system with selector in neutral position	Charge air system with selector in neutral position
	Discharged batteries	3	Operate engine starter	Re-charge batteries
	Blown fuses, tripped circuit breakers, etc.	4	Select 'Start' Test for supply potential (24 V) across test terminals in transistor	Check fuses in transistor and any protection device in feed to selector or translator
	Wiring continuity fault	5	Select 'Start' Select 'automatic' position. Supply potential should be present at: i) Terminals 2 (+) and 11 (–) in translator. If supply is present – See test 5a	Wiring fault – See test 5 (ii)
			ii) Pins 1 (+) and 11 (–) in plug 'S' at translator. If voltage is present, check continuity between plug 'S' and translator terminals	Wiring fault – See test 5 (iii)
			iii) Pins 3 (+) and 1 (–) in nine-way plug at selector. If voltage is present, check continuity between translator and selector	See test 5 (iv)
			iv) Pins 3 (+) and 1 (–) in seven-way connector at selector switch. If voltage is present, fault is in selector switch	Fault condition exists in vehicle electrical system outside automatic control
		5a	System voltage should be present between the following points: i) Terminals 5 (+) and 11 (–) in translator. If voltage is present – See test 6	Wiring fault – See test 5a (ii)
			ii) Pins 6 (+) and 11 (–) in plug 'S' at translator. If voltage is present check continuity between plug 'S' and terminal 5 in translator	Wiring fault – See test 5a (iii)
			iii) Pins 5 (+) and 1 (–) in nine-way connector at selector switch. If voltage exists, check continuity between selector switch and translator	Selector switch fault

SYMPTOM	POSSIBLE CAUSE	TEST No.	TEST PROCEDURE	ACTION
Cont'd.	Translator fault	6	With start switch ON, select automatic. Check for system potential at the following points: i) Terminals 21 (+) and 11 (–). (Vehicles with normal start in 2nd gear ONLY) ii) **or** Terminals 20 (+) and 11 (–). (Vehicles with normal start in 1st gear ONLY)	Renew the following by substitution: Module DB (Brown) Relay N Relay 2S Relay 3S Relay 4S Relay 5S
	Fault on air pressure	7	With start switch ON, select neutral then start engine and fully charge air system. Relay LP should operate	Renew relay LP. If relay LP still does not operate – refer to test 7a. If relay operates, refer to test 7b
		7a	With start switch ON, select neutral, then start engine and fully charge air system. Check for system potential at the following points: i) Terminals 8 (+) and 11 (–) in translator	Check continuity via plug 'S' back to gear selector. Check selector
			ii) Terminals 17 (+) and 11 (–) in translator	Continuity between terminals 17 and 18 should exist
			iii) Terminals 18 (+) and 11 (–) in translator	Check for continuity between terminals 17 and 18 via low air pressure switch. With system fully charged low air pressure switch should be closed
			If system potential is present at 7a (iii) and relay LP still **does not operate** a wiring fault in translator is apparent	Renew translator
		7b	With start switch ON, select neutral then start engine and fully charge air system. Select 'automatic'. Check for potential across 18V test terminals. Relay LP should operate. Continuity should exist between terminals 10 and 11	Test by substitution: Module VR (Brown) Module F (Grey) Module DA (Brown) Replace Relay LP. Replace Relay LP
	Wiring continuity fault – cable run – translator to electro-pneumatic valve unit	8	With start switch ON, select neutral and start engine to fully charge air system. Stop engine. Select 'automatic' and check for system voltage across the following points: (Figures in parentheses refer to vehicles with normal start in 1st gear – i.e. no kick-down facility). i) Terminals 21 (+) (20) and 11 in translator	See all previous notes

SYMPTOM	POSSIBLE CAUSE	TEST No.	TEST PROCEDURE	ACTION
Cont'd.	Cont'd.	Cont'd.	ii) Terminals 21 (+) (20) and 10 in translator	See all previous notes
			iii) Pins 5 (+) and 11 in plug 'G' at translator	Check connections
			iv) Pins B (+) (A) and 'G' in connector at EP valve unit	Check continuity
			v) Terminals B (+) (A) and 'G' in EP valve unit	Check connections
	Faulty EP valve unit	9	Check for air at inlet port on valve unit. Check for system voltage at terminals B (+) (A) and 'G' in EP valve	EP valve is faulty
	Defective gearbox	10	If previous tests were carried out successfully and air was being supplied to gearbox on selection of 'automatic'	Check mechanical aspects of epicyclic gearbox – see Group 4
2. No forward gears		11	Proceed exactly as for symptom 1	
3. Starting gear engages, but loss of automatic gears	'D' relay faulty	12	With start switch ON, select automatic. 'D' relay should operate	Renew 'D' relay
	Speed signal generating system faulty	13	Remove plug 'T' at translator and with Avometer switched to resistance range, measure resistance across pins 1 and 3 – this should be within the range 2–4 kilo-ohms	Check continuity to transmission. Replace speed signal transducer
	Faulty frequency/ voltage converter	14	Switch Avometer to 10V DC range. Monitor voltage at signal generator test terminals. As vehicle speed increases, voltage should rise	Renew frequency/voltage module (Black)
	Faulty relay or LS module	15	Start normally and accelerate vehicle. Relays 3S, 4S and 5S should energise in turn. If relays fail to energise before engine strikes the fuel injection governor – see R.H. column. If relays fail to operate see test 16. If relays operate see test 17	Replace relay associated with non-available gear. Replace LS module (yellow) in line with relay associated with non-available gear
	Potentiometer drift	16	Proceed as in Test 15 If relay fails to operate, see R.H. column	Adjust yellow potentiometer – associated with the appropriate level switch module – in 5° steps opposite to direction of arrow
	Wiring continuity fault	17	Proceed as in Test 15. As the vehicle accelerates and the relays operate, check for supply potential at the following points: a) **Relay 2S operates** (Start position for vehicles with kick-down facility). i) Terminals 21 (+) and 10 (–) in translator	Change 2S relay

SYMPTOM	POSSIBLE CAUSE	TEST No.	TEST PROCEDURE	ACTION
Cont'd.	Cont'd.	Cont'd.	Check for continuity between the following points: Terminal 21 in translator Pin 5 in plug 'G' Terminal 'B' in EP valve unit Check EP valve unit Check air piping to gearbox Check epicyclic gearbox (See Group 4)	
			b) **Relay 3S operates** (but no third gear) i) Terminals 22 (+) and 10 (–) in translator Check continuity between the following points: Terminals 22 Pin 6 in plug 'G' Terminal C in EP valve unit Check EP valve unit Check air piping to gearbox Check epicyclic gearbox (See Group 4)	Change 3S relay
			c) **Relay 4S operates** (but no 4th gear) i) Terminals 23 (+) and 10 (–) in translator Check for continuity between the following points: Terminal 23 in translator Pin 8 in plug 'G' Terminal 'D' in EP valve unit Check air piping to gearbox Check epicyclic gearbox (See Group 4)	Change 4S relay
			d) **Relay 5S operates** (but no 5th gear) i) Terminals 24 (+) and 10 (–) in translator Terminal 24 in translator Pin 7 in plug 'G' Terminal F in EP valve unit Check EP valve unit Check air piping to gearbox Check epicyclic gearbox (See Group 4)	Change 5S relay
4. Reverse gear unobtainable	Wiring continuity fault	18	With start switch ON, select reverse. Check for supply potential between: i) Terminal 9 (+) and 11 (–) in translator. (If voltage is present, refer to Test 18A). If voltage cannot be detected, check for continuity to selector switch via pin 7 in plug 'S'	Faulty selector switch
		18a	Terminal 7 (+) and (10) in translator. Check for continuity to EP valve via: Pin 9 in plug 'G' Terminal 'E' in EP valve unit Check EP valve unit Check piping to gearbox Check epicyclic gearbox (See Group 4)	Change relay D

SYMPTOM	POSSIBLE CAUSE	TEST No.	TEST PROCEDURE	ACTION
5. No 4th gear 'HOLD'	Cont'd.	19	With start switch ON, select 'H4'. Check for system potential between the following points: i) Terminal 4 (+) and 11 (–) in translator	Check continuity back to selector switch
			ii) Terminal 5 (+) and 11 (–) in translator	Change module DB (Brown)
			Relays H4 and 4B should operate	Test relay 4H, 4B, 5S by substitution
6. No 3rd gear 'HOLD'		20	With start switch ON, select 'H3'. Check for system potential at the following points: i) Terminals 3 (+) and 11 (–) in translator	Check continuity back to selector switch
			ii) Terminals 5 (+) and 11 (–) in translator	Change module DB (Brown)
			Relays H3 and 3B should operate	Replace relays H3, 3B, 4S by substitution
7. Vehicle performance poor on ALL DOWN changes	Faulty relay	21		Change N relay
8. Vehicle performs poorly on a particular DOWN change	Faulty module	22		Change defective module Ratios – Module (Blue) 5-4 – NG4 4-3 – NG3 3-2 – NG2 2-1 – NG1
9. Vehicle performance poor on ALL UP changes	Faulty throttle dip system	23	Relay 'C' should operate at every UP change	Change relay 'C' Change associated module Ratio – Module (Blue) 1-2 – TD2 2-3 – TD3 3-4 – TD4 4-5 – TD5
			Test for system potential between terminals 19 (+) and 11 (–) at each gear change	Change relay 'C'
			Check for continuous wiring to throttle dip EP valve unit: With start switch ON, bridge terminals 2 (+) and 19 (–) – throttle dip valve should operate	Check wiring continuity. One lead of throttle dip EP valve unit should be connected to (–)

SYMPTOM	POSSIBLE CAUSE	TEST No.	TEST PROCEDURE	ACTION
10. Kick-down facility malfunction	Wiring continuity fault	24	With start switch ON, select automatic. Check that 18V exists between the following points: i) Terminal 13 (+) and 18V test terminal (—)	Panel wiring — internal fault
			ii) Pin 1 (+) and 18V test terminal (—)	Check wiring to kick-down switch, also switch operation
			Operate kick-down switch (by depressing fully the accelerator pedal). 18V should now exist between terminal 14 and test terminal 18V (—)	Check wiring to kick-down switch, also switch operation
	Relay or module fault	25	Upon operation of kick-down switch, relay 'T' should energise; it should de-energise approximately 10 seconds after switch is released	Change relay 'T' Change module 'KD' (Green)
11. Vehicle persistently locks in gear — i.e. warning lamp illumination	Module or relay fault	26		Change relay 'W' Change module 'WS' (Red)

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. 7 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. 7

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.

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.

