JAGUAR

420

SERVICE MANUAL

NOTE: All references in this Manual to "right-hand side" and "left-hand side" are made assuming the person to be looking from the rear of the car or unit.

ISSUED BY

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Description Page

ENGINE

The Jaguar "420" has the twin overhead camshaft engine fitted with an "S" type cylinder head with straight ports and $\frac{3}{8}$" lift cams.

Compression Ratio			Engine No. Prefix
7 : 1	8 : 1	9 : 1	7F

Compression ratios of 7 : 1, 8 : 1 and 9 : 1 are specified for the 4.2 litre engine, the difference in compression ratios being obtained by varying the crown design of the piston.
The compression ratio of an engine is indicated by /7, /8 or /9 following the engine number.

DATA

Camshaft	
Number of journals	Four per shaft
Journal diameter	1.00" — .0005" — .001" (2.25 mm. — .013 mm. — .025 mm.)
Thrust taken	Front end
Number of bearings	Four per shaft (eight half bearings)
Type of bearings	White metal steel backed shell
Diameter clearance	.0005" — .002" (.013 — .05 mm.)
Permissible end float	.004" — .006" (.10 — .15 mm.)
Tightening torque—Bearing cap nuts	15 lb. ft. (180 lb. in.) (2.0 kg.m.)
Connecting Rod	
Length centre to centre	$7\frac{3}{4}$" (19.68 mm.)
Big end—Bearing type	Lead bronze, steel backed
Bore for big end bearing	2.288" — 2.335" (56.72 — 56.73 mm.)
Big end width	$1\frac{3}{16}$" — .006" (30.16 — .15 mm.) — .008" (— .20 mm.)
Big end—Diameter clearance	.0015" — .0033" (.037 — .083 mm.)
Big end—Side clearance	.0058" — .0087" (.15 — .22 mm.)
Bore for small end bush	1.0" — .0005" (25.5 — .013 mm.)
Small end bush — Type	Phosphor bronze—steel backed
Small end—Width	$1\frac{5}{64}$" (27.4 mm.)
Small end bush—Bore diameter	.875" + .0002" (22.22 + .005 mm.) — .0000" (— .000 mm.)
Tightening torque—connecting rod bolts	37 lb. ft. (450 lb. in.) (5.1 kg.m.)
Crankshaft	
Number of main bearings	7
Main bearing type	Lead bronze—steel backed shell
Journal diameter	2.75" — 2.7505" (69.85 — 69.86 mm.)
Journal length—Front	$1\frac{9}{16}$" (39.06 mm.)
Journal length—Centre	$1\frac{3}{8}$" + .001" (34.37 + .025 mm.) — .0005" (— .0125 mm.)
Journal length—Rear	$1\frac{11}{16}$" (42.86 mm.)
Journal length—Intermediate	$1\frac{7}{32}$" ± .002" (30.96 ± .05 mm.)
Thrust taken	Centre bearing thrust washers
Thrust washer—Thickness	.092" ± .001" and .096" ± .001" (2.33 ± .025 mm. and 2.43. ± 025 mm.)
End clearance	.004" — .006" (.10 — .15 mm.)
Main bearing length	
Front, Centre, Rear	$1\frac{1}{2}$." ± .005" (38.1 ± .13 mm.)
Intermediate	1" ± .005" (25.5 ± .13 mm.)
Diameter clearance	.0025" — .0042" (.063 — .106 mm.)

Crankshaft—continued

Crankpin—diameter	2.086″ + .0006″ (52.98 + .015 mm.) — .0000″ (— .000 mm.)
— length	$1\frac{3}{16}$″ + .0007″ (30.16 + .018 mm.) — .0002″ (— .006 mm.)
Regrind undersize	.010″, .020″, .030″, .040″ (.25 .51, .76, 1.02 mm.)
Minimum diameter for regrind	—.040″ (1 mm.)
Tightening torque—Main bearing bolts	83 lb. ft. (11.5 kgm.)

Cylinder Block

Material	4 KG. dry liners
Interference fit	.001″ — .005″ (.125 — .127 mm.)
Overall length of liner	6.959″ — 6.979″ (17.39 — 17.45 cm.)
Outside diameter of lead-in	3.758″ — 3.760″ (93.95-94 mm.)
Size of bore honed after assembly — in cylinder block	
Nominal	3.625″ (92.0750 mm.)
Main line bore for main bearings	2.9165″ + .0005″ (74.08 + .0125 mm.) — .0000″ (— .0000 mm.)

Cylinder Head

Type	Straight port
Material	Aluminium alloy
Valve seat angle —Inlet	45°
—Exhaust	45°
Tightening torque—Cylinder head nuts	58 lb. ft. (8.0 kgm.)
Firing order	1, 5, 3, 6, 2, 4 No. 1 cylinder at rear

Gudgeon Pin

Type	Fully floating
Length	3.0″ (76.2 mm.)
Inside diameter	$\frac{5}{8}$″ (15.87 mm.)
Outside diameter	.8750″ — .8752″ (22.22 — 22.23 mm.)

Lubricating System

Oil pressure—Hot	40 lb/sq. in. at 3,000 r.p.m.
Oil pump—Type	Eccentric rotor
—Clearance at end of lobes	.006″ max. (.15 mm.)
—End clearance	.0025″ max. (.06 mm.)
—Clearance between outer rotor and body	.010″ max. (.25 mm.)

Piston and Piston Rings

Type (8 : 1)	Solid skirt
Type (9 : 1)	Semi-split skirt
Skirt clearance (measured at bottom of skirt at 90° to gudgeon pin axis)	.0011″ — .0017″ (.028 — .043 mm.)

Compression height

7 : 1 compression ratio	1.841″ — 1.846″ (46.76 — 46.89 mm.)
8 : 1 compression ratio	2.064″ — 2.069″ (52.42 — 52.55 mm.)
9 : 1 compression ratio	2.242″ — 2.247″ (56.94 — 57.07 mm.)

Piston Rings Number

Compression	2
Oil control	1
Piston rings—Width	
Compression	.0770″ — .0780″ (1.97 — 2.00 mm.)
Oil control	Self-expanding
Piston rings—Thickness	
Compression	.151″ — .158″ (3.775 — 3.95 mm.)
Piston rings—Side clearance in groove	
Compression	.001″ — .003″ (.02 — .07 mm.)
Oil control	.001″ — .003″ (.02 — .07 mm.)
Piston rings—Gap when fitted to bore	
Compression	.015″ — .020″ (.38 — .51 mm.)
Oil control	.015″ — .033″ (.38 — .82 mm.)

Sparking Plugs

Make	Champion
Type	N.11.Y
Gap	.025″ (.63 mm.)

Tappets and Tappet Guides

Tappet—Material	Cast iron (chilled)
—Outside diameter	1.3738″ — 1.3742″
—Diameter clearance	.0008″ — .0019″ (.02 — .048 mm.)
Tappet Guide—Inside diameter (before reaming)	1.853″ — 1.857″ (34.37 — 34.48 mm.)
—Reaming size (when fitted)	1.375″ + .0007″ (34.925 + .018 mm.) — .0000″ (— .000 mm.)
—Interference (shrink) fit in head	.003″ (.07 mm.)

Timing Chains and Sprockets

Type	Duplex
Pitch	$\frac{3}{8}$″ (9.5 mm.)
Number of pitches—Top chain	100
—Bottom chain	82
Crankshaft sprocket—teeth	21
Intermediate sprocket (outer)—teeth	28
Intermediate sprocket (inner)—teeth	20
Camshaft sprocket—teeth	30
Idler sprocket	21

Valve Timing

Inlet valve opens	15° B.T.D.C.
Inlet valve closes	57° A.B.D.C.
Exhaust valve opens	57° B.B.D.C.
Exhaust valve closes	15° A.T.D.C.

Valve and Valve Springs

Valves — Material — Inlet	Silicon chrome steel
— Exhaust	21 - 4 - N5
Valve head diameter — Inlet	$1\frac{3}{4}$″ ± .002″ (44.45 ± .05 mm.)
— Exhaust	$1\frac{5}{8}$″ ± .002″ (41.27 ± .05 mm.)
Valve stem diameter — Inlet and exhaust	$\frac{5}{16}$″ — .0025″ } — .06 mm. — .0035″ } 7.95 — .09 mm.
Valve lift	$\frac{3}{8}$″ (9.4 mm.)
Valve clearance — Inlet	.004″ (.10 mm.)
— Exhaust	.006″ (.15 mm.)
Valve seat angle — Inlet	45°
— Exhaust	45°
Valve spring — Free length — Inner	$1\frac{21}{32}$″ (42 mm.)
— Outer	$1\frac{5}{16}$″ (49.2 mm.)
Valve spring — Fitted length — Inner	$1\frac{7}{32}$″ (30.96 mm.)
— Outer	$1\frac{5}{16}$″ (33.34 mm.)
Valve spring—Fitted load — Inner	30.33 lb. (13.76 kg.)
— Outer	48.375 lb. (21.95 kg.)
Valve spring—Solid length (max.) — Inner	.810″ (20.57 mm.)
— Outer	.880″ (22.35 mm.)
Number of free coils — Inner	6
— Outer	5
Diameter of wire — Inner	12 SWG (.104″) (2.64 mm.)
— Outer	10 SWG (.128″) (3.25 mm.)

Valve Guide and Valve Seat Insert

Valve guides—Material	Cast iron
Valve guide length—Inlet (without valve stem seal)	$1\frac{13}{16}$" (46.04 mm.)
—Inlet (with valve stem seal)	$1\frac{55}{64}$" (47.22 mm.)
—Exhaust	$1\frac{15}{16}$" (49.21 mm.)
Valve guide inside diameter—Inner	$\frac{5}{16}$" — .0005" (7.94 — .013 mm.) — .0015" (7.94 — .038 mm.)
—Exhaust	$\frac{5}{16}$" ± .0005" (7.94 ± .013 mm.)
Interference fit inhead	.0005" — .0022" (.013 — .055 mm.)
Valve seat inserts—Material	Cast iron (centrifugally cast)
Inside diameter—Inlet	$1\frac{1}{2}$" + .003" (38.1 + .076 mm.) — .001" (— .025 mm.)
—Exhaust	1.379"—1.383" (35.03 — 35.13 mm.)
Interference (shrink) fit in head	.003" (.076 mm.)

Fuel Requirements for 9 : 1 and 8 : 1 Compression Ratio Engines

If the engine is fitted with 9 : 1 compression ratio pistons (indicated by /9 after the engine number) use only Super grade fuel with a minimum octane rating of 98 (Research Method). If a car is fitted with 8 : 1 compression ratio pistons (indicated by /8 after the engine number) use Premium grade fuel with a minimum rating of 94 (Research Method).

If, of necessity, the car has to be operated on lower octane fuel do not use full throttle otherwise detonation may occur with resultant piston damage.

In the United Kingdom use '5 STAR' (9:1) or '4 STAR' (8:1) petrol.

ROUTINE MAINTENANCE

DAILY

Checking the Engine Oil Level

Check the engine oil level with the car standing on level ground, otherwise a false reading will be obtained. Remove the dipstick and wipe dry.

Replace and withdraw again; if the oil level is on the knurled patch, with the engine hot or cold, no additional oil is required. If the engine has been run immediately prior to making an oil level check, wait one minute after switching off before checking the oil.

Note: Almost all modern engine oils contain special additives and, whilst it is permissible to mix recommended brands, it is undesirable. If it is desired to change from one brand to another, this should be done when the sump is drained and the Oil Company's recommendation for flushing procedure carried out.

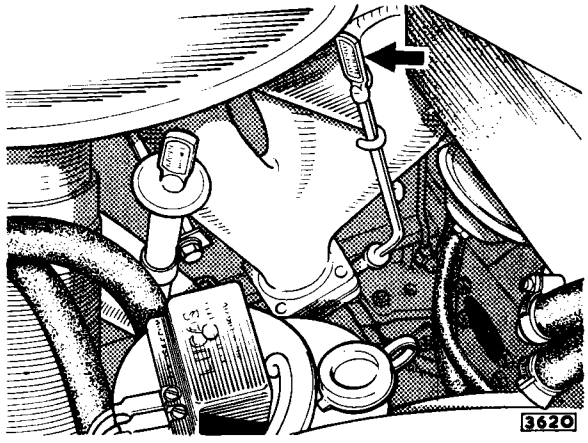


Fig. No. 1 *The engine dipstick*

EVERY 3,000 MILES (5,000 KM)

Changing the Engine Oil

Note: Under certain adverse conditions conducive to oil dilution and sludge formation, more frequent oil changing than the normal 3,000 miles (5,000 km) period is advised. Where the car is used mainly for low-speed city driving, particularly in cold weather or in dusty territory, the oil should be changed at least every 1,000 miles (1,600 km.).

The draining of the sump should be carried out at the end of a run when the oil is hot and will, therefore, flow more freely. The drain plug is situated at the right hand rear corner of the sump. When the engine oil is changed the oil filter element, which is situated on the right hand side of the engine, must also be changed. See page A.27.

Distributor—Lubrication

Lubricate the distributor, as detailed on page P.11.

Distributor Contact Breaker Gap

Check the gap between the contact points as detailed on page P.11.

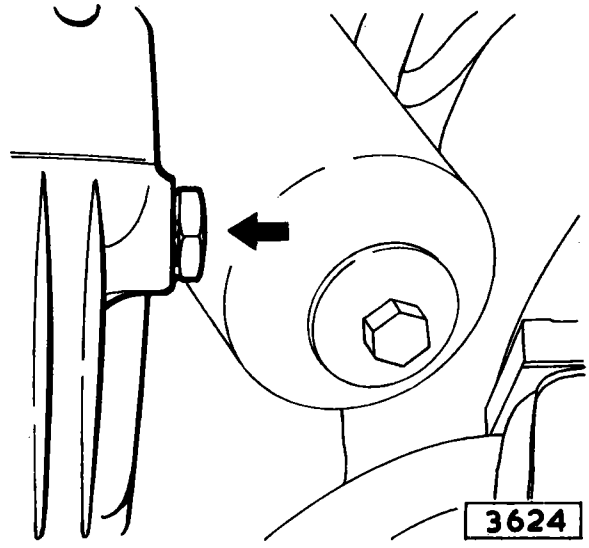


Fig. No. 2 *The engine drain plug*

Sparking Plugs

Every 3,000 miles (5,000 km.), or more often if operating conditions demand, withdraw, clean and reset the spark plugs.

The only efficient way to clean spark plugs is to have them properly serviced on machines specially designed for this purpose. These machines operate with compressed air and utilize a specially graded dry abrasive material to remove harmful deposits from the plug insulator without damaging the insulator surface. In addition, the majority of machines incorporate electrical testing apparatus enabling the plugs to be pressure tested for efficiency and gas tightness.

The points gap should be .025" (.64 mm.). When adjusting, always bend the side wire—never the centre electrode.

The Champion Spark Plug Co. supply a special combination gauge and setting tool; the use of this tool is recommended.

Every 12,000 miles (20,000 km.) a new set of plugs of the recommended type should be fitted. To save petrol and ensure easy starting, it is important to have the plugs tested regularly.

EVERY 6,000 MILES (10,000 KM)

Fan/Steering Pump Belt—Power Steering (if fitted)

Check for Wear

Every 6,000 miles (10,000 km) check the condition of the fan/steering pump belt. The belt tension is automatically adjusted by means of a spring loaded jockey pully and routine adjustment is not necessary.

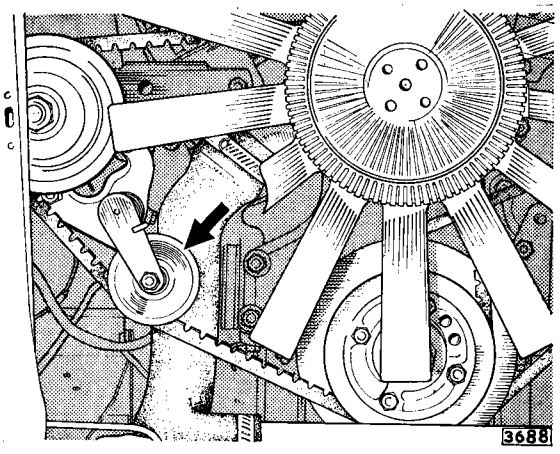


Fig. No. 3 *Fan/steering pump jockey pulley*

Fan Belt—Manual Steering (if fitted)
Check for Wear

Every 6,000 miles (10,000 km) check the fan belt for wear, and adjust as necessary.

To adjust, release the nut securing the jockey pulley pivot to the mounting bracket. Swing the pivot upwards until the correct tension is obtained and tighten the nut.

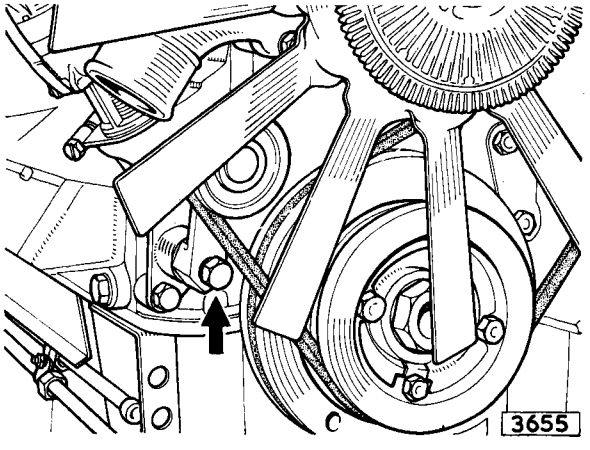


Fig. No. 4 *Fan belt tensioner (manual steering)*

Alternator Belt Tension

Every 6,000 miles (10,000 km) check the tension of the alternator belt.

To adjust, release the top mounting bolt (the nut "A" Fig. 5 is welded to the support bracket and cannot be turned). Release the bottom mounting nut "B" and swing the alternator upwards until the correct tension is obtained. Re-tighten the mounting nuts. When the belt is correctly tensioned, it should be possible to depress the belt $\frac{1}{2}$" (12.7 mm.) at a point midway between the two pulleys.

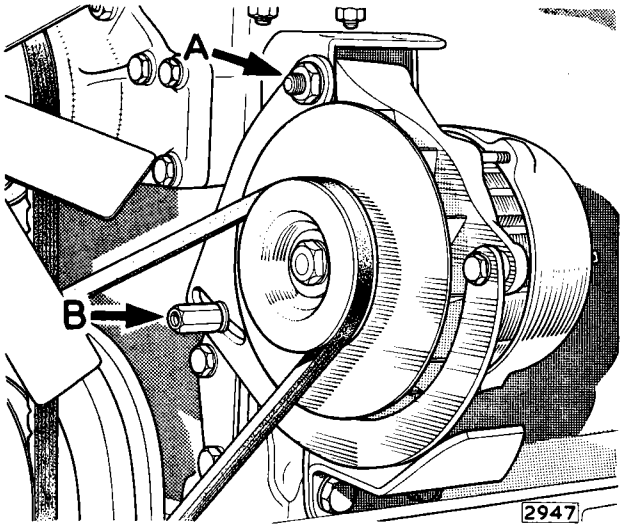


Fig. No. 5 *Alternator belt adjustment*

Air Conditioning Compressor Belt—Tension

Every 6,000 miles (10,000 km.) check the tension of the air-conditioning compressor belt (when fitted).

To tension, release the nut securing the jockey pulley pivot sufficiently to allow the pivot to be moved upward using a spanner on the pivot hexagon. Obtain the correct tension; tighten the securing nut and re-check.

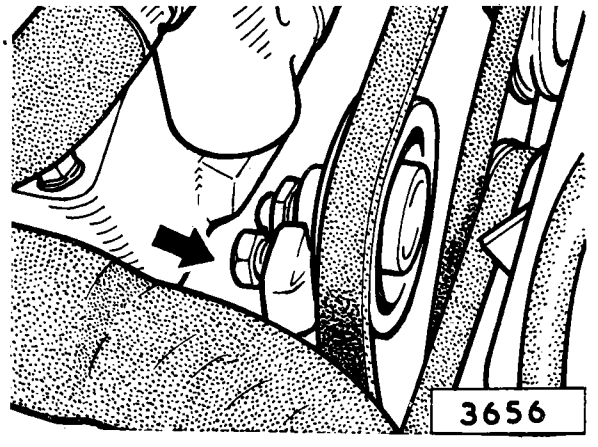


Fig. No. 6 *Compressor drive belt adjustment*

Top Timing Chain Tension

If the top timing chain is noisy, adjust the tension as detailed on page A.19.

EVERY 12,000 MILES (20,000 KM)

Air Cleaner

The air cleaner is of the paper element type and is fitted on top of the cylinder head.

No maintenance is required but the element must be renewed every 12,000 miles (20,000 km.) or more frequently in dusty territories.

To renew, roll back the sealing rubber between the carburetter elbow and the air cleaner. Slacken the two wing nuts securing the air cleaner to the bracket on the cylinder head.
Release the air cleaner by pulling it towards the left-hand wing valance. Release the two clips securing the end cover to the air cleaner; withdraw the end cover and filter element.
Remove the wing nut, washer, end cap and rubber seal securing the filter element to the end cover.
When refitting, ensure that the two rubber sealing rings are in the correct position.

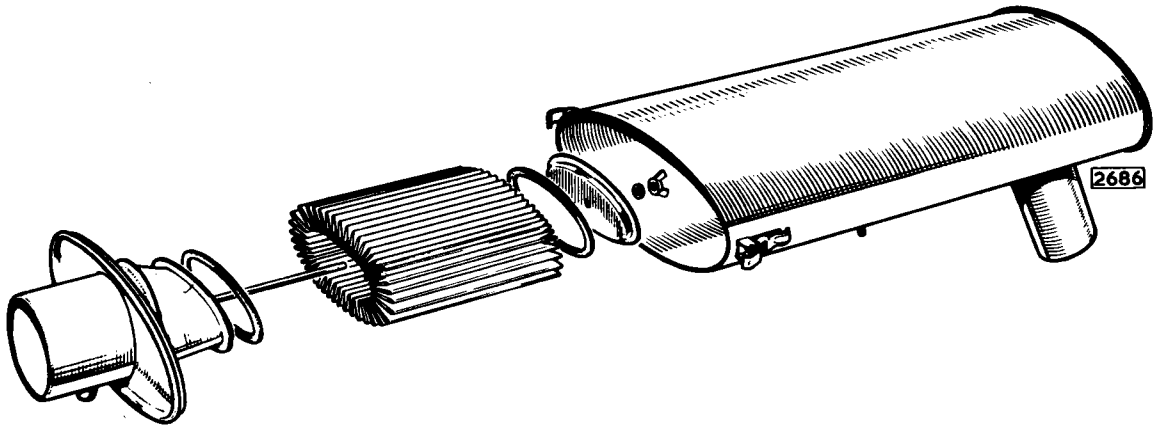


Fig. No. 7 *The air cleaner element*

RECOMMENDED LUBRICANTS

Component	Mobil	Castrol	Shell	Esso	B.P.	Duckham	Regent Caltex/Texaco
Engine	Mobil Special*	Castrol XL	Shell Super Oil	Esso Extra Motor Oil 10W/30* Esso Extra Motor Oil 20W/40*	Super Visco-Static 10W/40	Q20/50 or Q5500*	Havoline 20W/40 or 10W 30*
Upper cylinder lubrication	Mobil Upperlube	Castrollo	Shell U.C.L. or Donax	Esso U.C.L.	U.C.L.	Adcoid Liquid	Regent U.C.L.

* These oils should not be used in worn engines requiring overhaul.
If an SAE 30 or 40 oil has previously been used in the engine, a slight increase in oil consumption may be noticed but this will be compensated by the advantages gained.

CAPACITY

	IMPERIAL	U.S.	LITRES
Engine refill—including filter	12 pints	14¼ pints	6.75

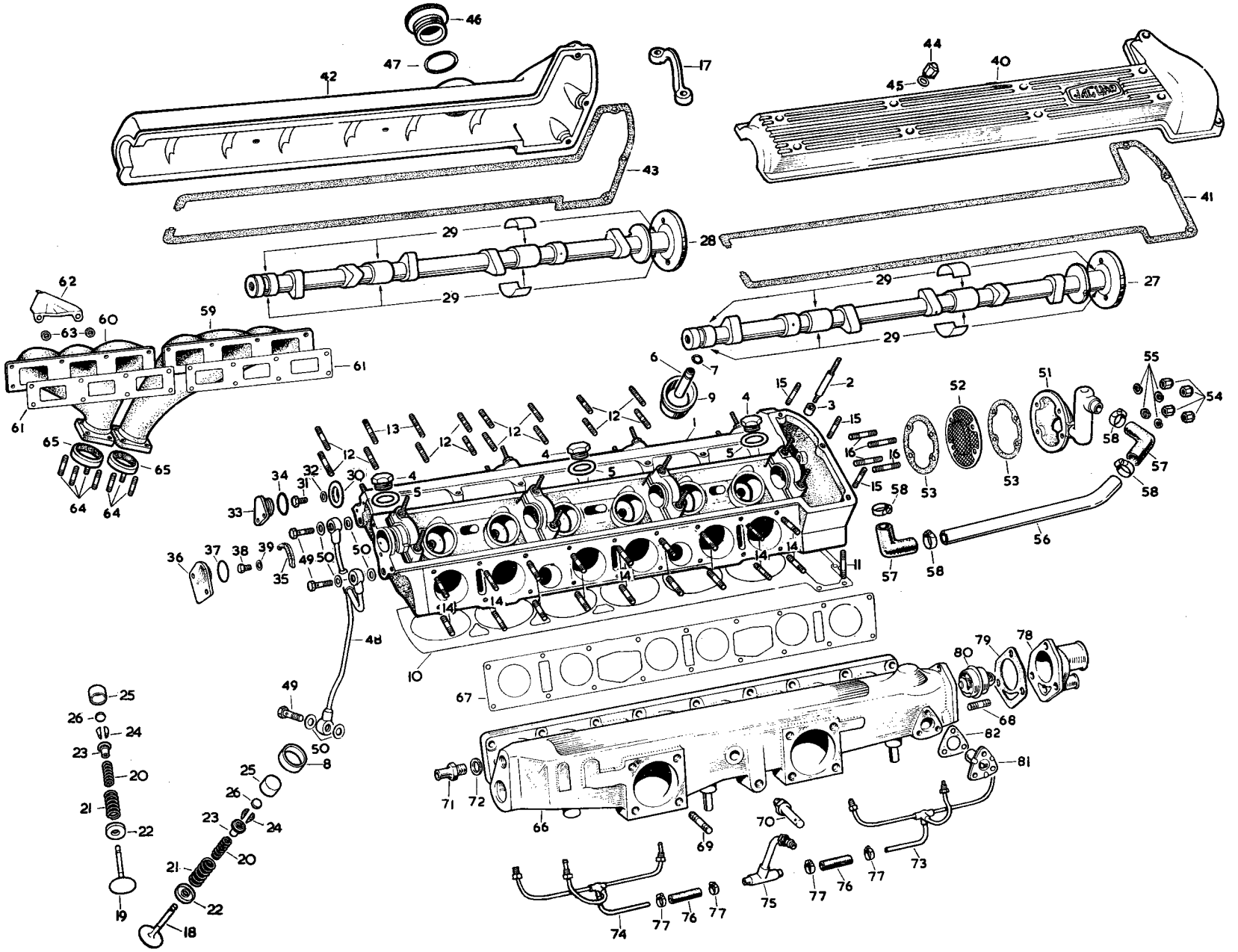


Fig. No. 8 *Exploded view of cylinder head*

JSP.154

1 Cylinder Head
2 Stud
3 Ring Dowel
4 Core Plug
5 Copper washer
6 Guide
7 Valve guide circlip
8 Valve insert (inlet valve)
9 Tappet guide
10 Gasket
11 Stud (short)
12 Stud (exhaust manifold)
13 Stud (exhaust manifold-long)
14 Stud (Inlet manifold)
15 Stud (camshaft covers)
16 Stud (breather housing)
17 Engine lifting bracket
18 Inlet valve
19 Exhaust valve
20 Valve spring (inner)
21 Valve spring (outer)
22 Valve spring seat
23 Valve spring collar
24 Valve cotters
25 Tappet
26 Valve adjusting pad
27 Inlet camshaft
28 Exhaust camshaft
29 Bearing (camshaft)
30 Oil thrower
31 Setscrew
32 Copper washer
33 Sealing plug
34 "O" Ring
35 Seal
36 Sealing plug
37 "O" Ring
38 Setscrew
39 Copper washer
40 Inlet camshaft cover
41 Gasket
42 Exhaust camshaft cover
43 Gasket
44 Dome nuts
45 Copper washer
46 Oil filler cap
47 "O" Ring
48 Oil pipe
49 Banjo bolt
50 Copper washer
51 Front cover
52 Gauze filter
53 Gasket
54 Dome nuts
55 Spring washer
56 Breather pipe
57 Hose
58 Clip
59 Exhaust manifold-Front
60 Exhaust manifold-Rear
61 Gasket
62 Clip
63 Distance piece
64 Stud
65 Sealing ring
66 Inlet manifold assembly
67 Gasket
68 Stud
69 Stud
70 Pivot pin
71 Adaptor
72 Washer
73 R.H. Manifold starting pipe
74 L.H. Manifold starting pipe
75 Starting pipe assembly
76 Tube (Neoprene)
77 Clip
78 Pipe—water outlet
79 Gasket
80 Thermostat
81 Thermostat—automatic choke
82 Gasket

Engine Overhaul—Part 1

This section covers the overhaul of the cylinder head and other engine parts with the engine in situ.

THE CYLINDER HEAD

REMOVAL

Drain the cooling system by turning the radiator drain tap remote control and opening the cylinder block drain tap. Conserve coolant if anti-freeze is in use.
Remove the bonnet by unscrewing the four setscrews, having previously marked the position of the hinges to facilitate adjustment on re-assembly. Remove the battery and battery platform. Remove the air silencer and air intake pipe. Disconnect the accelerator linkage at the throttle spindle and at the attachment to inlet manifold. Disconnect the petrol feed pipe at float chamber unions. Disconnect leads from auxiliary starting carburetter solenoid.
Detach the overflow pipe clip from the filter head. Detach the throttle spring from the anchor bracket on the filter head. Remove the distributor vacuum advance pipe completely.
Disconnect the top water hose and by-pass hose from the front of the inlet manifold water jacket.
Remove the high tension leads from the sparking plugs and the lead carrier from the thermostat housing. Remove the sparking plugs.
Note: In the event of a stripped thread in the cylinder head sparking plug holes due to seized plugs, refer to page A.39 for instructions for fitting sparking plug inserts.
Disconnect the engine breather pipe from the front cylinder head. Disconnect the exhaust manifolds from the engine. Disconnect two camshaft oil feed pipe unions from the rear of the cylinder head.
Disconnect the heater hose from the rear of the inlet manifold water jacket. Disconnect the heater pipe clips from the inlet manifold. Disconnect the cable from the water temperature gauge bulb in the inlet manifold water jacket. Slacken the clip and disconnect the vacuum servo pipe from the connection at the front of the inlet manifold.
Remove the dome nuts from each camshaft cover and lift off the covers.
Remove four nuts securing the breather housing to the front of cylinder head and withdraw the housing, observing position of baffle plate with two holes vertical. Release tension on camshaft chain by slackening nut on eccentric idler sprocket shaft, depressing spring-loaded stop peg and rotating serrated adjuster plate clockwise. Anti-clockwise rotation of the serrated adjuster, viewed from the front of the engine, tightens the chain. Use Churchill Tool J2 (Fig. 18).

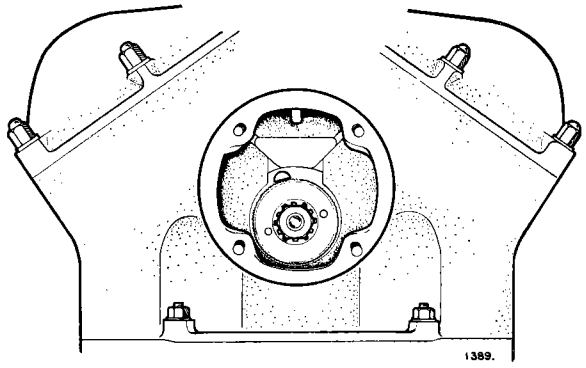


Fig. No. 9 *The serrated plate for adjustment of the top timing chain is accessible after removal of the engine breather housing*

Break the locking wire on the two setscrews securing the camshaft sprockets to respective camshaft. Remove one setscrew only from each of the camshaft sprockets; rotate the engine until the two remaining setscrews are accessible and remove these screws. Do NOT rotate the engine or the camshafts after having disconnected the sprockets. The two camshaft sprockets may now be slid up the support brackets.

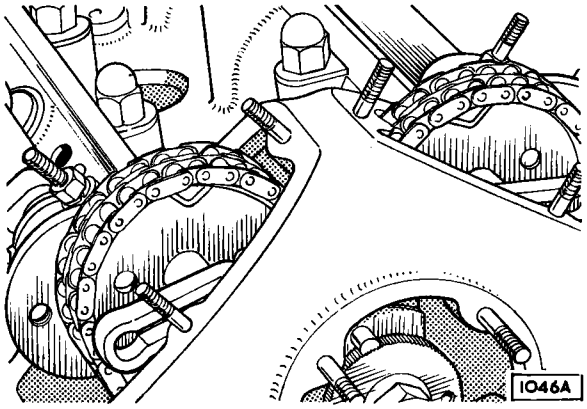


Fig. No. 10 *Showing camshaft sprockets disconnected*

Remove the fourteen cylinder head dome nuts and six nuts securing the front of the cylinder head, working diagonally out from the centre.
On cars fitted with air conditioning it will be necessary to remove the alternator and compressor to gain access to the cylinder head nuts (16 and 18, Fig. 16).
Note: On right hand drive, manual transmission cars, it will be necessary to slacken the nuts securing the clutch master cylinder and move the cylinder rearwards to enable the rear carburetter flange to pass.
Slacken the nuts, a part at a time, until they become free. Lift off the cylinder head complete with manifold and carburetters. Remove and scrap the old cylinder head gasket.
Note: As the valves in the fully open position protrude below the cylinder head joint face, the cylinder head must not be placed joint face downwards directly on a flat surface; support the cylinder head on wooden blocks, one at each end.

DISMANTLING

Remove Valves

With the cylinder head on the bench, remove the inlet manifold and carburetters.
Remove the four bearing caps from each camshaft and lift out the camshafts. Note the mating marks on each bearing cap.

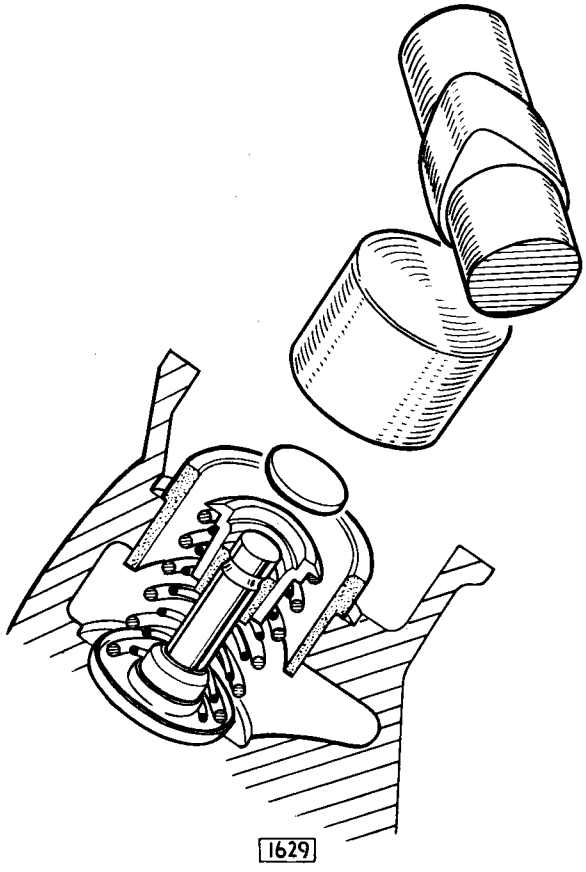


Fig. No. 11 *Tappet and adjusting pad*

Remove the twelve floating and adjusting pads situated between tappets and valve stems. Lay out the tappets and pads in order, to ensure that they can be replaced in their original guides.
Obtain a block of wood the approximate size of the combustion chambers and place this under the valve heads in No. 1 cylinder combustion chamber. Press down the valve collars and extract the split cotters. Remove collars, valve springs and spring seats. Repeat for the remaining five cylinders. Valves are numbered and must be replaced in the original locations, No. 1 cylinder being at the rear, that is, the flywheel end.
Note: Commencing at engine number 7F2478 the inlet valve guides are fitted with oil seals which should be removed before the valve spring seat.

DECARBONISE CYLINDER HEAD

Remove all traces of carbon from the combustion chambers and deposits from the induction and exhaust ports. The cylinder head is of aluminium alloy and great care should be exercised not to damage this with scrapers or sharp pointed tools. Use worn emery cloth and paraffin only. Thoroughly clean the water passages in the cylinder head. Clean the carbon deposits from the piston crowns and ensure that the top face of the cylinder block is quite clean particularly round the cylinder head studs.

CHECK VALVE GUIDES

The valve guides are of cast iron and are chamfered at the upper ends. The outside diameter of the guide is reduced at the lower end to provide a "lead-in" when fitting the guide to the cylinder head. The inlet and exhaust guides are of different lengths, the inlet being the shorter of the two.
The valve guides are fitted with circlips to ensure positive location in the head.
From engine number 7F.2478 oil seals are fitted to the inlet valve guide—a second groove being machined in the guide above the circlip groove to seat the oil seal.
Examine the guides for evidence of wear in the bore. The clearance between the valve stem and the guide when new is .001" to .004" (.025 to .10 mm.).
If it is found necessary to replace worn valve guides, they must be fitted in accordance with the following instructions and only genuine factory replacement parts used.
Heat the cylinder head by immersing in boiling water for 30 minutes. With a piloted drift, drive out the old valve guide from the combustion chamber end.
Ream the valve guide bore in the cylinder head to a diameter of 0.505" + .0005" (12.83 mm. + .012 mm.)
−.0002" (−.005 mm.)
If the bores are larger than these dimensions, they should be reamed out to the following dimensions and the respective oversize valve guides fitted.
0.510" + .0005" (12.95 mm. + .012 mm.)
−.0002" (− .005 mm.)
Coat the valve guide with graphite grease and fit the circlip.
Re-heat the cylinder head.
With a piloted drift, drive in the valve guide from the top until the circlip registers in the groove machined in

the guide bore of the cylinder head. Visually check that the circlip has seated correctly in the groove.

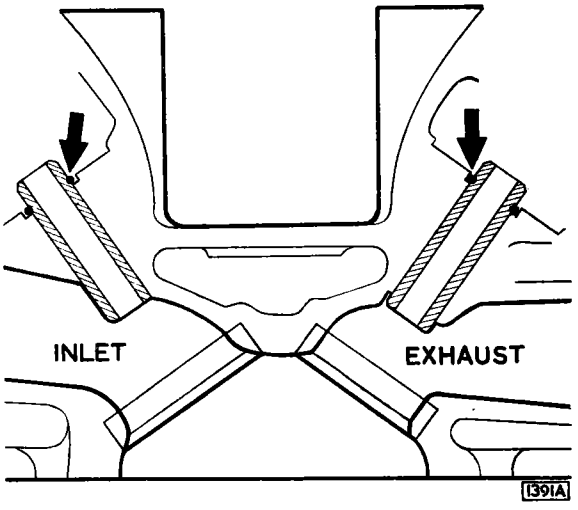


Fig. No. 12 *Showing the fitted position of the valve guides*

CHECK TAPPET GUIDES

Examine the tappets and tappet guides for signs of wear. The diametrical clearance between the tappet and tappet guide should be .0008" to .0019" (.02 to .05 mm.).
Examine the adjusting pads for signs of indentation. Renew if necessary with the appropriate size when making valve clearance adjustment on re-assembly.

Tappet Guide Replacement

Note: Before attempting to perform the operations described under the above heading and under the heading "Valve Seat Inserts", ensure that adequate machining facilities are available, and that the machine shop is equipped with an oven capable of heating the cylinder head to a temperature of 300 °F (150 °C).

If it is found necessary to replace the tappet guides, they must be fitted in accordance with the following instructions and only genuine factory replacement parts used.
Remove the old tappet guide by boring out until the guide collapses. Take care not to damage the bore for the guide in the cylinder head.
Carefully measure the diameter of the tappet guide bore in the cylinder head at room temperature—68 °F (20 °C). Grind down the 1.643" (41.73 mm.) outside diameter of tappet guide to a diameter of .003" (.08 mm.) larger than the tappet guide bore dimension, that is to give an interference fit of .003" (.08 mm.).
Also grind off the same amount from the "lead-in" at the bottom of the tappet guide. The reduction in diameter from the adjacent diameter should be .0032" to .0057" (.08 to .14 mm.).
Heat the cylinder in an oven for half an hour from cold at a temperature of 300 °F (150 °C).
Fit the tappet guide, ensuring that the lip at top of guide beds evenly in the recess.
After fitting, ream tappet guide bore to a diameter of
$1\frac{3}{4}$" + .0007" (34.925 mm. + .018 mm.)
− .0000" (− .000 mm.)

Note: It is essential that, when reamed, the tappet guide bore is concentric with the bore of the valve guide.

Replacing Valve Seat Inserts

Remove the inserts by machining, leaving a thin skin of metal 0.010" (0.25 mm.) thick which can be removed easily without damaging the insert bores.
Carefully measure diameter of insert recess in cylinder head at room temperature 68 °F. (20 °C). Grind down outside of insert to a diameter of .003" (.08 mm.) larger than recess dimension, that is, to give an interference fit of .003" (.08 mm.).
Heat the cylinder head in an oven for one hour from cold to a temperature of 300 °F. (150 °C).
Fit insert, ensuring that it beds evenly in its recess.

Check Valve Springs

Test the valve springs for pressure, either by comparison with the figures given in the "Valve Spring Data" or by comparison with a new valve spring.
To test against a new valve spring, insert both valve springs end to end between the jaws of a vice or under a press with a flat metal plate interposed between the two springs. Apply a load to partly compress the springs and measure their comparative lengths.

REASSEMBLING

Regrind Valves and Seats

Examine the valves for pitting, burning or distortion, and reface or renew the valves as necessary. Also reface the valve seats in the cylinder head and grind the valves to their seats using a suction valve tool. When refacing the valves or seat inserts, do not remove more metal than is necessary to clean up the facings.
The valve seat angles :-

Inlet	Exhaust
45 °	45 °

Renew valves where the stem wear exceeds .003" (.08 mm.). The clearance of the valve stem in the guide when new is .001" to .004" (.025 to .10 mm.).
If any new valve seat inserts have been fitted, the following instructions should be carried out to ensure that the valve clearance can be obtained within the range of the adjusting pads, that is, .085" to .110" (2.16 to 2.79 mm.).
Assemble the camshafts to the cylinder head. Fit the appropriate valve to the insert in question and, with the valve seat faces touching, check the distance between the top of the valve stem and the back of the cam. This should be .320" (8.13 mm.) **plus** the appropriate valve clearance. (The figure of .320" (8.13 mm.) includes an allowance for an adjusting pad thickness of .095" (2.41 mm.) to .097" (2.46 mm.) which will, if necessary, permit the fitting of thicker or thinner adjusting pads when making the final valve clearance adjustment.)
If the distance is greater than the figure of .320"

(8.13 mm.), plus the appropriate valve clearance, grind the valve seat of the insert with suitable valve grinding equipment until the correct distance is obtained.

Example: Assume that the valve insert in question is an exhaust and the distance between the top of the valve stem and the back of the cam is found to be .344" (8.74 mm.).

Adding the exhaust valve clearance of .006" (.15 mm.) to .320" (8.13 mm.) equals .326" (8.28 mm.). In this case the valve seat of the insert will have to be ground down to reduce the distance between the top of valve stem and the back of the cam by .018" (.46 mm.), that is .344" minus .326" (8.74 minus 8.28 mm.).

Refit Valves and Springs

Refit valves in the order removed and place the cylinder head on the wooden blocks (Fig. 14).

Refit valve seats, (on later engines refit the inlet valve guide oil seals) springs and collars. Compress the springs, using Churchill Tool No. J6118 and insert the split cotters.

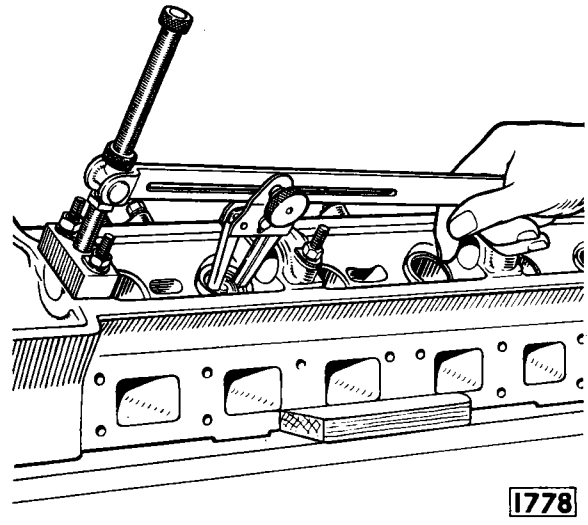


Fig. No. 13 *Fitting the valve springs utilising the valve spring compressing tool (Churchill Tool No. J6118)*

Replace the tappets and tappet adjusting pads in the order removed.

Replace the camshaft shell bearings—in their original positions if the same bearings are being refitted.

It is unlikely, except after very high mileages, to find wear in the camshafts and camshaft bearings.