Tools, Fig. 8, 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. 8, in the defective

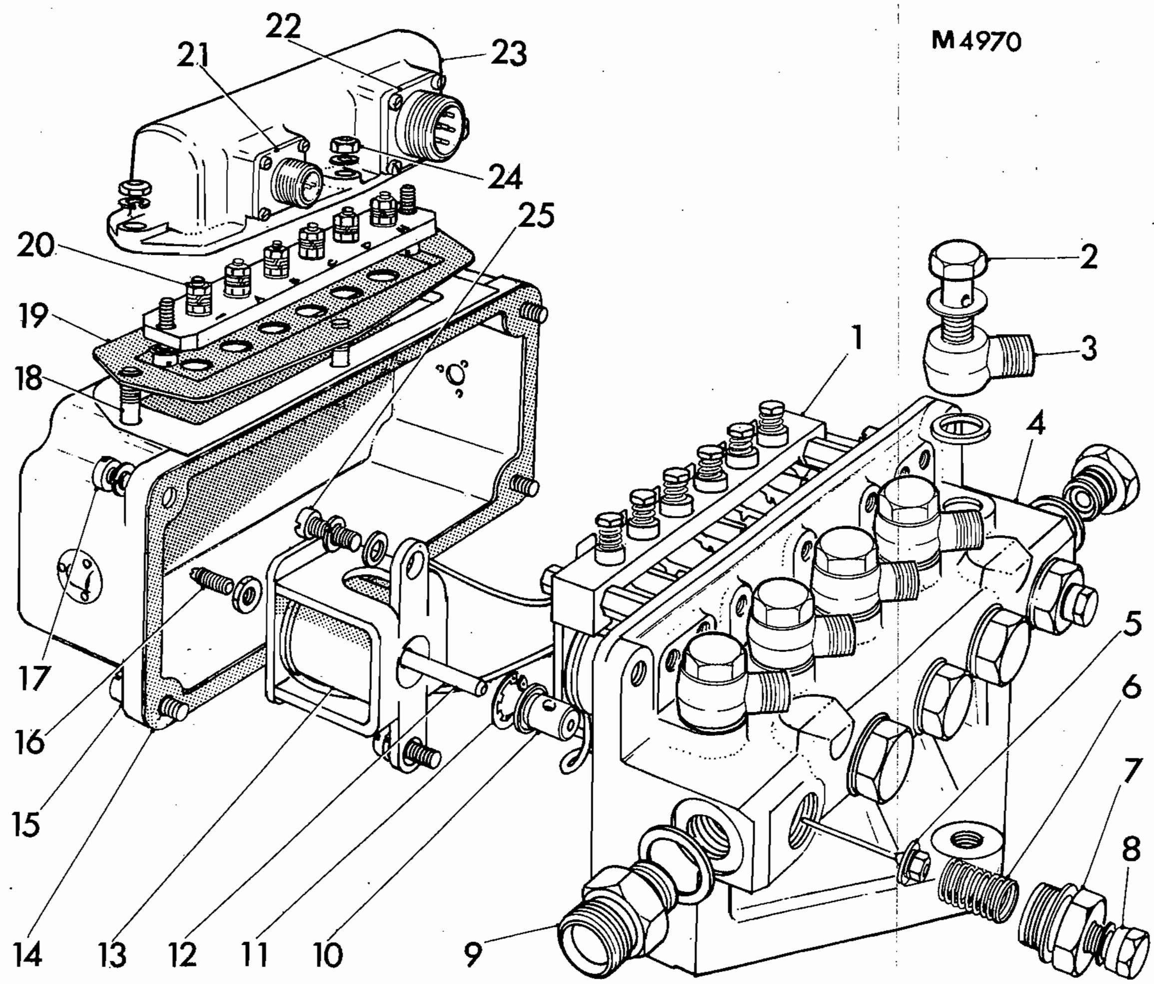


FIG. 7. 5-WAY ELECTRO-PNEUMATIC VALVE

1. Contact holder
2. Screw—air outlet
3. Pipe connector
4. Valve body
5. Plunger valve
6. Spring
7. Valve plug
8. Drain plug
9. Connector—air inlet
10. Valve seat
11. Circlip
12. Valve rod
13. Solenoid
14. Gasket
15. Cover
16. Adjusting screw
17. Screw
18. Stud
19. Gasket
20. Terminal strip
21. Plug, 2-pin
22. Plug, 7-pin
23. Cover
24. Nut
25. Screw

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. 8, 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. 8 into the hole in the valve seat (10) Fig. 7. Hold the tool upright and ensure that the tool

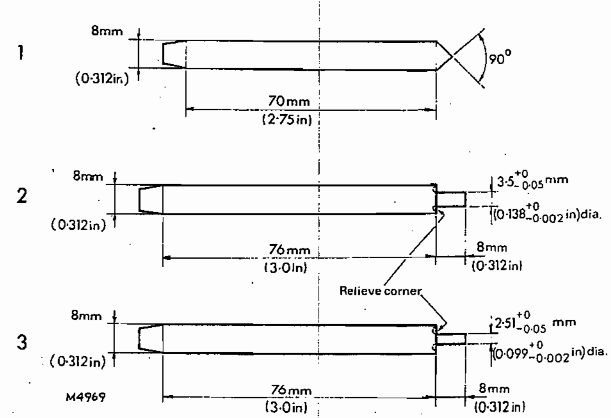


FIG. 8. VALVE SEAT TOOLS

Material — Item 1, Silver steel, hardened and ground.
Item 2, 3, Mild Steel, fine turned finish

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 — Elvolube — 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. 7
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^2 (80 lbf/in^2).
   A pressure gauge with a full scale deflection 0 — 7.0 kgf/cm^2 (0 — 100 lbf/in^2).
   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^2 (80 lbf/in^2) 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^2 (40 lbf/in^2) after five minutes in the condition at Operation 4.

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^2 (80 lbf/in^2). 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.

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'.

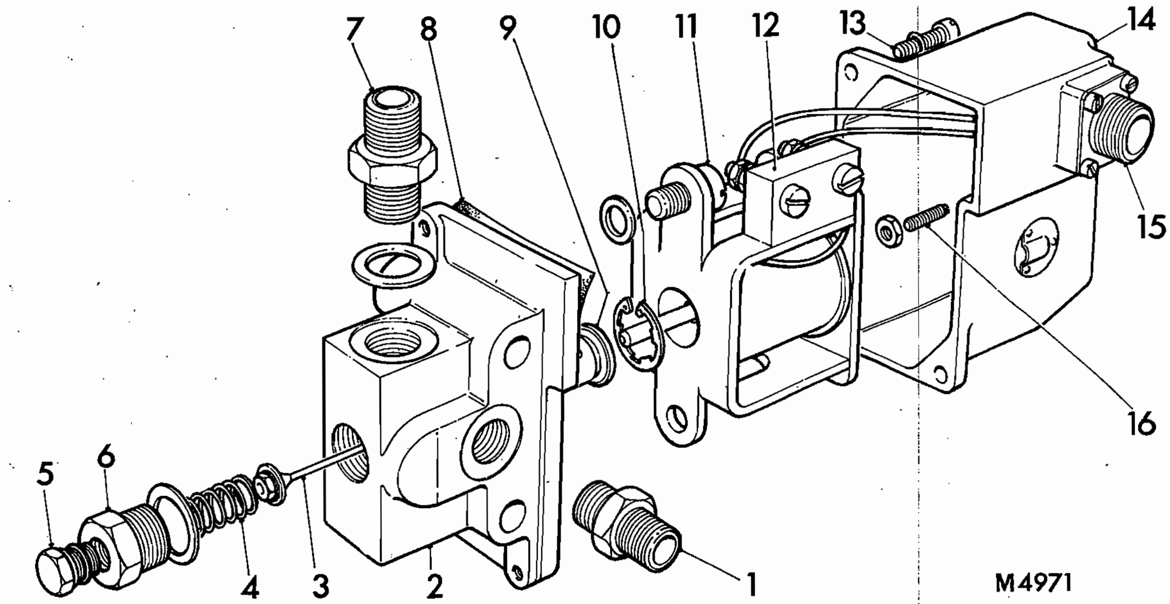


FIG. 9. 1-WAY ELECTRO-PNEUMATIC VALVE

1. Connector — air inlet
2. Valve body
3. Plunger valve
4. Spring
5. Drain plug
6. Valve plug
7. Connector — air outlet
8. Gasket
9. Valve seat
10. Circlip
11. Screw
12. Solenoid
13. Screw
14. Cover
15. Plug, 2-pin
16. Adjusting screw

17. Refit covers (15) and (23).

18. Remove the blanking unions.

1-Way Electro-Pneumatic Valve Unit, Fig. 9

Maintenance, removal and refitment, dismantling and re-assembly procedures are generally similar to those of the 5-way unit.

Throttle Dip Valve

REMOVAL AND REFITMENT

To Remove
Exhaust the auxiliary air reservoir.

Unscrew the pipe unions at pressure inlet and outlet ports.

Isolate the batteries and disconnect the wiring.

Release the two retaining screws and remove the valve.

To Refit
Refitment is reversal of the removal procedure.

OVERHAUL

To Dismantle, Fig. 10
Releasing the screw (10) and detach the junction box (9) and gasket (8).

Unscrew nut (1) with washer (2), remove coil (7).

Unscrew sleeve assembly (3) then remove plunger (5) and spring (4).

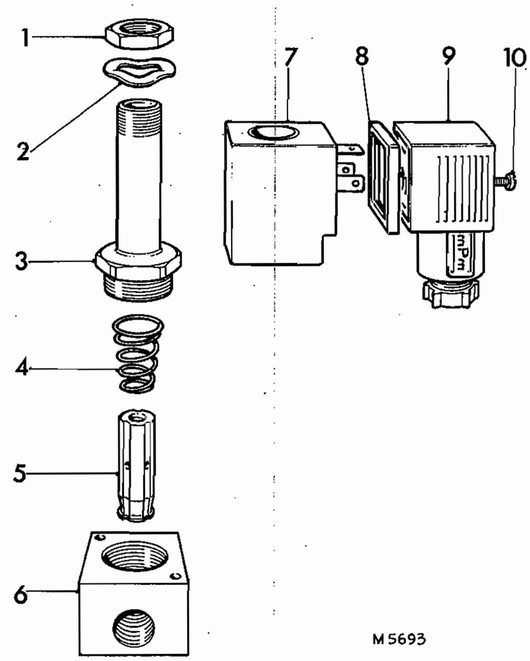


FIG. 10. THROTTLE DIP VALVE — DISMANTLED

1. Nut
2. Washer
3. Sleeve assembly
4. Spring
5. Plunger assembly
6. Body
7. Coil
8. Gasket
9. Junction box
10. Screw

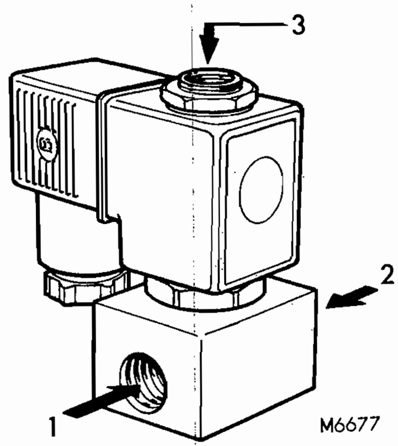


FIG. 11. THROTTLE DIP VALVE
1. Inlet port 2. Outlet port 3. Exhaust port

To Reassemble, Fig. 10
Assembly is a reversal of the dismantling procedure. Before commencing check the following:

1. That the neoprene seats in the plunger (5) are undamaged.

2. Correct plunger is used in valve. This may be verified as follows: Approximately check the spring forces behind the neoprene seats, by applying pressure – using a small blunt instrument – to the seats. The lower spring force (main spring end) should be considerably greater than the upper one.

3. For spring (4) collapse – the free length of which should be 16 mm (0.63 in) approximately.

4. Internal port orifices are not damaged – centre port in body (6) and port in sleeve assembly (3).

5. With an Avometer measure coil resistance – at ambient temperature this should be approximately 65 ohms.

When re-assembling securely tighten the sleeve assembly (3) into body (6).

Only lightly secure coil retaining nut – do not overtighten.

If a new spring (4) is fitted to plunger (5), wind spring onto plunger from the recessed end.

Testing, Fig. 11

1. Connect pressure supply within the range 3,2 to 7,0 kgf/cm^2 (45 to 100 lbf/in^2) to port 1.

2. Connect air pressure gauge to port 2.

3. Admit air to valve, neither pressure at port 2 nor leaks at port 3 should be evident.

   Check for leaks at joint between sleeve assembly (3) and body (6). If these exist, re-tighten sleeve assembly into body. Should leaks persist, fit new body and sleeve.

4. Energise coil. Pressure will appear downstream of port 2. De-energise coil – exhausting air should be evident at port 3.

   When exhaust is complete re-check for leaks at port 3. If leaks at port 3 are evident, the following are probable causes due to damaged sealing surfaces:

   (a) de-energised
   plunger, body or both.

   (b) energised
   plunger, sleeve assembly or both.

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.

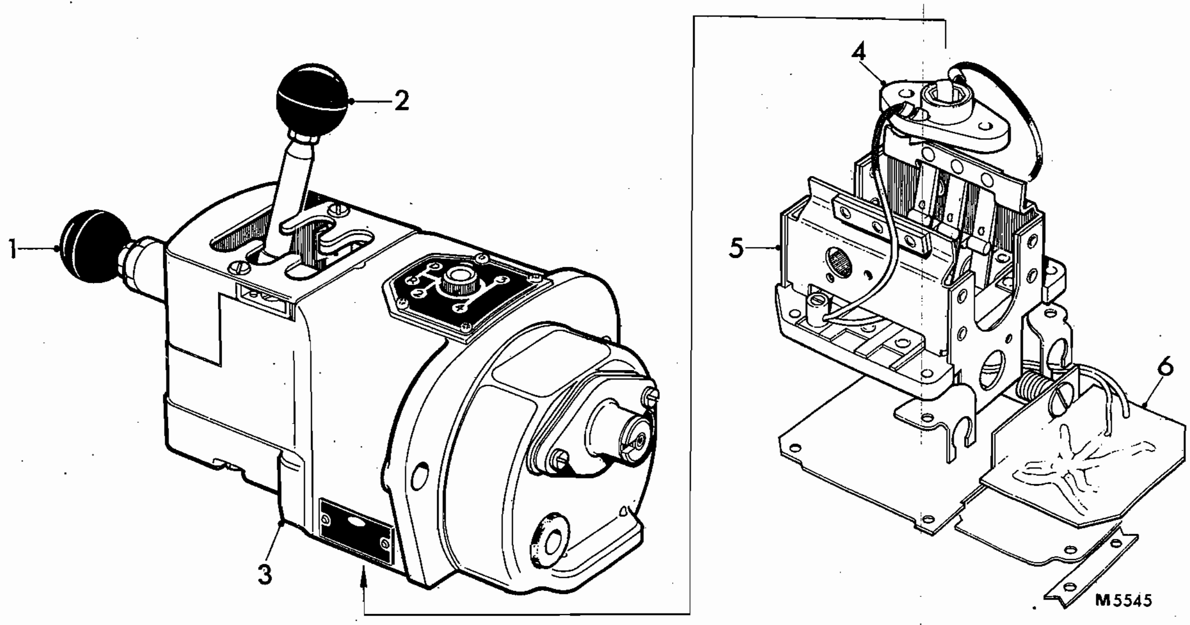


FIG. 1 EXPLODED VIEW OF SELECTOR SWITCH

1. Reverse gear protection plunger
2. Selector lever
3. Switch body
4. Bulb holder
5. Contact unit
6. Transistorised protection unit

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 ± 0.2 mm (0.060 ± 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.

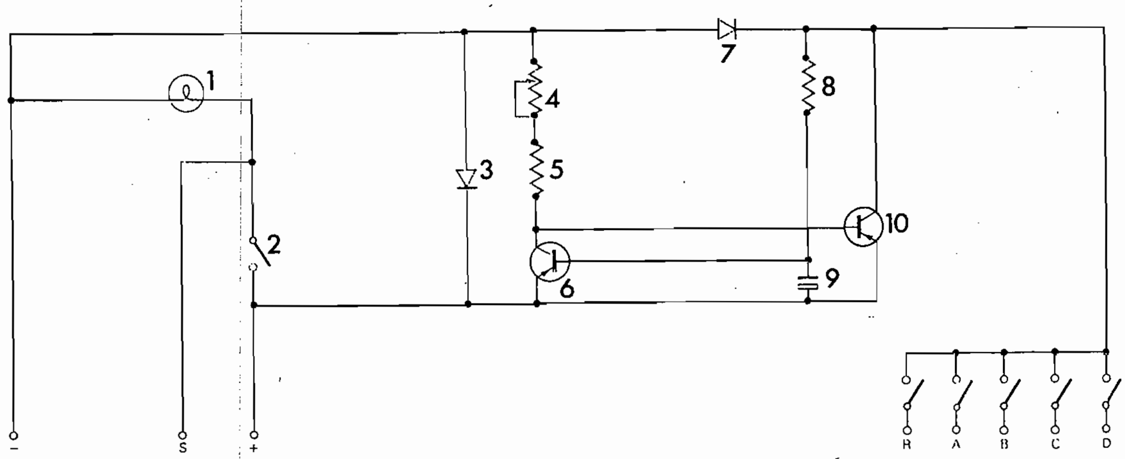


FIG. 2 TRANSISTORISED TWO GEAR PROTECTION CIRCUIT

1. Warning lamp
2. Warning lamp switch
3. Diode (D2)
4. Resistor (R2)
5. Resistor (R1)
6. Transistor (T1)
7. Diode (D2)
8. Resistor (R3)
9. Capacitor (C1)
10. Transistor (T2)

REMOVAL AND REFITMENT

To Remove

1. Open isolator.

2. Remove the two fixing bolts, then partially withdraw switch from its mounting.

3. Remove terminal cover plates (15) and (16), Fig. 3, and locking strip (14). Note and disconnect cable connections. When pulling cables through their guides (11) and (12), take care not to damage the contact unit assembly (18). Remove switch.

To Refit

Refitment is a reversal of the removal procedure.

Dismantling

1. Release the four screws (17) and withdraw the contact unit assembly (18) until it is possible to reach the inner terminals, note and record the location of all cables and connections. Withdraw contact unit assembly (18).

2. Release locknut (32) remove control knob (33) and the locknut.

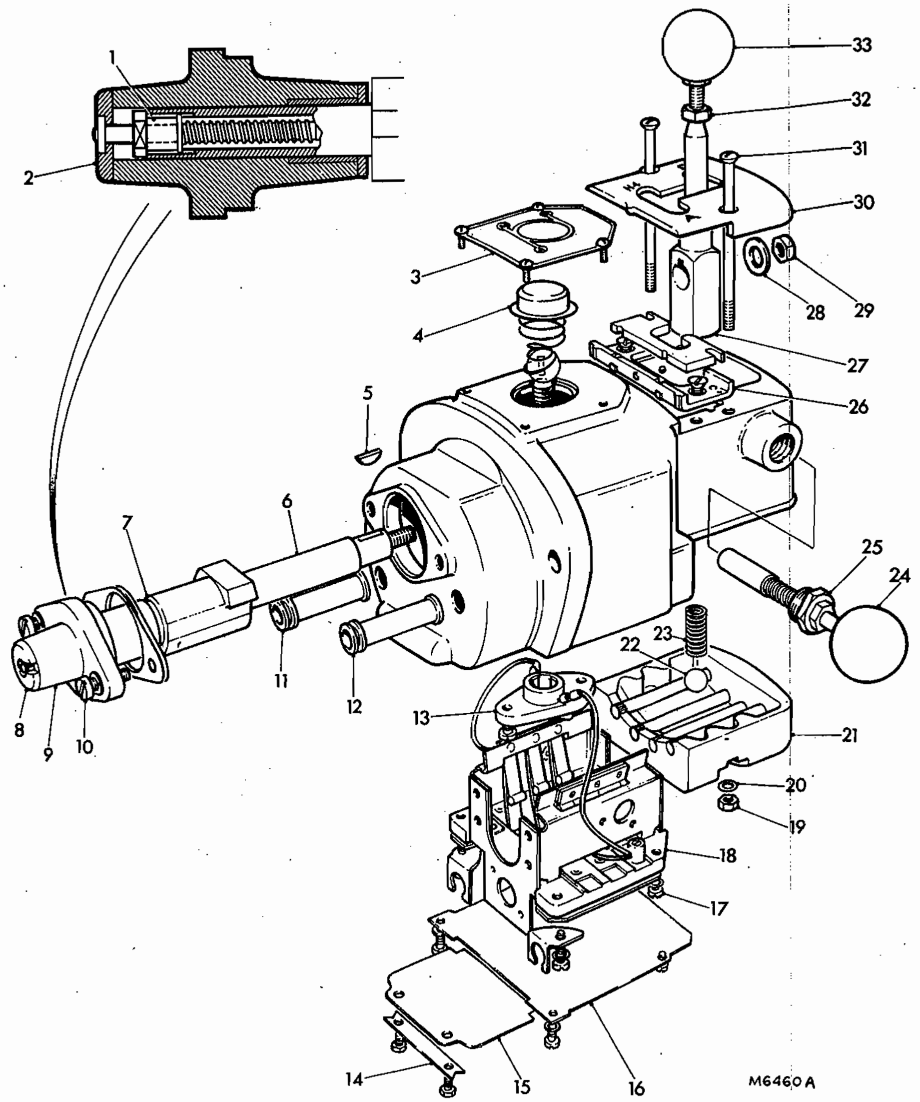


FIG. 3. EXPLODED VIEW OF GEAR SELECTOR SWITCH

1. Spindle
2. Nut
3. Indicator plate
4. Lens assembly
5. Key
6. Operating spindle
7. Washer, thrust
8. Cap—end
9. Bearing, end
10. Screw
11. Guide, cable
12. Guide, cable
13. Lampholder
14. Locking strip
15. Cover plate
16. Cover plate
17. Screw
18. Contact unit
19. Nut
20. Washer
21. Cover, housing
22. Indexing ball
23. Spring
24. Stop, reverse
25. Nut, gland
26. Latch
27. Lever, selector
28. Washer
29. Nut
30. Cover
31. Bolt
32. Nut, lock
33. Control knob

3. Remove nuts (19) and washers (20), take off cover housing (21). Remove indexing ball (22) and spring (23). Remove top cover (30) by unscrewing the two fixing bolts (31). Remove latch (26) and the two small ball bearings when accessible.