The bearings are of the precision shell type and under no circumstances should these be hand scraped or the bearing caps filed. Undersize bearings are not supplied.

Replace each camshaft with the keyways in the front bearing flange at 90° to the adjacent cover face (using the valve timing gauge). See Fig. 21.

Refit the bearing caps to their respective positions and the 'D' washers, spring washers and nuts.

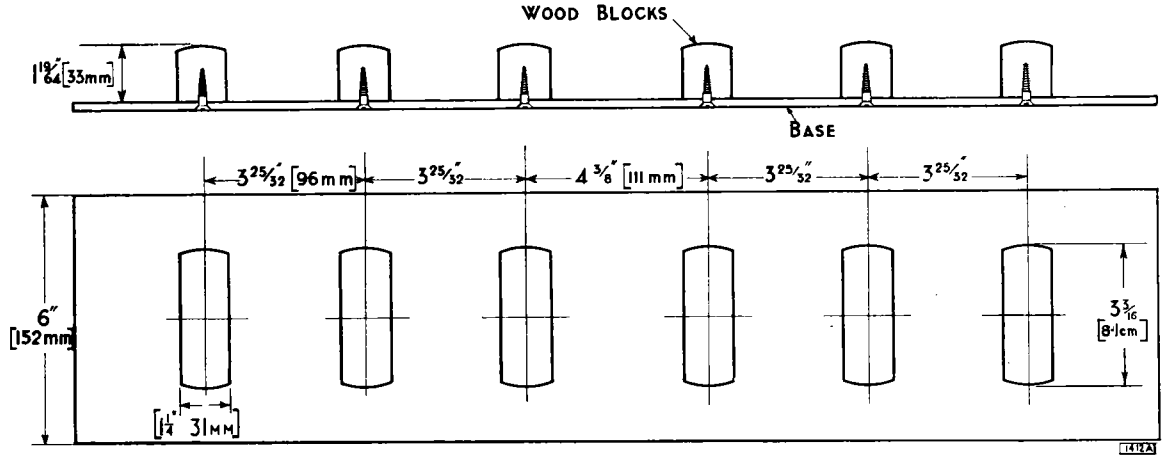


Fig. No. 14 *Combustion chamber blocks for valve removal*

Tighten down the bearing caps evenly, a turn at a time. Finally tighten the nuts to a torque of 15lb/ft. (2.0 kg/m).

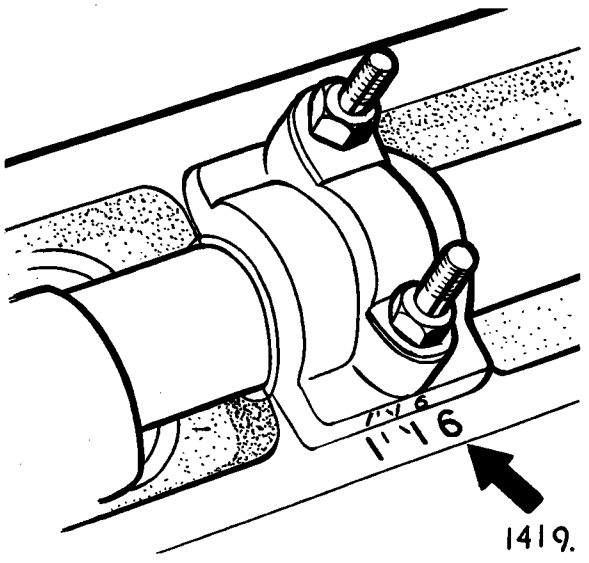


Fig. No. 15 *Showing the corresponding numbers on the bearing cap and cylinder head*

Check Valve Clearances

When checking the valve clearances, the camshafts must be fitted one at a time as, if one camshaft is rotated when the other camshaft is in position, fouling is likely to take place between the inlet and exhaust valves.
Obtain and record all valve clearances by using a feeler gauge between the back of each cam and the appropriate valve tappet.

Correct valve clearances are :-
Inlet .004" (.10 mm.)
Exhaust .006" (.15 mm.).
Adjusting pads are available rising in .001" (.03 mm.) sizes from .085" to .110" (2.16 to 2.79 mm.) and are etched on the surface with the letter 'A' to 'Z', each letter indicating an increase in size of .001" (.03 mm.). Should any valve clearance require correction, remove the camshaft, tappet and adjusting pad. Observe the letter etched on the existing adjusting pad and should the recorded clearance for this valve have shown, say, .003" (.08 mm.) excessive clearance, select a new adjusting pad three sizes thicker than the original pad. As an example, assume that No. 1 inlet valve clearance is tested and recorded as .007" (.18 mm.). On removal of the adjusting pad, if this is etched with the letter 'D' then substitution with a pad bearing the letter 'G' will correct the clearance for No. 1 inlet valve.
Finally, tighten the camshaft bearing nuts to a torque of 15lb./ft. (2 kg./m.).
Refit the inlet manifold with a new gasket.

Refit Cylinder Head

Turn No. 6 (front) piston to the Top Dead Centre position with the distributor rotor arm opposite No. 6 cylinder segment.
Remove all oil and grease from the mating surfaces by means of a cloth wetted with trichlorethylene, petrol or other volatile grease solvent, wiping dry with a clean cloth.
Fit the cylinder head gasket taking care that the side marked "Top" is uppermost. Fit the cylinder head, complete with inlet manifold, to the cylinder block. Note that the second cylinder head stud from the front on the left hand side is a dowel stud.
Fit the sparking plug lead carrier to the appropriate studs on the right hand side. Fit 'D' washers to the remaining studs.

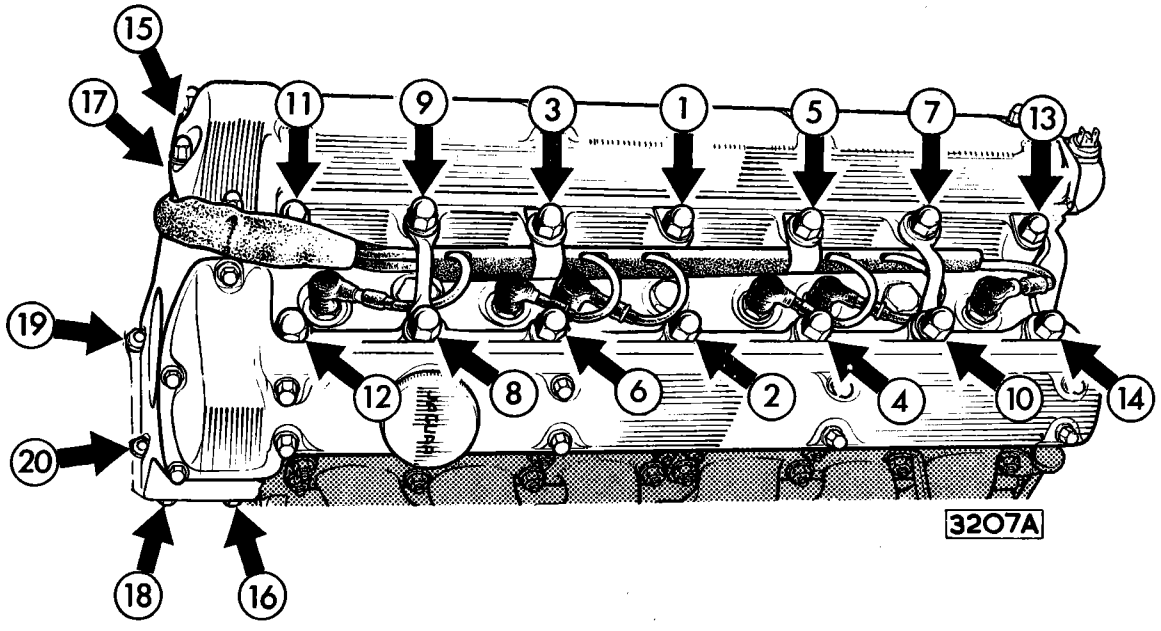


Fig. No. 16 *Cylinder head nut tightening sequence*

Tighten the fourteen large cylinder head dome nuts a part of a turn at a time to a torque of 58 lb/ft. (8.0 kg/m.) in the order shown in Fig. 16. Also tighten the six nuts securing the front end of the cylinder head.
Do NOT rotate the engine or camshafts until the camshaft sprockets have been connected to the camshafts.

Check Valve Timing
Withdraw the circlips retaining the adjusting plates to the camshaft sprockets and pull the adjusting plates forward until the serrations disengage. Replace the sprockets on to the flanges of camshafts and align the two holes in the adjuster plate with the two tapped holes in each camshaft flange. Engage the serrations of the adjuster plates with the serrations in the sprockets.

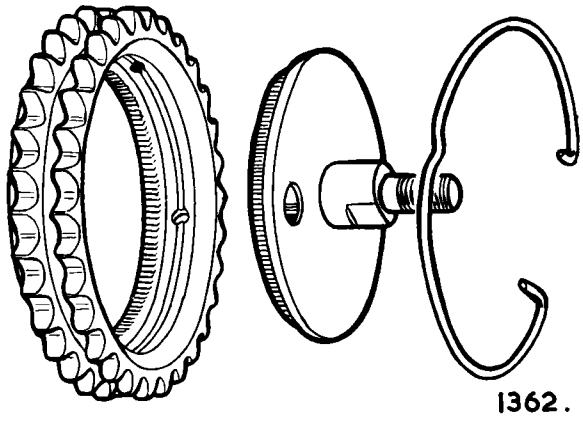


Fig. No. 17 *Exploded view of the camshaft sprocket assembly*

Note: It is most important that the holes are in exact alignment, otherwise when the setscrews are fitted the camshafts will be moved out of position. If difficulty is experienced in aligning the holes exactly, the adjuster plates should be turned through 180°, which, due to the construction of the plate, will facilitate alignment. Fit the circlips to the sprockets and one setscrew to the accessible hole in each adjuster plate. Turn the engine until the other two holes are accessible and fit the two remaining setscrews.
Tension the timing chain by pressing the locking plunger inwards and rotating the serrated plate anti-clockwise, using Churchill Tool J2.
If required, this special tool can be made to the dimensions shown on Fig. 19.

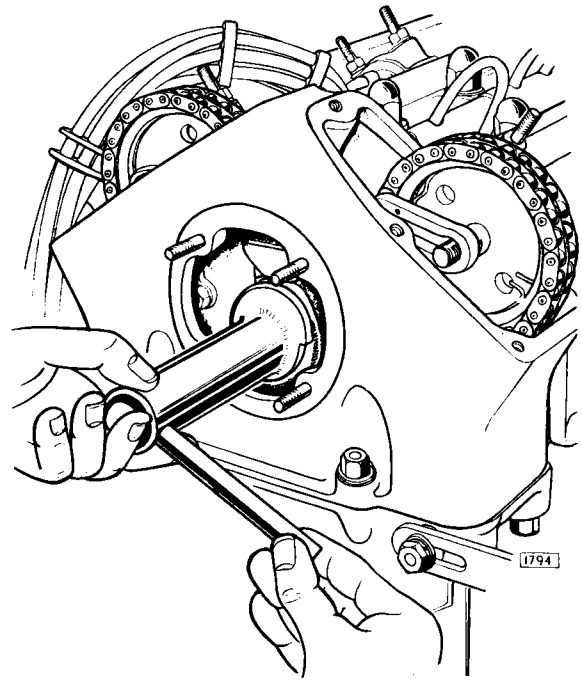


Fig. No. 18 *The top timing chain adjuster in position*

When correctly tensioned, there should be slight flexibility on both outer sides of the chain below the camshaft sprockets, that is, the chain must not be dead tight. Release the locking plunger and securely tighten the locknut.

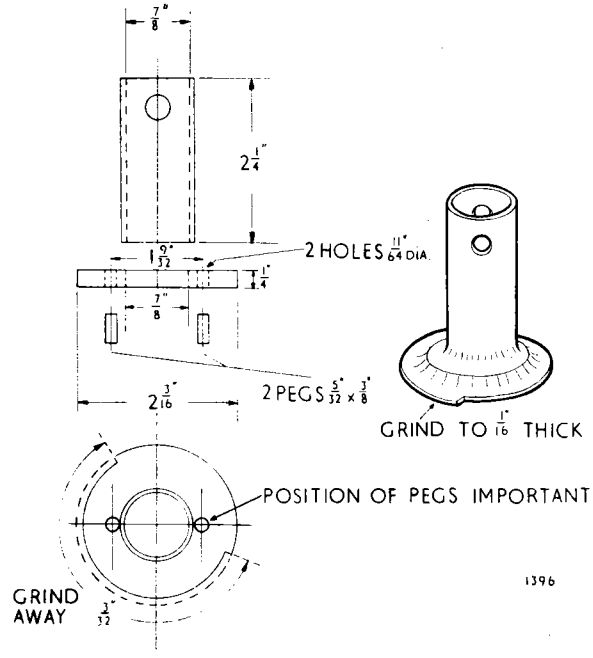


Fig. No. 19 *Dimensions for top timing chain adjuster tool*

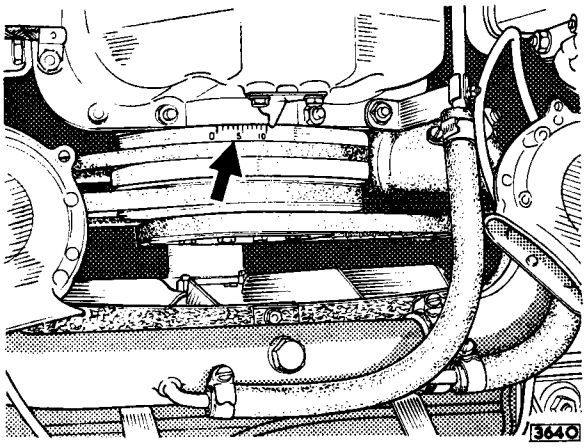


Fig. No. 20 *Location of T.D.C. marks*

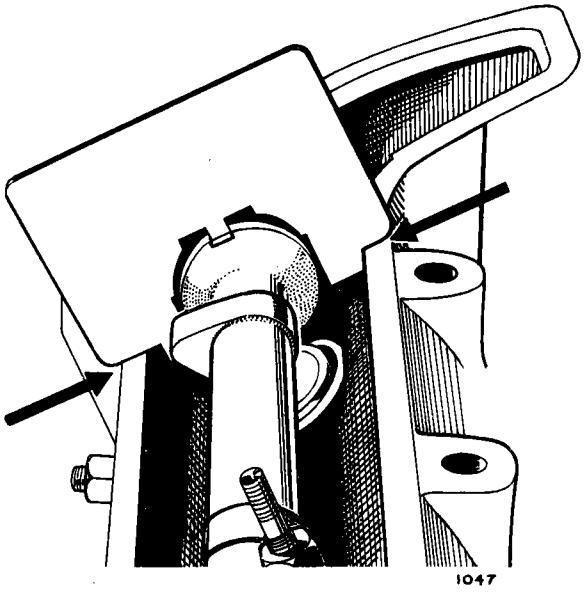


Fig. No. 21 *The valve timing gauge in position. Ensure that the gauge is seated at the points indicated by arrows*

Check that No. 6 piston is at Top Dead Centre; the pointer on the timing scale (Fig. 20) will then be opposite the figure "O".

Recheck the position of the camshafts with the valve timing gauge. Secure the four setscrews for the camshaft sprockets with new locking wire.

Clean the sparking plugs and set gaps; if possible, use approved plug cleaning and testing equipment. Clean and adjust distributor contact breaker points.
The remainder of the re-assembly is the reverse of the removal procedure.

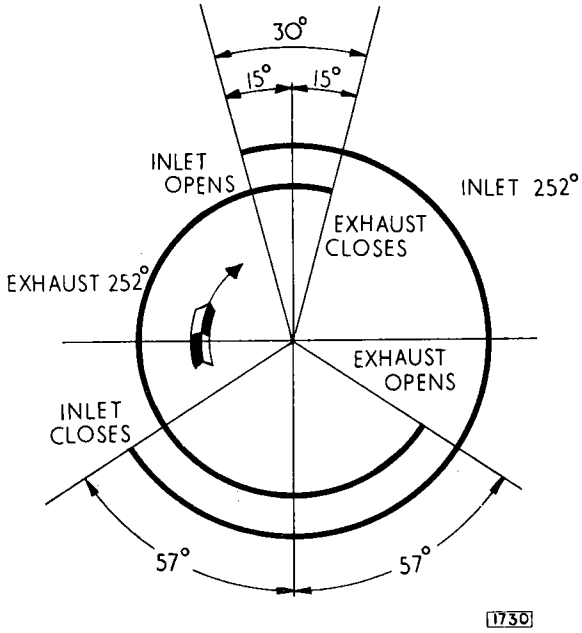


Fig. No. 22 *Valve timing diagram*

PISTONS AND GUDGEON PINS

The pistons are made from low expansion aluminium alloy.
The pistons have three rings, two compression and one oil control. The top compression ring only is chromium plated; both the top and second compression rings have tapered periphery. The fully floating gudgeon pin is retained in the piston by a circlip at each end.

REMOVAL

As the pistons will not pass the crankshaft, it will be necessary to withdraw the pistons and connecting rods from the top. The connecting rod bolts should, however, be removed to allow the big end to pass easily through the bore. Proceed as follows :-

Remove Cylinder Head
Remove cylinder head as described on page A.14.

Remove Sump
Remove the sump as described on page A.27.

Remove Piston and Connecting Rod
Remove the split pins and nuts from the connecting rod bolts. Remove the connecting rod cap, noting the

corresponding cylinder numbers on the connecting rod and cap. Remove the connecting rod bolts and withdraw the piston and connecting rod from the top cylinder block.

OVERHAUL

Pistons are supplied complete with gudgeon pins which have been selectively assembled and are, therefore, not interchangeable with one another.
The pistons fitted to an engine should not vary one with another by more than 2 drams (3.5 grammes).

Gudgeon Pin Fitting

Gudgeon pins are a double thumb push fit in the piston at normal room temperature 68 °F (20 °C).

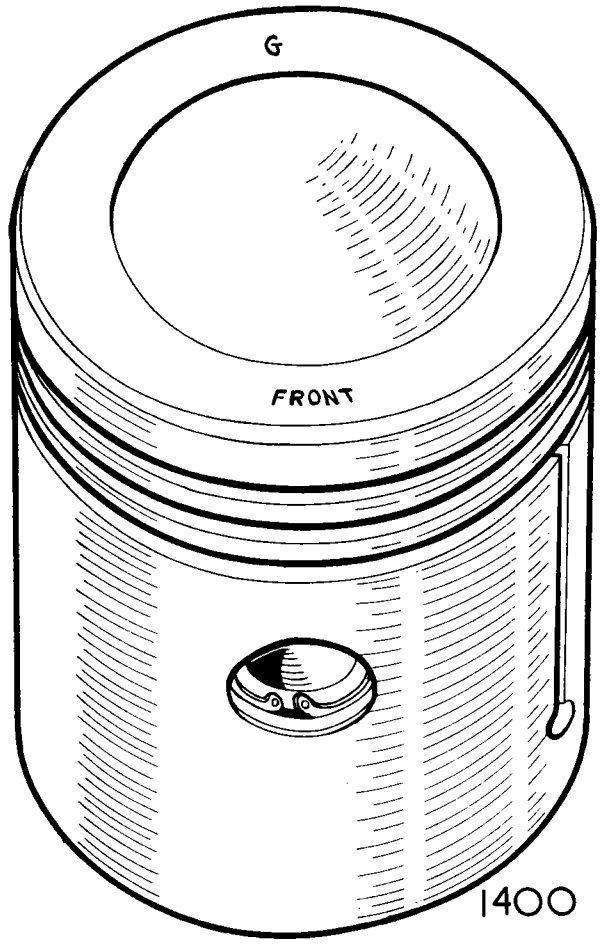


Fig. No. 23 *Showing the markings on the piston crown*

When actually removing or refitting the gudgeon pin, the operation should be effected by immersing the piston, gudgeon pin and connecting rod small end in a bath of hot oil. When the piston and the small end have reached a sufficient temperature (230 °F. 110 °C) the gudgeon pin can be moved into position. Always use new circlips on assembly.

When assembling the engine, centralise the small end of the connecting rod between the gudgeon pin bosses in the piston and ensure that the connecting rod mates up with the crankshaft journal without any pressure being exerted on the rod.

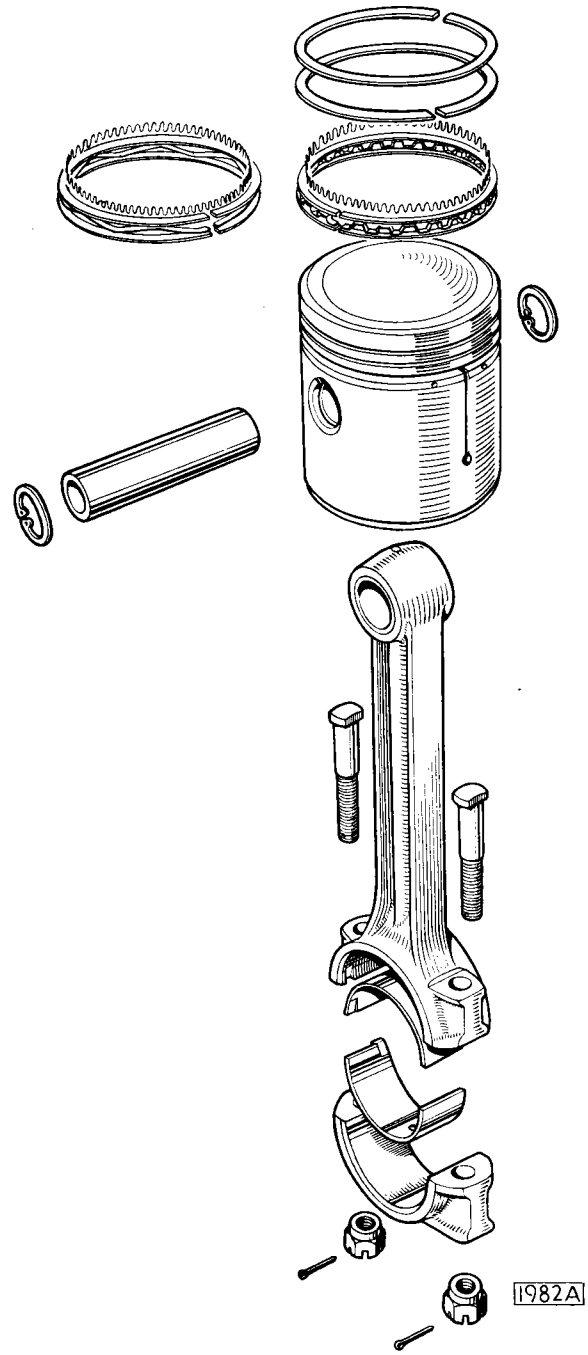


Fig. No. 24 *Exploded view of piston and connecting rod*

Piston Grades

The following selective grades are available in standard size pistons only. When ordering standard size pistons the identification letter of the selective grade should be clearly stated. Pistons are stamped on the crown with the letter identification and the cylinder block is also stamped on the top face adjacent to the bores.

Grade Identification Letter	For cylinder bore size
F	3.625 -3.6253" (92.075 -92.0826 mm.)
G	3.6254-3.6257" (92.0852-92.0928 mm.)
H	3.6258-3.6261" (92.0953-92.1029 mm.)
J	3.6262-3.6265" (92.1055-92.1131 mm.)
K	3.6266-3.6269" (92.1156-92.1233 mm.)

Oversize Pistons

Oversize pistons are available in the following sizes :- +.010" (.25 mm.) +.020" (.51 mm.) +.030" (.76 mm). There are no selective grades in oversize pistons as grading is necessary purely for factory production methods.

For reboring the cylinders see the instructions given on page A.38.

Piston Rings

Check the piston ring gap with the ring as far down the cylinder bore as possible. Push the ring down the bore with a piston to ensure that it is square and measure the gap with a feeler gauge. The correct gaps are as follows :-

Compression rings .015" to .020" (.38 to .51 mm.).
Oil control rings (Maxiflex) .015" to .033" (.38 to .83 mm.)

Both the top and second compression rings have a tapered periphery and must be fitted the right way up.

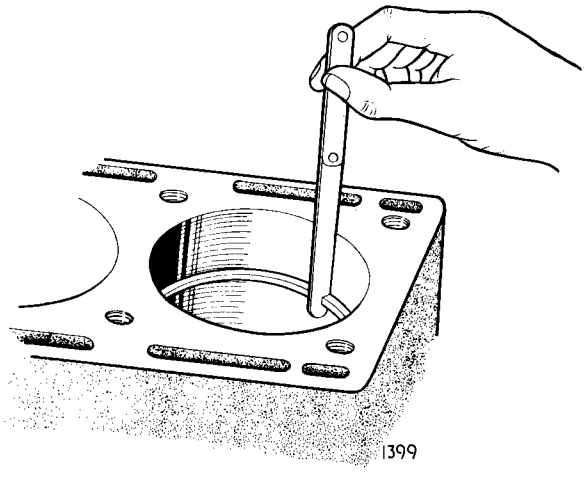


Fig. No. 25 *Checking the piston ring gap*

The narrowest part of the ring must be fitted uppermost to assist in identifying the narrowest face, a letter 'T' or 'TOP' is marked on the side of the ring to be fitted uppermost.

The oil control ring consists of two steel rails with a spacer between the two. These rails are held together as an assembly with an adhesive. The expander, which is fitted inside the oil control ring, should be assembled with the two lugs positioned in the hole directly above the gudgeon pin bore.

With the rings fitted to the piston check the side clearance in the grooves which should be .001" to .003" (.025 to .076 mm.).

One of the compression rings is hard chrome plated and the ring must be fitted to the top groove in the piston.

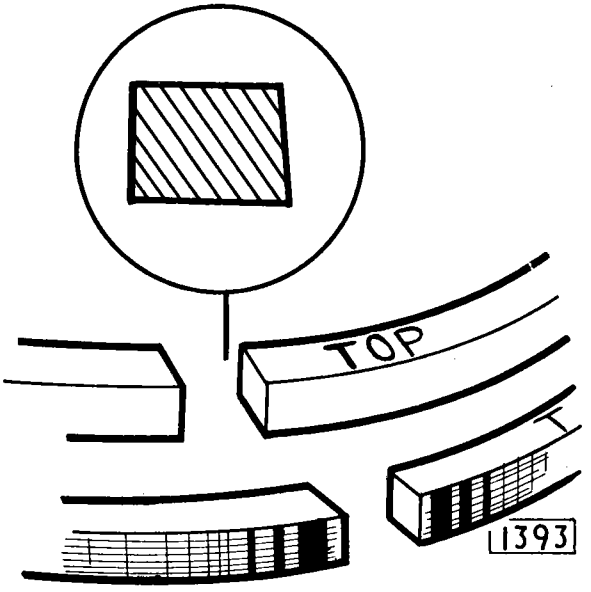


Fig. No. 26 *Showing the identification marks on tapered periphery compression rings*

Refitting

Pistons and connecting rods must be fitted to their respective cylinders (piston and connecting rods are stamped with their cylinder number, No. 1 being at the rear) and the same way round in the bore.

The pistons must be fitted with split on the left-hand or exhaust side of the engine. To facilitate correct fitting, the piston crowns are marked "Front", see Fig. 23.

Use a piston ring clamp when entering the rings into the cylinder bore.

The cap must be fitted to the connecting rod so that the cylinder numbers stamped on each part are on the same side.

Tighten the connecting rod nuts to a torque of 37lb/ft (5.1 kg.m.).

Refit sump and cylinder head.

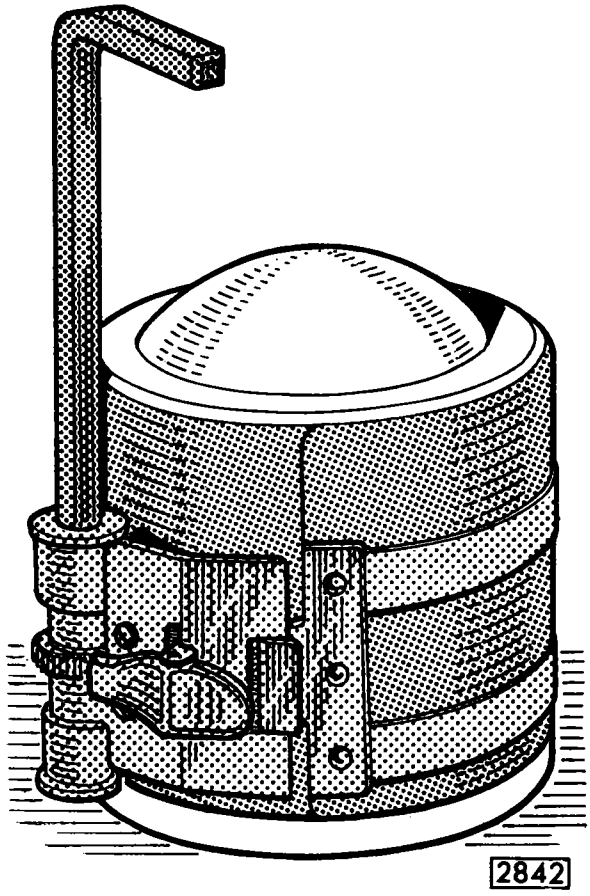


Fig. No. 27 *Using a piston ring clamp*

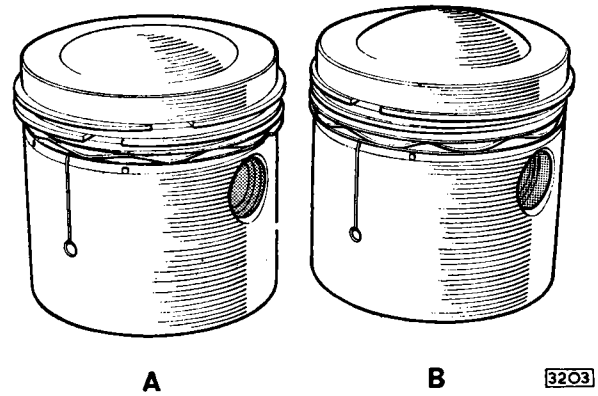


Fig. No. 28 *4.2 Litre pistons "A" 8:1 compression ratio "B" 9:1 compression ratio*

THE CONNECTING ROD AND BEARINGS

The connecting rods are steel stampings and are provided with precision shell big-end bearings and steel backed phosphor-bronze small end bushes. A longitudinal drilling through the connecting rod provides an oil feed from the big end to the small end bush.

REMOVAL

Remove piston and connecting rods as detailed on page A.20.

Remove gudgeon pin and withdraw piston as detailed on page A.21.

OVERHAUL

If connecting rods have been in use for a very high mileage, or if bearing failure has been experienced, it is desirable to renew the rod(s) owing to the possibility of fatigue.

The connecting rods fitted to an engine should not vary one with another by more than 2 drams (3.5 grammes). The alignment should be checked on an approved connecting rod alignment jig. Correct any misalignment as necessary. The big end bearings are of the precision shell type and under no circumstances should they be hand scraped or the bearings caps filed. The small ends are fitted with steel-backed phoshor-bronze bushes which are a press fit in the connecting rod. After fitting, the bush should be reamed or honed to a diameter of .875" to .8752" (22.225 to 22.23 mm.). Always use new connecting bolts and nuts at overhauls. Before fitting new big end bearings, the crankpin must be examined for damage or the transfer of bearing metal.

When a new connecting rod is fitted, although the small end bush is reamed to the correct dimensions, it may be necessary to hone the bush to achieve the correct gudgeon pin fit.

REFITTING

Refit the connecting rods and pistons as detailed on page A.22.

BIG END BEARING REPLACEMENT

The big end bearings can be replaced without removing the engine from the car.

Before fitting the new bearings the crankpins must be examined for damage or for the transfer of bearing metal.

Remove the sump as detailed on page A.27.

Turn the engine until the big-end bearing is at the bottom dead centre position.

Remove the connecting rod cap, noting that the corresponding cylinder number on the connecting rod and cap are the same side.

Lift the connecting rod off the crankpin and detach the bearing shells.

If all the bearings are to be replaced they are most easily replaced in pairs, that is, in pairs of connecting rods having corresponding crankpin throws.

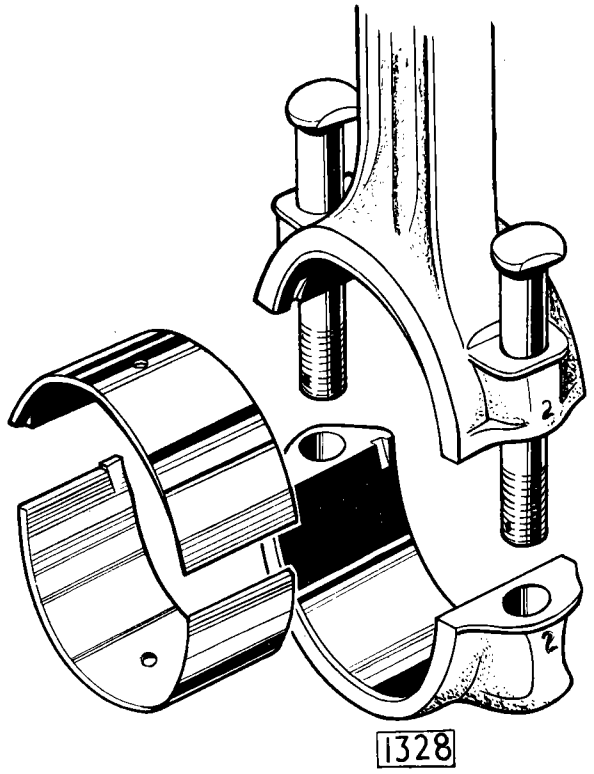


Fig. No. 29 *Corresponding cylinder number on connecting rods and caps*

THE OIL PUMP

The oil sump is of the eccentric rotor type and consists of five main parts :—the body, the driving spindle with the inner rotor pinned to it, the outer rotor and the cover, which is secured to the main body by four bolts, finally being secured to the engine with additional dowel bolts. The inner rotor has one lobe less than the number of internal segments in the outer rotor. The spindle centre is eccentric to that of the bore in which the outer rotor is located, thus the inner rotor is able to rotate within the outer, and causes the outer rotor to revolve. The inlet connection is positioned in the pump cover, and the outlet connection in the body. These are both connected to the ports in the pump.

Consider the oil flow with the lobes of the inner rotor lying along the line of eccenticity. In this position oil is free to flow from the port into the space (dotted portion) between the rotors, and on the other side of the lobe (shaded portion) the oil is free to flow into the delivery port (see Fig. 30.).

In the second position, the inner and outer rotors have rotated and caused the oil that was flowing from the inlet port into the space between them to be cut off from the port and transferred to the enclosed space between the ports. Similarly, the space which enclosed oil free to flow to the delivery port in the first position, has decreased in size in the second position, and thus caused the oil to flow into the delivery port. The action of the pump is then a repetition of the above, oil flowing into the space between the rotors from the inlet port under atmospheric pressure and being discharged into the delivery port by reason of the space in which it is contained, decreasing in size as it passes over the port.

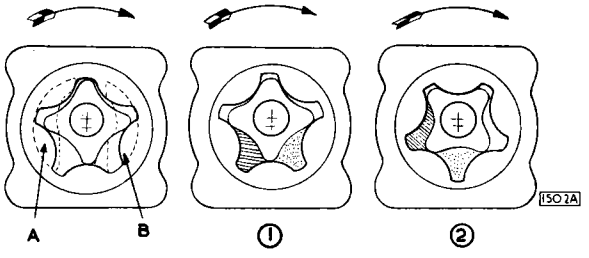


Fig. No. 30 *The operation of the rotor type oil pump. "A" indicates the outlet port. "B" indicates the inlet port. 1 First position. 2 Second position*

REMOVAL

Remove the sump as described on page A.27.
Detach the suction and delivery pipe brackets and withdraw the pipes from the oil pump.
Tap back the tab washers and remove the three bolts which secure the oil pump to the front main bearing cap.
Withdraw the oil pump and collect the coupling sleeve at the top of the drive shaft.

DISMANTLING

Unscrew the four bolts and detach the bottom cover from the oil pump.
Withdraw the inner and outer rotors from the oil pump body. The inner rotor is pinned to the drive shaft and must not be dismantled.

OVERHAUL

Check the clearance between lobes of the inner and outer rotors which should be .006" (.15 mm.) maximum (see Fig. 31.).

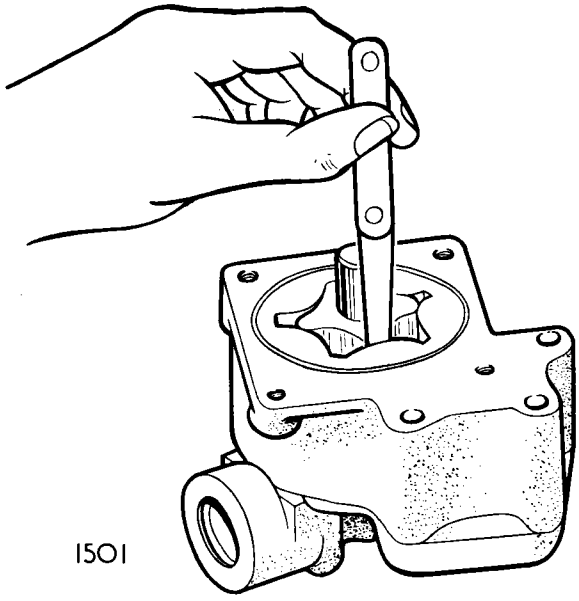


Fig. No. 31 *Measuring the clearance between the inner and outer rotors*

Check the clearance between the outer rotor and the pump body (see Fig. 32) which should not exceed .010" (.25 mm.).
Check the end-float of the rotors by placing a straight edge across the joint face of the body and measuring the clearance between the rotors and straight edge (see Fig. 33). This clearance should be .0025" (.06 mm.), and in an emergency can be restored by lapping the pump body and outer rotor on a surface plate to suit the inner rotor.

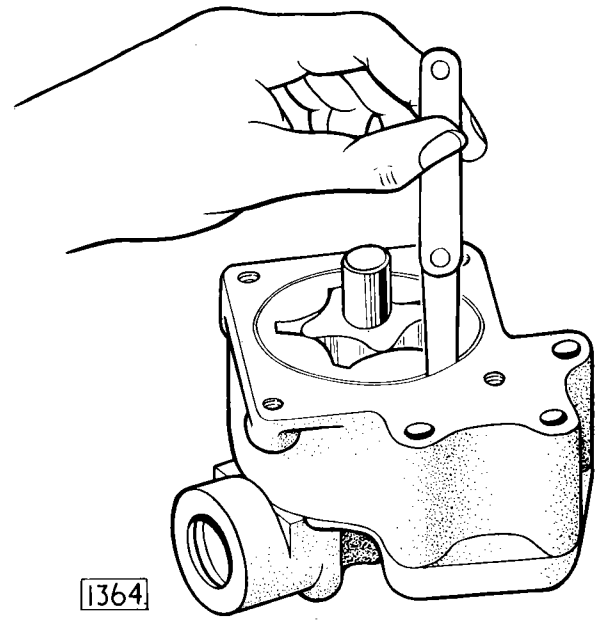


Fig. No. 32 *Measuring the clearance between the outer rotor and pump body*

Examine the pump body and bottom cover for signs of scoring and the drive shaft bores for signs of wear; fit new parts as necessary.
Place the drive shaft in a vice fitted with soft jaws and and check that the inner rotor is tight on the securing pin.
Note that the drive shaft, inner and outer rotors are supplied only as an assembly.

RE-ASSEMBLING

Re-assembly is the reverse of the dismantling procedure, but it is important when fitting the outer rotor to the pump body to insert the chamfered end of the rotor foremost.
Always fit new 'O' rings to the suction and delivery pipe hoses.

REFITTING

Refitting is the reverse of the removal procedure.
Do not omit to fit the coupling sleeve to the squared end of the drive shaft before offering up the oil pump.
After fitting of the oil pump, check that there is appreciable end-float of the coupling sleeve.

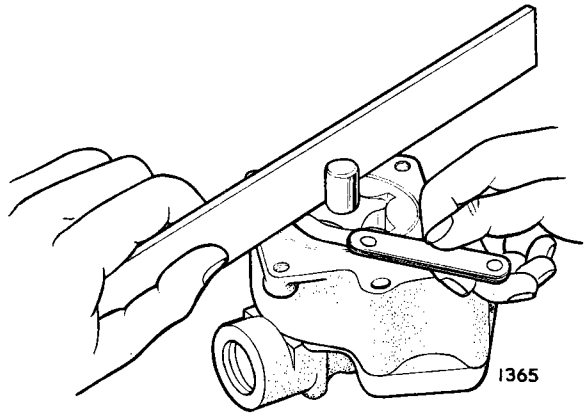


Fig. No. 33 *Measuring the end float of the rotors*

Fig. No. 34 Exploded view of the oil pump *(1) Pump body (2) Rotor assembly (3) Cover (4) Setscrew (5) Setscrew (6) Spring washer (7) "O" ring (8) "O" ring (9) Drive shaft (10) Bush (11) Washer (12) Helical gear (13) Key (14) Nut (15) Special washer (16) Coupling sleeve (17) Dowel bolt (18) Bolt (19) Tab washer (20) Oil delivery pipe (21) Gasket (22) Tab washer (23) Strut (24) Clip (25) Oil suction pipe (26) Clip (27) Strut (28) Strut (29) Strut (30) Sealing Plate (31) Spring (32) Split pin*

THE OIL FILTER

The oil filter is of the full flow type and has a renewable element. The oil from the oil pressure relief valve is returned to the sump by an external rubber hose. The oil pressure relief valve is retained by the outlet adaptor to which the hose to the sump is attached.
A balance valve fitted in the filter head opens at a pressure differential of 10-15 lb/sq. in. (0.7-1.1 kg/sq. cm.) to provide a safeguard against the possibility of the filter element becoming so choked that oil is prevented from reaching the bearings.

REMOVAL

The oil filter is located on the right hand side of the engine.
With the car on a ramp, disconnect the cable from the oil pressure transmitter unit and slacken the clip at the oil return hose. Remove the five bolts securing the filter head to the cylinder block. Remove the clip retaining the carburetter float chamber overflow pipes and the anchor bracket for the throttle spring.
Remove the oil filter assembly from beneath the car.

REFITTING

Reverse the removal procedure.
Fit a new gasket between the filter head and the cylinder block.

ELEMENT REPLACEMENT

It is most important to renew the oil filter element at every oil change.
Unscrew the central bolt and remove the canister and element from beneath the car. Thoroughly wash the canister with petrol and allow to dry before inserting a new element.
When refitting the canister, always renew the rubber sealing ring in the filter head, ensuring that it is correctly seated before tightening the centre bolt.

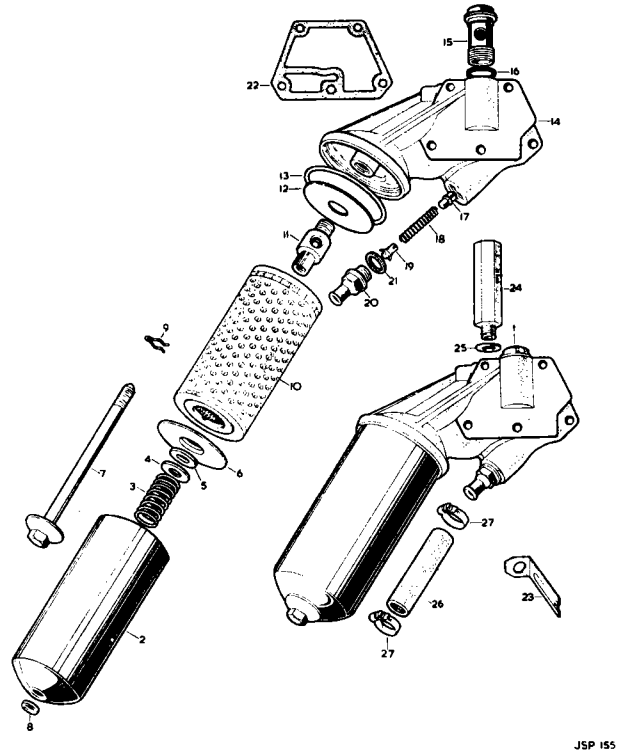


Fig. No. 35 Exploded view of oil filter *(1) Oil filter assembly (2) Canister (3) Spring (4) Plain washer (5) Felt washer (6) Pressure plate (7) Bolt (8) Rubber washer (9) Spring clip (10) Element (11) Anchor insert (12) Clamping plate (13) Sealing ring (14) Filter head (15) Balance valve (16) Washer (17) Relief valve (18) Spring (19) Spider (20) Adaptor (21) Washer (22) Gasket (23) Bracket (24) Adaptor (25) Washer (26) Hose (27) Clips*

THE OIL SUMP

REMOVAL

Drain the sump.
Remove the front suspension unit as detailed on page J.3.
Slacken the clip and disconnect the oil return hose at the oil filter head.
On cars fitted with automatic transmission, remove the two oil cooler pipes from the transmission and radiator.
Unscrew the 24 setscrews and 2 bolts and detach the sump from the cylinder block; note the short setscrew is fitted at the right-hand front corner of the sump (Fig. 36).
Remove the four nuts securing the sump baffle plate. Withdraw the baffle plate and remove the nuts securing the filter basket. Wash the basket in petrol.
Remove the two nuts securing the oil return pipe flange to the sump; examine the 'O' ring and renew if necessary.

REFITTING

Scrape off all traces of old gaskets or sealing compound from the faces of the sump and cylinder block.
Always fit new gaskets and rear oil seal when refitting the sump. If time permits, roll the new oil seal into a coil and retain this position with string for a few hours

to assist in fitting the seal in its semi-circular housing. Fit the filter basket and baffle plate. Coat the mating surfaces of the sump and block with a good quality jointing compound; fit the new gasket and secure the sump with the setscrews and bolts.
Re-attach the oil return pipe flange and connect the oil return hose at the filter head.
Refit the transmission oil cooling pipes to the transmission and radiator.