4. Remove the spindle nut (29) and washer (28) from the operating spindle (6).

5. Ease off the gear selector lever (27) from the operating spindle (6) and remove key (5).

6. Remove the two screws (10) and withdraw end bearing (9) complete with operating spindle (6).

7. Remove indicator plate (3) and withdraw bezel complete with lamp bulb (4).

8. Remove the two screws and withdraw lamp holder (13).

9. Remove reverse stop (24) by unscrewing gland nut (25).

10. Remove end cap (8) then ease operating spindle from end bearing (9) taking care not to lose thrust washer (7).

11. Unscrew nut (2) and withdraw the small spring loaded spindle (1) from the operating spindle (6).

Note: The contact unit is a non-serviceable part and must be renewed where necessary.

Assembly

1. Assemble small spring loaded spindle (1) to the operating spindle (6) and secure with nut (2).

2. Fit the operating spindle (6) and the thrust washer (7) to the end bearing (9) and secure the cap (8).

3. Assemble the reverse stop (24) to the switch body and secure with gland nut (25).

4. Assemble lamp holder (13) to the contact unit assembly (18) and secure with two screws.

5. Assemble bezel (4) complete with lamp bulb to switch body and secure indicator plate (3) with four screws.

6. Assemble the operating spindle (6), the end bearing (9) and gasket as a unit into the switch body and secure with the screws (10).

7. Fit the key (5) in the operating spindle (6) and assemble selector lever (27), fit the washer (28) and secure nut (29).

8. Assemble latch (26), ensuring the two small ball bearings are correctly located — and assemble top cover (30). Insert the two fixing bolts (31).

9. Hold top cover (30) firmly on the switch body, pack the spring (23) with Shell Alvania 2 grease and assemble the indexing spring (23) and ball (22) into the base of the selector lever (27).

10. With the tracks lightly greased, locate cover housing (21) on the fixing bolts (31) and secure with washers (20) and nuts (19).

11. With locknut (32) assembled, screw control knob (33) onto selector lever (27) and secure by tightening locknut.

12. Secure contact unit assembly (18) to switch body with washers and screws (17).

13. Draw external wiring through cable guides (11) and (12) and connect to the terminals on the contact unit assembly (18). Examine switch contacts — check that the gaps are set to open to 1.5±0.2 mm (0.060±0.010 in).

    Bend the fixed contact arms if the gaps are not correct.

14. Assemble and secure the terminal cover plates (15) and (16) plus locking strip (14).

GROUP 9

SUSPENSION AND CHASSIS EQUIPMENT

SECTION 1

Suspension

DATA

Type	Laminated semi-elliptical with anti-roll clips at both ends

Spring eye sleeve bore reamed to 41.3/41.26 mm (1.626/1.6245 in)

Front Springs	
Number of plates	3 at 12.7 mm (0.5 in)
	3 at 11.9 mm (0.469 in)
Rear Springs	
Number of plates	8 at 15.9 mm (0.625 in)
Shock Absorbers	Telescopic non-adjustable
Torque Figure	
Shackle bolts	69 kgf m (500 lbf ft)

Front spring

To Remove

1. Set hand control valve in 'PARK' position and isolate batteries.
2. Slacken front wheel nuts; jack up front of vehicle and position blocks behind spring rear brackets.
3. Remove wheels and check that all load has been taken off the springs.
4. Remove shackle pin retaining bolts.
5. Remove U-bolts securing nuts and the spring saddle.
6. Remove shackle plates and drive out the forward pin.
7. Extract lower rear shackle pin by levering against the frame side member.
8. Remove spring and release shackle pin from the spring eye.

Inspection

Shackle pins and bushes should be checked for excessive wear and renewed if defective, see Data.

Renew thrust washers and O-rings.

Weak or broken springs should be exchanged, not overhauled.

To Refit

1. Fit shackle pin in rear spring eye and secure shackles with thrust washers and O-ring to the pin.
2. Position spring over front axle and fit lower rear shackle pin.

Note: The 2nd leaf of the spring is lipped below the front shackle; the correct fitting of the spring is important.

3. Fit front pin and shackle plates.
4. Position spring saddle, fit and tighten U-bolts.
5. Fit and tighten shackle pin retaining bolts to correct torque, see Data.
6. Fit road wheels, remove blocks and lower vehicle onto road wheels, tighten wheel nuts to 55.2 kgf m (400 lbf ft).

Rear Springs

To Remove

1. Set hand control valve in 'PARK' position and isolate the batteries.
2. Slacken road wheel retaining nuts, jack wheel clear of ground and fit axle stand.
3. Raise chassis and take the weight off the spring.
4. Remove road wheels.

5. Remove shackle pin retaining bolts.

6. Remove shackle pin adjusting nuts and tap the pins through the spring eyes.

7. Remove the U-bolt nuts and lower the spring.

Inspection

Examine shackle pins and bushes and renew any defective part.

Renew thrust washers and O-rings.

Weak or broken springs should be exchanged not overhauled.

To Refit

1. Raise the spring into position and fit the U-bolt nuts.

2. Fit shackle pins, retaining bolts and adjusting nuts. Adjust shackle pin as described under Adjustment.

3. Fit automatic lubrication pipe or grease nipples and lubricate the spring shackles as described in Group 1.

4. Fit road wheel.

5. Remove axle stand and lower vehicle onto road wheels.

6. Tighten wheel nuts to 55.2 kgf m (400 lbf ft).

ADJUSTMENT

1. Ensure that both retaining bolts are slack.

2. Tighten adjusting nut.

3. Tighten retaining bolt located at opposite end of adjusting nut.

4. Slacken adjusting nut one-sixth of a turn and tighten inner retaining bolt.

SECTION 2

Automatic Lubrication

DATA

Make	Tecalemit
Type	Airdromic Mk. 3
Pump operating pressure	345–827 kN/m^2 (3.52–8.44 kgf/cm^2) (50–120 lbf/in^2)
Safety valve cut out pressure	496 kN/m^2 (5.06 kgf/cm^2) (72 lbf/in^2). See note
Recommended lubricant	0°–21°C (32°–70°F) SAE 90 below 0°C (32°F) SAE 80 above 21°C (70°F) SAE 140
Oil reservoir capacity	6.8 litres (1.5 gal)
Oil filter	30 micron paper element
Pumping unit output:	
Red	0.010 cc/stroke
Green	0.015 cc/stroke
Orange	0.025 cc/stroke

DESCRIPTION

The automatic lubrication system ensures that each point being served receives a specific quantity of oil at intervals regulated by the distance travelled. The system consists of a pump assembly, an air control unit, a safety valve and a pressurized air supply. The air supply is taken from the auxiliary or spring brake parking reservoir, via a safety valve. The valve cuts out the lubrication system if the air pressure falls below a predetermined minimum, thus ensuring that an air supply is still available for the braking system of the vehicle.

The pump assembly houses a roller clutch which drives three single-lobed cams, each cam operating a row of twelve pumping units disposed radially around the pump body. The pumping units are connected with nylon tube to the required points, feeding a calibrated amount of oil to each one.

The air control unit, driven by the speedometer drive and fed with air from the safety valve, houses a continuously rotating single-lobed cam which operates an inlet and exhaust valve. Initially the inlet valve is opened, allowing a charge of air to operate the driving mechanism in the main pump. As the cam rotates the inlet valve closes and the exhaust valve opens, allowing the air pressure to discharge to atmosphere through a vent in the control unit housing. An oil unloader valve is incorporated in the main pump casing to release any oil that leaks past the piston during operation.

MAINTENANCE

For general lubrication periods, refer to Group 1.

IMPORTANT: Strict cleanliness must be observed during maintenance procedures to prevent the ingress of dirt or foreign matter.

Periodic overhaul is not necessary as the pump is self-lubricated and the safety valve (Tecalemit only), air control unit, pump drive and pumping units are sealed assemblies.

Should any of these units become unserviceable, they must be renewed.

Lubrication Procedure and Testing

1. Drain the oil reservoir at the feed pipe and remove it from the vehicle.

2. Discard the filter element, wash out the reservoir with a suitable cleaning fluid, then refit a new filter ensuring correct seating.

3. Refit the reservoir, connect the feed pipe and top up with specified oil to the correct level.

4. Carry out a functional test as follows:

   Slacken the outlet from the safety valve or, if more convenient, the inlet on the air control unit, and allow air pressure to fall until the safety valve cuts out. Check cut-out pressure, see Data. Rectify fault if necessary and re-connect the feed pipe.

   Charge the vehicle air system to maximum pressure.

   Remove the air control unit from the gearbox, keeping the air lines connected.

   Remove the speedometer drive, the pulsator or protection cap and note the direction of worm shaft rotation.

   Attach to the air control unit a hand drill or a slow electric drill not exceeding 900 rev/min.

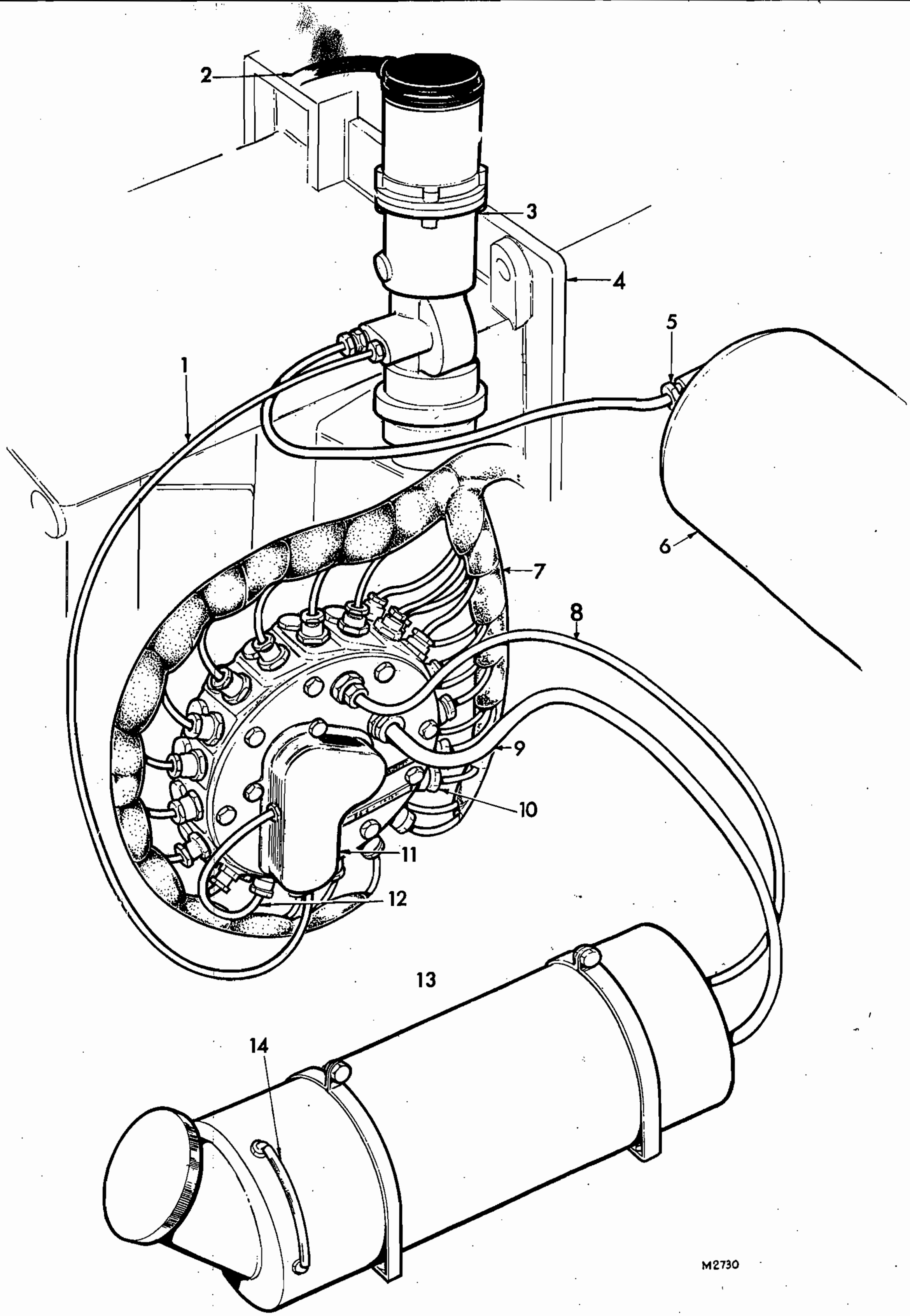


FIG. 1 AIRDROMIC AUTOMATIC LUBRICATION SYSTEM

A. Gearbox limiting valve
B. Tecalemit type safety valve

1. Air supply tube
2. Connection to speedometer
3. Air control unit
4. Vehicle gearbox
5. Air take-off point
6. Auxiliary reservoir
7. Loom
8. Vent tube
9. Oil supply tube
10. Pumping units
11. Power unit
12. Power unit self-lubrication supply tube
13. Oil reservoir
14. Oil level indicator

Apply a soap solution around the air line connections and operate the drill for about 200 revolutions.

Examine the components for air leakage. Rectify if necessary.

Refit the air control unit and the speedometer drive, pulsator or protection cap.

REMOVAL AND REFITMENT

Pump Drive Mechanism

To Remove

1. Disconnect the air and oil supply and blank off the oil supply with a suitable plug. Remove one of the bottom pumping units, drain the pump body, then refit the unit.

2. Mark the position of cover to body, remove the setscrews and rotate the cover slightly in an anti-clockwise direction to break the gasket seal.

3. Ease away the cover with an anti-clockwise rotation.

4. Discard the paper gasket.

To Refit

Refitment is a reversal of the removal procedure, using new gaskets, but any movement of the cover when fitting must be in an anti-clockwise direction. Before final tightening of the setscrews it is advisable to connect the air supply and rotate the pump to align the camshaft in its bearings.

Camshaft

To Remove

1. Disconnect all feed pipes from the pump, marking their relative positions. Plug the oil feed pipe.

2. Remove the pump assembly from the vehicle.

3. Remove all pumping units, marking their relative positions.

4. Remove the front cover as described in Pump Drive Mechanism removal.

5. Remove the camshaft.

To Refit

Refitment is a reversal of the removal procedure, using new gaskets, following precautions under To Refit, Pump Drive Mechanism.

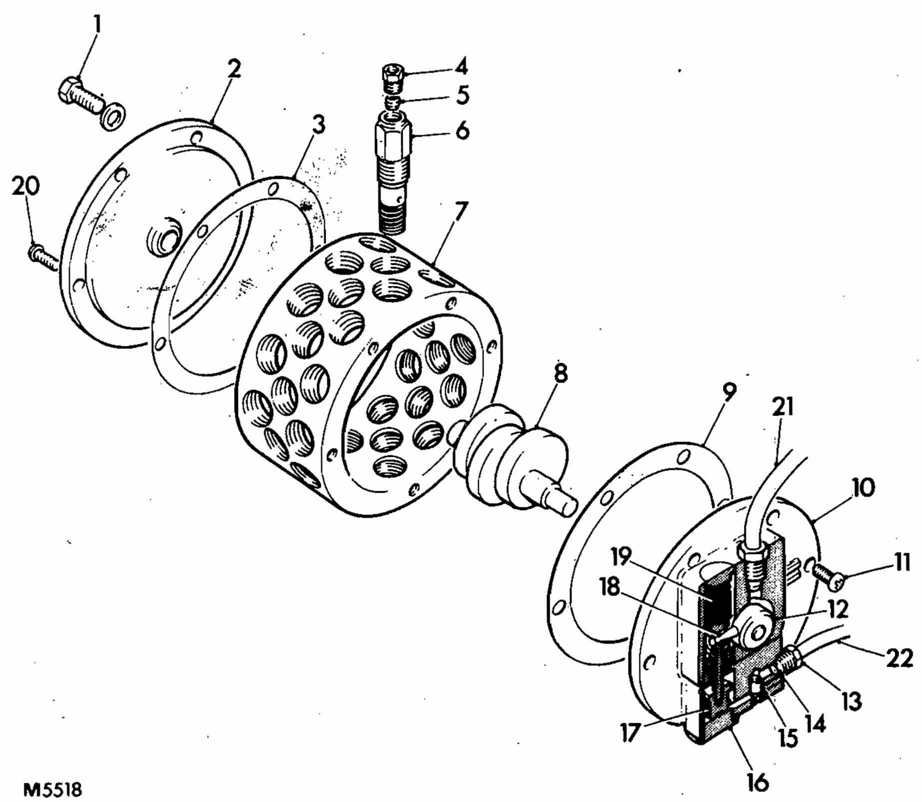


FIG. 2 EXPLODED VIEW OF PUMP ASSEMBLY

1. Mounting bolt
2. Rear cover
3. Gasket
4. Sleeve nut
5. Cone
6. Pumping unit
7. Pump casing
8. Camshaft
9. Gasket
10. Front cover assembly
11. Retaining screw
12. Roller clutch assembly
13. Sleeve nut
14. Cone
15. Oil unloader valve
16. Piston stroke adjusting plug
17. Piston
18. Clutch operating lever
19. Piston return spring
20. Retaining screw
21. Oil supply line
22. Air feed line

FAULT TRACING CHART

Fault	Possible Cause	Remedy
1. All bearings dry	(a) Incorrect oil being used, reservoir empty or filter blocked.	(a) Check the oil, clean the filter or refill the reservoir as necessary.
	(b) Air lock in oil supply pipe to the pump.	(b) Check the run of the pipe for freedom from kinks and dips. Re-route the pipe if necessary.
	(c) Mechanical failure of pump.	(c) With maximum air pressure in the system, disconnect the air control unit from the gearbox and rotate the drive in the correct direction at a maximum speed of 900 rev/min using either a hand drill or an electric drill. Check air lines for leaks, using a soap solution. Rectify as necessary. Construct a testing tube using a piece of transparent nylon tube at least 300 mm (12 in) long and 4 mm ($\frac{5}{32}$ in) diameter. Remove a loom pipe from a pumping unit and fit a pre-filled testing tube with at least 13 mm (½ in) of oil showing above pumping unit. (This can be controlled with the finger tip blocking the tube.) Mark the oil level and operate the pump from the control unit. If there is no increase in oil level, renew the front cover assembly. An increase in level proves the pump to be serviceable. Refit the components removed for this test.
	(d) No air supply to pump assembly.	(d) Disconnect the air line from the pump assembly and operate the system as in (c) above. If no air flow is evident check for correct connection to the air control unit and then the outlet and inlet sides of each component in turn, i.e. air control unit and air safety valve and by a process of elimination determine the faulty component and renew as necessary. Pay particular attention to the gauze filter in the safety valve inlet connection. If dirty it is recommended that the valve should be renewed. It also indicates that the air supply is contaminated and has caused internal damage to the safety valve. Checking both outlet and inlet sides will also prove the interconnecting pipe runs. When re-connecting air lines take care not to cross lines, paying particular attention to the connections of the air control unit. The line from the safety valve must be connected to the control unit connection marked 'IN'.
2. One or more bearings dry or receiving insufficient lubrication.	(a) Oil leakage due to loose connections or damaged loom tubing.	(a) Examine all oil pipework and tubing for signs of leakage or damage. Rectify as necessary.
	(b) Faulty pumping unit.	(b) Follow section 1 (c) of this chart, connecting the testing tube to the suspect pumping unit. If there is no apparent increase in oil level, the pumping unit is faulty and must be replaced. An increase in oil level proves damaged piping or loose connections. Check and rectify.

Chassis Equipment

Fuel Tanks
Maintenance

If trouble is experienced with dirty fuel, drain and remove the tanks. Clean by blowing high pressure steam through the tanks for several minutes or flush out with boiling water.

Leaks can be repaired by soldering at this stage. DO NOT apply heat to the tank before cleaning or serious damage by fire can result.

Ensure that tanks are dry before refitting.

To Remove

1. Remove drain plug and transfer the fuel into suitable clean containers.

2. Disconnect fuel feed pipes and transfer pipe.

3. Take the weight of the tank off the straps; remove the pins from the strap brackets and remove tank from vehicle.

To Refit

1. Ensure that rubber packings are correctly located, lift fuel tank into position and pass the pins through the mounting brackets and strap eyes.