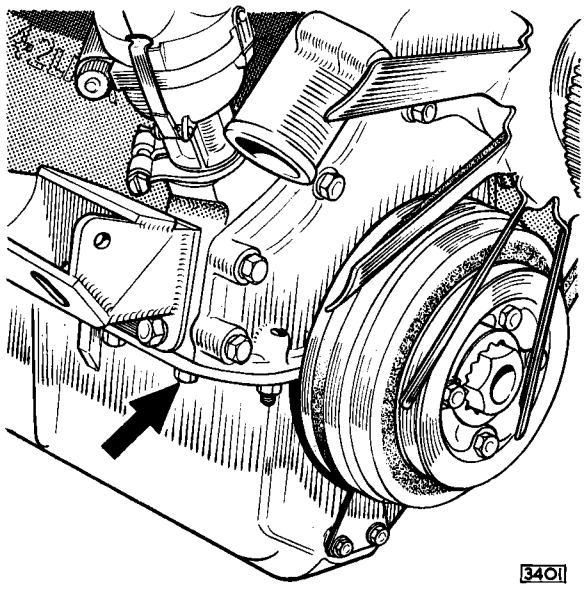


Fig. No. 36 *Location of short setscrew*

THE INLET MANIFOLD

REMOVAL
Remove the air filter, air intake and carburetters as detailed on page B.7.
Remove the distributor cap and detach the lead carrier from the thermostat housing. Tie up the distributor cap to the top of the cylinder head.
Disconnect the top water hose and by-pass hose from the front of the manifold. Disconnect the heater hose from the rear of the manifold.
Disconnect the brake vacuum hose from underneath the manifold.
Disconnect the heater vacuum hose from underneath the manifold.
Pull the cable from the "Lucar" connector to the temperature transmitter.
Withdraw the nuts securing the manifold to the cylinder head and remove the manifold.

REFITTING
Refitting is the reverse of the removal procedure.

THE CRANKSHAFT DAMPER

A torsional vibration damper is fitted at the front of the crankshaft.
The damper consists of a malleable iron ring bonded to a thick rubber disc. An inner member, also bonded to the disc, is attached to a hub which is keyed to a split cone on the front extension of the crankshaft.
The crankshaft damper and pulley are balanced as an assembly, therefore, before dismantling the assembly, mark each part so that they can be fitted in their orignal positions.

REMOVAL
Remove the fan/steering pump belt.
If the air conditioning is fitted, remove the compressor belt.
Remove the alternator belt.
Knock back the tabs and remove the washer securing the large damper bolt.
Unscrew the four setscrews securing the pulley/s to the damper and withdraw the pulley. Unscrew the large bolt and remove the flat washer. Insert two levers

behind the damper and ease it off the split cone—a sharp tap on the end of the cone will assist removal.

Overhaul
Examine the rubber portions of the damper for signs of deterioration and, if necessary, fit a new damper.

Examine the pulley/s for signs of wear. The drive should be taken on the 'V' faces of the pulley/s; renew the pulley/s if a new belt bottoms in the 'V' groove.

Refitting
Refitting is the reverse of the removal procedure.

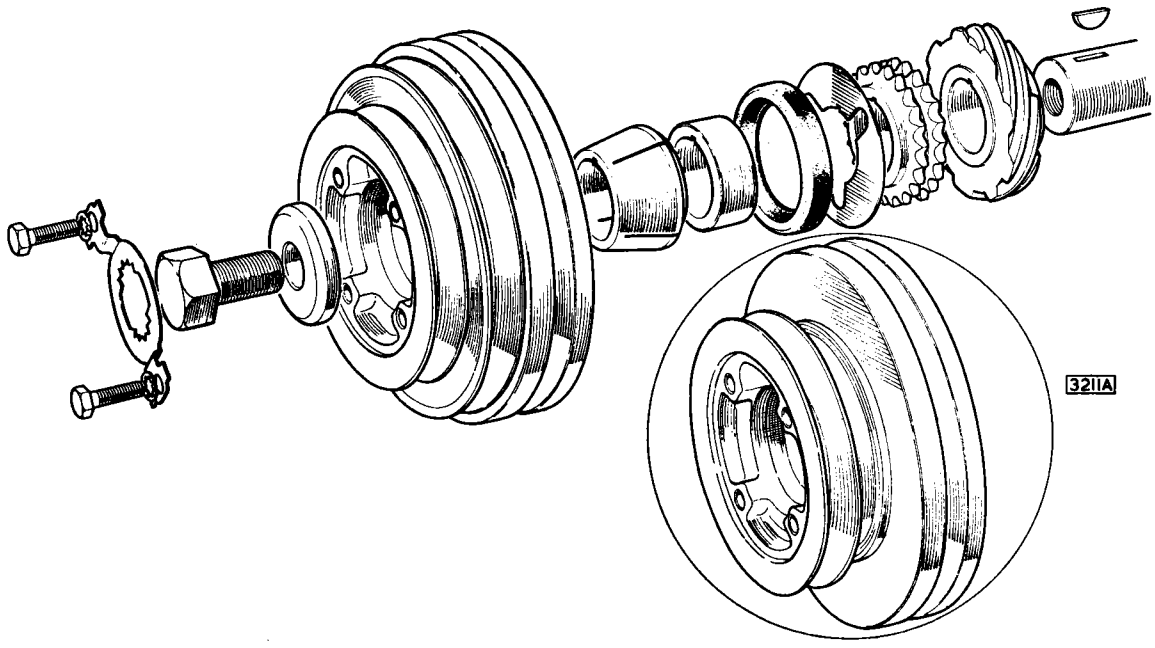


Fig. No. 37 *Exploded view of damper and pulleys*

THE TIMING GEAR

DESCRIPTION

The camshafts are driven by Duplex endless roller chains in two stages.
The first stage or bottom timing chain drives the larger wheel of a double intermediate sprocket; the second stage or top timing chain passes round the smaller wheel of the intermediate sprocket, both camshaft sprockets and is looped below an idler sprocket.
The idler sprocket has an eccentric shaft for top timing chain tension adjustment and the bottom chain is automatically tensioned by an hydraulic tensioner bolted to the cylinder block. Rubber vibration dampers are located at convenient points around the chains.

REMOVAL

Remove the cylinder head as detailed on page A.14.
Remove the sump as detailed on page A.27.
Withdraw the header tank, cowl, fan and radiator as detailed on page C.5.
Remove the water pump as detailed on page C.8.
Remove the damper assembly (see page A.28) and withdraw the split cone.
Withdraw the setscrews securing the timing cover to the block and remove the cover.
Withdraw the hexagon headed plug from the end of the bottom timing chain tensioner; insert an Allen key into the hole until it registers in the end of the restraint cylinder; turn the key clockwise until the cylinder can be felt to be fully retracted within the body. The adjuster head will then be free from the chain.
Remove the setscrews securing the tensioner body to the block and withdraw the tensioner complete with the conical gauze filter fitted in the tensioner oil feed hole in the cylinder block. Unscrew the four set screws securing the assembly to the block. Leave the setscrews in position.
Remove the two setscrews securing the intermediate damper to the block and a further two setscrews securing the bottom chain vibration damper to the block. Withdraw the timing gear assembly.

DISMANTLING

Remove the nut and serrated washer from the idler shaft and withdraw the plunger and spring.
Remove the four nuts securing the front mounting bracket to the rear bracket. Collect the upper timing chain dampers, distance pieces and top chain retainer.
Remove the bottom timing chain from the large intermediate sprocket.
Withdraw the circlip from the end of the intermediate sprocket shaft and press the shaft out of the bracket. Withdraw the two sprockets.

OVERHAUL

Examine the timing chains for signs of damage or wear. Replace as necessary.
Inspect the sprockets and replace if the teeth show signs of excessive wear.

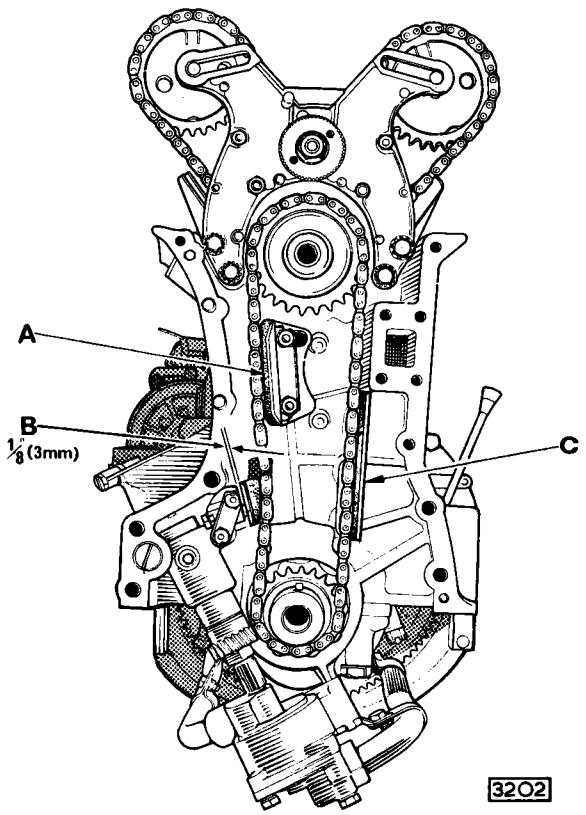


Fig. No. 38 *When fitting a new lower timing chain, set the intermediate damper (A) in light contact with the chain when there is ⅛" (3mm) gap between the rubber slipper and the tensioner body. In the case of a worn chain, the gap (B) will be increased to avoid fouling between the chain and the cylinder block. Set the lower damper (C) in light contact with the chain*

Examine all vibration dampers and replace if any signs of wear are apparent.

ASSEMBLING

Fit the eccentric shaft to the hole in the front mounting bracket. Insert the spring and locking plunger for the serrated plate to the hole in the front mounting bracket. Fit the serrated plate and secure with the shakeproof washer and nut. Fit the idler sprocket (21 teeth) to the eccentric shaft.
Fit the two intermediate sprockets (20 and 28 teeth) to their shaft with the larger sprocket forward and press the shaft through the lower central hole in the rear mounting bracket locating the rollpin of the shaft in the groove machined in the rear bracket. Secure with a circlip at the rear of the bracket.
Fit the top timing chain (longer chain) to the small intermediate sprocket and the bottom timing chain (short chain) to the large intermediate sprocket.
Loop the top timing chain under the idler sprocket and assemble the front mounting bracket to the rear bracket with the two chain dampers and distance pieces interposed between.
Position the lugs of the top timing chain retainer on the front mounting bracket and pass the four securing bolts through the retainer lugs, brackets, dampers and distance pieces.
Secure the two mounting brackets together with four studs and nuts.

REFITTING

Fit the bottom timing chain over the crankshaft sprocket and attach the assembly to the block with four bolts.
Fit the top timing chain over the camshaft sprockets. Attach the bottom chain vibration damper to the block. Fit the conical filter to the oil feed hole in the block. Fit shims as necessary between the backing plate and the block so that the timing chain runs centrally along the adjuster slipper. Fit the tensioner to the block with two setscrews and lock the tab washers.
It is IMPORTANT that no attempt is made to release the locking mechanism until the adjuster has been finally mounted on to the engine with the timing chain in position.
Insert the Allen key, turn clockwise until the tensioner head moves forward under spring pressure against the chain. Fit the plug to the hole in the tensioner body and secure with the tab washer.
Allow the rubber slipper to project from the body by ⅛" (Fig. 38) and adjust the intermediate damper on its slotted holes until this dimension is retained.
This dimension will have to be increased with a worn or stretched chain.
Complete the refitting by reversing the removal procedure.

ENGINE MOUNTINGS

The engine is supported at the front on two rubber mountings which are attached to brackets on the front sub frame. The rear is supported on a coil spring which is mounted in a channel support bolted to the body floor. An extension of the spring retainer passes through a rubber bush in the channel support.

FRONT ENGINE MOUNTINGS

Removal

Support the engine by lifting straps. Remove the large set bolt, spring washer and plain washer.
Raise the engine so that the front mounting brackets are just clear of the mounting rubbers.
Remove the two bolts securing the front engine mounting to the support bracket on the body side members. Repeat the operation for the other side.

Refitting

Reverse the removal procedure to refit.

REAR ENGINE MOUNTING

Removal

Support the rear engine mounting with a jack. Remove the four setscrews, spring washers and oval washers; lower the jack slowly to release the tension on the mounting spring. Remove the mounting and spring. Ensure that the four spacers between the mounting and the body are not mislaid.

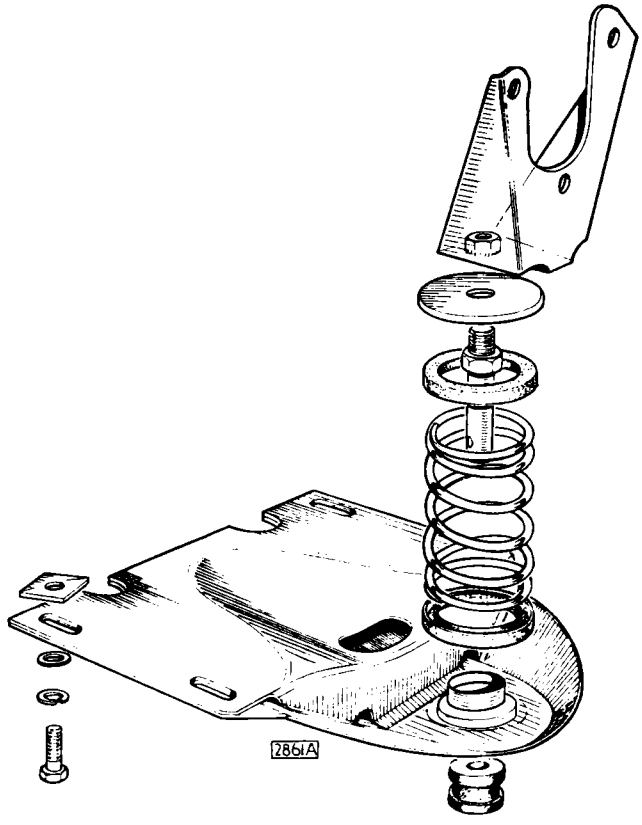


Fig. No. 39 *Rear engine mounting*

Refitting

Reverse the removal procedure to refit.

THE ENGINE STABILISER

The engine stabiliser is situated at the rear of the engine and consists of a rubber/steel mounting attached to the body which is connected to brackets on the clutch housing via a rubber bushed link pin. The link pin is threaded at its upper end and is connected to the rubber mounting by means of flanged washers and a self-locking nut.

ADJUSTMENT

It is MOST IMPORTANT that the stabiliser is assembled in the following manner, as failure to observe this procedure may cause engine vibration and/or fouling of the gearbox in its cowl due to the engine having been pulled off its mountings.

1. Screw the lower flanged washer (D. Fig. 40) up the stabiliser pin until the flange contacts the bottom of the stabiliser rubber mounting (C). The washer is slotted on its upper face and can be screwed up the pin by engaging a thin bladed screwdriver in the slot through the centre hole of the rubber mounting.
2. Fit the upper flanged washer (B) and tighten down with the self-locking nut (A).

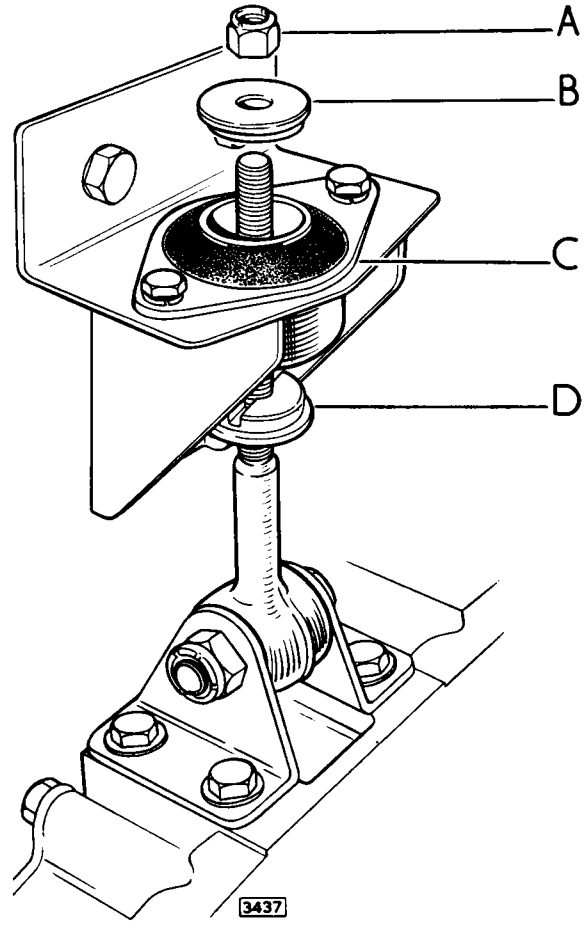


Fig. No. 40 *The engine stabiliser*

Engine Overhaul — Part 2

This section covers the removal of the engine and transmission unit from the car; dismantling the engine, and overhaul of various components which otherwise could not be serviced with the engine in situ.

ENGINE REMOVAL AND REFITTING

REMOVAL (Fig. 41)
Remove the bonnet (1)—for details see page N.6.
Remove the battery.
Drain the engine sump (2) and cooling system (3).
Remove the air cleaner (4).
Remove the automatic transmission oil cooler (5)—if fitted.
Remove the radiator (6)—for details see page C.5. If an air conditioning system is fitted, see note on page C.6 before attempting to remove the condenser.
Disconnect :-
Starter motor cables (7).
The H.T. lead from the coil (8).
The cables from the alternator (9).
The temperature transmitter cable (10).
Automatic choke cables (11).
The oil pressure transmitter cable (12).
The earth strap (13).
Remove the carburetter fuel feed pipe from the filter bowl (14).
Disconnect the carburetter linkage (15).
Disconnect the kick-down linkage (16)—automatic transmission cars.
Remove the brake vacuum pipe from the underside of the inlet manifold (17).
Remove the heater vacuum tank hose from the underside of the manifold (18).
Disconnect the heater hoses (19) from the engine.
Disconnect the power steering hoses (20) at the pump and blank off the unions. Slacken off the adjuster nuts and press the pump towards the engine to its minimum adjustment point.
If fitted, remove the air conditioning compressor unit (21) with its mounting bracket and tie securely to the wing valance. **DO NOT DISCONNECT THE HOSE CONNECTIONS FROM THE COMPRESSOR.**
Disconnect the exhaust pipes (22) at the manifold flanges and the exhaust mounting strap (23) from the bell housing.
Disconnect the speedometer cable (24).

On automatic transmission models proceed as follows :-
Remove the nut securing the selector cable to the lever on the transmission unit (25).
Remove the bolt securing the cable clamp (26) to the abutment bracket on the converter housing.

On standard transmission and overdrive models proceed as follows :-
Remove the gear control knob and the lever grommet (27).
Remove the console (28)—for details see page N.5.
Disconnect the reverse light switch (and overdrive switch if fitted) cables at the snap connectors (29).
Detach the clutch slave cylinder from the bell housing (30).

For all models continue as follows :-
Remove the rear engine mounting (31) as detailed on page A.31.
Disconnect the propeller shaft at the front flange (32).
Support the engine on lifting tackle by means of the engine lifting straps.
Remove the front engine mountings (33) and the engine stabiliser (34) as detailed on page A.31.
Lower the rear of the engine, support on the jack used for rear mounting removal, and withdraw forwards.

REFITTING
Refitting is the reverse of the removal procedure.
When fitted, adjust the rear stabiliser as detailed on page A.31.

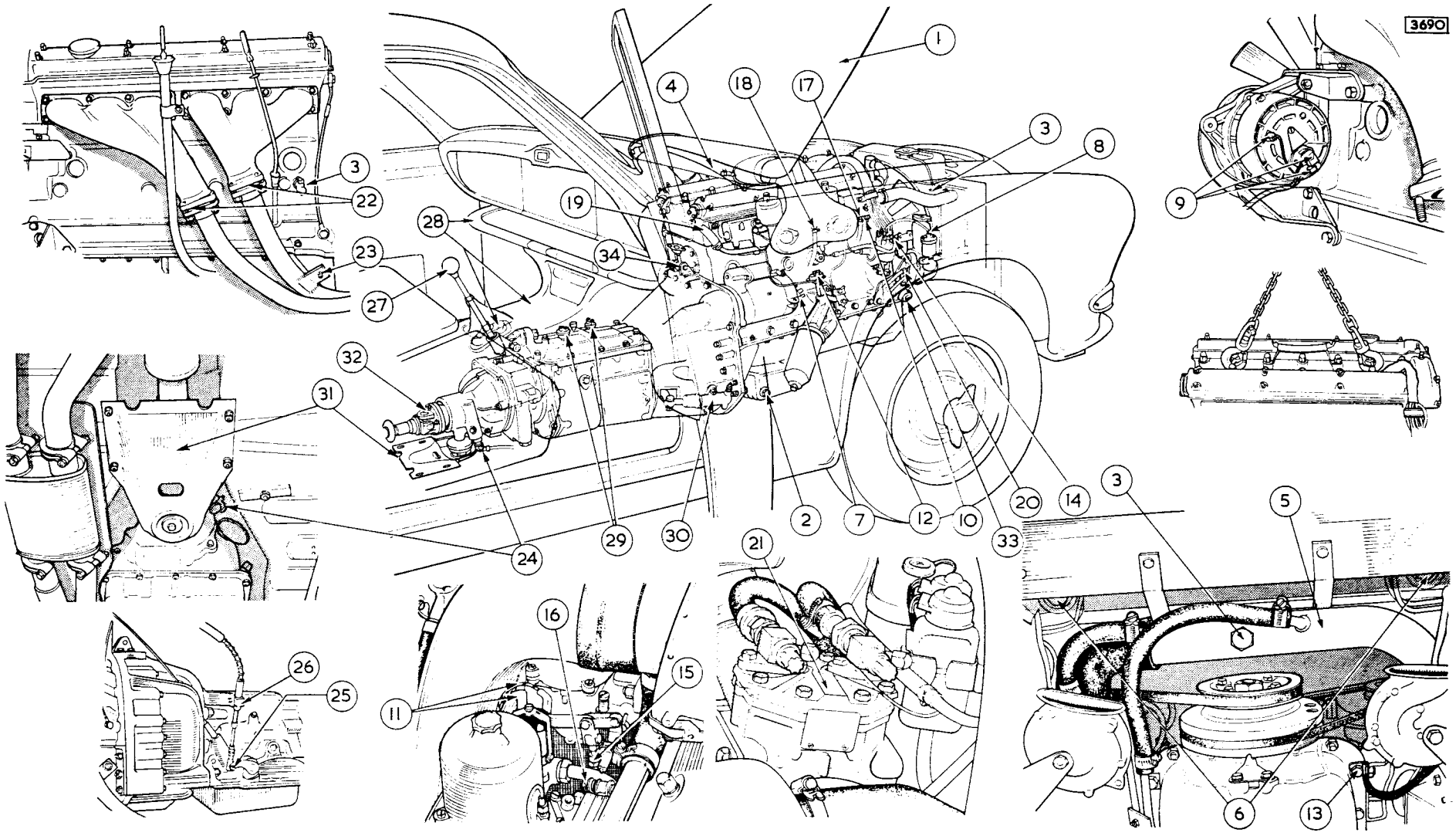


Fig. No. 41 *Engine removal*

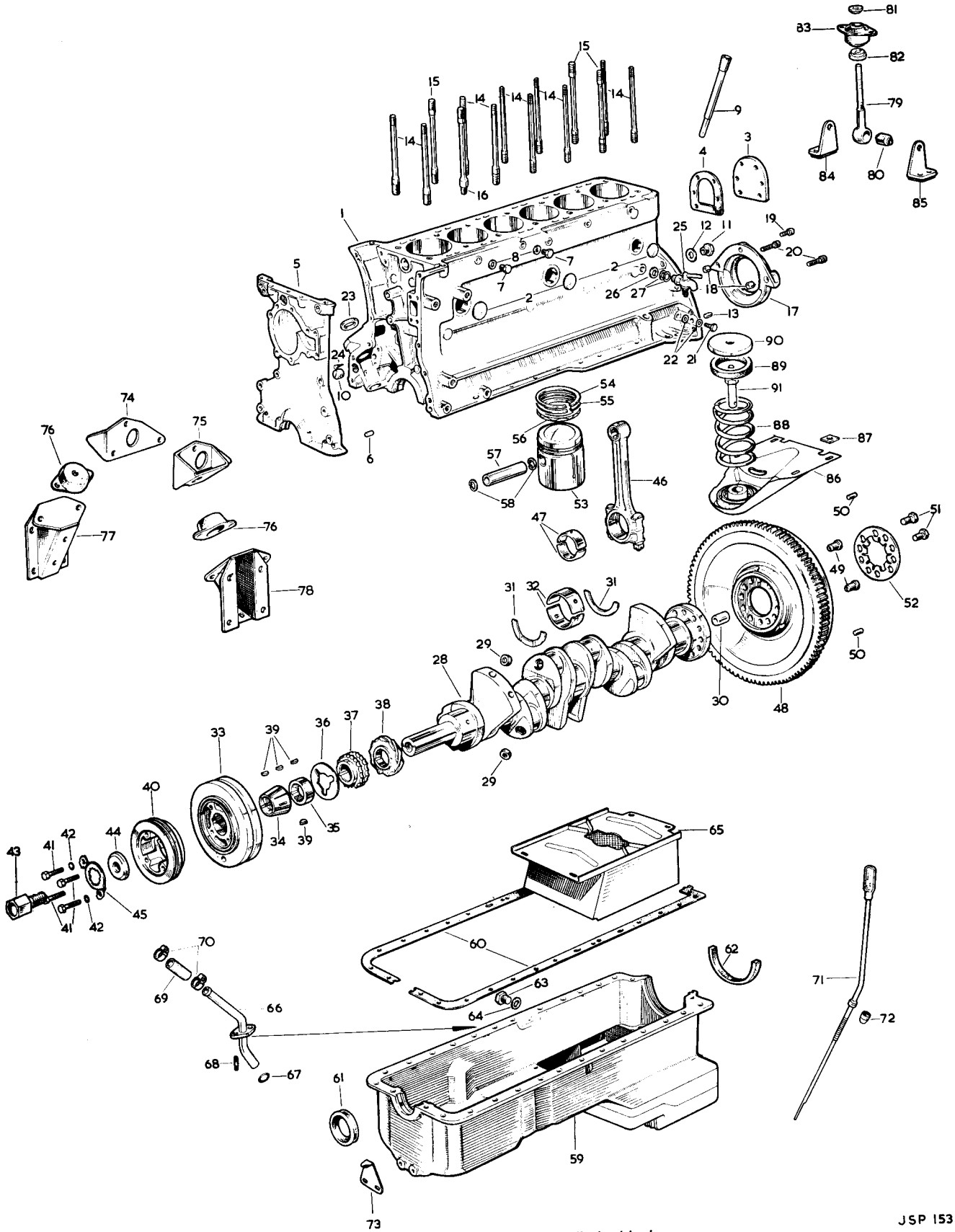


Fig. No. 42 *Exploded view of cylinder block*

1 Cylinder block assembly
2 Core plug
3 Blanking plate
4 Gasket
5 Front timing cover
6 Dowel
7 Setscrew
8 Copper washer
9 Dipstick adaptor tube
10 Plug
11 Headed plug
12 Copper washer
13 Dowel
14 Stud (plain)
15 Stud (plain)
16 Stud (dowel)
17 Cover assembly
18 Ring Dowel
19 Cap screw (centre)
20 Cap screw (outer)
21 Banjo bolt
22 Copper washer
23 Sealing ring
24 Filter gauze
25 Drain tap
26 Copper washer
27 Fibre washer
28 Crankshaft
29 Screwed plug
30 Bush
31 Thrust washer
32 Main bearings
33 Crankshaft damper
34 Cone
35 Distance piece
36 Oil thrower
37 Timing chain sprocket
38 Gear
39 Key
40 Pulley
41 Bolt
42 Lock washer
43 Bolt
44 Washer
45 Tab washer
46 Connecting rod
47 Big end bearing
48 Flywheel
49 Dowel
50 Dowel
51 Setscrew
52 Lockplate
53 Piston
54 Pressure ring (upper)
55 Pressure ring (lower)
56 Scraper ring (Maxiflex)
57 Gudgeon pin
58 Circlip
59 Oil sump
60 Gasket
61 Seal
62 Seal
63 Drain plug
64 Copper washer
65 Baffle assembly
66 Pipe assembly
67 "O" Ring
68 Stud
69 Hose
70 Hose clip
71 Dipstick assembly
72 Washer
73 Ignition timing pointer
74 Bracket assembly (R.H.)
75 Bracket assembly (L.H.)
76 Front engine mounting
77 Support bracket assembly (R.H.)
78 Support bracket assembly (L.H.)
79 Stabilising link
80 Bush
81 Stepped washer
82 Stepped bush
83 Rubber mounting
84 Bearing bracket (R.H.)
85 Bearing bracket (L.H.)
86 Bracket assembly (rear mounting)
87 Packing piece
88 Coil spring
89 Spring seat (rubber)
90 Coil spring retainer
91 Pin assembly

ENGINE—DISMANTLING

GENERAL
The following instructions apply when the engine components are removed with the engine out of the chassis.
All references made in this section to the top or bottom of the engine are with the unit in the normal upright position. References to the left or right-hand side assume the engine to be upright and viewed from the rear.

TRANSMISSION UNIT (AUTOMATIC TRANSMISSION)
Removal
Disconnect the kick-down linkage at the operating shaft.
Drain the oil from the transmission unit.
Remove the bolts securing the transmission to the converter housing and withdraw the unit.

TORQUE CONVERTER AND FLYWHEEL
Removal
Withdraw the cover from the front of the converter housing.
Remove the starter motor and withdraw the setscrews securing the converter housing to the engine.
Remove the four setscrews, accessible through the starter motor mounting aperture, securing the torque converter to the flywheel. Rotate the engine to gain access to each setscrew in turn.
Remove the ten setscrews and locking plate securing the flywheel to the crankshaft and withdraw the flywheel.

GEARBOX (STANDARD TRANSMISSION)
Removal
Remove the setscrews and nuts securing the bell housing to the engine and withdraw the gearbox unit. The unit must be supported during this operation in order to avoid straining the clutch driven plate and constant pinion shaft.

CLUTCH AND FLYWHEEL
Removal
Unscrew the six setscrews securing the clutch cover to the flywheel and remove the clutch assembly.
Retain any balance weights which may be fitted under the setscrew heads and note the location for reference when refitting.
Knock back the tabs of the locking plate securing the ten flywheel bolts.
Unscrew the flywheel bolts and remove the locking plate, detach the flywheel from the crankshaft flange by gently tapping with a rawhide mallet.
If the starter gear ring is badly worn a new flywheel should be fitted, since the starter gear teeth are integral with the flywheel and, in this case, it will be necessary to balance the flywheel and clutch as an assembly as detailed on page D.9.

REMOVE ALTERNATOR
Release the top mounting bolt and the bottom mounting nut. Swing the alternator inwards and remove the drive belt.
Withdraw the bolt and nut and remove the alternator and mounting bracket.

REMOVE DISTRIBUTOR
Spring back the clips and remove the cover complete with high tension leads. Disconnect the low tension lead, remove the clamp plate setscrew and lock washer, and withdraw the distributor.

REMOVE CYLINDER HEAD
Remove the cylinder head as detailed on page A.14.

THE CRANKSHAFT

The counterbalanced crankshaft is of manganese molybdenum steel and is supported in seven precision shell bearings. End thrust of the crankshaft is taken on two semi-circular white metal faced steel thrust washers fitted in recesses in the centre main bearing cap. A torsional vibration damper is fitted at the front end.
Initially, the crankshaft is itself balanced both statically and dynamically and is then re-balanced as an assembly with the flywheel and clutch unit attached.

REMOVAL
Remove the crankshaft damper as detailed on page A.28. Remove the sump by unscrewing the setscrews securing the sump to the block.
Remove the pistons and connecting rods as detailed on page A.20.
Tap back the tab washer securing the distributor drive gear nut and remove the nut and washer. Tap the squared end of the distributor drive shaft through the gear noting that the gear is keyed to the shaft. Remove the gear and thrust washer and withdraw the drive shaft.
Remove the timing gear assembly as described on page A.29.
Knock back the tab washers securing the fourteen main bearing cap bolts. **Note that on later engines plain washers are substituted for tab washers.**
Unscrew the bolts and the main bearing caps, noting the corresponding numbers stamped on the caps and bottom of crankcase and also the thrust washers fitted to the recesses in the centre main bearing cap.

Detach the bottom half of the rear oil seal by unscrewing the two Allen screws.
Note that the two halves are located by hollow dowels.
The crankshaft can now be lifted out from the crankcase.
Remove the distance piece and oil thrower and withdraw the crankshaft sprocket and oil pump drive gear.
Collect the woodruff keys.

OVERHAUL

Regrinding of the crankshaft journals is generally recommended when wear or ovality in excess of .003" (.08 mm.) is found. Factory reconditioned crankshafts are available on an exchange basis, subject to the existing crankshaft being fit for satisfactory reconditioning, with undersize main and big end bearings—.010" (.25 mm.),—.020" (.51 mm.),—.030" (.76 mm), and .040" (1.02 mm.).
The identification figures for the under-size journals will be found stamped on the crankshaft webs.
The necessary bearings will not be supplied with the reground crankshaft and must be ordered separately.

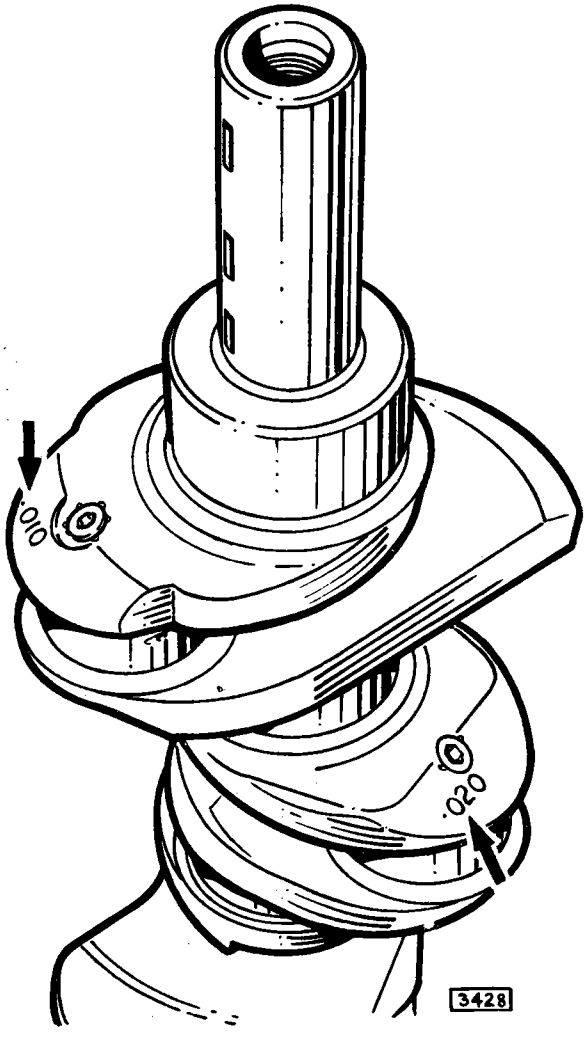


Fig. No. 43 *Identification figures for undersize main and big end bearings*

Grinding beyond the limits of .040" (1.02 mm.) is not recommended and in such circumstances a new crankshaft must be obtained.

Renewing the Rear Oil Seal

Before refitting the crankshaft, replace the rear asbestos seal and size correctly.
Remove the three Allen screws securing the top half of the oil seal noting the hollow locating dowels at the two outer holes.
Prise out the asbestos seal from the groove.

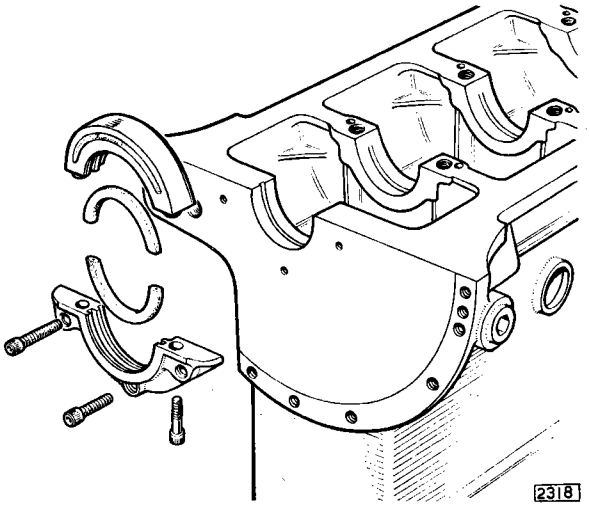


Fig. No. 44 *Exploded view of crankshaft rear oil seal*

Carefully tap the new seal on the side face to narrow the section of the seal. Fit the seals to the housing and press into the groove using a hammer handle until the seal does not protrude from the ends of the housing. DO NOT cut the ends off the seal if they protrude from the housing but continue to press the seal into the

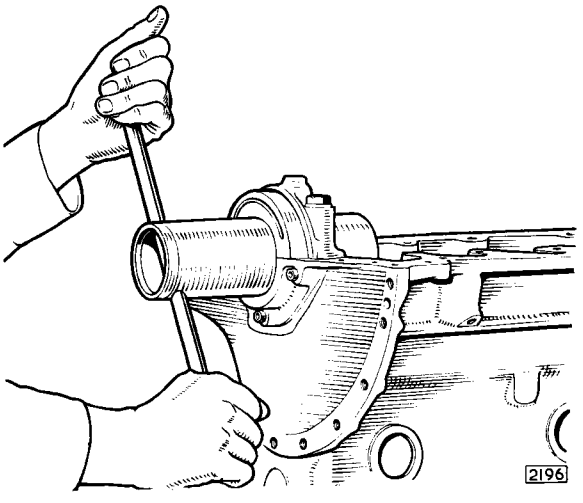


Fig. No. 45 *Sizing the rear oil seal using Churchill Tool No. J.17*

groove until both ends are flush. Using a knife or similar tool, press all loose ends of asbestos into the groove so they will not be trapped between the two halves of the housing when assembled.
Assemble the two halves of the rear seal and secure with the two Allen screws. Fit the rear main bearing cap without the bearings and tighten to a torque of 83 lb.ft. (11.5 kgm.). Fit the seal and housing to the cylinder block and secure with the three Allen screws. Smear a small quantity of colloidal graphite around the inner surface of the asbestos seal and insert the sizing bar (Churchill tool No. J.17). Ensure that the pilot end of the tool enters the bore of the rear main bearing and then press the bar inwards and rotate at the same time until the bar is fully home.
Remove the bar by pulling and twisting at the same time. Remove the three Allen screws securing the oil seal housing to the block and remove the two Allen screws securing the two halves of the seal. Separate and remove the rear main bearing.
Fit the main bearing shells to the top half of the main line bore in the cylinder block. Lay the crankshaft in the bearing shells. Fit the rear oil seal.

Refitting
New crankshaft thrust washers should be fitted, these being in two halves located in recesses in the centre main bearing cap. Fit the main bearing cap with a thrust washer, white metal side outwards, to the recess in each side of cap. Tighten down the cap and check the crankshaft end float, which should be .004" to .006" (.10 to .15 mm.). The thrust washers are supplied in two thicknesses, standard and .004" (.10 mm.) oversize and should be selected to bring the end float within the required limits. It is permissible to fit a standard size thrust washer to one side of the main bearing cap and an oversize washer to the other. Oversize thrust washers are stamped .004" on the steel face.

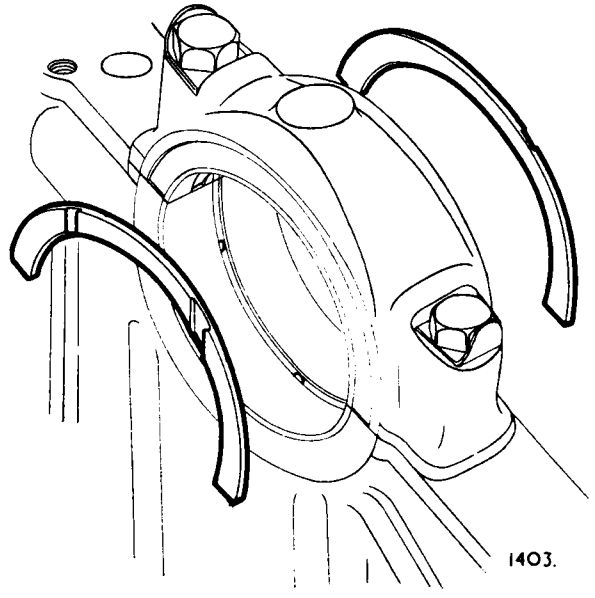


Fig. No. 46 *Crankshaft thrust washers*

Ensure that the oil passages in the crankshaft are clear and perfectly clean before re-assembling. If the original crankshaft is to be refitted remove the Allen headed plugs in the webs (which are secured by staking) and thoroughly clean out any accumulated sludge with a high pressure jet followed by blowing out with compressed air.
After refitting the plugs, secure by staking with a blunt chisel.
Fit the main bearing caps with the numbers stamped on the caps with the corresponding numbers stamped on the bottom face of the crankcase.
Fit the main bearing cap bolts and tighten to a torque of 83 lb.ft. (11.5 kgm.).
Test the crankshaft for free rotation.
The tab washers for the rear main bearing bolts are longer than the remainder and the plain ends should be tapped down around the bolt hole bosses (early engines only).
The remainder of the refitting procedure is the reverse of the removal.

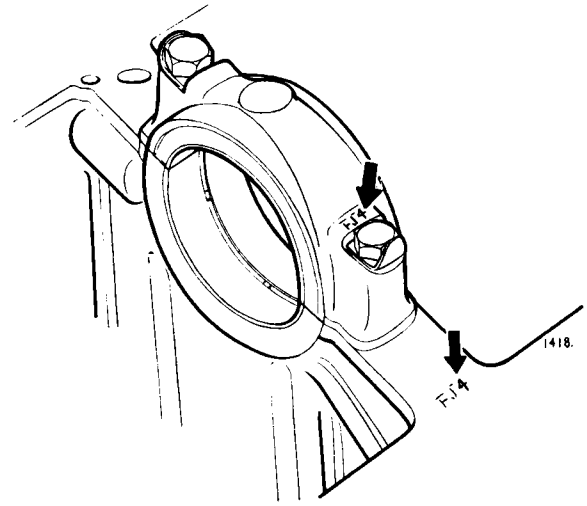


Fig. No. 47 *Showing the corresponding numbers on main bearing caps and crankcase*

Fit the Woodruff key to the inner slot and tap the oil pump drive gear into position with the widest part of the boss to the rear. Fit the Woodruff key to the outer slot and tap the crankshaft timing gear sprocket into position. Fit the oil thrower and distance piece.
Turn the engine until Nos: 1 and 6 pistons are on T.D.C.
Place the distributor drive shaft into position with the offset slot in the top of the shaft as shown in Fig. 48.
Withdraw the shaft slightly, maintaining the same slot position, and place the thrust washer and drive gear on the end of the shaft. Press the shaft into the drive gear ensuring that the key engages the keyway correctly.

Fit the pegged tab washer with the peg in the keyway of the drive gear.
Fully tighten the nut and secure with the tab washer. Check the end float of the shaft which should be .004" —.006" (.10—.15 mm.). If no clearance exists, fit a new oil/pump/distributor drive gear which will restore the clearance. In an emergency, the thrust washer may be reduced in thickness by rubbing down on a piece of emery cloth placed on a surface plate.

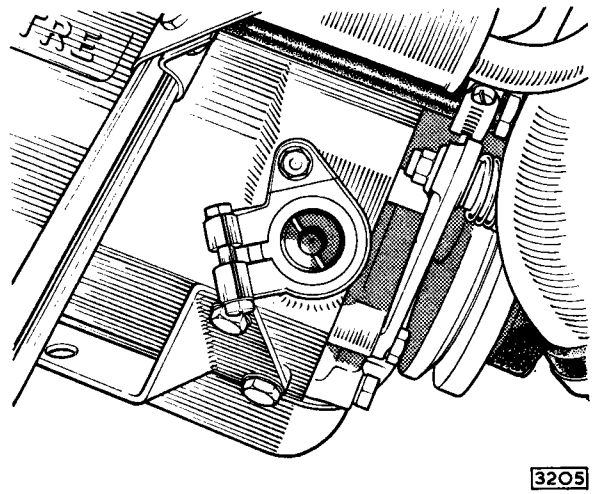


Fig. No. 48 *Showing the fitted location of distributor drive gear*

THE CYLINDER BLOCK

The cylinder block is of chromium iron and is integral with the crankcase. The main bearing housings are line bored and the caps are not interchangeable, corresponding numbers being stamped on caps and the bottom face of the crankcase for identification purposes. Pressed in dry liners are fitted.

Overhaul
Remove the cylinder head as detailed on page A.14.
Withdraw pistons and connecting rods as described on page A.20.
Remove the crankshaft as detailed on page A.35.
Check the top face of the cylinder block for truth. Check that the main bearing caps have not been filed and that the bearing bores are in alignment.
Should the caps show damage or the bearing housing misaligned, the caps must be re-machined and the bearing housings line bored.
Remove the cylinder head studs. Check area around the stud holes for flatness. Skim any raised areas flush with the joint face to ensure a perfectly flat surface.
Reboring is normally recommended when the bore wear exceeds .006" (.15 mm.). Reboring beyond the limit of .030" (.76 mm.) is not recommended. Oversize pistons are available up to this limitation—see page A.22.
If the bores will not clean out at .030" (.76 mm.), new liners and standard size pistons should be fitted.
Press out the worn liners from below, using the illustrated stepped block.
Before fitting a new liner, lightly smear the cylinder walls with jointing compound to a point halfway down the bore and also smear the top outer surface of the liner.
Press in the new liners from the top and lightly skim the tops of the liners flush with the top face of the cylinder block.
Bore out and hone the liners to suit the grade of pistons to be fitted. (See piston grades page

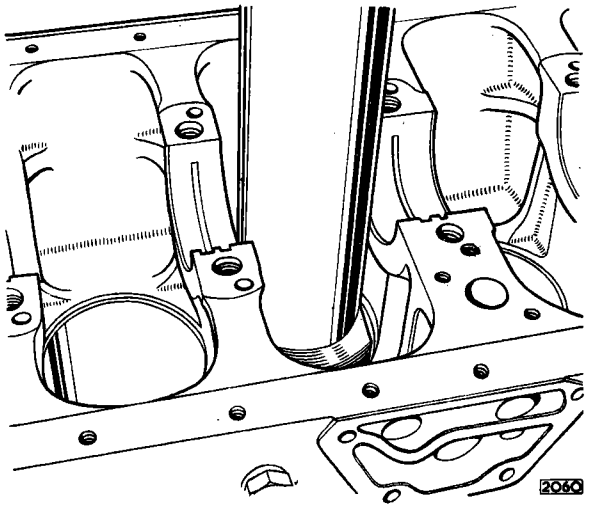


Fig. No. 49 *Pressing out a cylinder liner using a stepped block*

Following reboring, the blanking plugs in the main oil gallery should be removed and the cylinder block oilways and crankcase interior thoroughly cleaned.
When dry, coat the interior of the crankcase with an oil and heat resisting paint.
Check all welch washers fitted to the cylinder block and renew any which show signs of leaking.

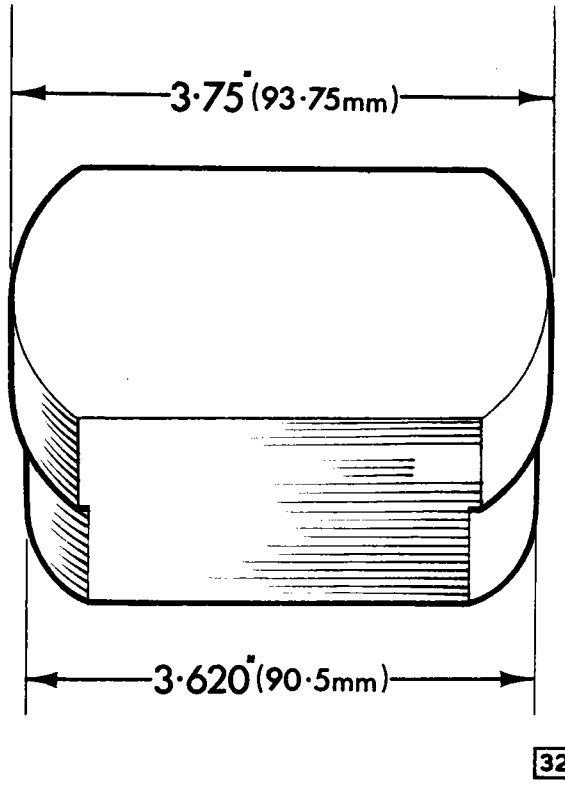


Fig. No. 50 *Dimensions for stepped block for cylinder liner removal*

Rebuilding the Engine
Refit the crankshaft as detailed on page A.37.
Replace the pistons and connecting rods as detalied on page A.22.
Refit the cylinder head as described on page A.18.

Refitting the Engine
Refit the engine by reversing the removal procedure, detailed on page A.32.

SPARKING PLUG INSERTS

If it becomes necessary to fit sparking plug inserts due to a stripped thread in the cylinder head spark plug holes, proceed as follows :-
Bore out the stripped thread to .75" (19.05 mm.) diameter and tap out to $\frac{1}{2}$" B.S.P. as shown in Fig. 51.
Make a counterbore $\frac{57}{64}$" (22.62 mm.) diameter to take the larger diameter of the insert as shown in Fig. 51.
Fit the screwed insert (C.22381) ensuring that it sits firmly in the face at the bottom of the thread.
Drill and ream a $\frac{1}{8}$" (3.17 mm.) diameter hole $\frac{3}{16}$" (4.76 mm.) deep between the side of the insert and the cylinder head as shown in Fig. 52.
Drive in the locking pin and make sure that the pin is below the surface as in Fig. 52. Secure by peening over the aluminium on the chamfered portion of the insert and also the locking pin.

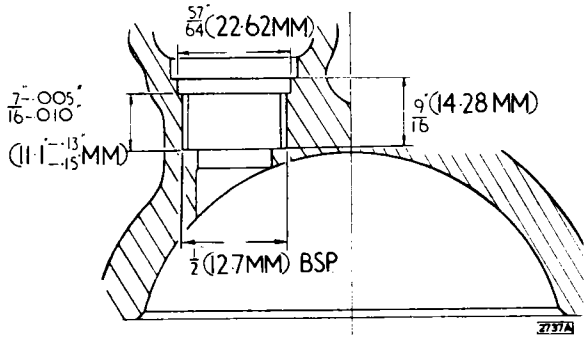


Fig. No. 51 *Boring and tapping instructions for spark plug inserts*

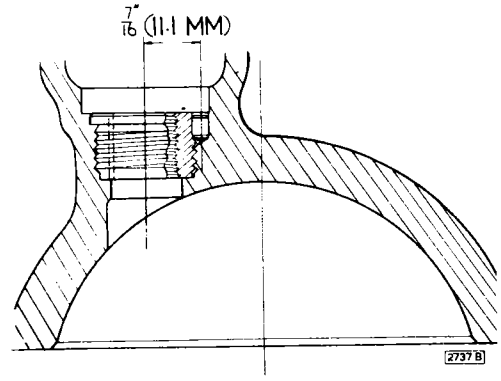


Fig. No. 52 *Fitting the screwed inserts*

CARBURETTERS AND FUEL SYSTEM

SECTION B

INDEX

CARBURETTERS

PETROL PUMP

CARBURETTERS

DESCRIPTION

The Power Unit is fitted with twin H.D.8 type carburetters. The enrichment device for starting consists of an auxiliary carburetter attached to the front carburetter.

The jet, which is fed through its lowest end, is attached to a synthetic rubber diaphragm by means of a jet cup and jet return spring cup, the centre of the diaphragm being compressed between these two parts; at its outer edge it is held between the diaphragm casing and the float chamber arm. The jet is controlled by the jet return spring and the jet actuating lever, the latter having an external adjusting screw which limits the upward travel of the jet and thus controls the mixture adjustment; screwing it in (clockwise) enriches the mixture, and unscrewing it weakens the mixture.

Idling

The carburetter idles on the main jet and the mixture is conducted along the passageway connecting the choke space to the other side of the throttle disc.

The quantity of the mixture passing through the passageway and, therefore, the engine idling speed, is controlled by the slow-run valve. It follows that, when idling, the throttle remains closed against the bore of the carburetter.

DATA

Type	S.U. H.D.8 (twin)
Size	2" (5.08 cm.)
Jet needle type	UM
Jet size	.125" (3.17 mm.)
Auxiliary starting carburetter needle type	425/8

Note: The jet needle type is stamped on the side or top face of the parallel portion of the needle. The auxiliary starting carburetter needle is stamped with the large number on the shoulder of the needle with the small number on the parallel portion of the needle.

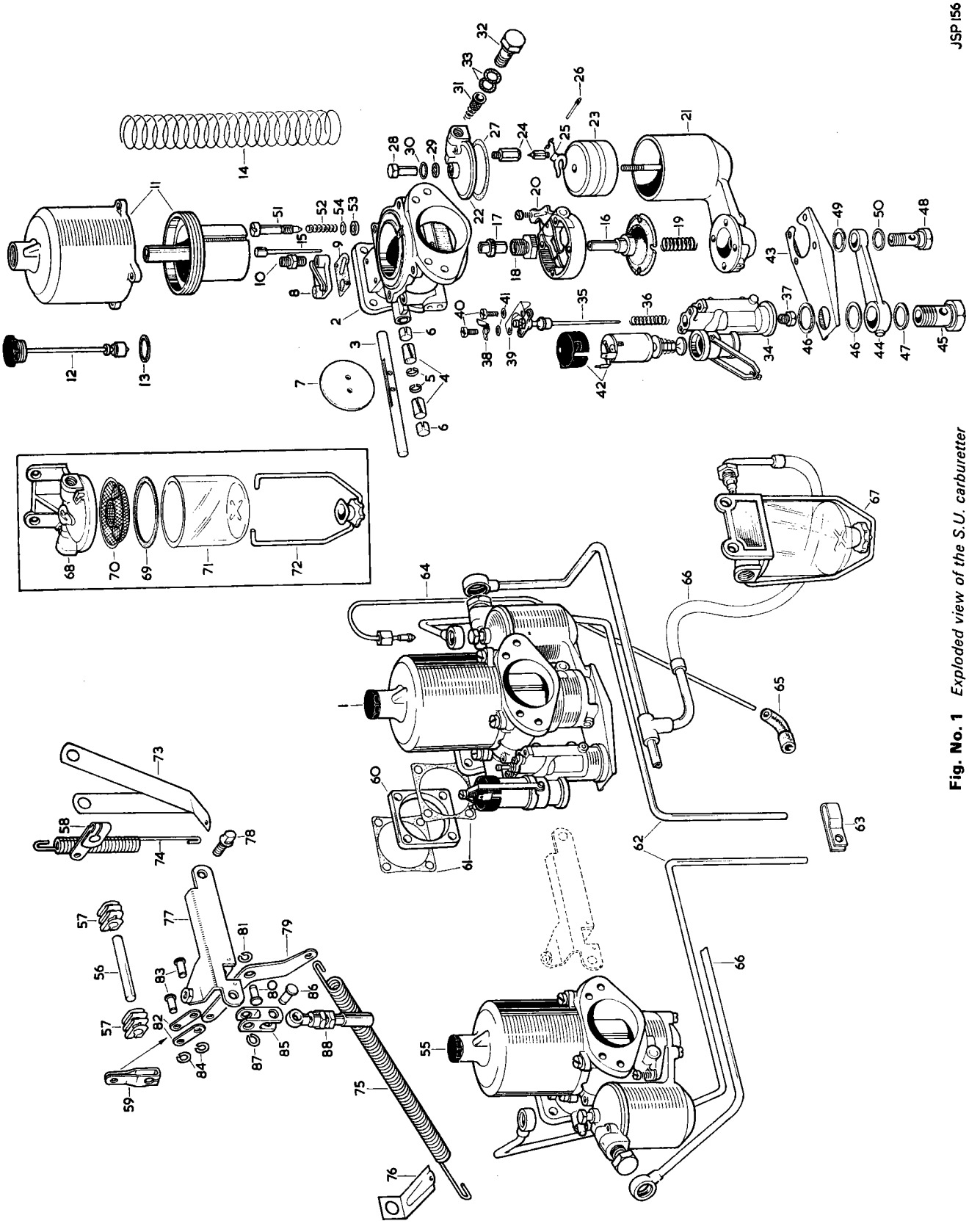


Fig. No. 1 *Exploded view of the S.U. carburetter*

1 Front carburetter assembly
2 Body
3 Throttle spindle
4 Bush
5 Retaining ring
6 Retaining ring
7 Throttle disc
8 Adaptor
9 Gasket
10 Ignition union
11 Suction chamber
12 Damper assembly
13 Washer
14 Springs
15 Jet needle
16 Jet assembly
17 Jet bearing
18 Nut
19 Spring
20 Jet housing
21 Float chamber
22 Lid
23 Float
24 Needle and seat
25 Lever
26 Knurled pin
27 Gasket
28 Cap nut
29 Serrated washer
30 Aluminium washer
31 Filter
32 Banjo bolt
33 Fibre washer
34 Thermostat washer
35 Acceleration needle assembly
36 Spring
37 Jet
38 Spring
39 Dust shield
40 Screw
41 Shakeproof washer
42 Solenoid
43 Bracket
44 Connecting arm
45 Banjo bolt
46 Washer
47 Washer
48 Banjo bolt
49 Fibre washer
50 Aluminium washer
51 Valve
52 Spring
53 Gland washer
54 Dished washer
55 Rear carburetter
56 Connecting rod
57 Coupling
58 Lever (front)
59 Lever (rear)
60 Insulator
61 Gasket
62 Overflow pipe
63 Clip
64 Suction pipe
65 Elbow (P.V.C.)
66 Petrol feed pipe
67 Petrol filter
68 Filter casting
69 Sealing washer
70 Filter gauze
71 Glass bowl
72 Retaining strap
73 Bracket assembly
74 Throttle return spring
75 Throttle return spring
76 Bracket
77 Stop bracket
78 Dowel bolts
79 Intermediate lever
80 Clevis pin
81 Circlip
82 Intermediate throttle link
83 Clevis pin
84 Circlip
85 Trunnion
86 Clevis pin
87 Circlip
88 Throttle link rod

ROUTINE MAINTENANCE

EVERY 3,000 MILES (5,000 KM.)
Lubricate Carburetter Piston Damper
Each carburetter is fitted with an hydraulic piston damper which, unless periodically replenished with oil, will cause poor acceleration and spitting back through the carburetter on rapid opening of the throttle.
To replenish with oil, unscrew the cap on top of suction chambers and lift out the damper valve which is attached to the cap. Fill the hollow piston spindle, which can be seen down inside the bore of the suction chamber, with S.A.E.20 engine oil.

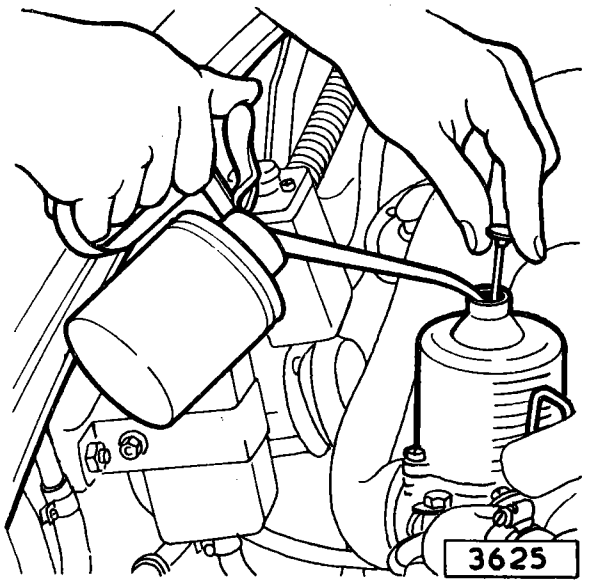


Fig. No. 2 *Topping up the hydraulic damper*

Check Carburetter Slow Running
(A) Cars fitted with synchromesh gearbox
The idling speed of the engine when fully warmed up should be set at 700 r.p.m.
If the idling speed is less than 700 r.p.m. or if the engine is not idling smoothly, chatter from the constant mesh gears may be noticeable.

(B) Cars fitted with automatic transmission
The idling speed of the engine when fully warmed up should be set at 500 r.p.m. with P. or N. selected — there will be a slight reduction of idling speed when D1 or D2 is engaged.

EVERY 6,000 MILES (10,000 KM.)
Tune Carburetters
See instructions on page B.7.

Cleaning Carburetter Filters
Removal of the bolt securing the petrol pipe banjo union to each float chamber will expose the filters. Remove the filters and clean in petrol; do not use a cloth as particles will stick to the gauze.
When refitting, insert the filter with the spring first and ensure that the fibre washers are replaced one to each side of the banjo union.

Fuel Feed Line Filter
The filter is attached to the right-hand side wing valance and is of the glass bowl type with a filter gauze.
At the recommended intervals, or more frequently if the glass bowl shows signs of becoming full of sediment, slacken the locking nut, swing the retaining clip to one side, and remove bowl, sealing washer and filter gauze.
Clean the filter gauze and bowl by washing in petrol. Examine the sealing washer and if necessary fit a new one.

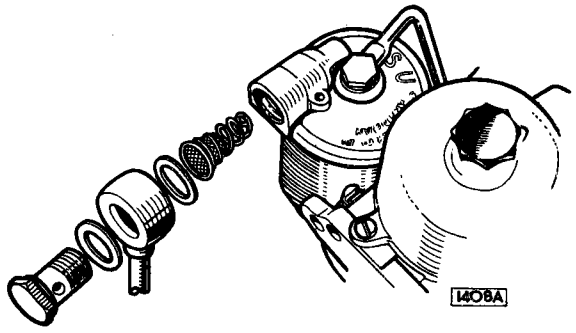


Fig. No. 3 *Carburetter filter removal*

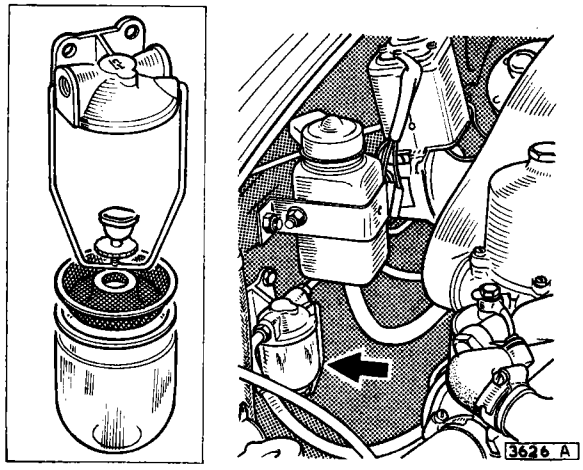


Fig. No. 4 *Fuel feed line filter*

CARBURETTERS

Removal

Remove the air intake pipe from the carburetters.
Remove the petrol feed pipes at the banjo connections of each float chamber, collecting the filters and fibre washers.
Withdraw the distributor vacuum advance pipe completely.
Disconnect the petrol feed from the auxiliary starting carburetter and the petrol overflow pipes from the clip on the oil filter head.
Disconnect the cables from the automatic choke.
Remove the circlip and withdraw the clevis pin to disconnect the throttle link rod.
On automatic transmission cars, remove the spring clip securing the kick-down link located at the rear of the rear carburetter.
Disconnect the throttle return spring from the intermediate throttle lever.
Unscrew the four nuts securing each carburetter to the inlet manifold and withdraw the carburetters.

Refitting

Refitting is the reverse of the removal procedure. Renew the carburetter/manifold gaskets. Two gaskets are fitted to each carburetter, one either side of the heat insulator pads.

CLEANING THE SUCTION CHAMBER AND PISTON

This should be done at approximate intervals of every twelve months or if the carburetter is dismantled for any reason. After detaching, clean the main inside bore of the suction chamber and the two outside diameters of the piston with a rag moistened in petrol or thinners, and then reassemble in a dry and clean condition with a few spots of thin oil on the piston rod only. Do NOT use metal polish to clean the suction chamber and piston.

CARBURETTER TUNING

It is useless to attempt carburetter tuning until the cylinder compressions, valve clearances, sparking plug gaps and contact breaker point gaps have been tested, checked and adjusted, if necessary. The distributor centrifugal advance mechanism and vacuum advance operation should be checked and ignition timing set to the correct figure. For final road test, adjustment of not more than six clicks of the micrometer adjustment at the distributor to either advance or retard is permitted. The ignition setting is important since, if retarded or advanced too far, the setting of the carburetters will be affected.
Only two adjustments are provided at the carburetters: (i) The slow running volume screw (A) (Fig. 5) governing idling speed, and (ii) the mixture adjusting screws (B) governing mixture strength. Correct setting of the mixture strength at idling speed ensures that the carburetters are correctly adjusted throughout their entire range.
Ensure that the needles are correctly located in the pistons, that is, with the shoulder of the needles flush with the base of the pistons. Check over the carburetters and ensure that pistons are free in the suction chambers, petrol filters clean, and hydraulic piston

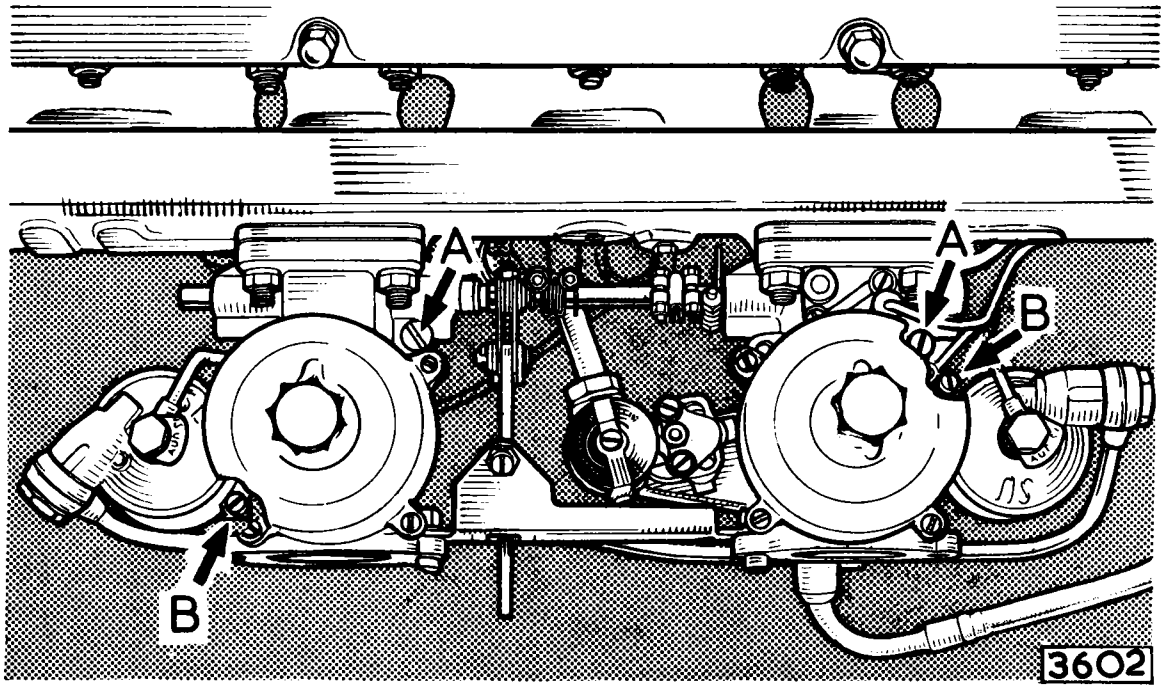


Fig. No. 5 Carburetter tuning. *"A" Slow running volume screw. "B" Mixture adjusting screw.*

dampers topped up with the recommended grade of engine oil. Lubricate the throttle controls and check for free operation and full travel.

Before carrying out the instructions which follow, it is desirable to ensure that the mixture strength of both carburetters is correct. To do this, screw out both mixture screws until the tops of the jets are flush with the jet bridge in each carburetter body; this can be observed through the piston chamber after removal of the suction chamber and piston. Screw in the mixture screws until the jets start to move and then rotate screws a further $3\frac{1}{2}$ turns.

Slacken one clamp bolt on the coupling between the throttle spindles, check that both butterfly valves are fully closed by rotating both spindles clockwise when viewed from the front. Tighten the coupling clamp bolt. Screw in (rotate clockwise) the slow running volume screws until they are down fully in their seatings. Unscrew each screw $2\frac{1}{2}$ turns.

Run the engine until the normal operating temperature is reached and check that both carburetters are sucking equally by placing one end of a length of rubber tube to the ear and the other end inside of each carburetter intake in turn. Rotate the slow running volume screws until the carburetters are synchronised, that is, are sucking equally and the engine is idling at approximately 500 r.p.m. on cars fitted with automatic transmission, 700 r.p.m. manual transmission cars.

Recheck that both butterfly valves are fully closed by rotating the throttle spindles (in a clockwise direction looking from the front) and noting if any change in engine speeds results; no change in engine speed or note should result if the butterfly valves are fully closed.

Recheck the mixture by screwing the mixture screws up (weaker) or down (richer) by the same amount until the fastest idling speed consistent with even running is obtained.

As the mixture is adjusted, the engine will probably run faster and it may be necessary to adjust the slow running screws to retain the correct idling speed.

Check the mixture strength by lifting the piston of the front carburetter by approximately $\frac{1}{32}$" (.08 mm.) if when:— the engine speed increases and continues to run faster, the mixture is too rich; the engine speed immediately decreases, the mixture is too weak; the engine speed momentarily increases very slightly, the mixture is correct.

Repeat the operation for the rear carburetter and, after adjustment, re-check the front carburetter as both are inter-dependent.

When the mixture is correct, the exhaust note should be regular and even. If it is irregular with a splashy type of mis-fire and colourless exhaust, the mixture is too weak. If there is a regular or rhythmical misfire in the exhaust note with a blackish exhaust, then the mixture is too rich.

Float Chamber Fuel Level

When the fuel level setting is correct a $\frac{7}{16}$" (11.1 mm.) test bar will just slide between the lid face and the inside curve of the float lever fork when the needle valve is in the "shut-off" position.

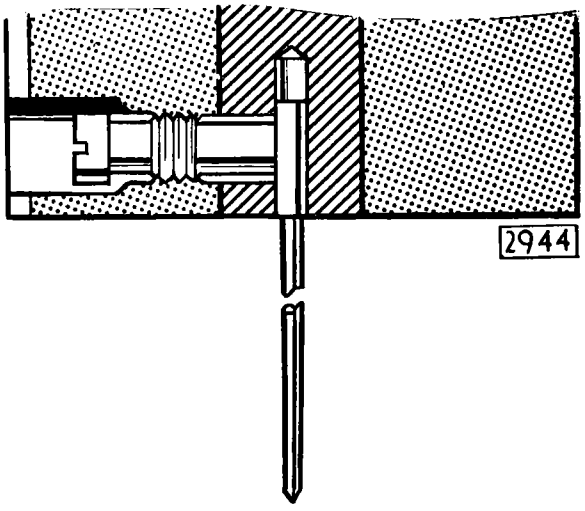


Fig. No. 6 *Positioning the jet needle*

If the float lever fails to conform with this check figure, it must be carefully bent at the start of the fork section, in the necessary direction for correction. Take care to keep both prongs of the fork level with each other and maintain the straight portion of the lever dead flat.

When setting the fuel lever, ensure that the spring loaded plunger (A) in the "Delrin" needle is not compressed.

It is not advisable to alter the fuel level unless there is trouble with flooding; although too high a level can cause slow flooding, particularly when a car is left ticking over on a steep drive. It should also be remembered that flooding can also be caused by grit in the fuel jamming open the needle valve; undue friction in the float gear; excessive engine vibration, or a porous float.

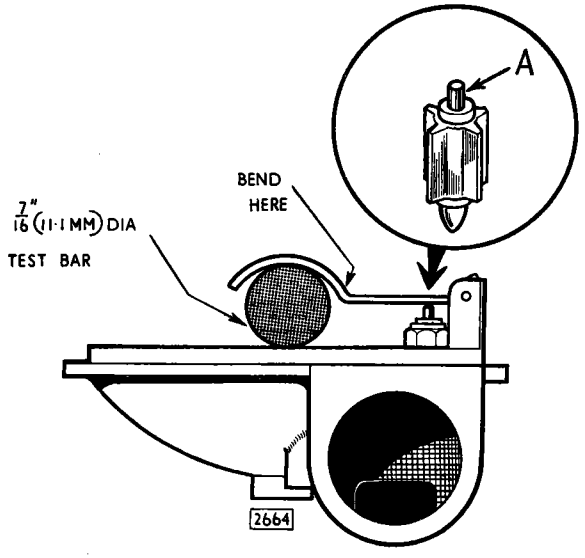


Fig. No. 7 *Checking the float lever setting*

CENTRING THE JET

Warning: Take care not to bend the carburetter needle when carrying out this operation.

Remove the carburetter from the engine as described on page B.7.

Remove the four setscrews securing the float chamber to the carburetter body. Remove the float chamber, jet housing and jet. Remove the hydraulic damper.

With a ring spanner slacken the jet locking nut approximately half a flat. Replace the jet and diaphragm assembly.

The jet is correctly centred when the piston falls freely and hits the jet "bridge" with a metallic click. To centre the jet, push the jet and diaphragm assembly as high as possible with the hand, and with a pencil or rod gently press the piston down on to the jet bridge; centralisation will be facilitated if the side of the carburetter body is tapped lightly. Tighten the jet locking nut.

The actual centring must be carried out with the setscrew holes in the jet diaphragm and carburetter in alignment. After tightening the jet locking nut the jet diaphragm must be kept in the same position relative to the carburetter body; the simplest way to do this is to mark one of the corresponding jet diaphragm and carburetter body setscrew holes with a soft pencil. Failure to do this may cause the centralisation to be upset.

Check that the centralisation is correct by noting if there is any difference in the sound of the piston hitting the jet bridge with the jet in its highest and lowest positions. If there is any difference in the sound, the procedure for centralising the jet will have to be repeated.

If difficulty in centring the jet is encountered after carrying out the above procedure, the jet needle can be lowered slightly in the piston to make the centralising effect more positive. The needle must, however, be restored to the normal position when checking the centralisation.

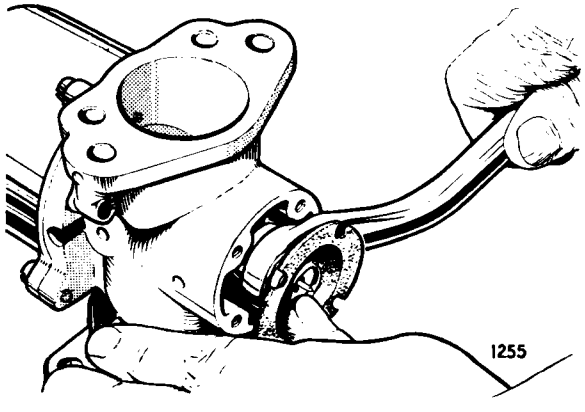


Fig. No. 8 *Centring the jet*

THE AUXILIARY STARTING CARBURETTER

Description (Fig. 9)

The enrichment apparatus for starting is, in effect, an auxiliary carburetting system. The main body casting (1) containing a solenoid-operated valve and fuel metering system is illustrated as a separate unit attached by means of a ducted mounting arm to the base of the main carburetter fuel inlet.

The auxiliary carburetter forms, therefore, a separate unit additional to the normal float chamber retained by the hollow cross-drilled bolt.

Fuel is supplied to the base of the jet (9), which is obstructed to a greater or lesser degree by the tapered slidable needle (10).

When the device is in action, air is drawn from atmosphere through the air intake (7) and thence through the passage (8), being carburetted with fuel as it passes the jet (9). The mixture is thence carried upwards past the shank of the needle (10) through the passage (14) and so past the aperture provided between the valve (3) and its seating (2). From here it passes directly to the inlet manifold through an external feed pipe.

The device is brought into action by energising the winding of the solenoid (5) from the terminals (6). The centrally located iron core (4) is thus raised magnetically, carrying with it the ball-jointed disc valve (3) against the load of the small conical spring and thus uncovering the aperture provided by the seating (2).

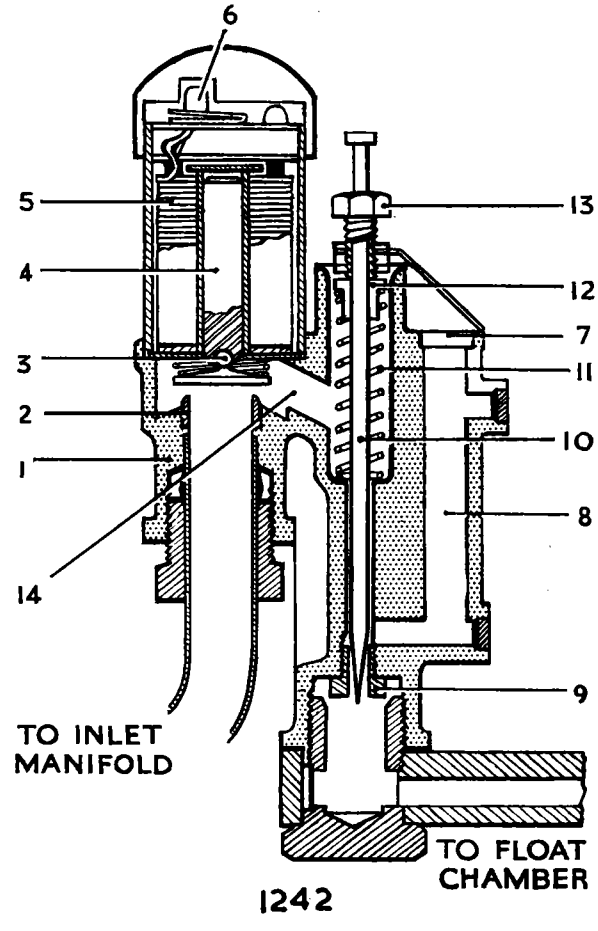


Fig. No. 9 *Sectioned view of the auxiliary starting carburetter*

Considering the function of the slidable needle (10), it will be seen that this is loaded upwards in its open position by means of the light compression spring (11) which abuts against a disc (12) attached to the shank of the needle. The needle continues upwards through the vertically adjustable stop (13) in which it is slidable mounted and it finally terminates in an enlarged head. Depression within the space surrounding the spring (11) is directly derived from that prevailing in the induction tract, and this exerts a downward force upon the disc (12), which is provided with an adequate clearance with its surrounding bore. This tends to overcome the load of the spring (11) and to move the needle downwards, thus increasing the obstruction afforded by the tapered section which enters the jet (9). The purpose of this device is to provide two widely different degrees of enrichment, the one corresponding to idling or light cruising conditions and the other to conditions of open throttle or full-power operation. In effect, under the former conditions the high induction depression prevailing will cause the disc (12) to be drawn downwards, drawing the tapered needle into the jet (9), while under the latter, the lower depression existing in the induction tract will permit the collar to maintain its upward position with the needle withdrawn from the jet.

The tuning elements concerned in this device are the size and degree of taper of the lower end of the needle (10), the diameter of the disc (12), the load provided by the spring (11) and the degree of movement permitted to the needle assembly, as determined by the adjustment of the stop (13).

The solenoid (5) is energised by means of a thermostatically operated switch housed in the inlet manifold water jacket. This is arranged to bring the apparatus into action at temperatures below about 30-35 °C. (86-95 °F).

Adjustment

The engine must be at its normal running temperature before any attempt is made to tune the auxiliary enrichment device.

As it can generally be assumed that the tapered form of the needle (10), the strength of the spring (11), and the diameter of the disc (12) have already been appropriately chosen, tuning is generally confined to the adjustment of the stop screw (13). It will be appreciated that the main purpose of this adjustment is to limit the downward movement of the needle, the head of which abuts against the upper surface of the stop screw at the lower extremity of its travel. The final downward movement of this needle determines, as has been described, the degree of enrichment provided under idling conditions with the auxiliary carburetter in operation. An appropriate guide to its correct adjustment in this respect is provided by energising the solenoid when the engine has already attained its normal temperature. The stop screw (13) should be then so adjusted that the mixture is distinctly although not excessively rich, that is to say, until the exhaust gases are seen to be discernibly black in colour, but just short of the point where the engine commences to run with noticeable irregularity.

Anti-clockwise rotation of the stop will, of course, raise the needle under these conditions and increase the mixture strength, while rotation in the opposite direction will have the opposite effect. In order to energise the solenoid under conditions when the thermostatic switch will normally have broken the circuit, it is merely necessary to short-circuit the terminal of the thermostatic switch directly to earth with a screwdriver and flick open the throttles when the starting device will be heard to come into operation with a pronounced hissing noise.

Thermostatic Switch — Removal

The thermostatic switch which controls the operation of the auxiliary starting carburetter is situated at the front end of the inlet manifold water jacket.

Remove the electrical cable from the Lucar connection on the switch.

If the radiator filler cap is securely tightened, no appreciable amount of water will escape when the auxiliary starting carburetter switch is removed. Alternatively, a small amount of water can be drained from the radiator.

Remove the three securing setscrews and washers and withdraw the switch and the cork gasket.

Refitting

Refitting is the reverse of the removal procedure. A new cork gasket must be fitted when the switch is replaced. If any water has been drained from the radiator or has escaped during the removal of the switch, the radiator should be topped up to the correct level.

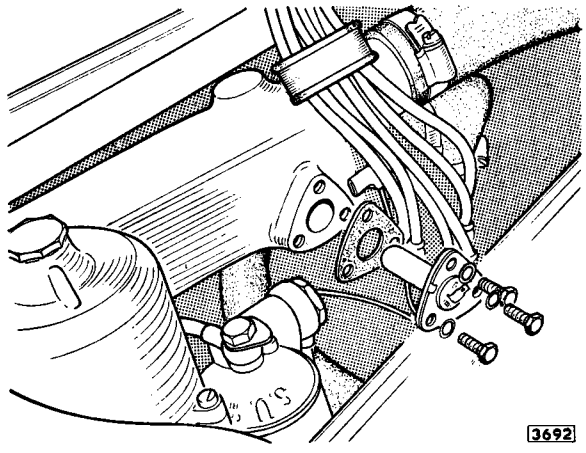


Fig. No. 10 *Removing the auxiliary starting carburetter thermostatic switch*

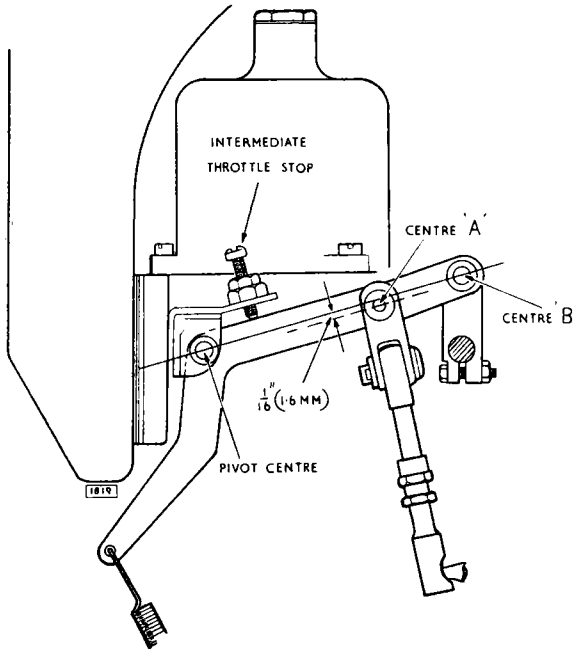


Fig. No. 11 *Throttle control linkage setting*

THROTTLE CONTROL LINKAGE SETTING

If carburetters have been removed or throttle linkages has been disturbed, particular attention must be paid to the setting adjustment of the control linkage.

To adjust, proceed as follows:—

(i) Disconnect front carburetter coupling and rear carburetter throttle lever by releasing clamp bolts.

Check that both butterflies are fully closed and that the rear carburetter coupling bolt is clearing the manifold nut. With both carburetters fully closed, retighten front coupling.

(ii) Unscrew intermediate throttle stop and push down on bell crank lever until centre "A" is $\frac{1}{16}$" (1.6 mm.) below a line from centre "B" to pivot centre (Fig. 11). When in this position screw down stop on to intermediate throttle lever and lock in position. Lock lever to carburetter spindle.

(iii) Ensure that when the throttle is closed the intermediate lever does not foul the petrol connection pipe. Open throttle fully and check that both carburetters are in the fully open position.

The Fuel System

THE PETROL PUMP

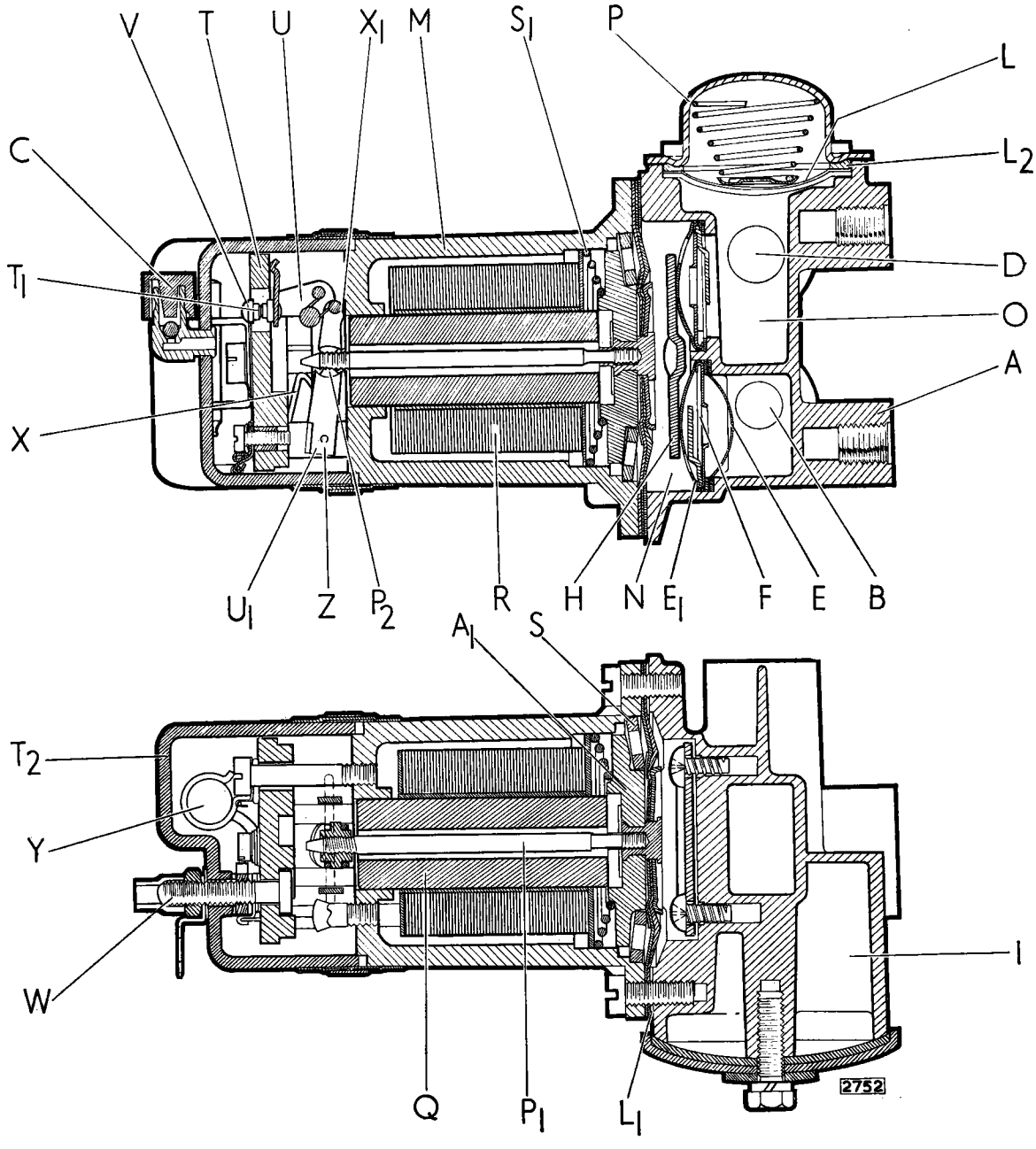


Fig. No. 12 *The petrol pump*

Warning: *If at any time, it becomes necessary to blow through the fuel feed pipes the outlet pipes must be disconnected from the pumps.*
Failure to observe this procedure will cause the Melinex valves to be displaced or damaged.

DESCRIPTION (Fig. 12)
The pump consists of three main assemblies, the main body casting (A); the diaphragm armature and magnet assembly (M) contained within the housing; and the contact breaker assembly housed within the end cap (T2). A non-return valve assembly (C) is affixed to the end cover moulding to assist the circulation of air through the contact breaker chamber.
The main fuel inlet (B) provides access to an inlet air bottle (I) while access to the main pumping chamber (N) is provided by an inlet valve assembly. This assembly consists of a Melinex valve disc (F) permanently assembled within a pressed-steel cage, held in position by a valve cover (E.1).
The outlet from the pumping chamber is provided by an identical valve assembly which operates in the reverse direction. Both inlet and outlet valve assemblies together with the filters are held in position by a clamp plate (H). The valve assemblies may be removed by detaching the clamp plate (H) after removing the self-tapping screws. A filter (E) is provided on the delivery side of the inlet valve assembly. The delivery chamber (O) is bounded by a flexible plastic spring loaded diaphragm (L) contained by a vented cover (P). Sealing of the diaphragm (L) is provided by the rubber sealing ring (L.2).

The magnetic unit consists of an iron coil housing, and iron core (Q), an iron armature (A1) provided with a central spindle (P1) which is permanently united with the diaphragm assembly (L1), a magnet coil (R) and a contact breaker assembly consisting of parts (P2), (U1), (U), (T1), (V). Between the coil housing and the armature are located 11 spherically edged rollers (S). These rollers locate the armature (A1) centrally within the coil housing and permit freedom of movement in a longitudinal direction.
The contact breaker consists of a bakelite pedestal moulding (T) carrying two rockers (U) and (U1) which are both hinged to the moulding at one end by the rocker spindle (Z). These rockers are interconnected at their top ends by means of two small springs arranged to give a throw-over action. A trunnion (P2) is carried by the inner rocker and the armature spindle (P1) is screwed into this trunnion. The outer rocker (U) is fitted with two tungsten points which contact with corresponding tungsten points which form part of the spring blade (V) connected to one end of the coil. The other end of the coil is connected to a terminal (W) while a short length of flexible wire (X) connecting the outer rocker to one of the screws holding the pedestal moulding onto the coil housing, provides an earth return to the body of the pump. It is important that the body of the pump be effectively earthed to the body of the vehicle by means of the earthing terminal provided on the flange of the coil housing.