2. Re-connect fuel feed pipes and transfer pipe.

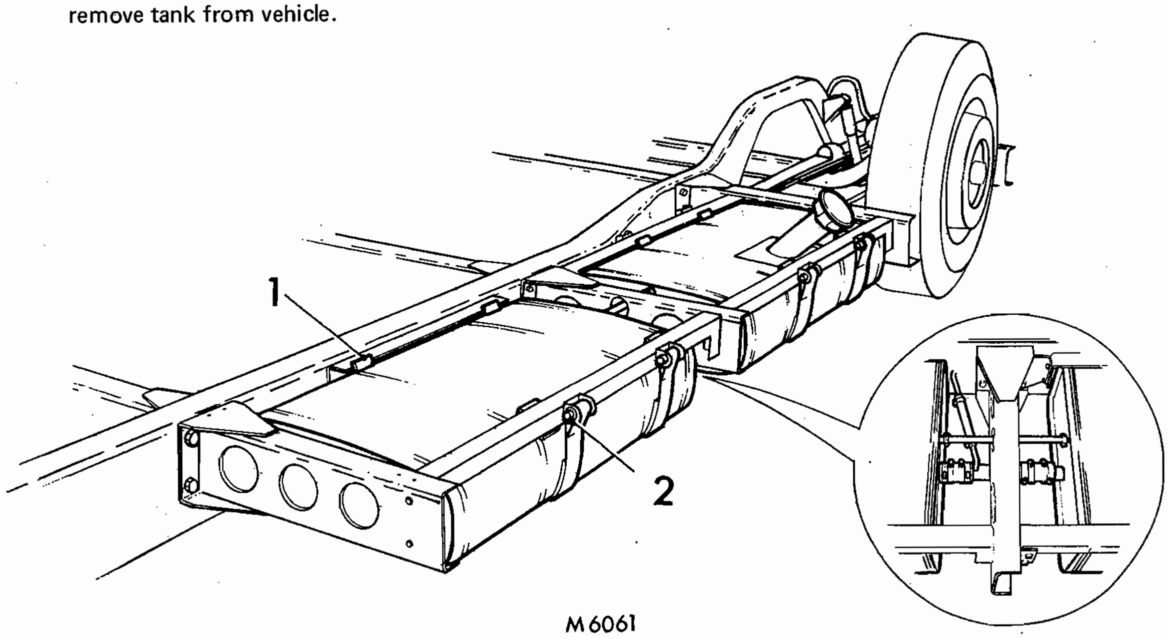


FIG. 1 FUEL TANKS
1. Rubber packing 2. Strap pins
Inset shows the connecting transfer pipe

EXHAUST SYSTEM

Any of the pipes can be renewed independently by disconnecting the relevant clips or flange mounting bolts and separating the scrap section from the system.

Fit and secure a new section and check for leaks.

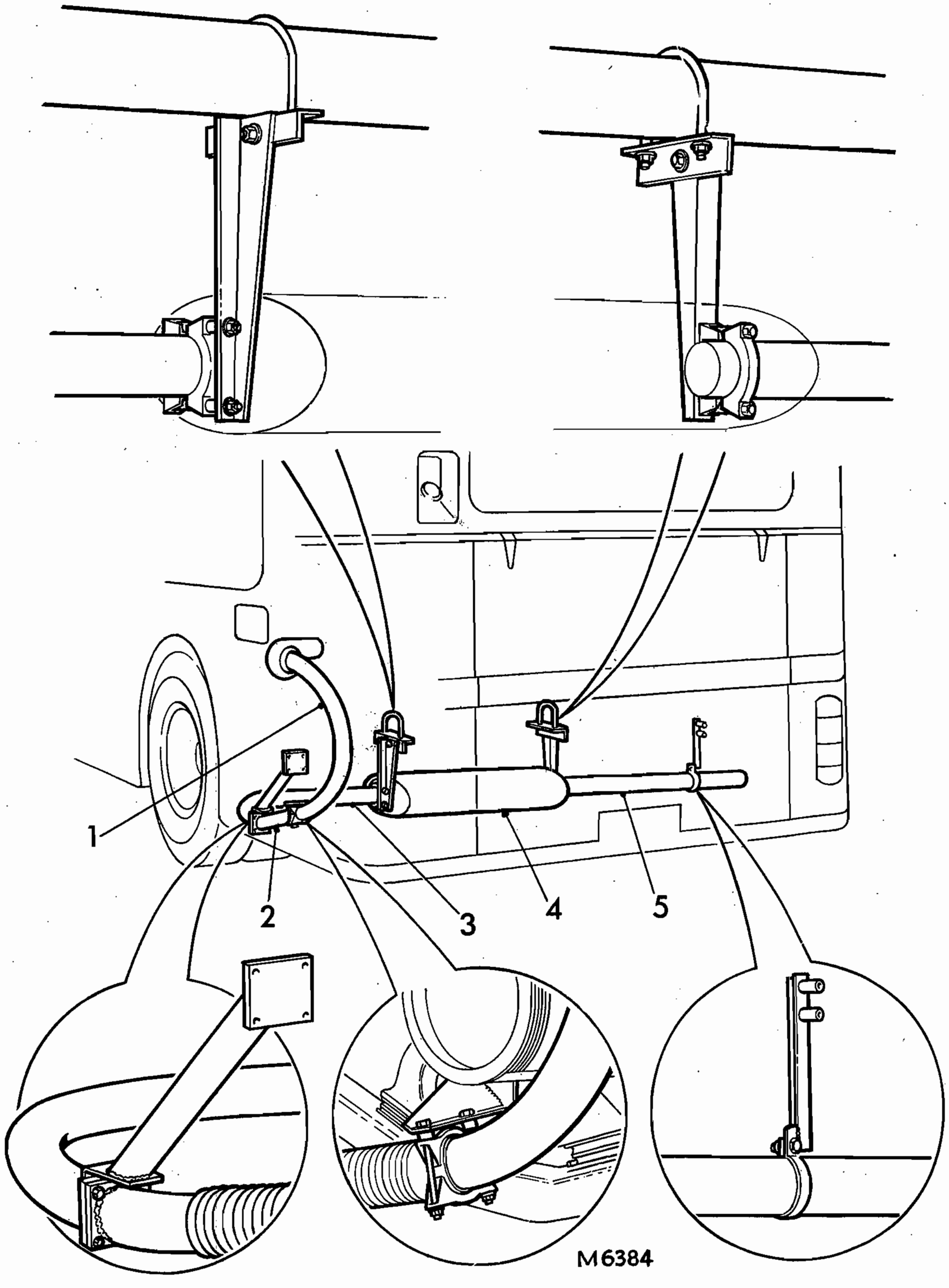


FIG. 2 EXHAUST SYSTEM

1. Pipe-turbo-charger to flexible pipe.
2. Flexible pipe
3. Pipe—flexible to silencer
4. Silencer
5. Tail pipe

Tubeless Tyres

REMOVAL AND REFITMENT (B TYPE RIMS)

Equipment Required Fig. 1

1. One 5629 Schrader valve or equivalent.
2. One tin of lubricant.
3. One medium size brush.
4. One medium weight hammer.
5. One pair Melco TTL.3 levers or equivalent.
6. One pair vice grips.

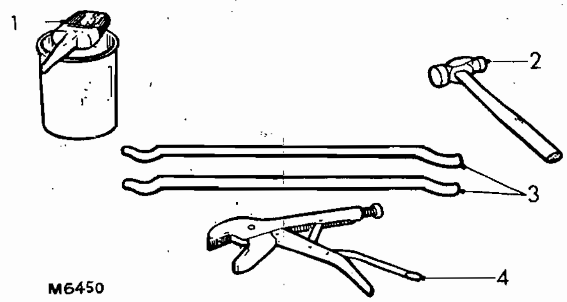


FIG. 1. TOOLS AND EQUIPMENT

1. Lubricant and brush
2. Hammer
3. Two tyre levers
4. Vice grips

General Notes

Ensure at all times that the wheel rims are free from rust and dirt and that the flange areas are not distorted. Clean up the bead contact areas as necessary using a wire brush and emery cloth. Wipe with a clean rag. Repaint rim using an epoxy resin paint, if necessary, before refitting the tyre.

Ensure that the valve aperture is clean and free from burrs.

To Remove

1. Deflate tne tyre completely.
2. Lay the assembly on a clean floor area with the nave/dish uppermost. Unseat the first bead using an unseating tool if necessary.
3. Apply lubricant around the rim flange and bead. Fig. 2.

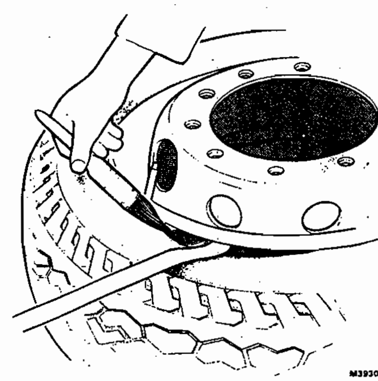


FIG. 2. LUBRICATING BEAD AND FLANGE

4. Remove the first bead using the levers as for normal car tyres, Fig. 3.

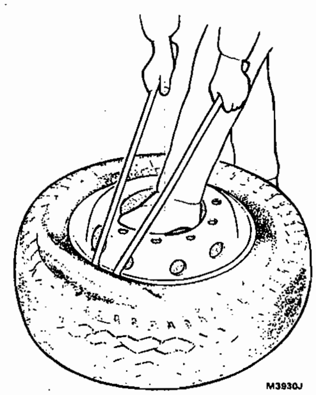


FIG. 3. REMOVING FIRST BEAD

5. Stand the assembly in an upright position and insert the levers between the rim and second bead, Fig. 4. Using a liberal amount of lubricant around the rim and bead, ease off the second bead with a regular rocking motion. If the bead is tight removal may be assisted by hammer blows applied with care to the tyre bead.