WARNING: If at any time, it becomes necessary to blow through the fuel feed pipes, the outlet pipes must be disconnected from the pumps. Failure to observe this procedure will cause the Melinex valves to be displaced or damaged.

OPERATION
When the pump is at rest the outer rocker (U) lies in the outer position and the tungsten points are in contact. Current passes from the Lucar connector (W) through the coil and back to the blade (V), through the points and to earth, thus energising the coil and attracting the armature (A1). The armature, together with the diaphragm assembly, then retracts thereby sucking petrol through the inlet valve into the pumping chamber (N). When the armature has travelled nearly to the end of its stroke, the throw-over mechanism operates and the outer rocker moves rapidly backwards, thus separating the points and breaking the circuit.
The spring (S1) then re-asserts itself, forcing the armature and diaphragm away from the coil housing. This action forces petrol through the delivery valve at a rate determined by the requirements of the engine. As the armature nears the end of its stroke the throw-over mechanism again operates, the tungsten points remake contact and the cycle of operations is repeated. The spring blade (V) rests against the small projection moulding (T) and it should be set so that when the points are in contact, it is deflected away from the moulding. The gap at the points should be approximately 0.030" (0.75 mm.) when the rocker (U) is manually deflected until it contacts the end face of the coil housing.

REMOVAL
Disconnect the feed and earth cables from the pump. Remove two nuts and locking washers securing the pump clamp to the mounting studs.
Remove the pump and disconnect the inlet and outlet pipes by withdrawing the banjo bolts and washers.
Examine the rubber insulated mounting studs for deterioration, and replace if necessary, otherwise excessive petrol pump noise may result.

REFITTING
Refitting is the reverse of the removal procedure.

DISMANTLING (Fig. 13)
Contact Breaker
Remove the insulated sleeve (33), terminal nut (32) and connector (31), with its shakeproof washer.
Remove the tape seal (if fitted) and take off the end cover.
Unscrew the 5 B.A. screw (24) which holds the contact blade (22) to the pedestal (16) and remove the condenser (25) from its clip. This will allow the washer (23), the terminal tag (11), and the contact blade to be removed.

Coil Housing and Diaphragm
Unscrew the coil housing securing screws (7), using a thick-bladed screwdriver to avoid damaging the screw heads.
Remove the earthing screw (9).
The coil housing (6) may now be removed from the body (1). Next remove the diaphragm and spindle assembly (2) by taking hold of the diaphragm and unscrewing it anti-clockwise until the armature spring (5) pushes the diaphragm away from the coil housing.

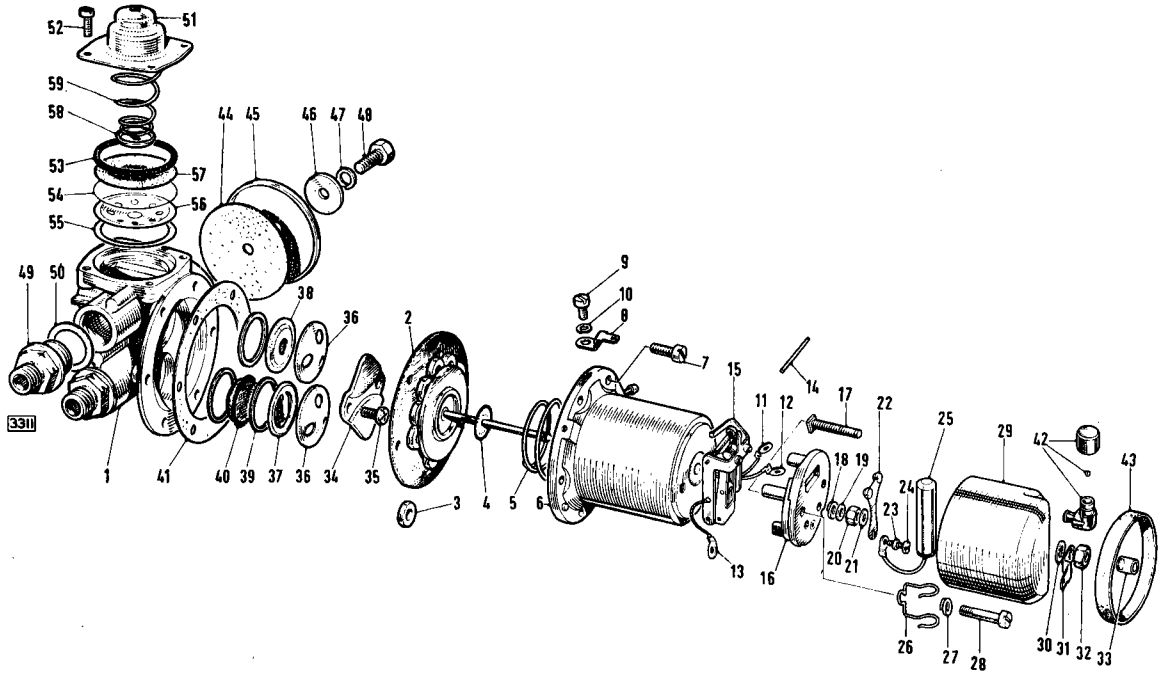


Fig. No. 13 *Exploded view of the petrol pump*

1 Pump body
2 Diaphragm and spindle assembly
3 Armature centralising roller
4 Impact washer
5 Armature spring
6 Coil housing
7 Screw
8 Earth connector
9 Screw
10 Spring washer
11 Terminal tag
12 Terminal tag
13 Earth tag
14 Rocker pivot pin
15 Rocker mechanism
16 Pedestal
17 Terminal stud
18 Spring washer
19 Lead.washer
20 Terminal nut
21 Washer
22 Contact blade
23 Washer
24 Screw
25 Condenser
26 Clip
27 Spring washer
28 Screw
29 End cover
30 Shakeproof washer
31 Lucar connector
32 Nut
33 Insulating sleeve
34 Clamp plate
35 Screw
36 Valve cap
37 Inlet valve
38 Outlet valve
39 Sealing washer
40 Filter
41 Diaphragm gasket
42 Vent valve
43 Sealing band
44 Inlet air bottle cover joint
45 Inlet air bottle cover
46 Dished washer
47 Spring washer
48 Screw
49 Outlet connection
50 Fibre washer
51 Cover (delivery flow smoothing device)
52 Screw
53 "O" ring
54 Diaphragm barrier
55 Sealing washer
56 Diaphragm plate
57 Rubber diaphragm
58 Spring end cap
59 Diaphragm spring

It is advisable to hold the housing over the bench so that the 11 brass rollers (3) will not fall on the floor. The diaphragm and its spindle are serviced as a unit and should not be separated.

Pedestal and Rocker
Remove the end-cover seal washer (21), unscrew the terminal nut (20), and remove the lead washer (19). This will have flattened on the terminal tag and thread and is best cut away with cutting pliers or a knife. Unscrew the two B.A. screws (28), holding the pedestal to the coil housing, remove the earth terminal tag (13) together with the condenser clip (26). Tip the pedestal and withdraw the terminal stud (17) from the terminal tag (12). The pedestal (16) may now be removed with the rocker mechanism (15) attached.
Push out the hardened steel pin (14) which holds the rocker mechanism to the pedestal and separate the two.

Body and Valves
Unscrew the two Phillips screws (35) securing the valve clamp plate (34), remove the valve caps (36), valves (37) and (38), sealing washers and filter (40).
Note: Dismantling of the delivery flow smoothing device should only be undertaken if the operation of it is faulty, and if the necessary pressure-testing equipment after assembly is available. In this understanding proceed as follows:—
Remove the 4 B.A. screws (52) securing delivery flow-smoothing device vented cover (51), remove the cover, the diaphragm spring (59), rubber 'O' ring (53), spring cap (58), diaphragm (57), barrier (54), diaphragm plate (56) and sealing washer (55).
Remove the single 2 B.A. screw (48), securing the inlet air bottle cover (45). Remove the cover and gasket (44).
Unscrew the inlet and outlet connections.

INSPECTION
If gum formation has occurred in the fuel used in the pump, the parts in contact with the fuel will have become coated with a substance similar to varnish. This has a strong stale smell and may attack the neoprene diaphragm. Brass and steel parts so affected can be cleaned by being boiled in a 20 per cent. solution of caustic suds, dipped in a strong nitric acid solution and finally washed in boiling water. Light alloy parts must be well soaked in methylated spirits and then cleaned.
Clean the pump and inspect for cracks, damaged joint faces, and threads.
Examine the plastic valve assemblies for kinks or damage to the valve plates. They can best be checked by blowing and sucking with the mouth.
Check that the narrow tongue on the valve cage, which is bent over to retain the valve and to prevent it being forced out of position, has not been distorted but allows a valve lift of approximately $\frac{1}{16}$" (1.6 mm.).
Examine the delivery flow-smoothing device diaphragm, barrier, plate, spring, and spring cap for damage. If in doubt, renew the diaphragm.
Examine the inlet air bottle cover for damage.
Examine the valve recesses in the body for damage and corrosion; if it is impossible to remove the corrosion, or if the recess is pitted, the body must be discarded.
Clean the filter with a brush and examine for fractures, renew if necessary.
Examine the coil lead tag for security and the lead insulation for damage.
Examine the contact breaker points for signs of burning or pitting; if this is evident, the rocker assembly and spring blade must be renewed.
Examine the pedestal for cracks or other damage, in particular to the narrow ridge on the edge of the rectangular hole on which the contact blade rests.
If fitted, examine the non-return vent valve in the end-cover for damage, ensure that the small ball valve is free to move.
Examine the diaphragm for signs of deterioration.
Renew the following parts: all fibre and cork washers, gaskets, and 'O' section sealing rings, rollers showing signs of wear on periphery, damaged bolts and unions.

ASSEMBLY
Pedestal and Rocker
Note: The steel pin which secures the rocker mechanism to the pedestal is specially hardened and must not be replaced by other than a genuine S.U. part.
Invert the pedestal and fit the rocker assembly to it by pushing the steel pin (14) (Fig. 13) through the small holes in the rockers and pedestal struts. Then position the centre toggle so that, with the inner rocker spindle in tension against the rear of the contact point, the centre toggle spring is above the spindle on which the white rollers run. This positioning is important to obtain the correct "throw-over" action; it is also essential that the rockers are perfectly free to swing on the pivot pin and that the arms are not binding on the legs of the pedestal.
If necessary the rockers can be squared up with a pair of thin-nosed pliers.
Assemble the square-headed 2 B.A. terminal stud to the pedestal, the back of which is recessed to take the square head.
Assemble the 2 B.A. spring washer (1) (Fig. 14), and put the terminal stud through the 2 B.A. terminal tag (2), then fit the lead washer (3) and the coned nut with its

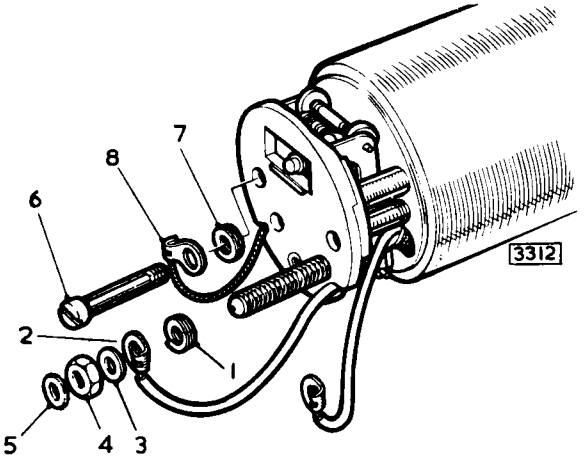


Fig. No. 14 *Attaching the pedestal to the coil housing*

coned face to the lead washer. (This makes better contact than an ordinary flat washer and nut). Tighten the 2 B.A. nut and finally add the end-cover seal washer (5).
Assemble the pedestal to the coil housing by fitting the two B.A. pedestal screws (6), ensuring that the spring washer (7) on the left-hand screw (9 o'clock position) is between the pedestal and earthing tag (8). When a condenser is fitted, its wire clip base is placed under the earthing tag and the spring washer is dispensed with. Tighten the screws, taking care to prevent the earthing tag (8) from turning, as this will strain or break the earthing flex. Do not overtighten the screws or the pedestal will crack.
Do not fit the contact blade at this stage.

Diaphragm Assembly
Place the armature spring into the coil housing with its larger diameter towards the coil (Fig. 13).
Before fitting the diaphragm make sure that the impact washer is fitted to the armature. (This is a small neoprene washer that fits in the armature recess). Do not use jointing compound or dope on the diaphragm.
Fit the diaphragm by inserting the spindle in the hole in the coil and screwing it into the threaded trunnion in the centre of the rocker assembly.
Screw in the diaphragm until the rocker will not "throw-over"; this must not be confused with jamming the armature on the coil housing internal steps.
Fit the 11 brass centralising rollers by turning back the diaphragm edge and dropping the rollers into the coil recess. The pump should be held in the left hand, rocker end downwards, to prevent rollers from falling out.
Fit the contact blade and adjust the finger setting as described under those headings, then carefully remove the contact blade.
Holding the coil housing assembly in the left hand in an approximately horizontal position (see Fig. 15), push the diaphragm spindle in with the thumb of the right hand, pushing firmly but steadily. Unscrew the diaphragm, pressing and releasing with the thumb of the right hand until the rocker just "throws over". Now turn the diaphragm back (unscrew) to the nearest hole and again 4 holes (two-thirds of a complete turn). The diaphragm is now correctly set.
Press the centre of the armature and fit the retaining fork at the back of the rocker assembly. This is done to prevent the rollers from falling out when the coil housing is placed on the bench prior to fitting the body, and it is not intended to stretch the diaphragm before tightening the body screws.

Body Components
In the AUF 301 pump the valve assemblies are retained internally in the body by a clamp plate secured with self-tapping screws. The inlet valve recess in the body is deeper than the other recess to allow for the filter and extra washer. Another feature of these pumps is the incorporation of an air bottle on the inlet and a flow-smoothing device on the delivery side.
The inlet air bottle is a chamber in the body casting blanked off by a simple cover and joint washer held by a single screw. The delivery flow-smoothing device is formed by a perforated metal plate which is in contact with a plastic barrier backed by a rubber diaphragm, all held in position by a spring and end-cap retained by a vented cover. This assembly seals the delivery chamber in the body.
Screw in the inlet and outlet connections with their sealing rings. Assemble the outlet valve components into the outlet recess in the following order, first a joint washer, then the valve, tongue side downwards, then the valve cap.
Assemble the inlet valve into the inlet recess as follows: first a joint washer, then the filter, dome side downwards, then another joint washer, followed by the valve assembly, tongue side upwards, then the valve cap.
Take care that both valve assemblies nest down in their respective recesses, place the clamp plate on top, and tighten down firmly to the body with the two screws.

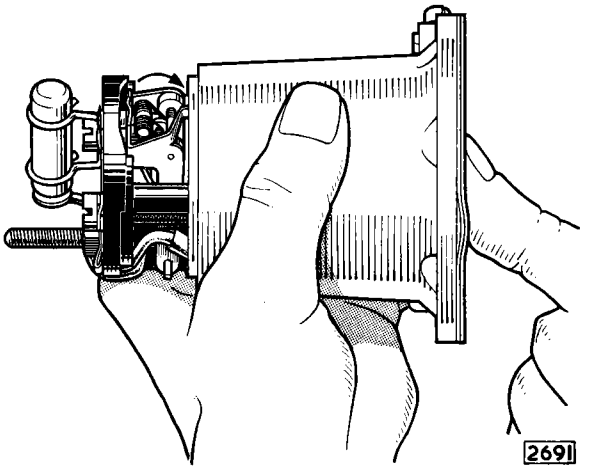


Fig. No. 15 *Checking the "throw-over" of the toggle*

Replace the inlet air bottle cover with its joint washer and tighten down the central screw.

Place the sealing washer in the bottom of the delivery flow-smoothing device recess (see Fig. 13), follow this with the perforated diaphragm plate, dome side downwards, then the plastic barrier, followed by the rubber diaphragm. Insert the 'O' section sealing ring into the recess and ensure that it seats evenly. Place the diaphragm spring, large end towards the vented cover, into the cover, place the spring end-cap on the small end of the spring, pass the assembly tool through the cover, spring, and end cap and turn it through 90° so that tension may be applied to the spring during assembly. Finally fit the spring and cap assembly onto the diaphragm, tighten the four retaining screws, and release the assembly tool. The pump should be pressure-tested after disturbance of the flow-smoothing device.

Body Attachment
Fit the joint washer to the body, aligning the screw holes.
Offer up the coil housing to the body, ensuring correct seating between them.
Line up the six securing screw holes, making sure that the cast lugs on the coil housing are at the bottom, insert the six 2 B.A. screws finger-tight. Fit the earthing screw with its Lucar connector.
Remove the roller retaining fork before tightening the body securing screws, making sure that the rollers retain their position; a displaced roller will cut the diaphragm. It is not necessary to stretch the diaphragm before tightening the securing screws.
Tighten the securing screws in sequence as they appear diametrically opposite each other.

Contact Blade (Fig. 16)
Fit the contact blade and coil lead to the pedestal with the 5 B.A. washer and screw. The condenser tag should be placed under the coil lead tag.
Adjust the contact blade so that the points are a little above the contact points on the rocker when the points are closed so that when the contact points make or break, one pair of points completely covers the other. As the contact blade is provided with a slot for the attachment screw, some degree of adjustment is possible.
Tighten the contact blade attachment screw when the correct setting is obtained.

Contact Gap Setting
Check that when the outer rocker is pressed onto the coil housing, the contact blade rests on the narrow rib or ridge which projects slightly above the main face of the pedestal. If it does not, slacken the contact blade attachment screw, swing the blade clear of the pedestal, and bend it downwards a sufficient amount so that when repositioned it rests against the rib lightly, over-tensioning of the blade will restrict the travel of the rocker mechanism. Correct positioning gives a gap of .035" ± .005" (0.9 mm. ± .13 mm.) between pedestal and tip of spring blade (Fig. 16).
Check the gap between rocker finger and coil housing with a feeler gauge, bending the stop-finger, if necessary, to obtain a gap of 0.070" ± 0.005" (1.8 mm. ± 0.13 mm.).

End-Cover
Tuck all spare cable into position so that it cannot foul the rocker mechanism. Ensure that the end-cover seal washer is in position on the terminal stud, fit the bakelite end-cover and lock washer, secure with a brass nut, fit the terminal tag or connector, and the insulated sleeve.
The pump is now ready for test.
After test replace the rubber sealing band over the end cover gap and seal with adhesive tape. This may be removed to improve ventilation when the pump is mounted internally in a moisture-free region but **must** be retained otherwise.

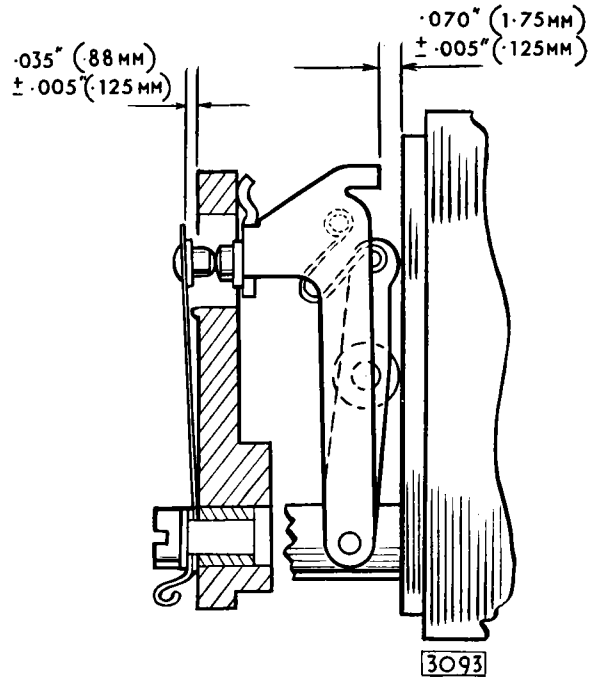


Fig. No. 16 *Rocker and contact clearances*

PETROL TANKS

Removal
It is not essential to drain the tanks as they can be lowered vertically from their mounts. The car should be raised on a hoist to allow work to be carried out from underneath.
Remove the three bolts attaching the exhaust silencers to the rubber mountings and the two bolts securing the exhaust pipes to the rear body coupling. The exhaust pipes can now be lowered.
Open the petrol filler doors and remove the filler caps. Disconnect the flexible petrol pipes from the tanks by unscrewing the unions located behind the trim panels on either side of the luggage compartment. Pull apart the snap connections to the petrol gauge units on each side.
Remove the setscrews securing the tank support cradles to the side members, unhook the cradles and remove the tanks.

Refitting
Reverse the removal procedure to refit.
Ensure that the electrical cables for the tank units are drawn up through the cover plate aperture before the tanks are attached to their mountings and that all grommets are replaced.

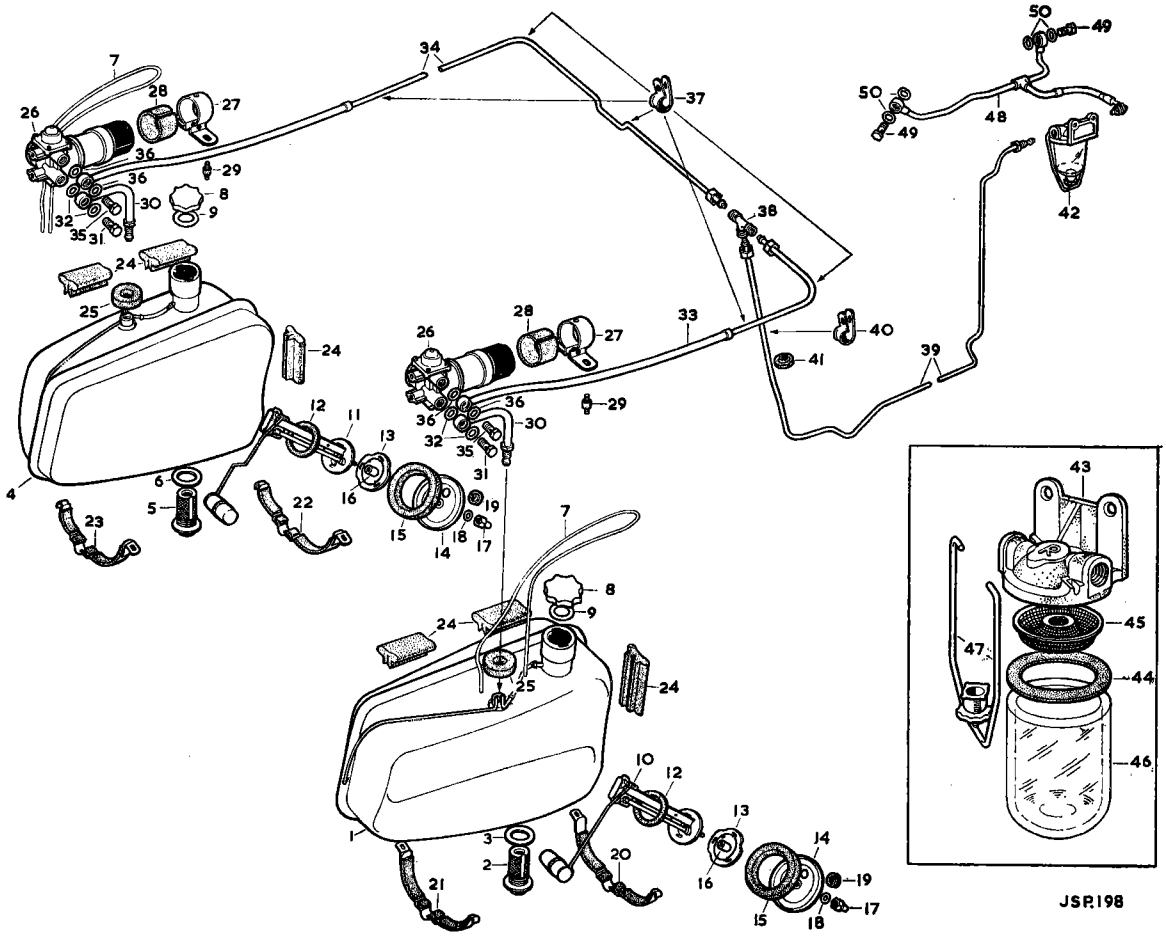


Fig. No. 17 *Exploded view of the petrol tank*

1 Petrol tank assembly R.H.
2 Petrol filter assembly
3 Washer
4 Petrol tank assembly L.H.
5 Petrol filter
6 Washer
7 Connecting tube
8 Filler cap
9 Sealing ring
10 Petrol gauge element (R.H.)
11 Petrol gauge element (L.H.)
12 Rubber seal
13 Locking ring
14 Cover ring
15 Sealing ring
16 Spacer
17 Nyloc cap nut
18 Fibre washer
19 Grommet
20 Cradle assembly
21 Cradle assembly
22 Cradle assembly
23 Cradle assembly
24 Locating pad
25 Sealing ring
26 Petrol pump assembly
27 Clip
28 Mounting rubber (Packing)
29 Mounting rubber
30 Petrol pipe assembly
31 Banjo bolt
32 Fibre washer
33 Petrol pipe assembly (R.H.)
34 Petrol pipe assembly (L.H.)
35 Banjo bolt
36 Fibre washer
37 Clip
38 T-piece
39 Petrol pipe
40 Clip
41 Grommet
42 Petrol filter assembly
43 Filter casting
44 Sealing washer
45 Filter gauze
46 Glass bowl
47 Retaining clip
48 Feed pipe
49 Banjo bolt
50 Fibre washer

COOLING SYSTEM

SECTION C

INDEX

COOLING SYSTEM

Water circulation is assisted by an impeller type pump mounted on the front cover of the engine, the system being pressurised and thermostatically controlled. Water is circulated from the right hand side of the cross-flow radiator by the water pump and flows through the cylinder block and the cylinder head water passages to the radiator header tank by way of the inlet manifold water jacket. The cooling fan is driven through a fluid coupling which slips at a predetermined speed.
When the engine is stationary, the fan is free to rotate and **it should not be assumed that the fan belt is slipping.**

DATA

	Imp. Pints	U.S. Pints	Litres
Total capacity— including heater	25½	30½	14.5
Water Pump—type			Centrifugal
—drive			Belt
Fan belt—angle of "V"			40°
Fan—number of blades			12
Fan to engine speed ratio			Fan drive through fluid coupling unit
Cooling system control			Thermosatt
Thermostat data			See page C.8
Radiator cap Make and type			A.C.—relief valve

ROUTINE MAINTENANCE

DAILY

Checking Radiator Water Level

Every day, check the level of the water in the radiator header tank and, if necessary, top up to the bottom of the filler neck.

Use water that is as soft as procurable; hard water produces scale which in time will affect the cooling efficiency of the system.

PERIODICALLY

Care of the Cooling System

The entire cooling system should occasionally be flushed out to remove sediment. To do this, open the radiator block, cylinder block drain taps and automatic transmission cooling unit if fitted. Insert a water hose into the radiator filler neck. Allow the water to flow through the system with the engine running at a fast idle speed (1,000 r.p.m.) to cause circulation, until the water runs clear.

Since deposits in the water will, in time, cause fouling of the surfaces of the cooling system with consequent impaired efficiency, it is desirable to retard this tendency as much as possible by using water that is as nearly neutral (soft) as is available. One of the approved brands of water inhibitor may be used with advantage to obviate the creation of deposits in the system.

When **refilling the cooling system** open the heater control tap by depressing "Heat" button. Check the radiator water level after running the engine and top up if necessary.

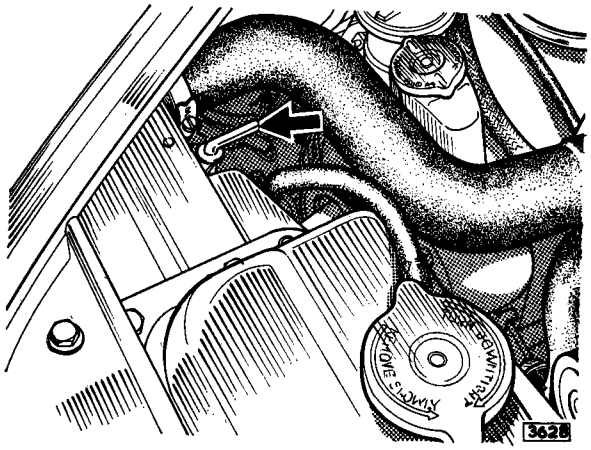


Fig. No. 1 *Radiator drain tap control*

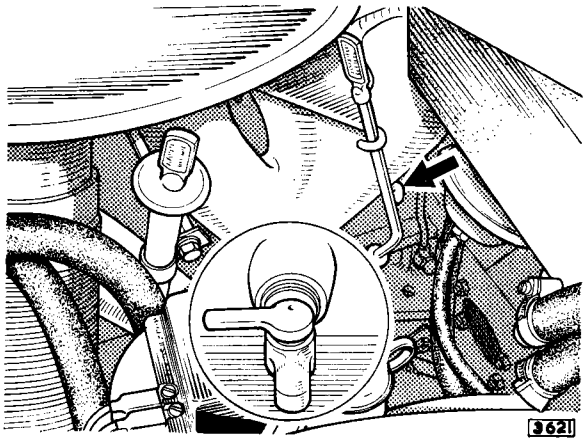


Fig. No. 2 *Cylinder block drain tap*

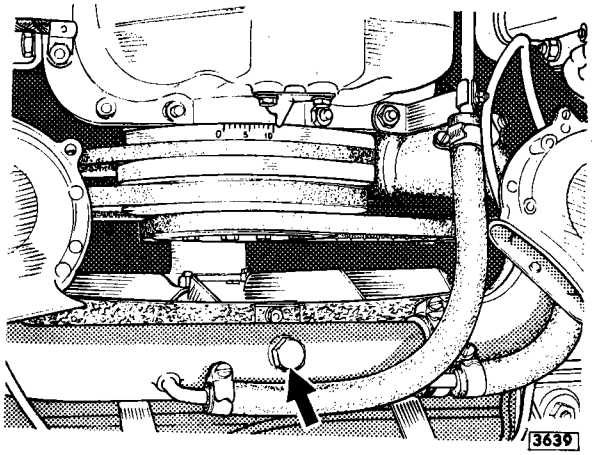


Fig. No. 3 *Drain plug for automatic transmission oil cooler*

FROST PRECAUTIONS

Anti-Freeze—Important
During the winter months it is strongly recommended that an anti-freeze compound with an inhibited Ethylene Glycol base is used in the proportions laid down by the anti-freeze manufacturers. It should be remembered that if anti-freeze is not used it is possible, owing to the action of the thermostat, for the radiator to "freeze-up" whilst the car is being driven, even though the water in the radiator was not frozen when the engine was started.
Before adding anti-freeze solution the cooling system should be cleaned by flushing.
The cylinder head gasket must be in good condition and the cylinder head nuts pulled down correctly, since if the solution leaks into the crankcase a mixture will be formed with the engine oil which is likely to cause a blockage of the oilways with consequent damage to working parts. Check the tightness of all water hose connections, water pump and manifold joints. To ensure satisfactory mixing, measure the recommended proportions of water and anti-freeze solution in a separate container and fill the system from this container, rather than add the solution direct to the cooling system.
When filling the cooling system, open the heater by depressing the "Heat" button. Check the radiator water level after running the engine and top up if necessary. If topping up is necessary during the period in which the anti-freeze solution is in use, this topping up must be carried out using anti-freeze solution or the degree of protection provided may be lost. Topping up with water will dilute the mixture possibly to an extent where damage by frost will occur.

Engine Heater
Provision is made on one side of the cylinder block for the fitment of an American standard engine heater element No. 7, manufactured by James B. Carter Ltd., Electrical Heating and Manufacturing Division, Winnipeg, Manitoba, Canada, or George Bray & Co. Ltd., Leicester Place, Blackman Lane, Leeds 2, England.

RADIATOR

The radiator is of the cross-flow type and is pressurised by the filler cap. This cap incorporates a pressure relief valve to hold pressure up to 4 lb/sq. in. above atmospheric pressure inside the system. When the pressure rises above 4 lb/sq. in., the spring loaded valve lifts off its seat and the excess pressure escapes through the overflow pipe. As the water temperature falls again, a small valve incorporated in the centre of the pressure valve unit opens and restores atmospheric pressure.
By raising the pressure inside the cooling system, the boiling point of the coolant is raised, thus reducing the risk of coolant loss.

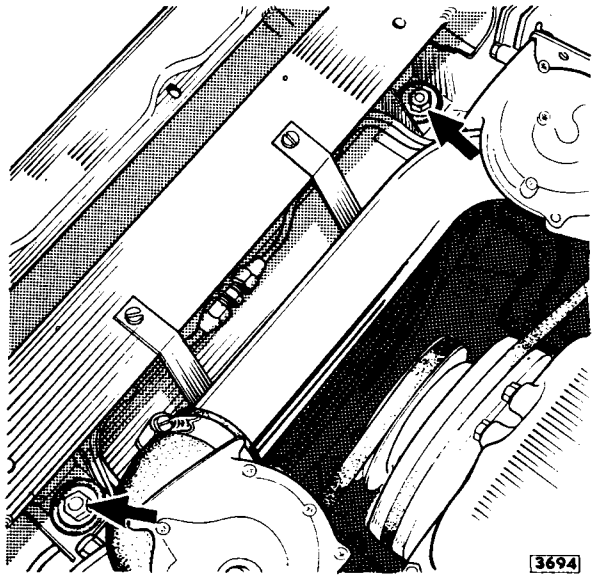


Fig. No. 4 *Radiator lower mounting points*

REMOVAL
Release the filler cap and drain the cooling system and block. Drain the lower radiator pipe if automatic transmission is fitted.
Release the hose clips and remove the header tank hose; the top radiator hose; the two hoses attached to the lower pipe.
Remove the four setscrews securing the header tank to the radiator and unscrew the two nuts securing the cowl to the tank. Withdraw the header tank.
Remove the setscrews securing the cowl to the radiator and unscrew the central bolt to the split cowl. Withdraw in two halves.
Remove the fan and Toquatrol unit as detailed on page C.7.
Withdraw the split pin and remove the remote drain control rod.
Remove the drain tap from the radiator.
Withdraw six pan-headed screws and lock washers and detach the front cross member cover plate beneath the radiator grille.
Withdraw the two lower mounting setscrews and collect the mounting rubbers. On early cars, unscrew the two nuts securing the radiator to the bracket on each wing valance. On later cars, withdraw the two bonnet stop setscrews and collect the mounting

straps. Protect the radiator matrix with suitable sheeting and withdraw from underneath the car.

Note: If an air conditioning system is fitted to the car, the condenser unit must be removed before it is possible to withdraw the radiator.

This operation requires the use of special tools and must ONLY be performed by Authorised Distributors, Dealers, or qualified Refrigeration Engineers.

IT IS DANGEROUS FOR ANY UNQUALIFIED PERSON TO ATTEMPT TO DISCONNECT OR REMOVE ANY PART OF THE AIR CONDITIONING SYSTEM.

REFITTING

Reverse the removal procedure to refit.

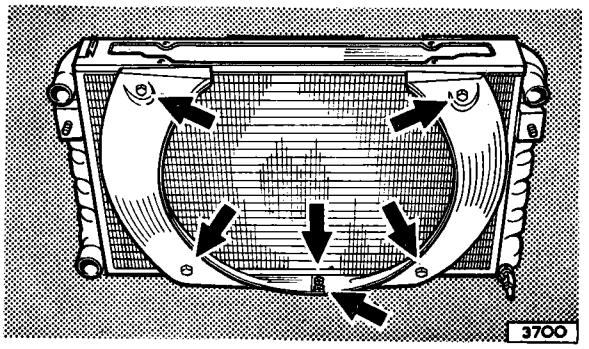


Fig. No. 5 *Radiator cowl mounting points*

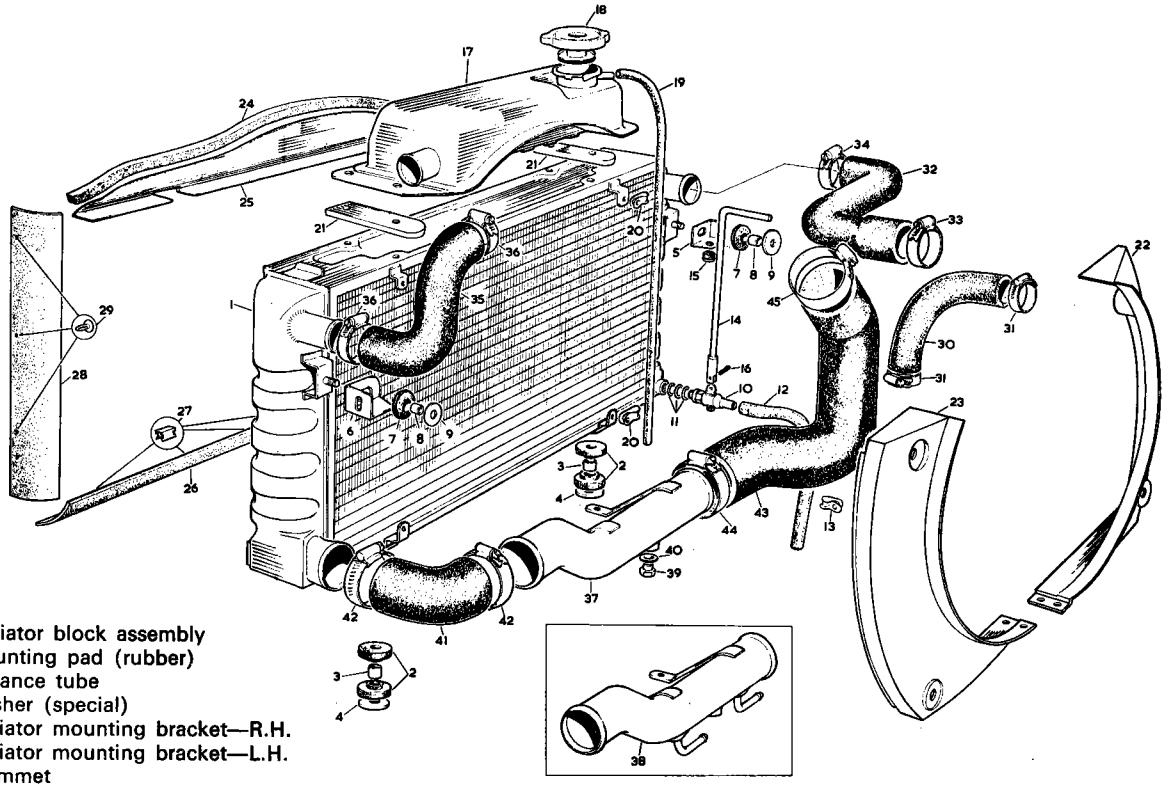


Fig. No. 6 *Exploded view of the radiator components*

1 Radiator block assembly
2 Mounting pad (rubber)
3 Distance tube
4 Washer (special)
5 Radiator mounting bracket—R.H.
6 Radiator mounting bracket—L.H.
7 Grommet
8 Distance tube
9 Washer (special)
10 Drain tap assembly
11 Fibre washer
12 Rubber tube
13 Clip
14 Control rod
15 Grommet
16 Split pin
17 Header tank
18 Filler cap
19 Overflow pipe
20 Clip
21 Packing piece
22 Fan cowl (R.H.)
23 Fan cowl (L.H.)
24 Rubber seal
25 Support strip
26 Seal
27 Clip
28 Seal
29 Stud
30 By-pass water hose
31 Clip
32 Hose
33 Clip
34 Clip
35 Header tank hose
36 Clip
37 Bottom water pipe (not automatic transmission)
38 Bottom water pipe (automatic transmission)
39 Drain plug
40 Fibre washer
41 Hose
42 Clip
43 Hose
44 Clip
45 Clip

FAN

Removal

Remove the four nuts securing the fan to the Torquatrol unit. Slide the fan up the hub of the pulley to gain access to the four nuts securing the Torquatrol unit to the pulley.
Withdraw the fan and Torquatrol unit.

Refitting

Reverse the removal procedure to refit.

FAN BELT

On cars fitted with power steering, the fan belt also drives the power steering pump. Slacken the adjustment bolt on the steering pump supporting strap and press the pump towards the engine. Press against the spring of the jockey pulley and ease the belt over the pulleys and fan blade tips. On cars fitted with manual steering, slacken the bolt securing the jockey pulley pivot to the mounting bracket; swing the pivot downwards to release the tension and remove the belt.

Refitting

Reverse the removal procedure to refit the belt. Ensure that the belt is not stretched over the pulleys by any other means than by hand. Using a tool may break the endless cords in the belt.

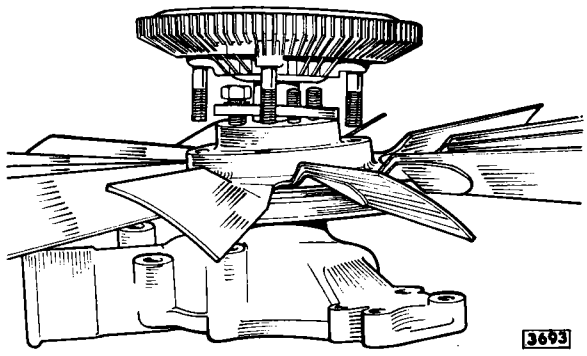


Fig. No. 7 *Fan removal*

THERMOSTAT

This is a valve incorporated in the cooling system which restricts the flow of coolant through the radiator until the engine has reached its operating temperature. When the engine temperature rises to a pre-determined figure (see "Thermostat Data") the thermostat valve commences to open and allows the water to circulate round the radiator. The flow of water increases as the temperature rises until the valve is fully open. Included in the system is a water by-pass utilizing a slot in the thermostat housing integral with the water outlet pipe. This allows the coolant to by-pass the radiator until the thermostat opening temperature is attained, thus providing a rapid warming up of the engine and in cold weather an early supply of warm air to the interior of the car via the heater.

Removal

Drain sufficient water from the system to allow the level to fall below the thermostat by operating the remote control of the drain tap situated at the top left-hand side of the radiator block. Slacken the clip and remove the top water hose on the water outlet pipe. Remove the two nuts and spring washers and the clip for the spark plug leads and withdraw the water outlet pipe. Lift out the thermostat.

Checking

Thoroughly clean the thermostat and check that the small hole in the valve is clear. Check the thermostat for correct operation by immersing in a container of cold water together with a thermometer and stirrer. Heat the water, keeping it well stirred and observe if the characteristics of the thermostat are in agreement with the data given under "Thermostat Temperatures".

Refitting

Refitting is the reverse of the removal procedure.
Always fit a new gasket between the water outlet pipe and the thermostat housing. Ensure that the recess in the thermostat housing and all machined faces are clean.

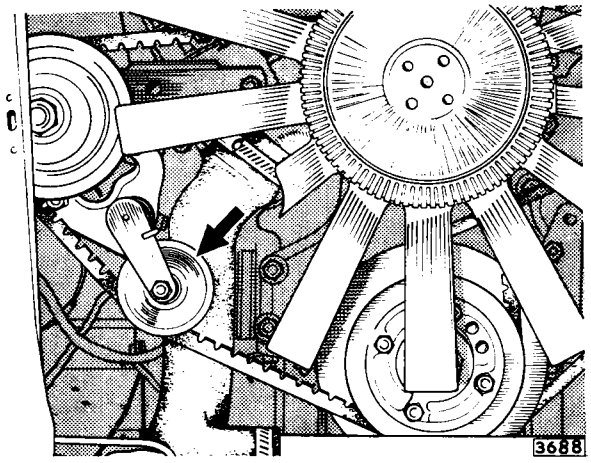


Fig. No. 8 *Fan/steering pump jockey pulley*

THERMOSTAT DATA

Start Operating Temperature	Fully Open Temperature	Remarks
159 °F.(70.5 °C.)	168 °F.(75.5 °C.)	
174 °F.(78.8 °C.)	183 °F.(83.7 °C.)	High setting for extreme winter conditions

WATER PUMP

The water pump is of the centrifugal vane impeller type, the impeller being mounted on a steel spindle which runs in a double row of ball bearings. These are sealed at their ends to exclude all dirt and to retain lubricant.

The main seal of the pump spindle is located in the pump housing by a metal cover and the carbon face maintains a constant pressure on the impeller by means of a thrust spring inside the seal.

A hole drilled in the top of the casting acts as an air vent and leads into an annular groove in the casting into which stray water is directed by a rubber thrower on the pump spindle. A drain hole at the bottom of the groove leads away any water and prevents seepage into the bearing.

REMOVAL

Drain the cooling system and cylinder block.

Remove the header tank.

Remove the fan and Torquatrol unit as detailed on page C.7.

If the car is fitted with power steering, remove the pump adjusting bolt.

If an air conditioner is fitted, remove the compressor front mounting bracket.

Disconnect all heater hoses.

Unscrew the setscrews attaching the water pump to the cylinder block and withdraw the pump.

DISMANTLING

Remove the water pump pulley by means of a suitable extractor as shown in Fig. 10.

Slacken off the locknut (4, Fig. 9) and remove lock-screw (3, Fig. 9).

Remove the spindle and impeller assembly from the pump body. This assembly must not be pushed out by means of a shaft, or the bearing will be damaged.

A tube measuring $1\frac{3}{32}$" (27.77 mm.) outside diameter and a $\frac{31}{32}$" (24.61 mm.) inside diameter must be used as shown (Fig. 12).

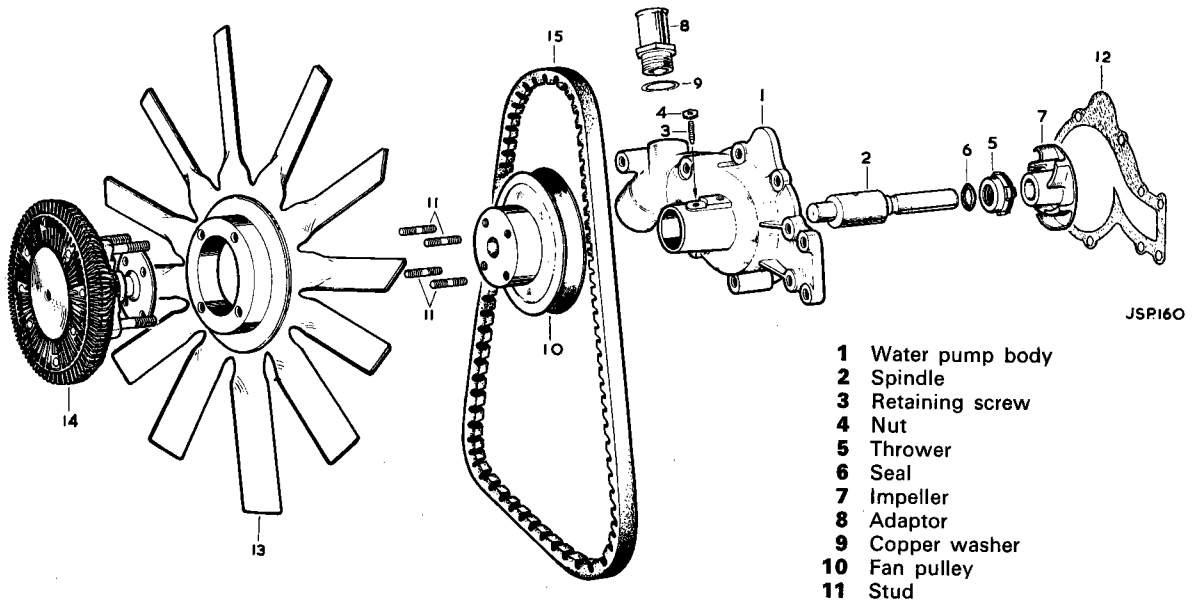


Fig. No. 9 *Exploded view of waterpump and fan*

1 Water pump body
2 Spindle
3 Retaining screw
4 Nut
5 Thrower
6 Seal
7 Impeller
8 Adaptor
9 Copper washer
10 Fan pulley
11 Stud
12 Gasket
13 Fan assembly
14 Automatic fan unit
15 Belt

CHECKING

Thoroughly clean all parts of the pump, except the spindle and bearing assembly, in a suitable cleaning solvent.

The bearing is a permanently sealed and lubricated assembly and therefore must not be washed in solvent. Inspect the bearing for excessive end play and remove any burrs, rust or scale from the shaft with fine emery paper. Prevent emery dust from entering the bearing by covering with a cloth.

If there are any signs of wear or corrosion in the bearing bore or on the face in front of the impeller, the housing should be renewed.

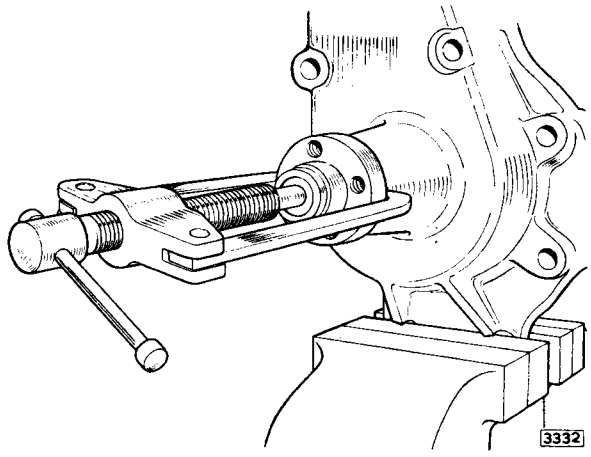


Fig. No. 10 *Withdrawing the fan hub from the spindle*

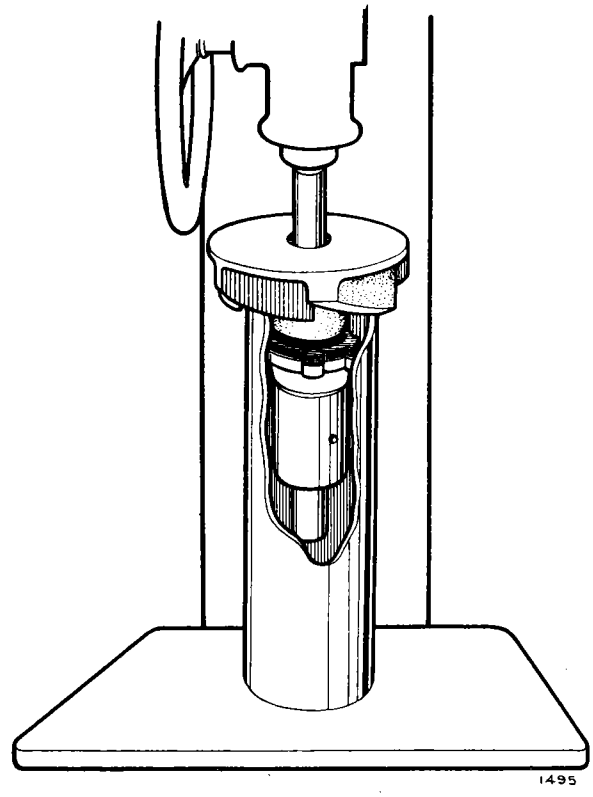


Fig. No. 11 *Removing the water pump impeller from the pump spindle*

REASSEMBLY

Install the shaft and bearing assembly into the pump body from the rear and line up the location hole in the bearing with the tapped hole in the body. Fit the locating screw and locknut. Place the rubber thrower in its groove on the spindle in front of the seal.

Coat the outside of the brass seal housing with a suitable water resistant jointing compound and fit into the recess in the pump body.

Press on the impeller as shown in Fig. 12 until the rear face of the impeller is flush with the end of the spindle. Press the water pump pulley onto the spindle until it is flush with the end of the shaft (Fig. 13).

REFITTING

Refitting is the reverse of the removal procedure, although care should be taken to renew the water pump to timing cover gasket, lightly smearing with grease before fitting. Refit the fan belt as previously described.

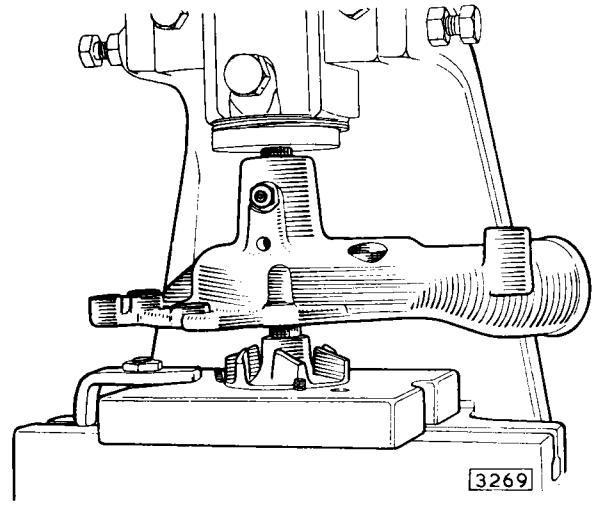


Fig. No. 12 *Fitting the impeller*

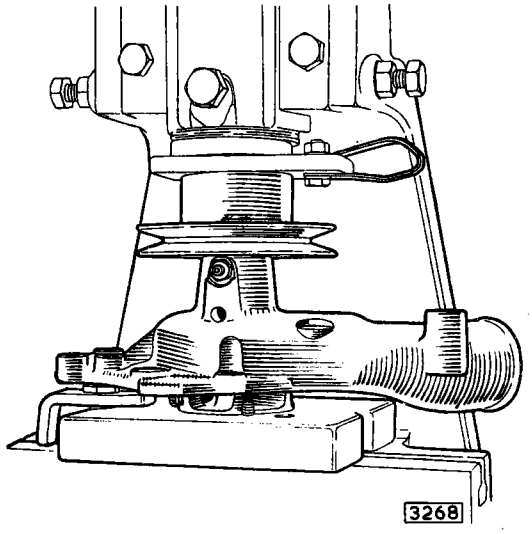


Fig. No. 13 *Pressing the water pump pulley on to the spindle*

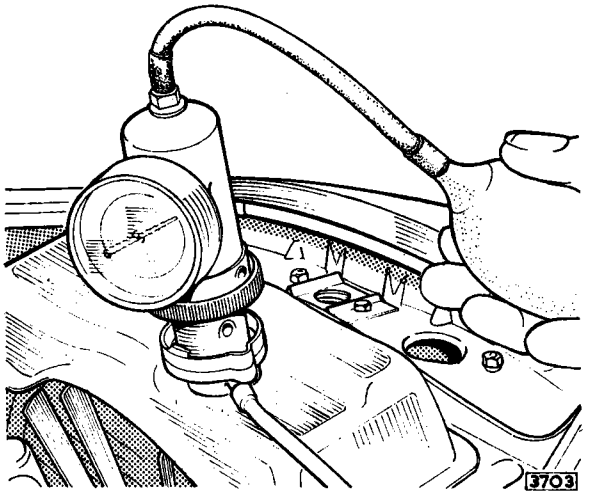


Fig. No. 14 *Pressure testing the cooling system*

WATER TEMPERATURE GAUGE

The indicator head is fitted in the instrument panel and operates on a thermal principle using a bi-metal strip surrounded by a heater winding.
The transmitter unit is mounted in the inlet manifold water jacket adjacent to the thermostat.
For a full description and a fault analysis of this instrument refer to pages P.51 and P.55.

PRESSURE TESTING RADIATOR CAP AND COOLING SYSTEM

The radiator cap and cooling system can be pressure tested and checked for leaks with the aid of the A.C. Delco Cooling Systems Tester RCT-1 (see Figs. 14, 15). This equipment is obtainable from A.C.—Delco Division of General Motors.

Fig. No. 15 *Pressure testing the radiator cap*

CLUTCH

SECTION D

INDEX

CLUTCH

DESCRIPTION

A diaphragm spring clutch is fitted to all cars equipped with standard transmission.

The diaphragm spring is riveted inside the cover pressing with two fulcrum rings interposed between the shoulders of the rivets and the cover pressing. The diaphragm spring also pivots on these two fulcrum rings. Depressing the clutch pedal actuates the release bearing causing a corresponding deflection of the diaphragm spring thus pulling the pressure plate from the driven plate and freeing the clutch.

DATA

Make	Borg and Beck
Model	BB9/412G
Clutch Release Bearing	Graphite
Operation	Hydraulic
Hydraulic Fluid	Castrol/Girling Crimson Clutch/Brake Fluid

ROUTINE MAINTENANCE

EVERY 3,000 MILES (5,000 K.M.)
Check the level of the fluid in the reservoir located under the bonnet.

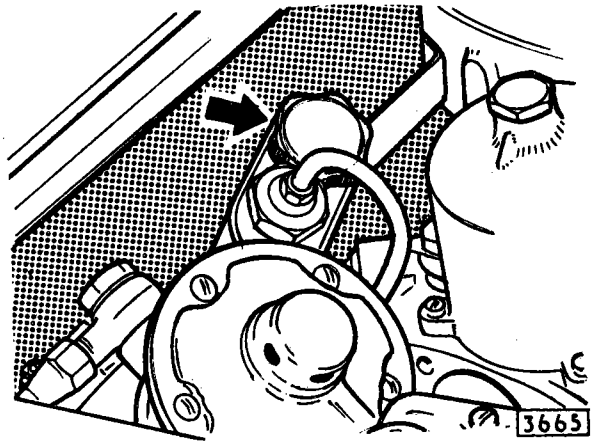


Fig. No. 1 *Location of clutch fluid reservoir (R.H.D.)*

Top up if necessary with the recommended grade of fluid to the bottom of the filler neck.

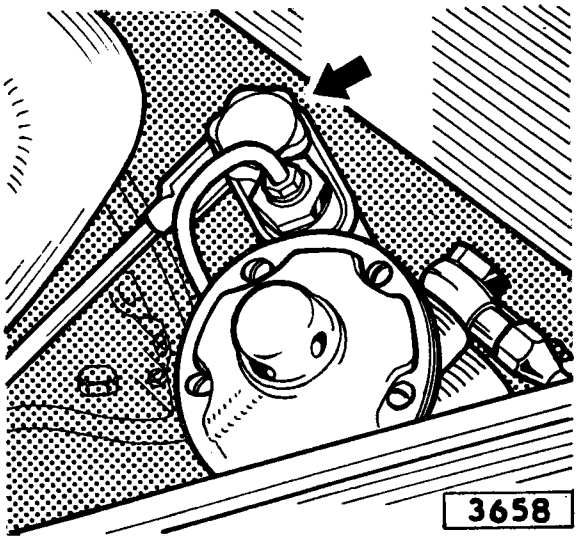


Fig. No. 2 *Location of clutch fluid reservoir (L.H.D.)*

Recommended Hydraulic Fluid
Castrol/Girling Crimson Clutch/Brake fluid is recommended. This conforms to SAE 70 R3 specifications but has a higher boiling point for additional safety.
The mixture of Castrol/Girling Crimson with a different fluid already existing in the system, is undesirable.
If Castrol/Girling Crimson is not readily available, only a fluid guaranteed to conform to SAE 70 R3 specifications may be used as an alternative.
In the event of deterioration of rubber seals and hoses due to the use of incorrect fluid, all the seals and hoses must be replaced and the system thoroughly flushed and refilled with one of the above fluids.

HYDRAULIC SYSTEM—GENERAL INSTRUCTIONS
Should it be found necessary to dismantle any part of the clutch system (that is, master cylinder or slave cylinder) the operation must be carried out under conditions of scrupulous cleanliness. Clean the mud and grease off the unit before removal from the vehicle and dismantle on a bench covered with a sheet of clean paper. Do not swill a complete unit after removal from the vehicle, in paraffin, petrol or trichlorethylene (trike) as this would ruin the rubber parts and, on dismantling, give a misleading impression of their original condition. Do not handle the internal parts, particularly rubbers, with dirty hands. Place all metal parts in a tray of clean brake fluid to soak; afterwards dry off with a clean, fluffless cloth, and lay out in order on a sheet of clean paper. Rubber parts should be carefully examined and if there is any sign of swelling or perishing, they should be renewed; in any case it is usually good policy to renew **all** rubbers. The main castings may be swilled in any of the normal cleaning fluids, but all traces of the cleaner must be dried out before assembly. In the case of the master cylinder, make sure that the by-pass port is clear by probing with a bent piece of wire not exceeding .018" (0.46 mm.) diameter.
If the by-pass port is clogged, rapid wear of the release bearing or clutch slip will result due to pressure being built up in the system.
All internal parts should be dipped in clean brake fluid and assembled wet, as the fluid acts as a lubricant. Rubber parts should be assembled by hand only.

BLEEDING THE SYSTEM
"Bleeding" the clutch hydraulic system (expelling air) is not a routine maintenance operation and should only be necessary when a portion of the hydraulic system has been disconnected or if the level of the fluid in the reservoir has been allowed to fall. The presence of air in the hydraulic system may result in difficulty in engaging gear owing to the clutch not disengaging fully.

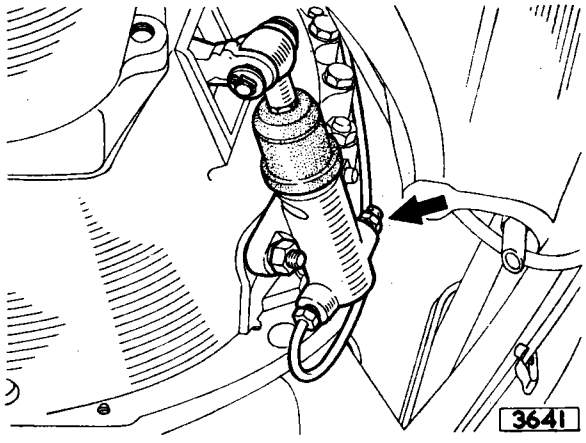


Fig. No. 3 *Location of clutch slave cylinder bleed nipple*

Fill up the master cylinder reservoir with brake fluid exercising great care to prevent the entry of dirt. Attach a rubber bleed tube to the nipple on the slave cylinder on the right-hand side of the clutch housing and allow the tube to hang in a clean glass jar partly filled with brake fluid. Unscrew the nipple one complete turn. Depress the clutch pedal slowly, **tighten the bleeder nipple before the pedal reaches the end of its travel** and allow the pedal to return unassisted.
Repeat the above procedure, closing the bleed nipple at each stroke, until the fluid issuing from the tube is entirely free from air, care being taken that the reservoir is replenished **frequently** during this operation, for should the level be allowed to drop below half-way air will enter the system.
On completion, top up the master cylinder reservoir to the bottom of the filler neck.
Do not, on any account, use the fluid which has been bled through the system to replenish the reservoir, as it will have become aerated. Always use fresh fluid straight from the tin.

FLUSHING THE SYSTEM

Should the fluid in the system become thick or "gummy" after many years in service, or after a vehicle has been laid up for some considerable time, the system should be drained, flushed and refilled. It is recommended that this should be carried out once every five years. Pump all fluid out of the hydraulic system through the bleeder screw of the clutch slave cylinder. To the bleeder screw on the slave cylinder, connect one end of a rubber tube and allow the other end to fall into a container, slacken the screw one complete turn and pump the clutch pedal by depressing it quickly and allowing it to return without assistance; repeat, with a pause between each operation, until no more fluid is expelled. Discard the fluid extracted.

Fill the supply tank with industrial methylated spirit and flush the system as described above. Keep the supply tank replenished until at least a quart of spirit has passed through the bleeder screw.

Remove the master cylinder and pour off any remaining spirit. Refit the master cylinder, refill with clean brake fluid and "bleed" the system.
Note: If the system has been contaminated by the use of mineral oil, etc., the above process will not prove effective. It is recommended that the various units, including the pipe lines, be dismantled and thoroughly cleaned and that all rubber parts, including flexible hoses, be renewed. The contaminated fluid should be destroyed immediately.

REMOVAL AND REFITTING A FLEXIBLE HOSE

In some cases, the cause of faulty clutch may be traced to a choked flexible hose. Do not attempt to clear the obstruction by any means except air pressure, otherwise the hose may be damaged. If the obstruction cannot be cleared, the hose must be replaced by a new one.

Removal

To renew a flexible hose, adopt the following procedure:—
Unscrew the tube nut from the hose union, then unscrew the locknut and withdraw the hose from the bracket. Disconnect the hose at the other end.

Refitting

When refitting a hose, first ensure that it is not twisted or "kinked" (this is MOST IMPORTANT) then pass the hose union through the bracket and, whilst holding the union with a spanner to prevent the hose from turning, fit the locknut and the shakeproof washer; connect up the pipe by screwing on the tube-nut.

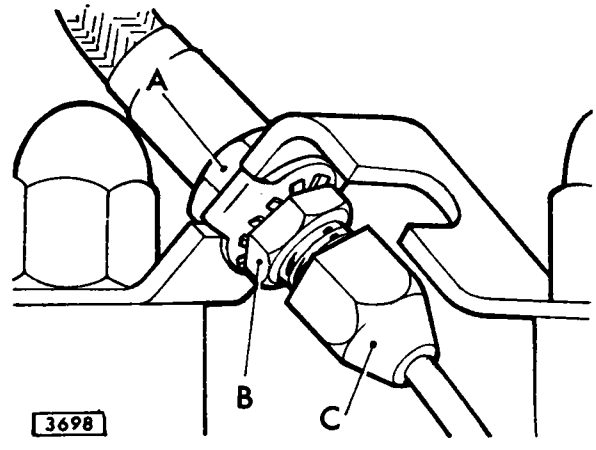


Fig. No. 4 *The flexible hose connections*

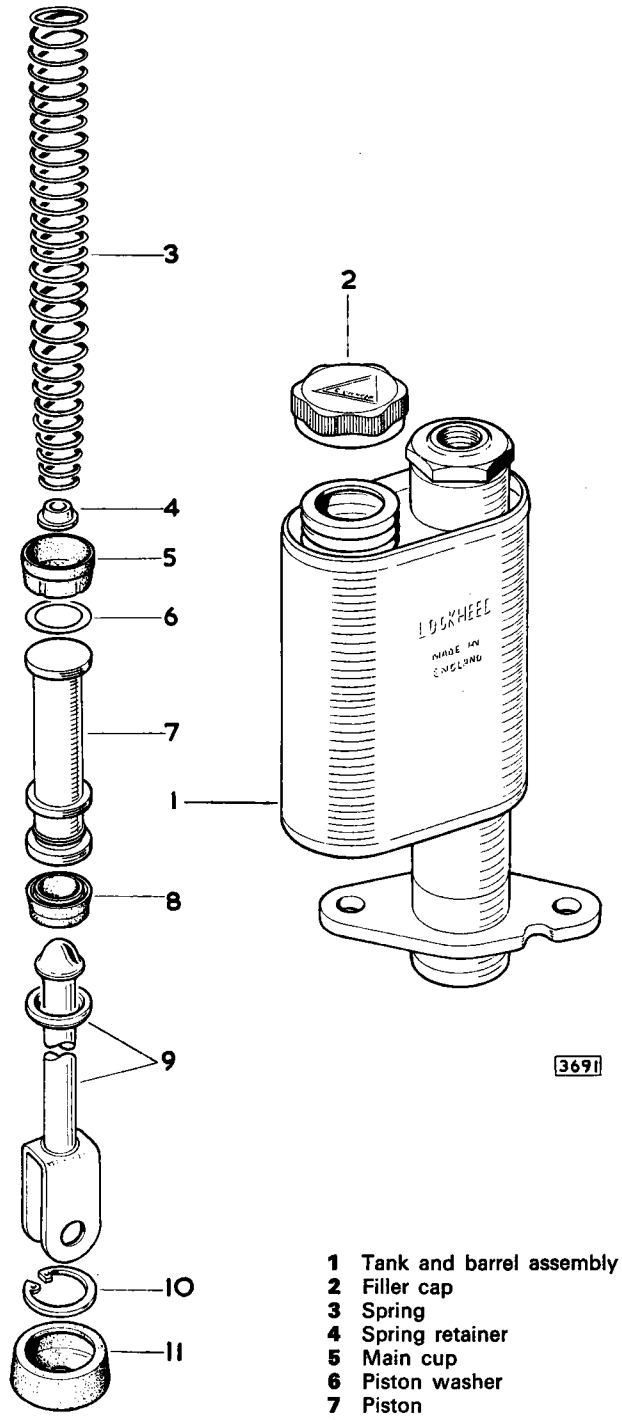
THE MASTER CYLINDER

The master cylinder consists mainly of a tank and barrel assembly (1, Fig. 5), the former surrounds the latter and is secured by soldering; at one end of the barrel a fixing flange is mounted, and this is secured in the same manner. The tank is fitted with a filler cap (2) which incorporates a baffle and screws down against a seal. A piston (7) is contained within the barrel, and has a rubber main cup (5) spring loaded against its inner end; between the cup and the piston a thin washer (6) is interposed to prevent the cup from being drawn into the small feed holes drilled around the piston head. The outer end of the piston carries a rubber secondary cup (8) and is formed with a depression to receive the spherical end of a push rod (9) which carries a piston stop and is retained by a circlip (10). A rubber boot (11), through which the push rod passes, is fitted on to the barrel to prevent the intrusion of dirt and moisture.
At the end opposite to the push rod, an end plug screws against a gasket and forms the outlet connection.

Principle of Operation
Depressing the clutch pedal causes the push rod to thrust the piston along the bore of the barrel, and the fluid thus displaced passes to the slave cylinder. Upon removal of the load from the clutch pedal, the return spring thrusts the piston back against its stop faster than fluid is able to return from the slave cylinder; this creates a depression in the master cylinder which draws the edge of the main cup away from the head of the piston and allows fluid from the tank to flow through the feed holes thus uncovered to make up the temporary deficiency. Meanwhile fluid returning from the slave cylinder, under load from the operating fork return spring, re-enters the master cylinder.
When the piston is fully back against its stop, the main cup uncovers a small by-pass port in the barrel, and this allows the release of excess fluid to the tank, thus permitting the operating fork to return to the "fully engaged" position; the by-pass port also compensates for contraction or expansion of the fluid, due to changes in temperature, allowing fluid to be drawn into or escape from the system. Should this port become blocked, the excess fluid would be unable to escape and the clutch would consequently slip.

Removal
Disconnect the outlet pipe from the end of the master cylinder; detach the push rod fork end from the clutch pedal; unscrew the fixing bolts and detach the master cylinder from the vehicle. Remove the filler cap (2) drain the fluid into a clean container, and replace the cap.

Dismantling
(1) Detach the rubber boot (11) from the end of the barrel, and move the boot along the push rod. Depress the push rod to relieve the spring load from the circlip (10), remove the circlip and with-



1 Tank and barrel assembly
2 Filler cap
3 Spring
4 Spring retainer
5 Main cup
6 Piston washer
7 Piston
8 Secondary cup
9 Push rod
10 Circlip
11 Rubber boot

Fig. No. 5 *Exploded view of the master cylinder*

draw the push rod, the piston (7), the piston washer (6), the main cup (5) and the spring (3). The end plug should not normally need to be removed from the barrel.

(2) Remove the secondary cup (8) by stretching it over the head of the piston.

Assembling

(1) If previously removed, fit the end plug and a new gasket.
(2) Fit the spring retainer (4) on to the small end of the spring; if the retainer is new the ears are to be bent over to secure it on the spring.
(3) Insert the spring, large end leading, into the barrel. Follow up with the main cup (5), lip leading, taking care not to turn back or buckle the lip.
(4) Insert the piston washer (6) so that the curved edge is towards the cup.
(5) Using the fingers only, stretch the secondary cup (8) on to the piston, with the small end towards the head, (that is, the drilled end) and with the groove engaging the ridge; gently work round the cup with the fingers to ensure correct bedding.
(6) Insert the piston in the barrel, with the head uppermost.
(7) If previously removed, stretch the rubber boot (11) on to the push rod, with the open end of the boot towards the spherical end of the push rod.
(8) Offer up the push rod to the barrel, push inwards and secure the piston stop, which is on the push rod, by fitting the circlip (10) at the end of the bore; it is MOST IMPORTANT that the circlip be correctly fitted in its groove. Stretch the large end of the boot on to the end of the barrel and into its correct position.
(9) Fill the tank with clean brake fluid to within half an inch of the filler cap orifice, and refit the filler cap (2) together with the seal; ensure that the filler cap is securely tightened, using a coin. With the master cylinder upright, filler cap at the top, test by pushing the push rod and piston further into the bore and allowing it to return unassisted; after one or two applications, fluid should flow from the outlet connection.

Refitting

Secure the master cylinder to the vehicle by fitting the fixing bolts through the flange. Connect the pipe to the outlet connection, the push rod to the pedal, refill with fluid and bleed the system. Check for leaks by depressing the clutch pedal once or twice and examining all hydraulic connections.

THE SLAVE CYLINDER

The clutch slave cylinder consists of a body (4, Fig. 6) which incorporates two threaded connections and is bored to accommodate a piston (5) against the inner face of which a rubber cup (3) is loaded by a cup filler (2) and a spring (1); the travel of the piston is limited by a circlip (6) fitted in a groove at the end of the bore. A rubber boot (7) through which a push-rod passes, is fitted on the body to prevent the intrusion of dirt or moisture.

One of the connections in the body receives a pipe from the clutch master cylinder, whilst the other is fitted with a bleeder screw; the connection for the pipe is parallel to the mounting flange on the body.

Removal

To remove from the vehicle, disconnect the pipe, detach the rubber boot from the body and remove the fixing screws; leave the push-rod attached to the vehicle. If the boot is not being renewed it may be left on the push-rod.

Dismantling

Remove the circlip (6) from the end of the bore and apply a **low** air pressure to the open connection to expel the piston (5) and other parts; remove the bleeder screw.

Assembling

Prior to assembly, smear all internal parts and the bore of the body with Rubberlube.
Fit the spring (1) in the cup filler (2) and insert these parts, spring uppermost, into the bore of the body (4). Follow up with the cup (3) lip leading, taking care not to turn back or buckle the lip; then insert the piston (5), flat face innermost, and fit the circlip (6) into the groove at the end of the bore.

Refitting

Fit the rubber boot (7) on the push-rod, if removed previously, and offer up the slave cylinder to the vehicle, with the push-rod entering the bore. Secure the cylinder with the fixing screws and stretch the large end of the boot into the groove on the body. Fit into their respective connections, the bleeder screw and the pipe from the clutch master cylinder.
When refitting the hydrostatic clutch slave cylinder it is IMPORTANT that the operating rod adjustment dimension (as shown in Fig. 7) is adhered to.
To obtain this dimension, proceed as follows:—

(1) Extract the clevis pin securing the operating rod to the clutch lever.

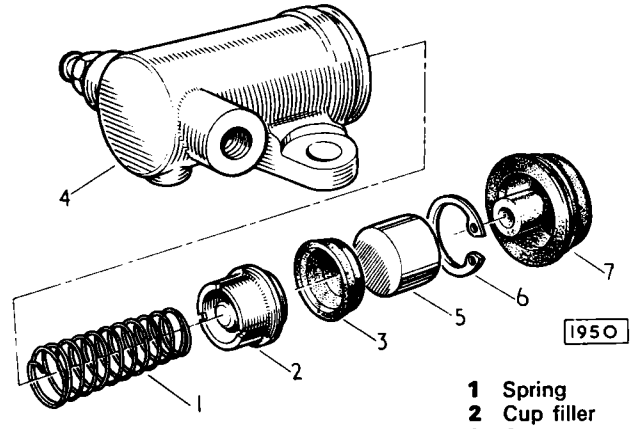


Fig. No. 6 *The hydrostatic clutch slave cylinder*

1 Spring
2 Cup filler
3 Cup
4 Body
5 Piston
6 Circlip
7 Rubber boot

(2) Release the fork end locknut.
(3) Push the clutch operating lever away from the slave cylinder until resistance is felt and retain in this position.
(4) Push the operating rod to the limit of its travel in to the slave cylinder and adjust the fork end to a dimension of .75" (19 mm.) between the centre of the fork end and the centre of the clutch operating lever. Tighten the locknut.
(5) Release the operating rod and connect the fork end to the lever. Refit the clevis pin.
(6) Bleed the clutch slave cylinder in the normal manner.

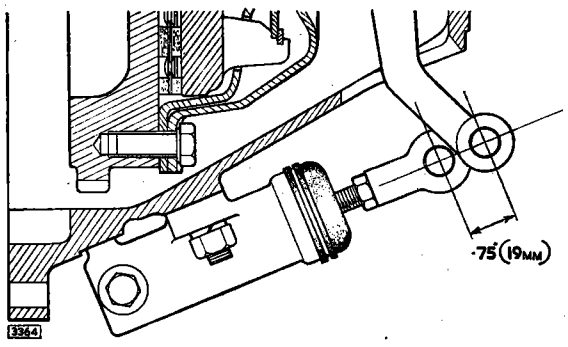
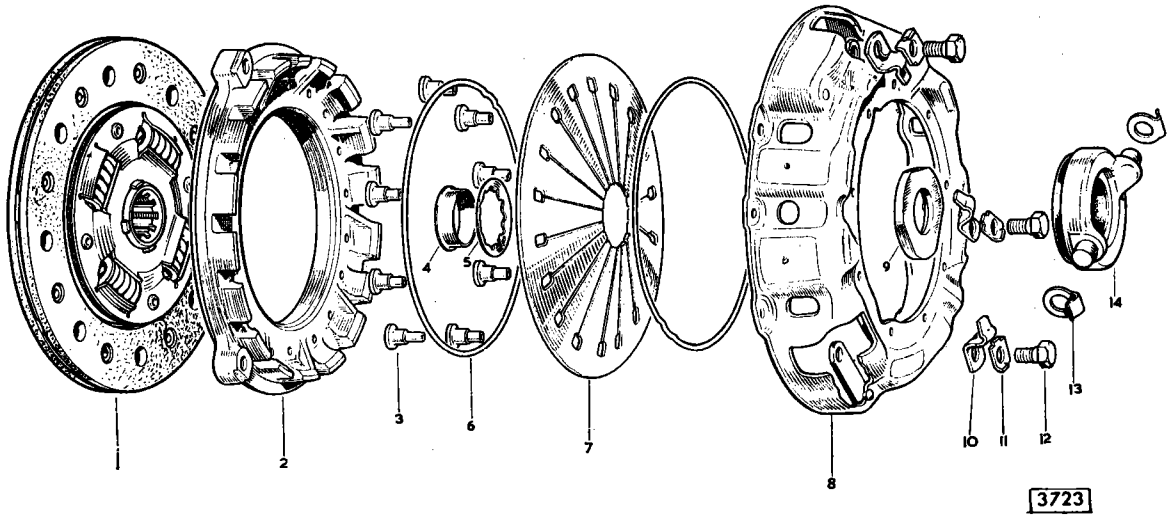


Fig. No. 7 *Setting dimension for refitting hydrostatic clutch slave cylinder*

THE CLUTCH UNIT



1	Driven plate	**6**	Fulcrum ring	**11**	Tab washer
2	Pressure plate	**7**	Diaphragm spring	**12**	Setscrew
3	Rivet	**8**	Cover pressing	**13**	Retainer
4	Centre sleeve	**9**	Release plate	**14**	Release bearing
5	Belleville washer	**10**	Retainer		

Fig. No. 8 *Exploded view of the diaphragm spring clutch*

SERVICING

The Borg and Beck diaphragm spring clutch is serviced in the U.K. ONLY by fitting an exchange unit which is available from the Works, Spares Division, Coventry. Individual parts are available from the same source for the repair of this clutch in Overseas Markets where exchange units may not be readily available. IT IS ESSENTIAL when overhauling the diaphragm spring clutch, to rigidly observe the service instructions detailed below and particular attention is drawn to the necessary special tools required.

GENERAL INSTRUCTIONS

To enable the balance of the assembly to be preserved after dismantling, there are corresponding paint marks on the cover plate and driving plate. In addition, there are corresponding reference numbers stamped in the flanges of the cover and driving plate.
When reassembling ensure that the markings coincide, and that, when refitting the clutch to the flywheel, the letter "B" stamped adjacent to one of the dowel holes coincides with the "B" stamped on the edge of the flywheel.

The clutch is balanced in conjunction with the flywheel by means of loose balance pieces which are fitted under the appropriate securing bolt. Each balance piece must be refitted in its original position, the number stamped on the balance weight corresponding to the number stamped on the cover plate. There are three balance weights stamped 1, 2 and 3, the weight stamped 3 being the heaviest.
If the graphite release bearing ring is badly worn it should be replaced by a complete bearing assembly.

CLUTCH REMOVAL

In order to remove the clutch, the engine and gearbox must first be removed (see Page A.32).
Remove gearbox and clutch housing from engine.
Remove the bolts securing the clutch to the flywheel and withdraw the clutch assembly.
Retain any balance weight fitted.

DISMANTLING

Removing Release Plate

The centrally mounted release plate is held in position by a small centre sleeve which passes through the diaphragm spring and belleville washer into the release plate.
To free the plate, collapse the centre sleeve with a hammer and chisel. To avoid any possible damage whilst carrying out this operation, support the release plate in the locating boss of the special tool which should be held firmly in a vice.

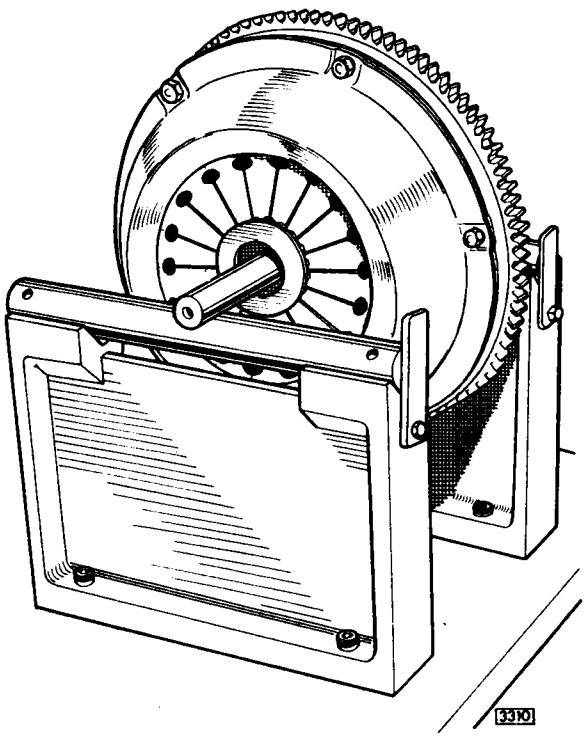


Fig. No. 9 *Clutch and flywheel balancing*

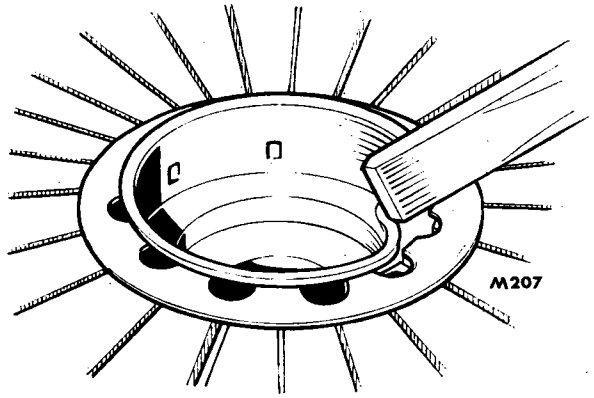


Fig. No. 10 *Collapsing the centre sleeve with a hammer and chisel*

Separating the Pressure Plate from Cover Pressing

Knock back the locking tabs and remove the three setscrews securing the pressure plate to the straps riveted to the cover pressing. These straps within the cover pressing must NOT be detached as this is an assembly reduced to its minimum as a spare part.

Dismantling the Cover Assembly

Remove the rivets securing the diaphragm spring and fulcrum rings by machining the shank of the rivets using a spot face cutter.
IT IS ESSENTIAL that the thickness of the cover is not reduced in excess of .005" (.127 mm.) at any point. The remaining portions of the rivets may be removed with a standard pin punch.

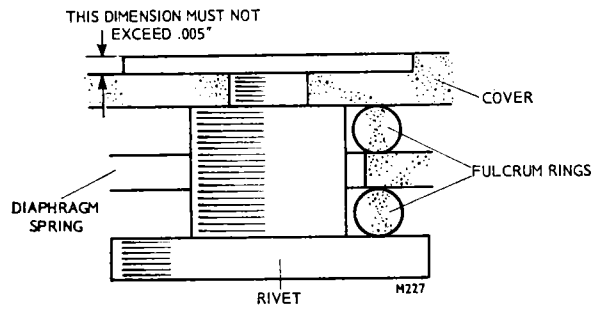


Fig. No. 11 *Do not reduce the thickness of the cover pressing in excess of .005" (.127 mm.).*

REBUILDING

The Cover Assembly

Prior to rebuilding, check the cover pressing for distortion. Bolt the cover firmly to a **flat** surface plate and check that a measurement taken at various points from the cover flange to the machined land inside the cover pressing do not vary by more than .007" (.2 mm.). If the measurement exceeds this figure the cover must be replaced.

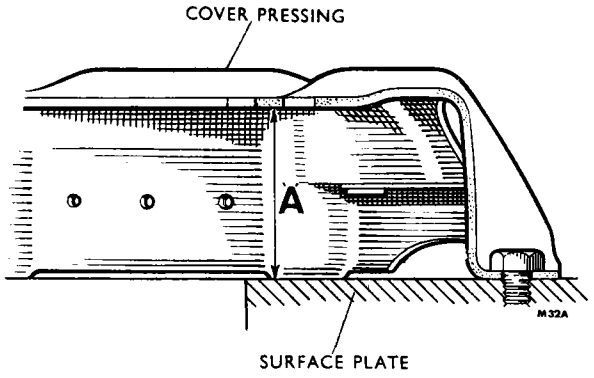
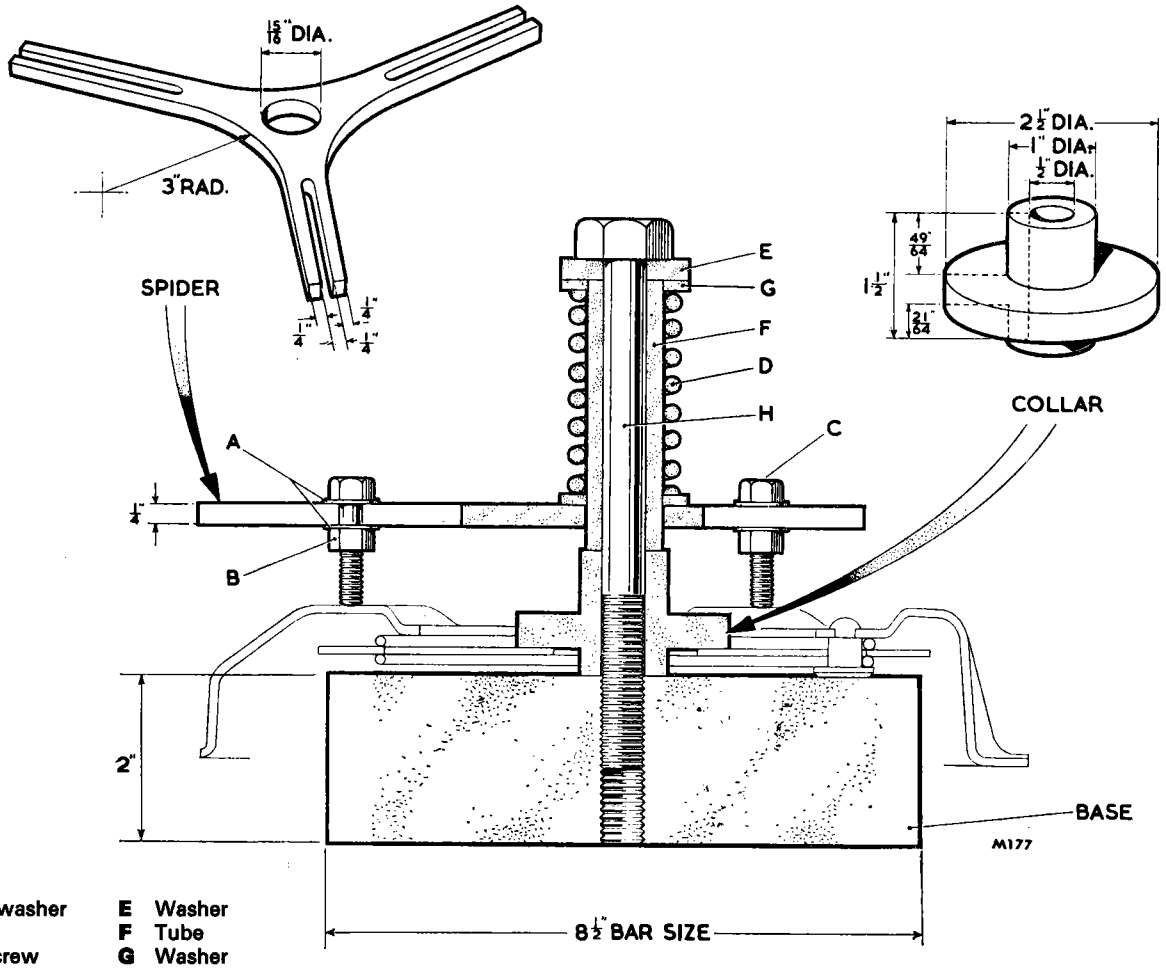


Fig. No. 12 *The measurement "A" must not vary by more than .007" (.2 mm.).*

To achieve a satisfactory result when riveting the diaphragm spring into the cover pressing, a special tool must be fabricated to the specifications given in Fig. 13.

All parts except the spring can be made from mild steel. Position the fulcrum ring inside the cover pressing so that the location notches in the fulcrum ring engage a depression between two of the larger diameter holes in the cover pressing.

Place the diaphragm spring on the fulcrum ring inside the cover and line the long slots in the spring with the small holes in the cover pressing. Locate a further fulcrum ring on the diaphragm spring so that the location notches are diametrically opposite the location notches in the first ring. Fit new shouldered rivets, ensuring that the shouldered portion of each seats on the machined land inside the cover.



A Flat washer
B Nut
C Setscrew
D Spring
E Washer
F Tube
G Washer
H Bolt

Fig. No. 13 *Dimension of special tool for compressing the diaphragm spring when rivetting the spring to cover pressing.*

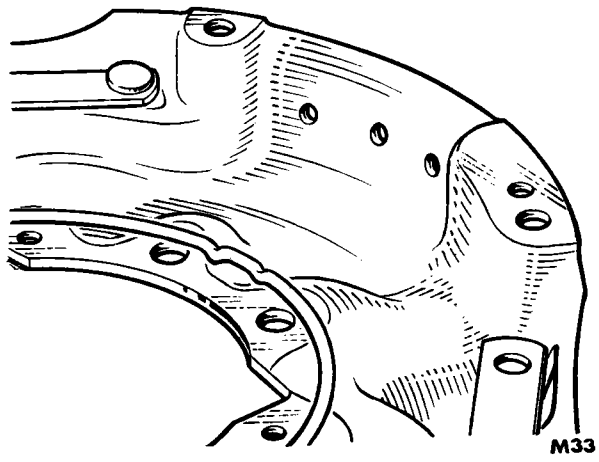


Fig. No. 14 *Assembly of cover pressing and fulcrum ring*

Place the base of the special tool on to the rivet heads. Invert the clutch and base plate.
Fit the collar to the large bolt and fit the large bolt complete with spring, spider and collar into the tapped hole in the base. Position the three setscrews on the spider so that they contact the cover pressing. Tighten down the centre bolt until the diaphragm spring becomes flat and the cover pressing is held firmly by the setscrews.