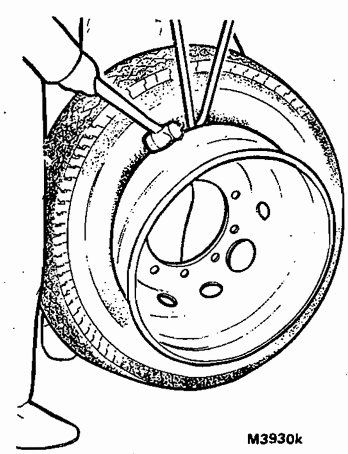


FIG. 4. REMOVING SECOND BEAD

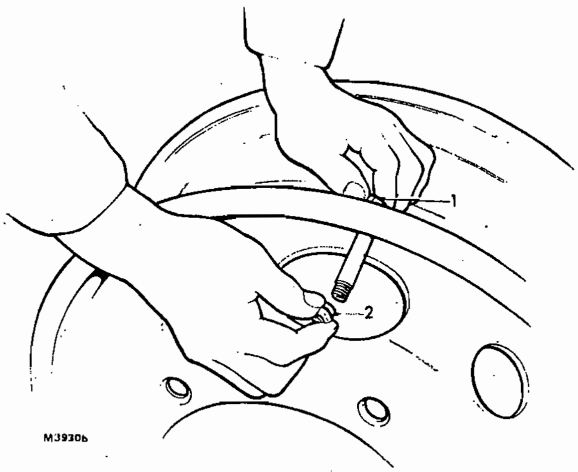


FIG. 5. FITTING VALVE STEM
1. Stem
2. Barrel nut—barrel towards rim

To Refit

1. Fit the valve stem to the rim ensuring that the locking nut is correctly fitted with the barrel towards the rim, Fig. 5.

2. Apply lubricant to the rim flange and well. Lay the rim flat on a clean floor area with the nave/dish of the rim uppermost.

3. Apply lubricant to the tyre beads.

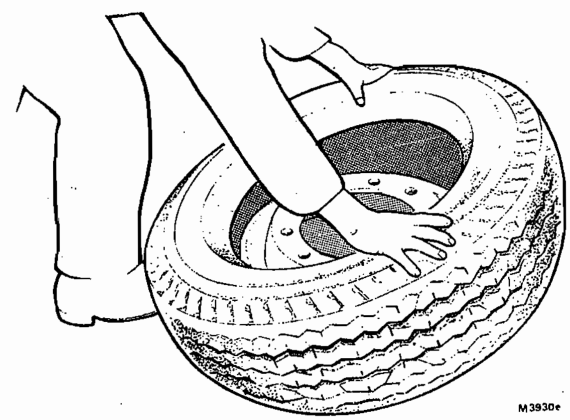


FIG. 6. FITTING FIRST BEAD

4. Position the tyre and using manual force fit the first bead as for normal car tyre fitting, Fig. 6.

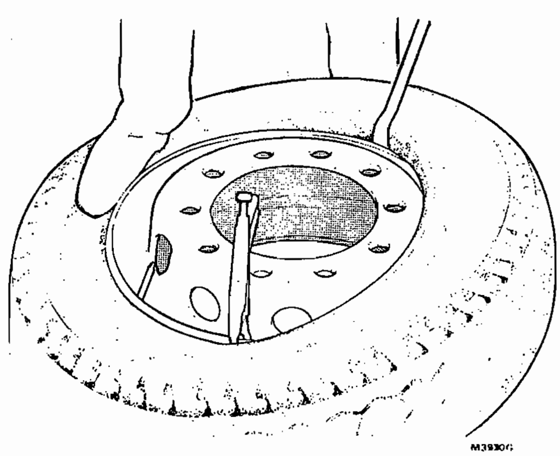


FIG. 7. FITTING SECOND BEAD

5. Apply the vice-grips to the rim to prevent the bead slipping over the flange, Fig. 7.

6. Fit the second bead using the levers working round from one side of the vice grips to the other. Do not attempt to locate a large bead area in one movement. Note the use of the foot to help keep the tyre bead in position, Fig. 7.

7. Inflate the tyre and check the valve for leaks. Check also that the beads are seated correctly and are concentric with the wheel.

MAINTENANCE

To obtain the maximum life from the tyres, they must be treated with consideration and serviced regularly.

Correct inflation is important and it should be noted that losses of air pressure up to 0.2–0.4 kgf/cm^2 (3 to 5 lbf/in^2) in a week's running are normal.

Inflation pressures are given on tyre manufacturers data charts and should be adhered to in order to promote satisfactory tyre life.

Persistent bursts of acceleration, sudden and harsh braking and fast cornering are practices which will cause the tyres to wear excessively. Similarly, the tyres of a vehicle always driven at high speeds will wear much more rapidly than will the tyres of a similar vehicle driven at reasonable speeds.

The correct alignment of road wheels is essential. Any error will cause excessive tread wear on the front tyres.

Oil and grease are particularly harmful to rubber, paraffin being almost instantaneous in its effect. Any oil which may be thrown on the tyres should be removed at the earliest possible moment.

All tyre manufacturers make several types of tyre, some of which have relatively thicker treads and because of this they generate higher running temperatures. To obtain good, safe tyre performance it is therefore essential to limit the maximum operating speeds of such tyres.

The British Tyre Industry recommendations for tyres inflated to recommended normal pressures and operating in accordance with the appropriate S.M.M. and T. load schedules are as follows.

Inter-City and Long Distance Buses

Tyres for normal highway use are suitable for vehicles operating within the current United Kingdom speed and load regulations, but any operator who is likely to cover 96 kilometres (60 miles) or more per hour should consult the tyre manufacturer.

P.T. Tyres for Public Service Vehicles used on town services

First tread P.T. tyres may be driven at speeds up to 80 kilometres (50 miles) per hour.

Tyre manufacturers should be consulted on speeds applicable overseas.

Ministry of Transport Regulations

The following summarizes the main legal requirements in the U.K. with regard to tyres as from April 1, 1968.

It is an offence under the M.O.T. regulations to use a pneumatic tyre if it is unsuitable, either in itself or in combination with other tyres on the vehicle; is not properly inflated; if it has a break in its casing cords or a cut deep enough to reach the body plies, a lump or bulge caused by separation or damage to the structure, or any portion of the ply or cord structure exposed; or if it does not have a tread pattern at least 1 mm deep.

Matching Tyres

Tyres on twin wheels of the rear axle should be mated for type (radial or cross-ply), size and tread. **The mixing of radial and cross-ply tyres on a vehicle is not recommended.** If one of the tyres fitted to a twin wheel is worn more than the other it should be fitted on the inside.

Periodical Interchange of Wheels

The tyres on a vehicle do not wear uniformly since each tyre is subjected to different stresses and varying loads according to the position of the wheel on the vehicle.

To compensate for uneven and 'heel-to-toe' wear it is advisable to interchange the positions of the wheel assemblies and at the same time to reverse the direction of normal rotation of the wheels. Interchange of wheels should be carried out at regular mileage intervals or at any time when irregular wear is first noted.

Fig. 8 illustrates the interchange of wheel assemblies. If a spare wheel is carried, it should be brought into use at the time of the change-over. This practice prevents deterioration of the tyre of the spare wheel and allows the maximum useful mileage to be obtained from all tyres.

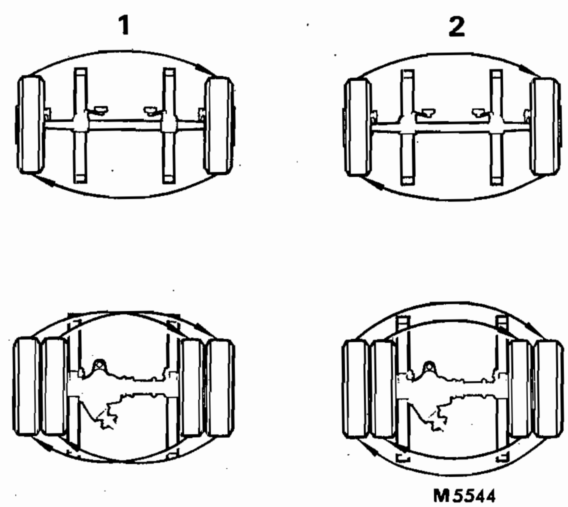


FIG. 8. ROAD WHEEL CHANGE SEQUENCE

(1) When inner and outer tyres have the same degree of wear.

(2) When inner tyres are more worn than the outer.

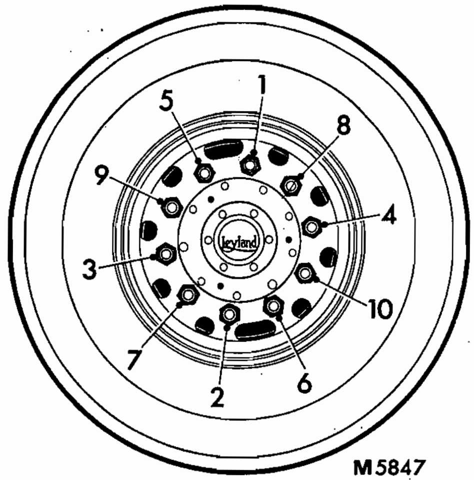


FIG. 9. TIGHTENING SEQUENCE FOR THE ROAD WHEEL NUTS

Fitting Wheels

Before fitting the road wheels, the studs and contact faces of the nuts should be lightly smeared with 90 EP oil. Fit the wheel then tighten the nuts evenly, in the sequence shown in Fig. 9 to a torque of 55.2 kgf m (400 lbf ft).

Note: Ensure when fitting twin wheels that the tyre valves are located at 180° one to the other.

When the appropriate lifting gear has been removed from the axle a final check should be made to ensure complete security.

Wheel nuts should be checked for tightness each week, or on completion of the initial run that follows a wheel change.

REMOVAL AND REFITMENT (3B TYPE RIMS)

Removal—Using Tyre Levers

1. Exhaust all air by removing valve core and, with the aid of a tyre lever or screwdriver, remove the locking ring. See Fig. 1.

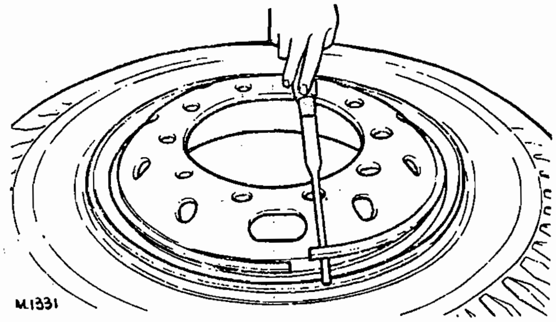


FIG. 1. REMOVING LOCK RING

2. Drive the "gooseneck" ends of the combination levers Dunlop TL/22 or Goodyear 3BT3 between the tyre bead and side flange at about 152 mm (6 in) apart as shown, see Fig. 2. Prise down and out in an arc of about 70°. Repeat this operation in progressive steps until the bead is completely free from the flange.

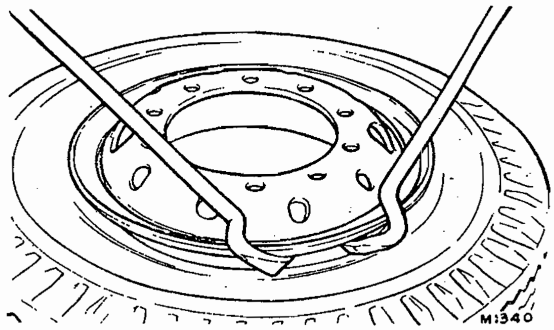


FIG. 2. USING COMBINATION LEVER TO FREE TYRE BEAD

3. Invert the wheel assembly and fit a dome cap to the valve stem. Using Dunlop tool VAT/1 or Goodyear 3BT/2 insert the hook end into the lock ring groove, adjust the tool to suit position of the valve aperture and insert the valve stem into the recessed nose of the valve removal tool, Fig. 3.