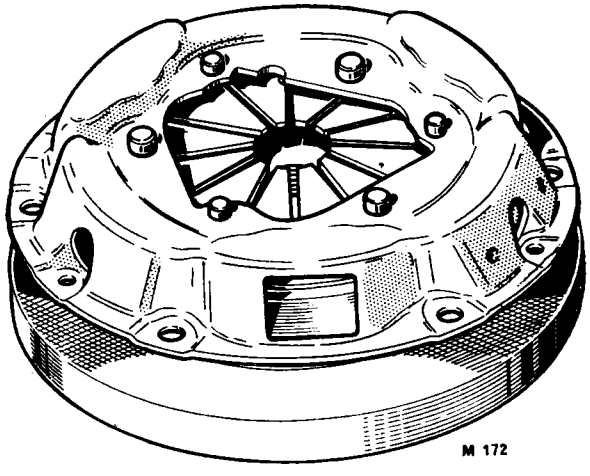


Fig. No. 15 *Clutch and base plate inverted*

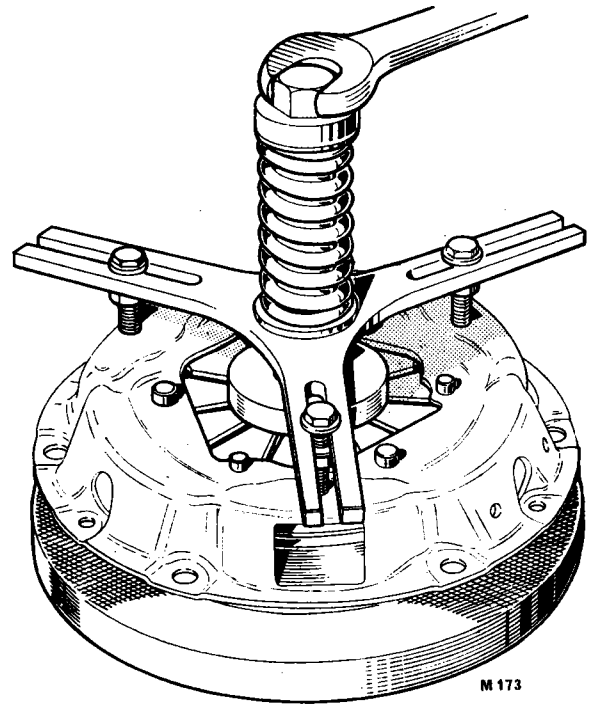


Fig. No. 16 *Tighten down the large nut so that the diaphragm spring is compressed flat*

Rivet securely with a hand punch.

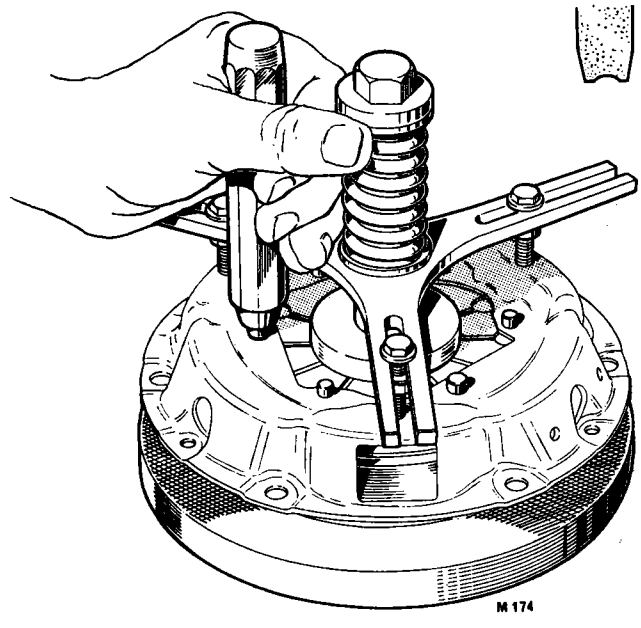
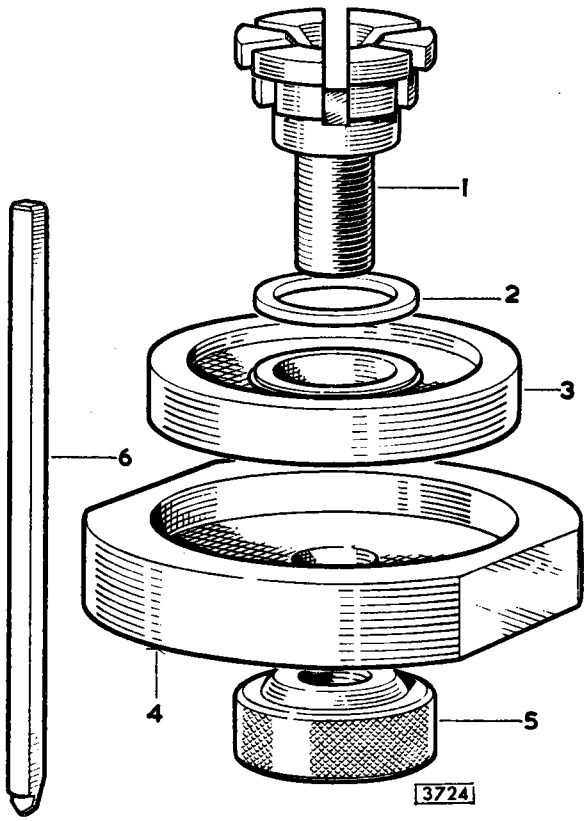


Fig. No. 17 *Rivetting with a hand punch*

Assembling the Pressure Plate to Cover Pressing
Before assembling the pressure plate to the cover pressing, examine the plate for any signs of wear. Should it have been damaged or have excessive scoring, it is strongly recommended that a new plate is fitted. If, however, renewal of the pressure plate is not possible, grinding of the original unit may be undertaken by a competent machinist, bearing in mind that incorrect grinding of the plate may seriously affect the operation of the clutch. IN NO CIRCUMSTANCES MUST THE PRESSURE PLATE BE GROUND TO A THICKNESS OF LESS THAN 1.070" (27.178 mm.).
Position the pressure plate inside the cover assembly so that the lugs on the plate engage the slots in the cover pressing. Insert the three setscrews through the straps which are rivetted to the cover pressing and lock with the tab washers.

Fitting a New Release Plate
A special tool (Part number SSC.805) is available from Automotive Products Ltd., Service and Spares Division, Banbury, England, for completion of this operation. Ensure that all parts of the clutch and special tool are clean.



1 Staking guide
2 Washer
3 Locating base
4 Base plate
5 Knurled nut
6 Punch

Fig. No. 18 *Special Tool (SSC805)*

Grip the base of the tool in a vice and place the locating boss into the counterbore of the base plate. Place the release plate, face downwards, into the counterbore of the locating boss.
Apply a little high melting point grease to the tips of the diaphragm spring fingers and position the clutch, pressure plate friction face upwards, on to the release plate.
Place the belleville washer, concave surface towards the spring, on to the centre of the diaphragm spring and then push the centre sleeve through the spring into the release plate.

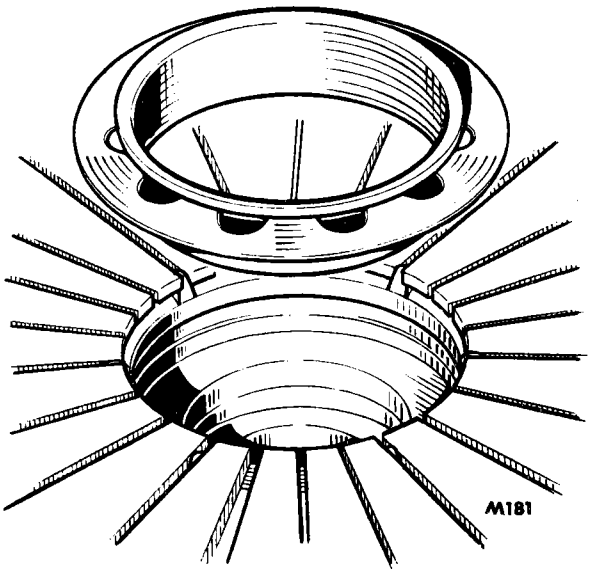


Fig. No. 19 *Fitting the sleeve and belleville washer*

Drop the special washer into the sleeve and insert the staking guide into the centre of the assembly. Fit the knurled nut to the thread on the staking guide, tighten down until the whole assembly is solid. Using the special punch, stake the centre sleeve in six places into the groove in the release plate.

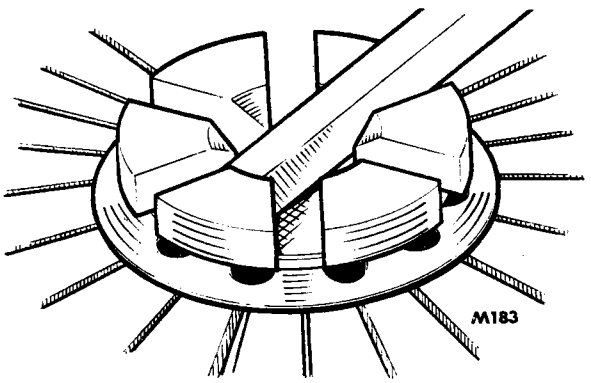


Fig. No. 20 *Staking the sleeve to the release plate*

REFITTING

Place the driven plate on the flywheel, taking care that the larger part of the splined hub faces the gearbox. Centralize the plate on the flywheel by means of the dummy shaft (a constant pinion shaft may be used for this purpose). Secure the cover assembly with the six setscrews and spring washers, tightening the screws a turn at a time by diagonal selection. Ensure that the "B" stamped adjacent to one of the dowel holes coincides with the "B" stamped on the periphery of the flywheel.

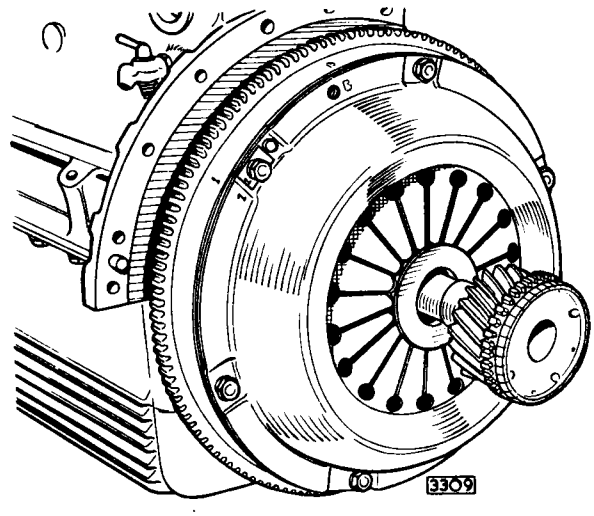


Fig. No. 21 *Centralising the driven plate on the flywheel by means of a dummy plate*

CONDITION OF CLUTCH FACINGS

The possibility of further use of the friction facings of the clutch is sometimes raised, because they have a polished appearance after considerable service. It is natural to assume that a rough surface will give higher frictional value against slipping, but this is not correct. Since the introduction of non-metallic facings of the moulded asbestos type, in service a polished surface is a common experience, but it must not be confused with a glazed surface which is sometimes encountered due to the conditions discussed below.

The ideal smooth or polished condition will provide a normal contact, but a glazed surface may be due to a film or a condition introduced, which entirely alters the frictional value of the facings. These two conditions might be simply illustrated by the comparison between a polished wood and a varnished surface. In the former the contact is still made by the original material whereas, in the latter instance, a film of dried varnish is interposed between the contact surfaces.

The following notes are issued with a view to giving useful information on this subject:—

(a) After the clutch has been in use for some little time under perfect conditions (that is, with the clutch facings working on true and polished or ground surfaces of correct material, without the presence of oil, and with only that amount of slip which the clutch provides for under normal conditions) then the surface of the facings assumes a high polish, through which the grain of the material can be clearly seen. This polished facing is of mid-brown colour and is then in a perfect condition.

(b) Should oil in small quantities gain access to the clutch in such a manner as to come into contact with the facings, it will burn off due to the heat generated by slip which occurs under normal starting conditions. The burning off of the small amount of lubricant has the effect of gradually darkening the facings, but provided the polish on the facings remains such that the grain of the material can be clearly distinguished, it has very little effect on clutch performance.

(c) Should increased quantities of oil or grease obtain access to the facing, one or two conditions, or a combination of the two, may arise, depending upon the nature of oil, etc.
   (i) The oil may burn off and leave on the surface a carbon deposit which assumes a high glaze and causes slip. This is a very definite, though very thin deposit, and in general it hides the grain of the material.
   (ii) The oil may partially burn and leave a resinous deposit on the facings, which frequently produces a fierce clutch, and may also cause a "spinning" clutch due to a tendency of the facings to adhere to the flywheel or pressure plate face.
   (iii) There may be a combination of (i) and (ii) conditions which is likely to produce a judder during clutch engagement.

(d) Still greater quantities of oil produces a black soaked appearance to the facings, and the effect may be slip, fierceness, or judder in engagement, etc., according to the conditions. If the conditions under (c) or (d) are experienced, the clutch driven plate should be replaced by one fitted with new facings, the cause of the presence of oil removed and the clutch and flywheel face thoroughly cleaned.

FAULT FINDING

SYMPTOM	CAUSE	REMEDY
Drag or Spin	(a) Oil or grease on the driven plate facings.	Fit new facings or replace plate.
	(b) Misalignment between the engine and splined clutch shaft.	Check over and correct the alignment.
	(c) Air in clutch system.	"Bleed" system. Check all unions and pipes.
	(d) Bad external leak between the clutch master cylinder and the slave cylinder.	Renew pipe and unions.
	(e) Warped or damaged pressure plate or clutch cover.	Renew defective part.
	(f) Driven plate hub binding on splined shaft.	Clean up splines and lubricate with small quantity of high melting point grease.
	(g) Distorted driven plate due to the weight of the gearbox being allowed to hang on clutch plate during assembly.	Fit new driven plate assembly using a jack to take overhanging weight of the gearbox.
	(h) Broken facings of driven plate	Fit new facings, or replace plate.
	(i) Dirt or foreign matter in the clutch.	Dismantle clutch from flywheel and clean the unit; see that all working parts are free. **Caution:** Never use petrol or paraffin for cleaning out clutch.
Fierceness or Snatch	(a) Oil or grease on driven plate facings.	Fit new facings and ensure isolation of clutch from possible ingress of oil or grease.
	(b) Misalignment.	Check over and correct alignment.
	(c) Worn out driven plate facings.	Fit new facings or replace plate.
Slip	(a) Oil or grease on driven plate facings.	Fit new facings and eliminate cause.
	(b) Seized piston in clutch slave cylinder.	Renew parts as necessary.
	(c) Master cylinder piston sticking.	Free off piston.
Judder	(a) Oil, grease or foreign matter on driven plate facings.	Fit new facings or driven plate.
	(b) Misalignment.	Check over and correct alignment.
	(c) Bent splined shaft or buckled driven plate.	Fit new shaft or driven plate assembly.
Rattle	(a) Damaged driven plate. (b) Excessive backlash in transmission. (c) Wear in transmission bearings. (d) Bent or worn splined shaft. (e) Release bearing loose on throw out fork.	Fit new parts as necessary.
Tick or Knock	Hub splines worn due to misalignment.	Check and correct alignment then fit new driven plate.
Fracture of Driven Plate	(a) Misalignment distorts the plate and causes it to break or tear round the hub or at segment necks.	Check and correct alignment and fit new driven plate.
	(b) If the gearbox during assembly be allowed to hang with the shaft in the hub, the driven plate may be distorted, leading to drag, metal fatigue and breakage.	Fit new driven plate assembly and ensure satisfactory re-assembly.
Abnormal Facing Wear	Usually produced by over-loading and by excessive clutch slip when starting.	In the hands of the operator.

GEARBOX AND OVERDRIVE

SECTION E

INDEX

OVERDRIVE

GEARBOX

DESCRIPTION

The gearbox is of the four speed type with a baulk-ring synchromesh on all four forward gears. With the exception of the reverse, the detents for the gears are incorporated in the synchromesh assemblies, and the three synchro balls engaging with grooves in the operating sleeve.
The detent for reverse gear is a spring loaded ball which engages in a groove in the selector rod.
Two interlock balls and a pin located at the front of the selector rods prevent the engagement of two gears at the same time.
The gears are pressure fed at approximately 5lb. per sq. in. from a pump driven from the rear of the mainshaft on standard transmission cars and fed by an overdrive oil pump on overdrive transmission cars.

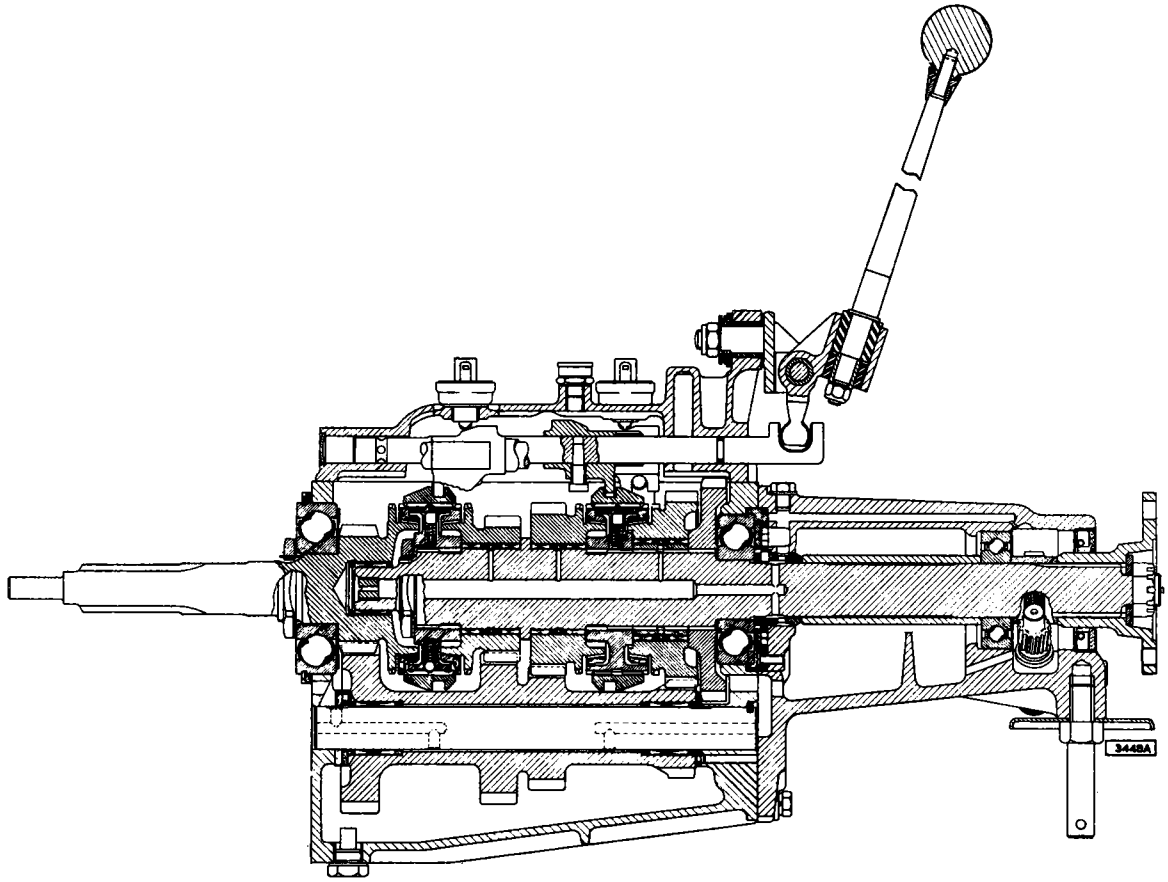


Fig. No. 1 *Longitudinal section of the gearbox*

DATA

Ratios:-

1st Gear	3.04 : 1
2nd Gear	1.973 : 1
3rd Gear	1.328 : 1
4th Gear	1.00 : 1
Reverse	3.49 : 1

1st gear-end float on mainshaft .005" to .007" (.13—.18 mm.).
2nd gear-end float on mainshaft .005" to .008" (.13—.20 mm.).
3rd gear-end float on mainshaft .005" to .008" (.13—.20 mm.).
Countershaft gear unit end float .004" to .006" (.10—.15 mm.).

ROUTINE MAINTENANCE

EVERY 3,000 MILES (5,000 KM)

Gearbox Oil Level

Check the level of the oil in the gearbox with the car standing on level ground.
A combined level and filler plug is fitted on the left hand side of the gearbox. Clean off any dirt from around the plug before removal.
The level of the oil should be to the bottom of the filler and level plug hole.

Overdrive Oil Level—Important

The oil for the lubrication and operation of the overdrive is fed from the gearbox casing and, therefore, checking the gearbox oil level will also check the level of oil in the overdrive unit, but as this unit is hydraulically controlled, extra attention should be paid to exercising absolute cleanliness when replenishing with oil. It is also important that the oil level is not allowed to fall appreciably, otherwise the operation of the overdrive will be affected.

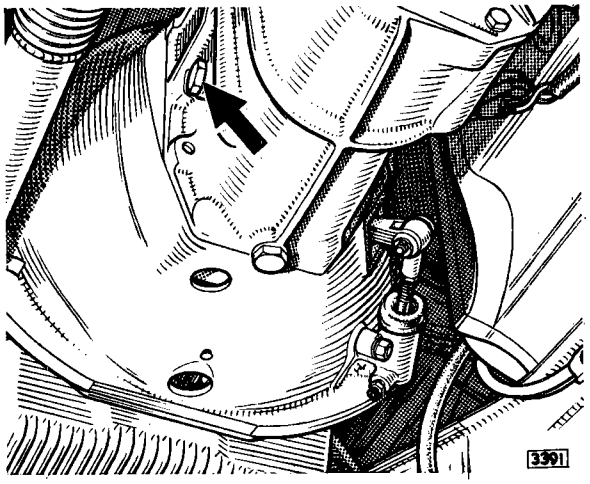


Fig. No. 2 *Gearbox oil level plug*

EVERY 12,000 MILES (20,000 KM)

Changing the Gearbox Oil

The draining of the gearbox oil should be carried out at the end of a run when the oil is hot and will therefore flow more freely.
The drain plug is situated at the front of the gearbox casing.
After all the oil has been drained, replace the drain plug and refill the gearbox with the recommended grade of oil through the combined level and filler plug hole. The level should be at the bottom of the hole.

Overdrive Oil Changing

The oil for the ovedrrive is common to that of the gearbox, but draining the oil from the gearbox will not drain the overdrive unit. When draining the gearbox, remove the filter plug (situated in the side of the overdrive unit) filter and magnetic washers. Thoroughly wash the filter and magnetic washers.
When dry, refit the filter, magnetic washers and filter plug. Fully tighten the filter plug and refill the gearbox and overdrive unit through the gearbox filler and level plug hole.
Recheck the level after the car has been run, as a certain amount of oil will remain in the hydraulic system of the overdrive.
Particular attention should be paid to maintaining absolute cleanliness when filling the gearbox and overdrive, as any foreign matter which enters may seriously affect the operation of the overdrive.

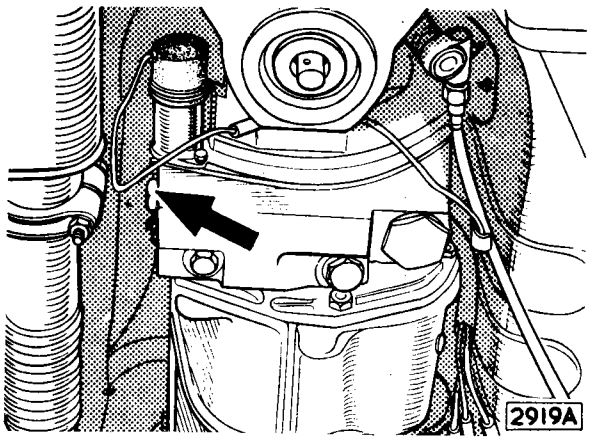


Fig. No. 3 *Overdrive filler plug*

RECOMMENDED LUBRICANTS

Mobil	Castrol	Shell	Esso	B.P.	Duckham	Regent Caltex/Texaco
Mobilube GX.90	Castrol Hypoy	Spirex E.P.90	Esso Gear Oil G.P.90/140	Gear Oil S.A.E.90 E.P.	Hypoid 90	Multigear Lubricant E.P.90

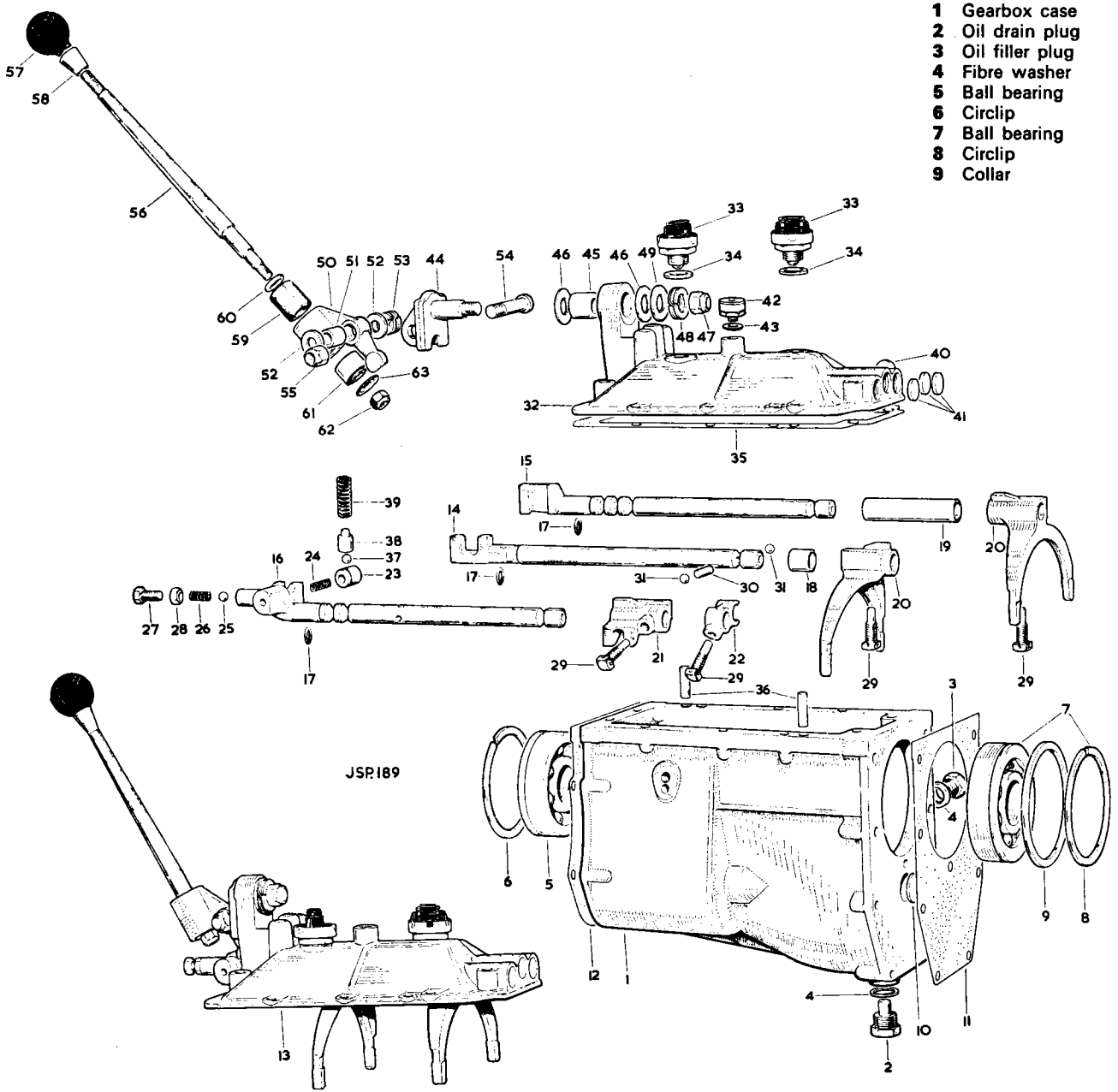
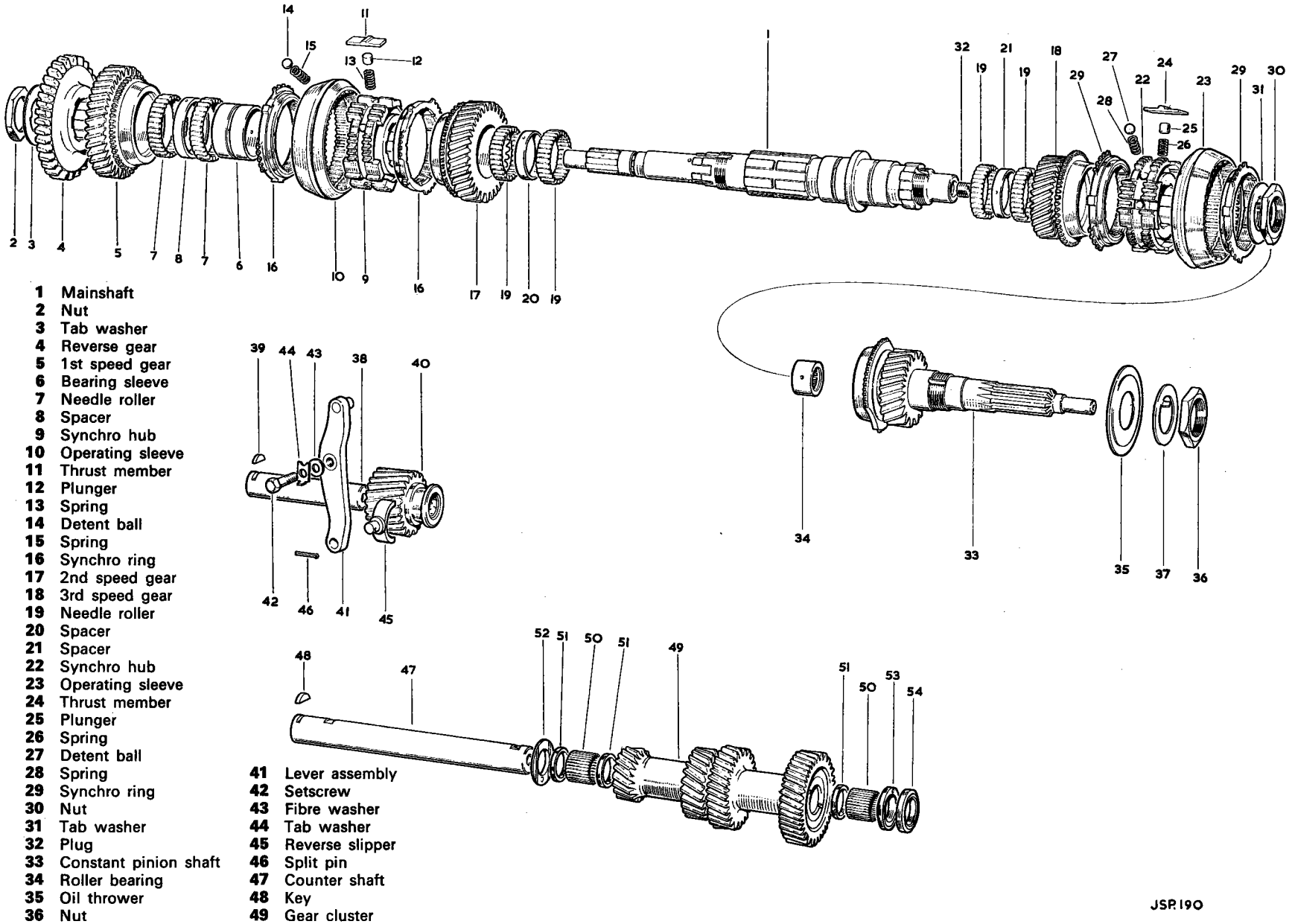


Fig. No. 4 *Exploded view of the gearbox and top cover*

1 Gearbox case
2 Oil drain plug
3 Oil filler plug
4 Fibre washer
5 Ball bearing
6 Circlip
7 Ball bearing
8 Circlip
9 Collar
10 Fibre blanking disc
11 Gasket
12 Gasket
13 Remote control assembly
14 Striking rod
15 Striking rod
16 Striking rod
17 "O" ring
18 Stop
19 Stop
20 Change speed fork
21 Change speed fork
22 Locating arm
23 Plunger
24 Spring
25 Ball
26 Spring
27 Screw
28 Nut
29 Dowel screw
30 Roller
31 Ball
32 Top Cover
33 Switch
34 Gasket
35 Gasket
36 Dowel
37 Ball
38 Plunger
39 Spring
40 Welch washer
41 Welch washer
42 Breather
43 Washer
44 Pivot jaw
45 Bush
46 Washer
47 Nut
48 Washer
49 "D" Washer
50 Selector lever
51 Bush
52 Washer
53 Washer
54 Pivot pin
55 Nut
56 Change speed lever
57 Knob
58 Locking cone
59 Upper bush
60 Washer
61 Lower bush
62 Nut
63 Washer



1 Mainshaft
2 Nut
3 Tab washer
4 Reverse gear
5 1st speed gear
6 Bearing sleeve
7 Needle roller
8 Spacer
9 Synchro hub
10 Operating sleeve
11 Thrust member
12 Plunger
13 Spring
14 Detent ball
15 Spring
16 Synchro ring
17 2nd speed gear
18 3rd speed gear
19 Needle roller
20 Spacer
21 Spacer
22 Synchro hub
23 Operating sleeve
24 Thrust member
25 Plunger
26 Spring
27 Detent ball
28 Spring
29 Synchro ring
30 Nut
31 Tab washer
32 Plug
33 Constant pinion shaft
34 Roller bearing
35 Oil thrower
36 Nut
37 Tabwasher
38 Reverse spindle
39 Key
40 Reverse idler gear
41 Lever assembly
42 Setscrew
43 Fibre washer
44 Tab washer
45 Reverse slipper
46 Split pin
47 Counter shaft
48 Key
49 Gear cluster
50 Needle roller
51 Retaining ring
52 Thrust washer
53 Thrust washer

Fig. No. 5 *Exploded view of gears*

GEARBOX—REMOVAL

In order to remove the gearbox (and overdrive if fitted) it is necessary to remove the engine and gearbox as a unit as detailed on page A.32. Separate the gearbox from the engine as described on page A.35.

GEARBOX—DISMANTLING

Remove Top Cover

Place the gear lever in neutral. Remove the eight setscrews and two nuts and lift off the top cover.

Remove Rear Extension

(Standard Transmission)
Engage first and reverse gears to lock the unit. Tap back the lockwasher and remove the flange nut. Withdraw the flange.
Withdraw the four setscrews and remove the rear cover.
Remove the speedometer pinion and bush assembly after unscrewing the retaining bolt.
Remove the six setscrews and withdraw the extension.
Collect the distance piece, oil pump driving pin and oil filter.

Remove Overdrive and Rear Cover

(Overdrive Cars)
Remove the four short setscrews retaining the overdrive to the adaptor plate and the two long setscrews at the base of the unit.
Remove the seven setscrews retaining the adaptor plate and lift off the plate.
Note: No oil pump or filter is employed on cars fitted with overdrive.

Remove Oil Pump

From inside the face of the rear extension, break the staking and withdraw the three countersunk setscrews securing the oil pump gear housing. Withdraw the housing by entering two of the screws into the tapped holes in the housing; screw in the setscrews evenly until the housing is free.
Mark the gears with marking ink so that they can be replaced the same way up in the housing.

Remove Countershaft

Remove the fibre plug from in front of the countershaft
Drive out the shaft from the front of the casing.
Ensure that the rear washer (pegged to the casing) drops down in a clock-wise direction when looking from the rear, to avoid trapping the washer with reverse gear when driving the mainshaft forward. This can easily be effected by pushing down the washer with a piece of stiff wire bent at right angles.

Remove Constant Pinion Shaft

Rotate the constant pinion shaft until the cutaway portions of the driving gear are facing the top and bottom of the casing, otherwise the gear will foul the cluster gear on the countershaft.
With the aid of two levers, ease the constant pinion shaft and front bearing assembly from the casing.

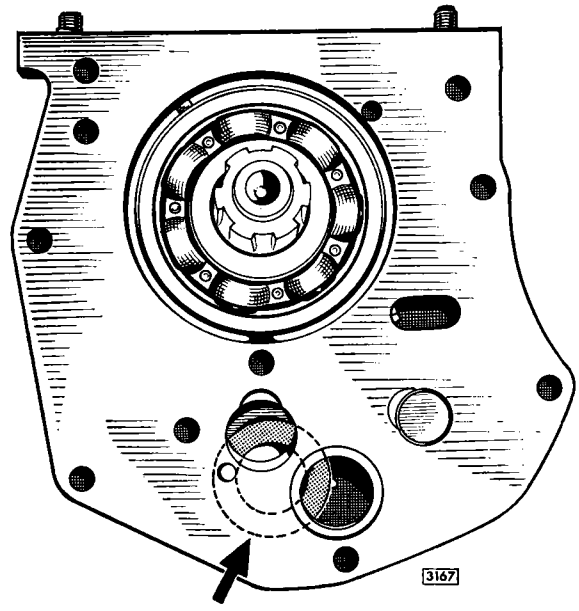


Fig. No. 6 *Ensure that the rear washer (indicated by the arrow) drops down in a clockwise direction*

Remove Mainshaft

Rotate the mainshaft until one of the cutaway portions in the 3rd/top synchro hub is in line with the countershaft, otherwise the hub will foul the constant gear of the countershaft.
Tap or press the mainshaft through the rear bearing, ensuring that the reverse gear is kept tight against the first gear.
Remove the rear bearing from the casing and fit a clamp on the mainshaft to prevent the reverse gear from sliding off the shaft.

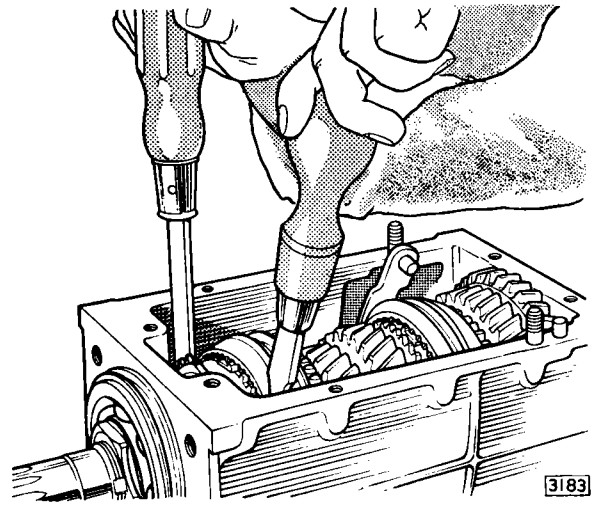


Fig. No. 7 *With the aid of two levers ease the constant pinion shaft forwards*

Slacken the reverse lever bolt to allow the lever to be moved freely back and forth. Lift out the mainshaft upwards and forward.
Lift out the cluster gear and collect the needle roller bearings and retaining rings.
Withdraw the reverse idler shaft and lift out the gear Note the locking key on the shaft.

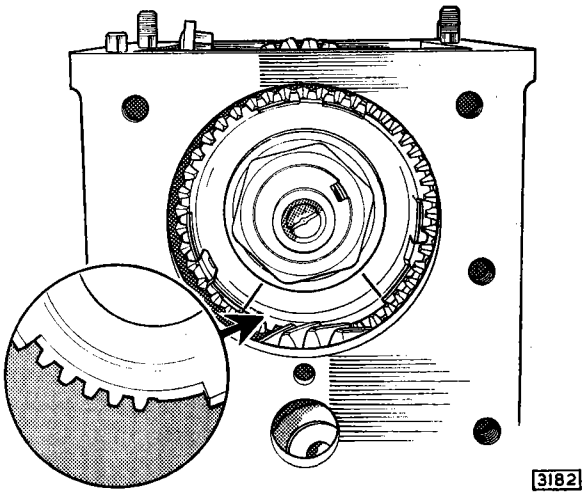


Fig. No. 8 *Rotate the mainshaft until one of the cut-away portions of the 3rd/top synchro hub is in line with the counter shaft.*

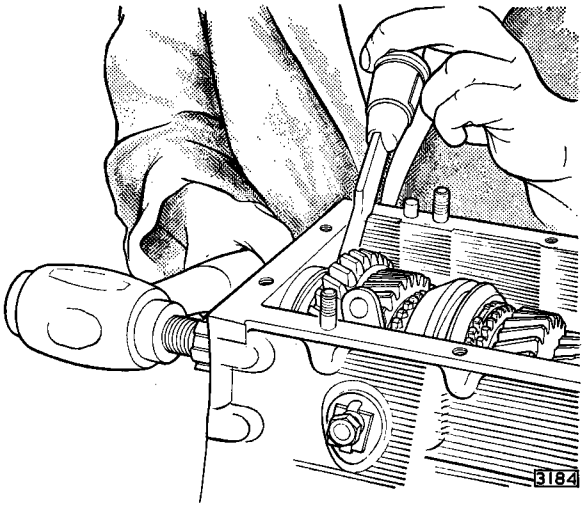


Fig. No. 9 *Tapping the mainshaft through the rear bearing*

Dismantling Constant Pinion Shaft

Remove the roller bearing from inside the constant pinion shaft.

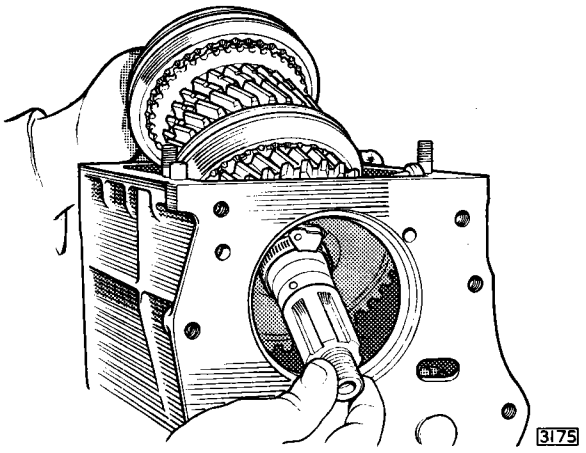


Fig. No. 10 *Removal of the mainshaft. Note the hose clamp fitted to rctain reverse gear*

Tap back the tab washer and remove the large nut, tab washer and oil thrower.
Tap the shaft sharply against a metal plate to dislodge the bearing.

Dismantling the Mainshaft

Note: The mainshaft needle roller bearings are graded in diameter and must be kept in sets for their respective positions.
Remove the hose clamp and withdraw the reverse gear.
Withdraw the 1st gear and collect the 120 needle rollers, spacers and sleeve.
Withdraw the 1st/2nd synchro assembly and collect the two loose synchro rings.
Withdraw 3rd gear and collect the 106 needle rollers.

Dismantling the Synchro Assembly

Completely surround the synchro assembly with a cloth and push out the synchro hub from the operating sleeve. Collect the synchro balls and springs, the thrust members, plungers and springs.

Dismantling the Top Cover

Unscrew the self-locking nut and remove the double coil spring, washer, flat washer, and fibre washer securing the gear lever to the top cover.
Withdraw the gear lever and collect the remaining fibre washer.
Remove the locking wire and unscrew the selector rod retaining screws.
Withdraw the 3rd/Top selector rods and collect the selector, spacing tube and interlock balls. Note the loose interlock pin at the front of the 1st/2nd selector rod.
Withdraw the reverse selector rod and collect the reverse fork, stop spring and detent plunger.
Withdraw the 1st/2nd selector rod and collect the fork and short spacer tube.

GEARBOX ASSEMBLY

Assembling the Synchros

The assembly procedure for 1st/2nd and 3rd/top synchro assemblies is the same.

Note: Although the 3rd/Top and 1st/2nd synchro hubs are similar in appearance, they are not identical and to distinguish them, a groove is machined on the edge of the 3rd/Top synchro hub (Fig. 11).