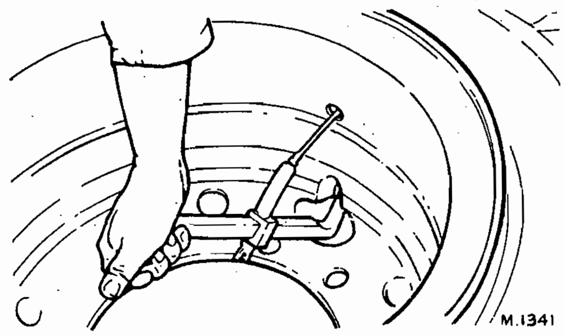


FIG. 3. REMOVING VALVE STEM

4. Push the valve stem back into the wheel base, Fig. 4.
   Note: The tool is designed to allow the valve stem to slip off and remain inside the tyre. The bead may now be freed as in Operation 2 and the tyre removed.

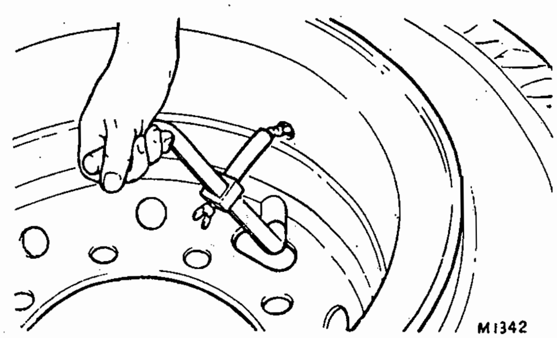


FIG. 4. VALVE STEM REMOVED

To Refit

1. Place supporting blocks under the wheel to raise it 75–100 mm (3 or 4 in). Apply tyre bead lubricant to the bead seat of the wheel and both beads of tyre.
2. Place the valve guide tool Dunlop VAT/1 or Goodyear 3BT1 in position as shown in Fig. 5 and lay the tyre on the wheel with the valve stem pointing upwards and aligned with the valve aperture.
3. With a dome cap fitted to the valve stem insert the tip of the stem in the slot of the valve alignment tool.
   Note: At this stage do not put the valve stem through the valve aperture in the wheel.

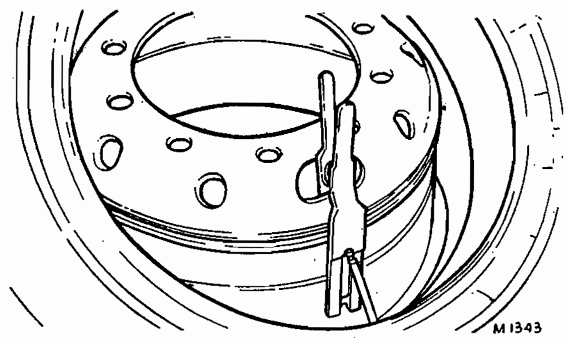


FIG. 5. VALVE ALIGNING TOOL IN POSITION

4. Steady and align the valve stem as the tyre is picked up to slide it over the barrel of the wheel. See Fig. 6.
5. Keep the tyre lifted high so that the valve stem slides down the slot of the guide tool cap first. When the valve stem reaches the valve aperture it will automatically enter.

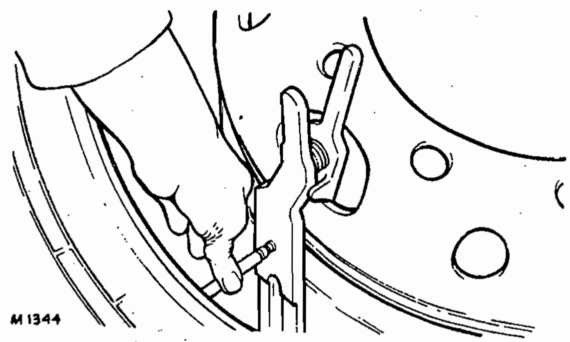


FIG. 6. ALIGNING VALVE STEM

6. Remove the Dunlop valve alignment tool by releasing the screw, or the Goodyear by unclipping from the wheel base. See Fig. 7.
7. Lubricate the side flange internally and externally.

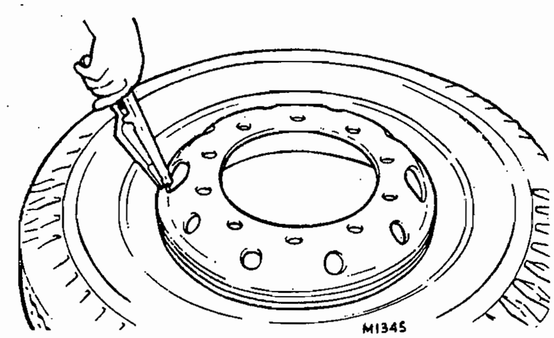


FIG. 7. REMOVING VALVE ALIGNMENT TOOL

8. Place the side flange and locking ring in position. Using levers, Dunlop TL/5A and TL/6A or, Goodyear 3BT3, depress the flange so that the locking ring may be snapped into its groove. See Fig. 8.

   WARNING: Before initial inflation check that the locking ring is correctly located and then suitably guard the tyre.

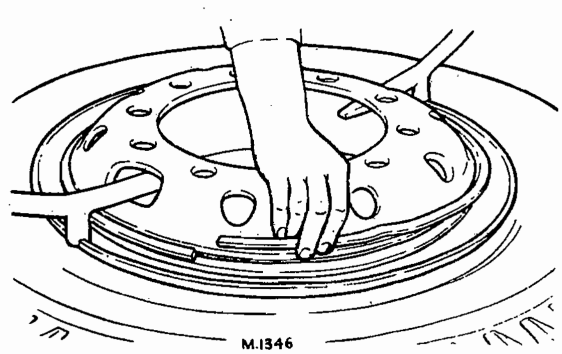


FIG. 8. FITTING LOCK RING

MAINTENANCE

To obtain the maximum life from the tyres, they must be treated with consideration and serviced regularly.

Correct inflation is important and it should be noted that losses of air pressure up to 0.21–0.35 kgf/cm^2 (3 to 5 lbf/in^2) in a week's running are normal.

Check tyre pressures weekly when the tyres are cold.

Inflation pressures are given on tyre manufacturers data charts and should be adhered to in order to promote satisfactory tyre life.

Persistent bursts of acceleration, harsh braking and fast cornering are practices which will cause the tyres to wear excessively. Similarly, the tyres of a vehicle always driven at high speeds will wear much more rapidly than will tyres of a similar vehicle driven at reasonable speeds.

The correct alignment of road wheels is essential. Any error will cause excessive tread wear on the front tyres. Oil and grease are particularly harmful to rubber, paraffin being almost instantaneous in its effect. Any oil which may be thrown on the tyres should be removed at the earliest possible moment.

All tyre manufacturers make several types of tyre, some of which have relatively thicker treads and because of this they generate high running temperatures. To obtain good safe tyre performance it is therefore essential to limit the maximum operating speeds of such tyres.

Tyre manufacturers should be consulted on speeds applicable.

Matching Tyres

Tyres on twin wheels of the rear axle should be mated for type (radial or cross-ply), size and tread. **The mixing of radial and cross-ply tyres on a vehicle is not recommended.** If one of the tyres fitted to a twin wheel is worn more than the other it should be fitted on the inside.

Interchange of Wheels

The tyres on a vehicle do not wear uniformly since each tyre is subjected to different stresses and varying loads according to the position of the wheel on the vehicle. To compensate for uneven and 'heel-to-toe' wear it is advisable to interchange the positions of the wheel assemblies and at the same time to reverse the direction of normal rotation of the wheels. Interchange of wheels should be carried out at regular mileage intervals or at any time when irregular wear is first noted.

Fig. 9 illustrates graphically the interchange of wheel assemblies. If a spare wheel is carried, it should be brought into use at the time of the change-over. This practice prevents deterioration of the tyre of the spare wheel and allows the maximum useful mileage to be obtained from all the tyres.

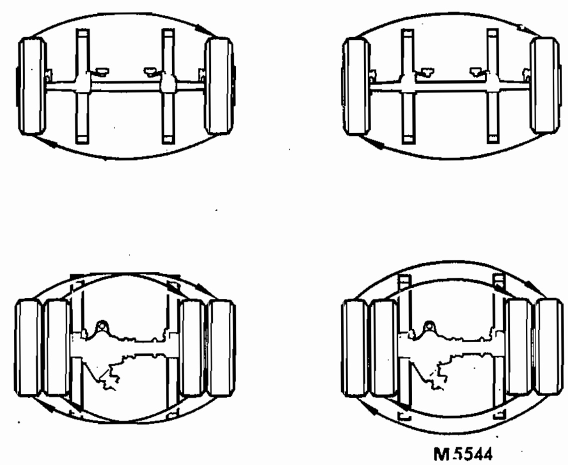


FIG. 9. ROAD WHEEL CHANGE SEQUENCE

(a) When inner and outer tyres have the same degree of wear.

(b) When inner tyres are more worn than the outer

Fitting Wheels

Before fitting the road wheels, the studs and contact faces of the nuts should be lightly smeared with EP.90 oil. Fit the wheel then tighten the nuts evenly, in the sequence shown in Fig. 10 to a torque of 55.2 kgf m (400 lbf ft).

Note: Ensure when fitting twin wheels that the tyre valves are located at 180° one to the other.

When the appropriate lifting gear has been removed from the axle a final check should be made to ensure complete security.

Wheel nuts should be checked for tightness each week, or on completion of the initial run that follows a wheel change.

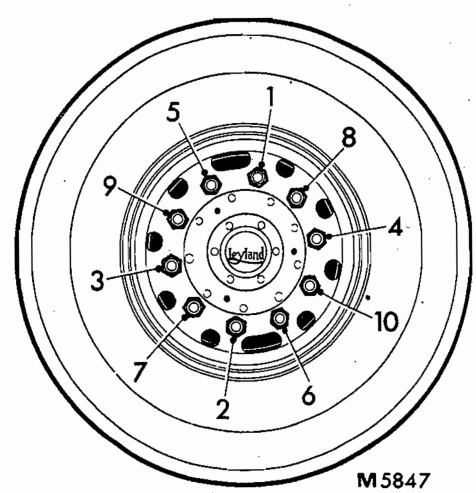


FIG. 10. TIGHTENING SEQUENCE FOR THE ROAD WHEEL NUTS