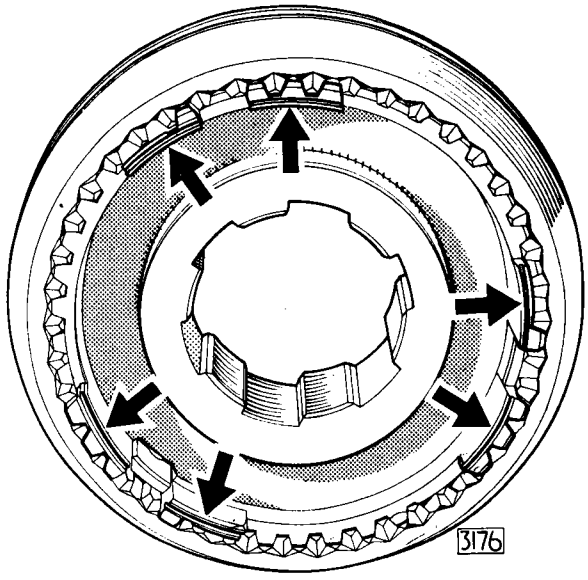


Fig. No. 11 *Identification grooves—3rd/top synchro assembly*

Assemble the synchro hub to the operating sleeve with :-

1. The wide boss of the hub on the opposite side to the wide chamfer end of the sleeve (Fig. 12).

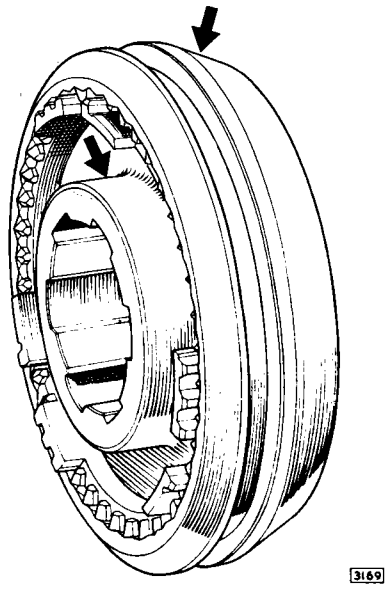


Fig. No. 12 *Assembly of synchro hub*

2. The three balls and springs in line with the teeth having three detent grooves (Fig. 13).

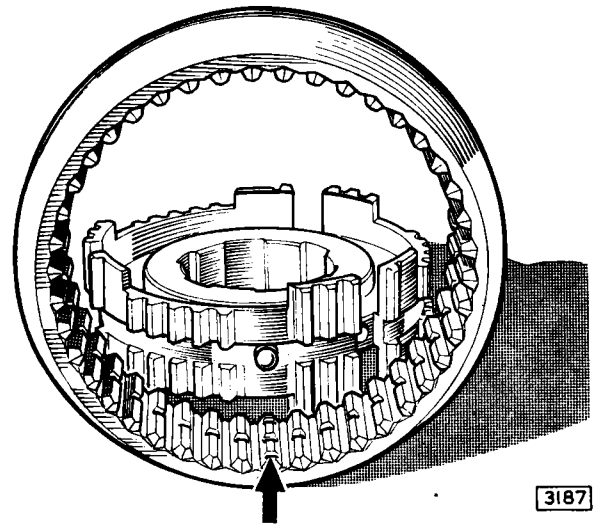


Fig. No. 13 *Fitting the synchro hub in the sleeve*

Pack the synchro hub so that the holes for the ball and springs are exactly level with the top of the operating sleeve (Fig. 14).

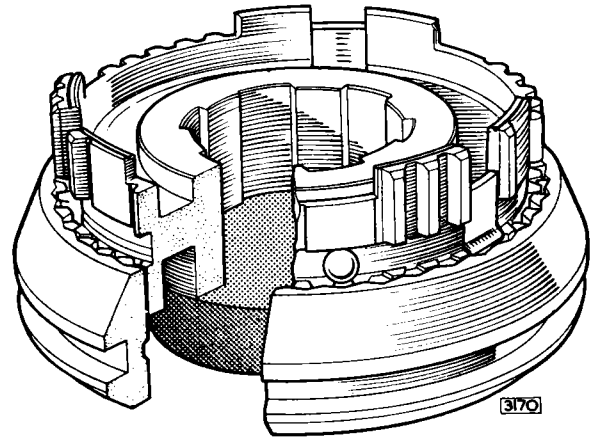


Fig. No. 14 *Fitting the springs, plungers and thrust members*

Fit the three springs, plungers and thrust members to their correct position with grease ; press down the thrust members as far as possible. Fit the three springs and balls to the remaining holes with grease.

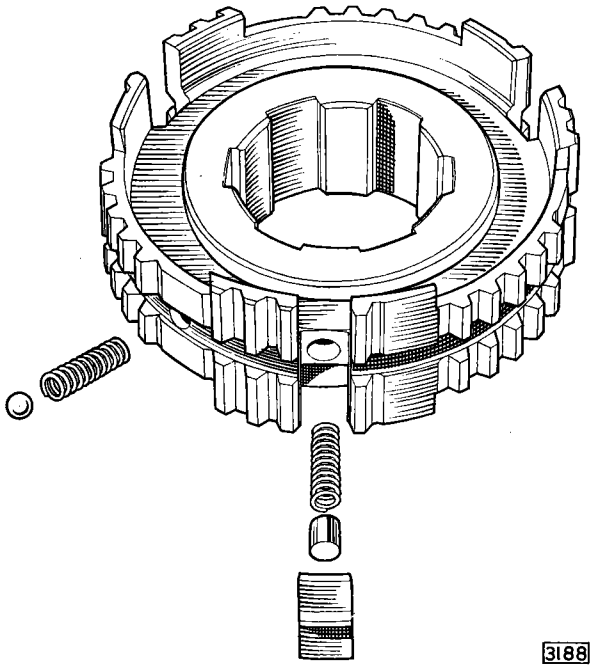


Fig. No. 15 *Showing the relative positions of the detent ball, plunger and thrust member*

Compress the springs with a large hose clip or a piston ring clamp as shown in Fig. 16, and carefully lift off the synchro assembly from the packing piece.

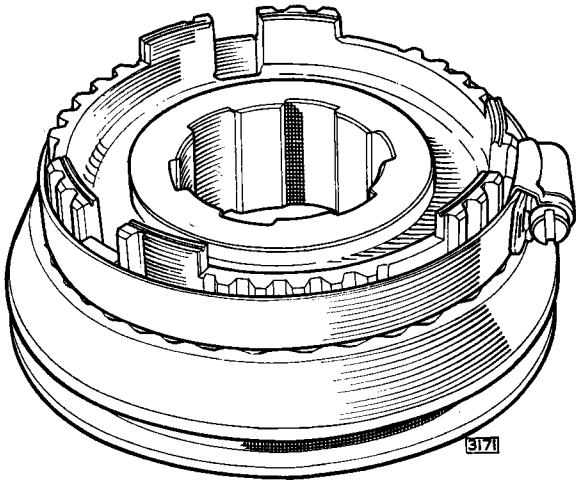


Fig. No. 16 *Compressing the spring*

Depress the hub slightly and push down the thrust members with a screwdriver until they engage the neutral groove in the operating sleeve (Fig. 17).

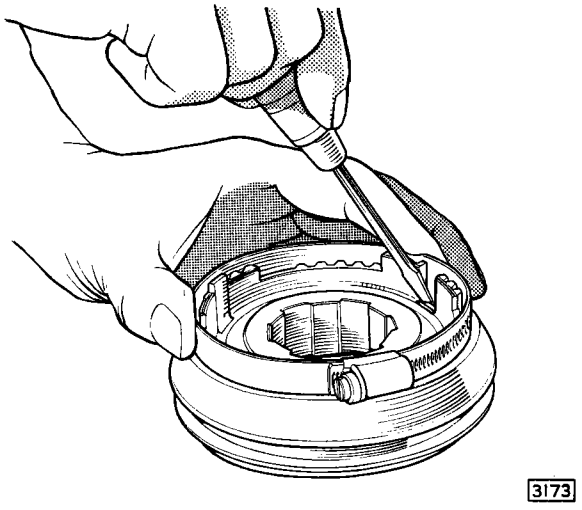


Fig. No. 17 *Pushing down the thrust members*

Finally, tap the hub down until the balls can be felt and heard to engage the neutral groove (Fig. 18).

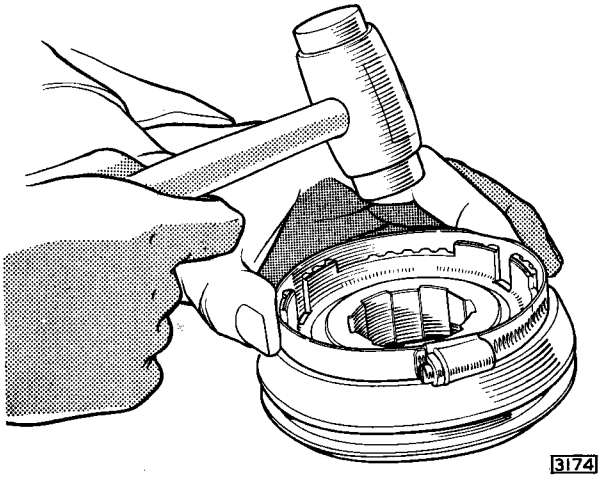


Fig. No. 18 *Tapping the hub into position*

Assembling the Cluster Gear

Fit one retaining ring in the front end of the cluster gear. Locate the 29 neddle roller bearings in position with grease and fit the inner thrust washer, ensuring that the peg on the washer locates in a groove machined on the front face of the cluster gear.
Fit a retaining ring, 29 needle roller bearings and a second retaining ring to the rear end of the cluster gear.

Checking the Cluster Gear Endfloat

Fit the reverse idler gear, lever and idler shaft.
Fit the pegged rear washer to its boss on the casing with grease.

Locate the outer thrust washer to the front of the cluster gear with grease; lower the cluster gear into position carefully. Insert a dummy shaft and check the clearance between the rear thrust washer and cluster gear. The clearance should be .004"—.006" (.10—.15 mm.) and is adjusted by means of the outer thrust washers. This is available in the following selective thicknesses:-

Part Number	Thickness
C.1862/3	.152" (3.86 mm.)
C.1862	.156" (3.96 mm.)
C.1862/1	.159" (4.04 mm.)
C.1862/2	.162" (4.11 mm.)
C.1862/4	.164" (4.17 mm.)

Assembling the Constant Pinion Shaft

Assembling is the reverse of the dismantling procedure but care must be taken to ensure that the bearing is seated squarely on the constant pinion shaft.

Assembling the Mainshaft

The assembling of the mainshaft is the reverse of the dismantling procedure, but the following points should be noted :-

1. The end float of the gears on the mainshaft is given in "Data" at the beginning of this section and if found to be excessive, the end float can only be restored by fitting new parts.
2. The needle rollers which support the gears on the mainshaft are graded on diameter, and rollers of one grade only must be used for an individual gear. The grades are identified by /1, /2 and /3 after the part number.
3. Fit a hose clamp to prevent reverse gear sliding off when assembling the mainshaft to the casing.

Assembling the Gears to the Casing

Withdraw the dummy shaft from the cluster gear and, at the same time, substitute a thin rod, keeping both the dummy shaft and rod in contact until the dummy shaft is clear of the casing. The thin rod allows the cluster gear to be lowered sufficiently in the casing for insertion of the mainshaft.

Fit a new paper gasket to the front face of the casing.

Enter the mainshaft through the top of the casing and pass the rear of the shaft through the rear bearing hole.

Enter the constant pinion shaft and bearing assembly through the bearing hole at the front of the casing with the cutaway portion of the driving gear at the top and bottom.

Tap the assembly into position entering the front end of the mainshaft in the spigot bearing of the constant pinion shaft.

Clamp the constant pinion shaft in position and, with a hollow drift, tap the rear bearing into position.

Withdraw the thin rod from the front bore of the cluster gear approximately half way and lever the cluster gear upwards, rotating the mainshaft and constant pinion shaft gently until the cluster gear meshes. Carefully insert the countershaft from the rear and withdraw the rod. Fit the key locating the countershaft in the casing.

Refitting the Rear Extension

Refit the gears to the oil pump the same way as removed, having previously coated the gears and the inside of the pump body with oil. Secure the pump housing with the three countersunk setscrews and retain by staking.

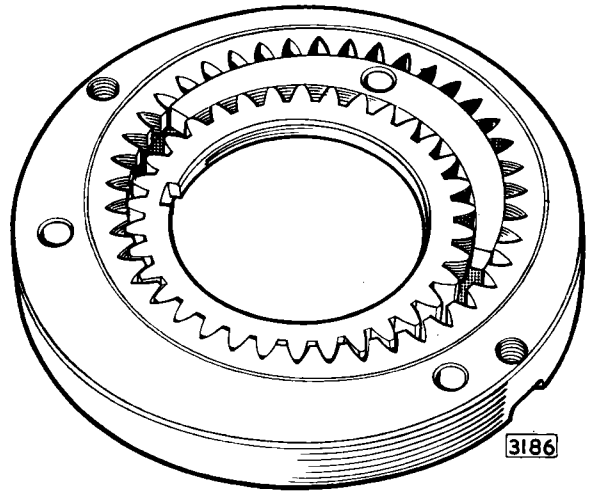


Fig. No. 19 *The oil pump*

Fit a new paper gasket to the rear of the casing.

Fit the distance piece and driving pin to the oil pump in the rear extension.

Offer up the rear extension and secure with seven screws.

Fit the speedometer driving gear to the mainshaft. Fit the speedometer driven gear and bush, with the hole in the bush in line with the hole in the casing, and secure with the retaining bolt.

Fit a new gasket to the rear cover face. Fit a new oil seal to the rear cover with the lip facing forward.

Fit the rear cover to the extension, noting that the setscrew holes are offset.

Fit the four bolts to the companion flange; slide on the flange and secure with a flat washer and split pin.

Refit Overdrive

Fit the adaptor plate to the gearbox with a new gasket and seven setscrews.

Rotate the gearbox mainshaft to position the cam with its highest point uppermost. The lower point will now coincide with the overdrive pump rollers. DO NOT TURN the mainshaft until after the overdrive has been fitted. Engage first gear.

Fit a new paper joint to the front face of the overdrive unit. Align the splines of the uni-directional clutch carrier as detailed on page E.22. Fit the overdrive to the gearbox carefully ensuring that the pump roller "rides" on the cam and that the overdrive pushes right up to the adaptor plate by hand pressure. If it will not, the splines will have become misaligned and the unit must be removed and lined up once more.

After the overdrive is fitted, tighten the four nuts on the front casing flange and also the two nuts on the long studs which go through the rear casing.

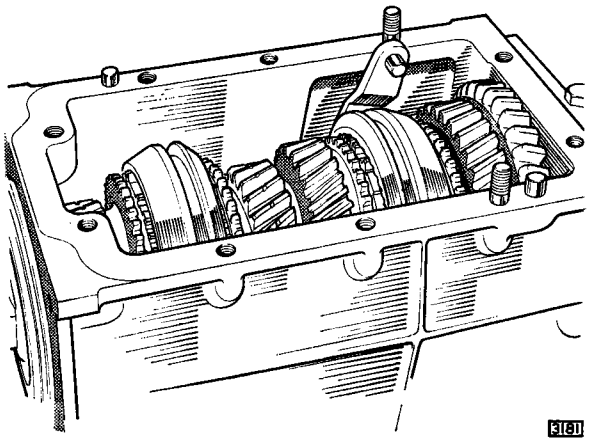


Fig. No. 20 *Re-assembled box prior to refitting the top cover*

Assembling the Top Cover

Assembling of the top cover is the reverse of the dismantling procedure, but ensure that the interlock balls and pin are fitted when assembling the selector rods. Renew the "O" rings on the selector rods.
To adjust the reverse plunger, first fit the plunger and spring. Fit the ball and spring and start the screw and locknut; press in the plunger as far as possible and tighten the screw to tighten the plunger.
Slowly slacken the screw until the plunger is released and the ball engages with the circular groove in the plunger. Hold the screw and tighten the locknut.

Fitting the Top Cover

Fit a new paper gasket. Ensure that the gearbox and top cover are in the neutral position. Ensure that the reverse idler gear is out of mesh with the reverse gear on the mainshaft by pushing the lever rearwards.
Engage the selector forks with the grooves in the synchro assemblies.
Secure the top cover with nuts and bolts noting that they are of different lengths.

Refit the Clutch Housing

Refit the clutch housing by reversing the removal procedure.
Fit a new oil seal to the housing with the lip of the seal facing the gearbox.
The oil seal has a metal flange and should be pushed in fully.
The two clutch housing securing bolts adjacent to the clutch fork trunnions are secured with locking wire; the remainder are secured with tab washers.
Note: After refitting the gearbox, run the car in top gear as soon as possible to attain the necessary mainshaft speed to prime the oil pump.

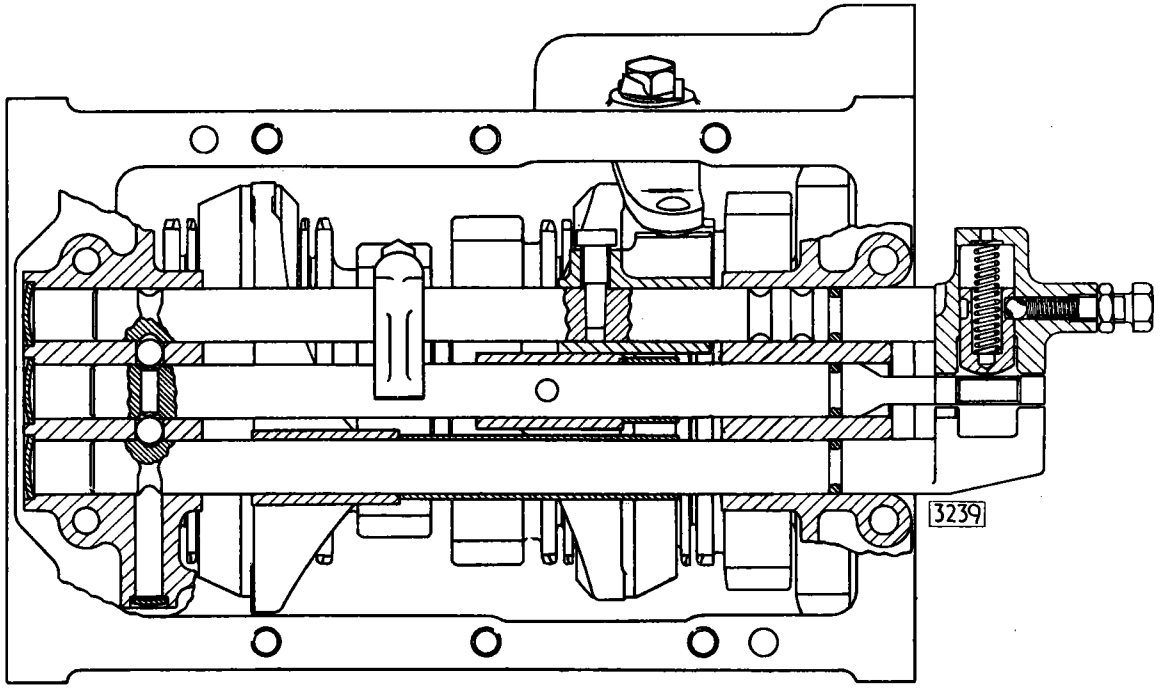


Fig. No. 21 *Plan view of gearbox showing selector arrangement*

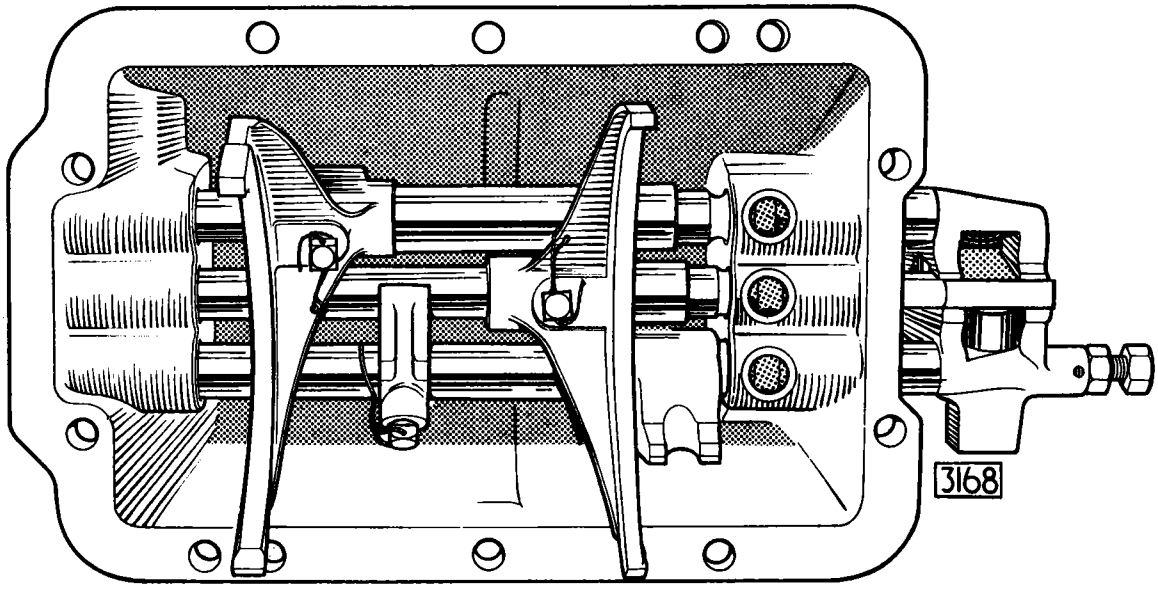


Fig. No. 22 *View of the underside of top cover*

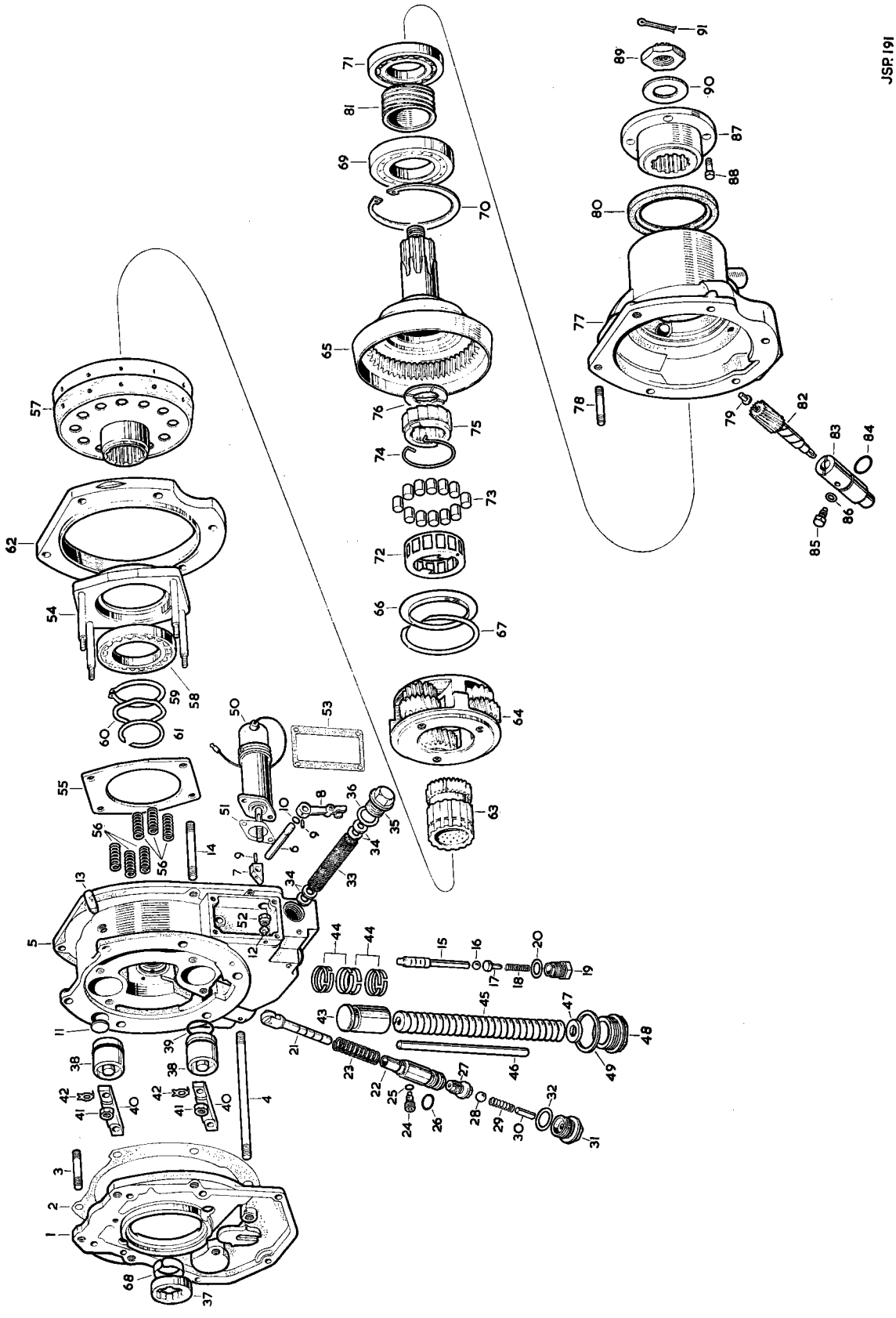


Fig. No. 23 *Exploded view of overdrive front and rear casing assemblies*

1 Adaptor plate
2 Gasket
3 Stud
4 Stud
5 Front casing
6 Shaft
7 Cam
8 Lever
9 Roll pin
10 "O" ring
11 Welch washer
12 Stop
13 Breather
14 Stud
15 Main operating valve
16 Ball
17 Plunger
18 Spring
19 Plug
20 Washer
21 Oil pump plunger assembly
22 Oil pump body
23 Spring
24 Screw
25 Fibre washer
26 "O" ring
27 Non-return valve body
28 Ball
29 Spring
30 Support rod
31 Plug
32 Copper washer
33 Oil filter
34 Magnetic ring
35 Plug
36 Washer
37 Cam
38 Operating piston
39 "O" ring
40 Bridge piece
41 Nut
42 Tab washer
43 Accumulator piston
44 Ring
45 Spring
46 Support rod
47 Packing washer
48 Plug
49 Washer
50 Solenoid
51 Gasket
52 Nut
53 Gasket
54 Thrust ring
55 Retaining plate
56 Spring
57 Clutch sliding member
58 Ball bearing
59 Circlip
60 Corrugated washer
61 Snap ring
62 Brake ring
63 Sun wheel
64 Planetary carrier assembly
65 Annulus assembly
66 Oil thrower
67 Spring ring
68 Spring ring
69 Ball bearing
70 Circlip
71 Ball bearing
72 Uni-directional clutch cage
73 Roller
74 Spring
75 Inner member for clutch
76 Thrust washer
77 Rear casing assembly
78 Stud
79 Thrust button
80 Oil seal
81 Speedometer driving gear
82 Speedometer driven gear
83 Bearing Assembly
84 "O" ring
85 Retaining screw
86 Copper washer
87 Connecting flange
88 Bolt
89 Nut
90 Washer
91 Split pin

OVERDRIVE

DESCRIPTION

The Laycock de Normanville overdrive unit consists of a hydraulically controlled epicyclic gear housed in a casing at the rear of the gearbox.

When engaged, the overdrive reduces the engine speed in relation to the road speed thus permitting high road speeds with low engine revolutions. Consequently, the use of the overdrive results in fuel economy and reduced engine wear.

The overdrive is operated by an electric solenoid controlled by a switch mounted on the steering column. Overdrive can only be engaged when the car is in top gear.

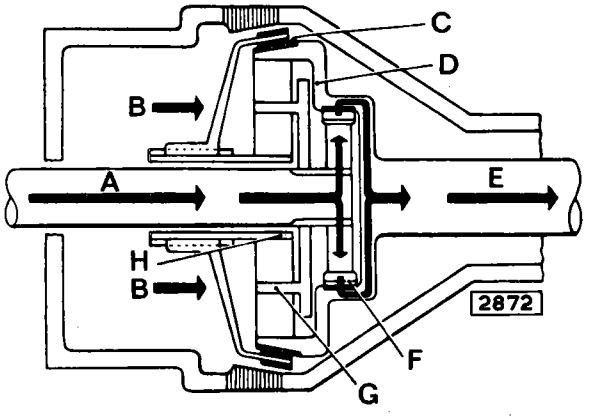


Fig. No. 24 *In direct drive*

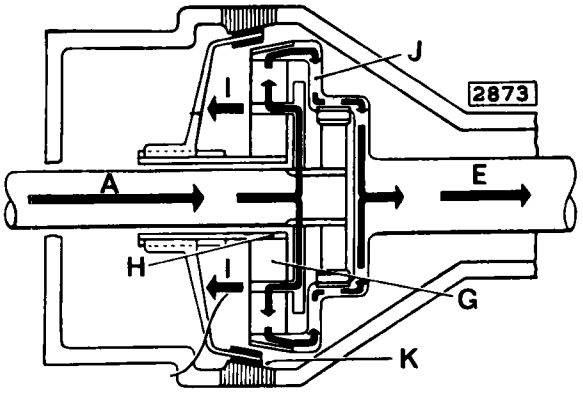


Fig. No. 25 *In overdrive*

A From gearbox
B Spring pressure
C Annulus and sunwheel locked
D Annulus
E To propeller shaft
F Uni-directional clutch
G Planet wheel and carrier
H Sunwheel
I Hydraulic pressure
J Annulus overdriven by planet wheels
K Locked cone clutch holds sunwheel

METHOD OF OPERATION (Fig. 23)

Power Input

The power input enters the overdrive unit through the extension of the gearbox driven shaft and by means of a cam (37) operates the plunger-type hydraulic pump (21). This, in turn builds up pressure against the spring loaded piston (43) in the accumulator cylinder placed across the bottom of the main casing.

The Sun-Wheel

The sun-wheel (63) is integral with an inner member (75) which is free to rotate on the input shaft. Immediately behind the sun-wheel and splined to the gearbox driven shaft is the planetary carrier (64) in which are mounted the three planet wheels.

The Uni-directional Clutch

This operates from the input shaft onto which is splined the inner member (75). The other components of this clutch are the rollers (73) and the outer member which is attached to the combined annulus and output shaft (65). The drive is transmitted from the input shaft through the clutch inner member and the rollers which are forced up the inner members' inclined faces wedging the whole clutch solid. The clutch then drives the annulus output shaft.

The Cone Clutch

The cone clutch (57) is mounted on the sliding member on which it is free to slide. The cone clutch springs (56), which hold the inner lining in contact with the corresponding cone of the annulus (65), maintain the clutch in the direct drive position. This prevents a free-wheel condition when the car tries to overun the engine. Engine braking is, therefore, always available.

Power is transmitted by way of the cone clutch, inner lining and the annulus, when the reverse gear is engaged as the uni-directional clutch is inoperative.

Hydraulic Operation

Overdrive is brought into operation by rotating the operating shaft thus lifting the operating valve. This action allows the stored hydraulic pressure in the accumulator to be applied to the two pistons (38). The pistons move the clutch (57) forward away from the annulus (65). During the forward movement of the clutch the drive from the engine to the wheels is maintained by the roller clutch.

The hydraulic operation causes the outer lining of the cone clutch to contact the brake ring (62), bringing the sun-wheel and sleeve (63) to rest.

This action is effected without shock as the clutch is oil immersed. The input drive now passes from the gearbox driven shaft to the planet carrier (64) and the rotation of the planet wheels around the stationary sun-wheel causes both the annulus and the output shaft to be driven faster than the input shaft. In this condition the outer member of the roller clutch over-runs the inner member (75).

Because the sun-wheel can move neither backwards or forwards there is always engine braking available in overdrive gear.

DATA

	Dimensions	Clearances
PUMP		
Plunger diameter	0.3742/0.3746" (9.36/9.37 mm.)	0.0002/.0.0016" (0.005/0.04 mm.)
Pump body bore	0.3748/0.3758" (9.37/9.397 mm.)	0.002/0.0016" (0.005/0.04 mm.)
PUMP ROLLER BUSH		
Outside diameter of bush	0.3736/0.3745" (9.34/9.36 mm.)	0.0005/0.0023" (0.0125/0.0575 mm.)
Inside diameter of roller	0.3750/0.3759" (9.375/9.389 mm.)	0.0005/0.0023" (0.0125/0.0575 mm.)
Inside diameter of bush	0.2510/0.2518" (6.25/6.295 mm.)	0.0007/0.0020" (0.0175/0.050 mm.)
Outside diameter of pin	0.2497/0.2502" (6.34/6.35 mm.)	0.0007/0.0020" (0.0175/0.050 mm.)
OPERATING PISTONS		
Piston diameter	1.3732/1.3741" (34.33/34.90 mm.)	0.0004/0.0023" (0.01/0.0575 mm.)
Bore diameter	1.3745/1.3755" (34.363/34.39 mm.)	0.0004/0.0023" (0.01/0.0575 mm.)
ACCUMULATOR		
Piston diameter	1.1232/1.241" (28.53/28.55 mm.)	0.0004/.0023" (0.01/0.0575 mm.)
Bore diameter	1.1245/1.1255" (28.56/28.59 mm.)	0.0004/.0023" (0.01/0.0575 mm.)
OPERATING VALVE		
Valve diameter	0.2494/0.2497" (6.235/6.243 mm.)	0.0003/0.0012" (0.0075/0.03 mm.)
Bore diameter	0.250/0.2506" (6.25/6.252 mm.)	0.0003/0.0012" (0.0075/0.03 mm.)
OVERDRIVE MAINSHAFT		
Diameter at oil transfer bush	1.1544/1.553" (28.86/28.88 mm.)	0.0029/0.0048" (0.072/0.12 mm.)
Inside diameter of bush	1.1582/1.1592" (28.96/28.98 mm.)	0.0029/0.0048" (0.072/0.12 mm.)
Diameter at sunwheel	1.1544/1.1553" (28.86/28.88 mm.)	0.0029/0.0048" (0.072/0.12 mm.)
Inside diameter of sunwheel bush	1.1582/1.1592" (28.96/29.98 mm.)	0.0029/0.0048" (0.072/0.12 mm.)
Diameter of spigot bearing	0.6235/0.6242" (15.58/15.61 mm.)	0.0008/0.0025" (0.02/0.0625 mm.)
Inside diameter of spigot bearing	0.6250/0.6260" (15.63/15.65 mm.)	0.0008/0.0025" (0.02/0.0625 mm.)
MISCELLANEOUS		
Clutch movement from direct to overdrive	0.080"/0.120" (2 — 3 mm.)	
HYDRAULIC PRESSURE	540/560 lb./sq. in. (37.966/39.372 kg./sq. cm.)	

DISMANTLING

If trouble should arise necessitating dismantling the unit, it will be necessary to remove the overdrive unit from the car. The engine, gearbox and overdrive unit are removed together as detailed on Page A.32.
Remove the gearbox and clutch housing from the engine.
Detach the clutch housing from the gearbox casing.
BEFORE COMMENCING ANY DISMANTLING OPERATIONS IT IS IMPORTANT THAT THE HYDRAULIC PRESSURE IS RELEASED FROM THE SYSTEM. DO THIS BY OPERATING THE OVERDRIVE 10-12 TIMES.

REMOVING THE OVERDRIVE FROM THE GEARBOX

The overdrive unit is separated from the gearbox at the joint between the gearbox rear extension and the overdrive front casing which are attached by seven studs.

REMOVAL

The unit is split at the rear face of the adaptor casing. There is no spring tension to release and, after removing the nuts on the securing studs, the overdrive can be withdrawn off the mainshaft, leaving the adaptor in place.

DISMANTLING

The overdrive can be divided into four main assemblies:
(a) Front casing and brake ring.
(b) Clutch sliding member.
(c) Planet carrier and gear train.
(d) Rear casing and annulus.

IMPORTANT: SCRUPULOUS CLEANLINESS MUST BE MAINTAINED THROUGHOUT ALL SERVICE OPERATIONS, EVEN MINUTE PARTICLES OF DUST, DIRT OR LINT FROM CLEANING CLOTHS MAY CAUSE DAMAGE OR, AT BEST, INTERFERE WITH CORRECT OPERATION.

Prepare a clean area in which to lay out the dismantled unit and some clean containers to receive the small parts.
Hold the overdrive with front casing uppermost in a vice fitted with suitable soft jaws.
Release the tab washers locking the four $\frac{1}{4}$" nuts retaining the operating piston bridge pieces. Remove the nuts, tab washers and bridge pieces.
Loosen the solenoid by the two screws to allow the front casing to be removed.
Remove the four nuts which secure the front and rear casings. Separate the two casings. The brake ring is spigotted into each half and may remain attached to the front half. In order to separate the brake ring from the casing, a few taps with a mallet will suffice.
Lift out the clutch sliding member complete with thrust ring, bearing and sun-wheel.
Lift out the planet carrier and gear train.

Front Casing and Brake Ring

Remove the operating valve plug and lift out the spring, plunger and ball. Remove the operating valve as described on Page E.22.
Remove the operating pistons by gripping the centre boss with a pair of pliers and applying a rotary pull.

The Solenoid

To take off the solenoid, first remove the rectangular cover plate by removing the four screws. Remove the two screws securing the solenoid which can then be pulled off. Ease the plunger out of the yoke of the valve operating lever.

The Accumulator

Access to the accumulator is gained by removing the large plug from the bottom of the unit on the off side. The length of the thread on the plug is sufficient to allow all compression to be released from the spring before the plug is completely unscrewed. The accumulator spring, support pin and washer will come out with the plug.
The accumulator piston has a groove inside the bore and a piece of stiff wire can be hooked into this to enable the piston to be withdrawn.

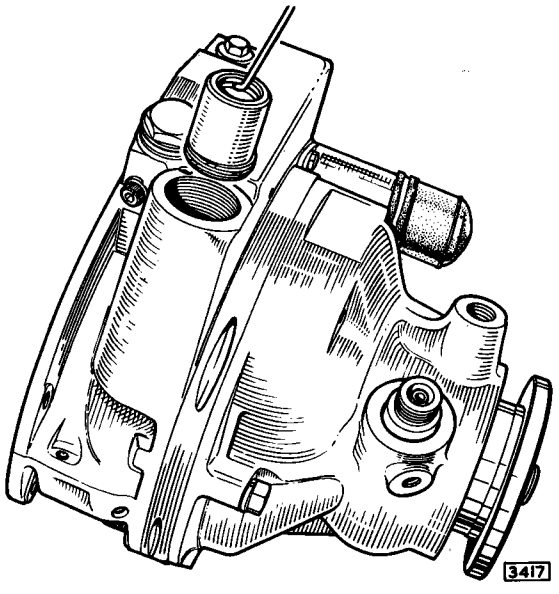


Fig. No. 26 *Removing the accumulator piston*

The Pump Non Return Valve

This valve is accessible when the centre plug in the bottom of the unit is removed. Unscrew the valve body using tool number L.213.
Remove the spring, support pin and $\frac{7}{32}$" (5.56 mm.) diameter ball.

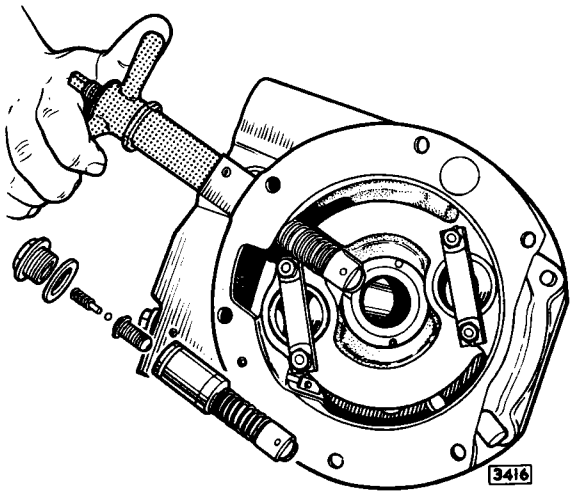


Fig. No. 27 *Removing the pump non-return valve. The valve components are shown exploded*

The Pump
Remove the locating screw (24 Fig. 23).
The pump body can now be extracted using tool number L.183A and adaptor L.183A-2. The plunger and spring will also come out when the body is withdrawn.

Oil Filter
Unscrew the plug which is situated immediately below the solenoid cover plate. The cylindrical gauze filter can then be withdrawn. Four magnetic rings are used in the filter assembly, two being located in the recess in the plug and two in the recess of the casing.

Clutch Sliding Member and Sun-wheel
Remove the circlip from the sun-wheel and slide off the corrugated washer and sliding member.

Planet Carrier Assembly
Inspect all the gear teeth for any signs of damage or chipping and assess the fit of the assembled bearings for any excessive clearance.
Planet gears are not available as separate items, therefore if damage or wear is apparent a new planet carrier assembly should be fitted.

Rear Casing and Annulus (Fig. 23)
To dismantle the assembly proceed as follows :
(a) remove spring ring (67) and oil thrower (66).
(b) remove the uni-directional clutch (72,73) by placing the special assembly ring (Tool L.178) centrally over the front face of the annulus and lifting the inner member of the uni-directional clutch up into it. This will ensure that the rollers do not fall out of the retaining cage.
(c) place the parts in a suitable container.

Alternatively, if dismantling further, remove the assembly ring and allow the rollers to come out. The hub will then come readily from the cage, exposing the spring. Remove the bronze thrust washer fitted between the hub of the uni-directional clutch and the annulus.
To remove the annulus:
(a) remove the speedometer dowel screw (85).
(b) withdraw the speedometer drive bush (83) and pinion (82).
(c) remove the coupling flange (87) and remove oil seal if necessary.
(d) press the annulus forward out of the rear casing.
The front and rear bearings will remain in the rear casing with the speedo-driving gear sandwiched between them.
(e) remove circlip (70) and then drive out the speedo driving gear and rear bearing. The front bearing can then be driven out.

IMPORTANT : EACH PART SHOULD BE THOROUGHLY CLEANED AND EXAMINED AFTER THE UNIT IS DISMANTLED.

INSPECTION

FRONT CASING AND BRAKE RING (Fig. 23)
Inspect the front casing for cracks and other damage. Examine the bores of the operating cylinders and accumulator for scores or other wear.
Check for signs of leaks from the plugged ends of the oil passages. Ensure that the sealing disc in the front face of the casing is tight and not leaking.
Inspect the centre bush for wear or damage.
Check operating pistons (38) for signs of scores and replace sealing ring (39) if there is any sign of damage or distortion.
Check the pump roller and its bronze bush for any undue wear. The roller pin is secured by a mills pin $\frac{1}{16}$" (1.6 mm.) dia. driven vertically into the curved portion of the pump plunger fork.
This pin can be sheared by driving the roller pin through the fork.
Check pump plunger for wear and scores.
Check pump body for wear and scores. Check the valve seat and ball to ensure that they are free from nicks and scratches.
Check the pump spring (23) for distortion.
Check the accumulator piston for signs of wear or scores. Check that there are no broken piston rings.
Check the accumulator spring for distortion or collapse.
Inspect the operating valve for distortion or collapse. See that it slides easily in the bore of the front casing.
Check that the ball seat is clean and free from scratches.
Check that the restrictor jet is clear. Check the ball and spring for distortion.
Clean the filter thoroughly in petrol. Remove all metallic particles fron the magnetic rings.
Check brake ring (62) for signs of wear, scoring or cracks.

CLUTCH SLIDING MEMBER (Fig. 23)
Inspect the clutch lining on the clutch sliding member for any signs of excessive wear or charring. If excessive wear or charring is apparent, replace the sliding member

complete. It is not possible to fit new linings only as the faces have to be fine machined to an accurate angle after rivetting.
Inspect the pins for the bridge pieces on the thrust ring (54) and check that they are tight and not distorted.
Inspect the ball race (58) and ensure that it rotates smoothly as this can otherwise be a source of noise when running in direct gear.
Inspect the clutch springs (56) for any signs of damage or collapse.

PLANET CARRIER AND GEAR TRAIN (Fig. 23)
If not previously inspected under **"DISMANTLING"** the gears and bearings should be inspected.
Inspect the teeth on the sun-wheel (63) for sign of damage or chips. If the bush is worn, a new gear complete must be fitted as the bore has to be machined concentric with gear teeth after sub-assembly.

REAR CASING AND ANNULUS (Fig. 23)
Ensure that the rollers of the uni-directional clutch (73) are not chipped and that the inner and outer members are free from damage. Check that the cage, particularly the two ears, is not distorted or broken.
Inspect the bronze washers fitted between the uni-directional clutch and the annulus.
Inspect the gear teeth of the annulus (65) for damage.
Inspect the conical surface for signs of wear. A bronze spigot bearing is fitted in the annulus under the uni-directional clutch. Inspect this for wear. This bearing has to be machined after sub-assembly and therefore cannot alone be replaced in the field. Where necessitated by bearing damage, a new annulus must therefore be used. Inspect the output shaft ball races (69) and (71). Confirm that they rotate smoothly.
Inspect the rear oil seal (80). If it is necessary to remove the seal, a new one must always be fitted.
Inspect the teeth of the speedometer pinion for wear.

RE-ASSEMBLY

FRONT CASING AND BRAKE RING

Insert the pump plunger, spring and body in the central holes in the bottom of the casing (see Fig. 27) taking care to locate the flat of the plunger against the thrust button which is situated below the centre bush. Tap the pump body home until the annular groove lines up with the locating screw hole in the casing and then insert the screw through the fibre washer and tighten ensuring that the dowel locates in the groove. Re-seat the non-return valve ball by lightly tapping it with a copper drift and then screw in the non-return valve body using Churchill Tool No. L.213. Fit the ball spring, support pin, copper washer and plug, tightening same while ensuring that the spring is located in the plug recess.

Accumulator
Carefully insert the piston in the casing, using Tool No. L.304. Insert the spring and support pin. Fit the fibre washer and plug. Ensure that the spring is located in the plug recess together with any packing washers that were originally fitted and then tighten.

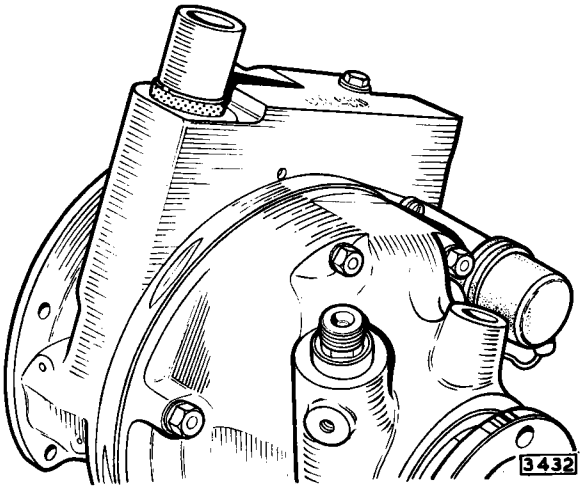


Fig. No. 28 *Refitting the accumulator piston using the special tool No. L.304*

OPERATING PISTONS

When inserting the operating pistons, carefully ease the rubber sealing rings into the cylinder bores. The centre bosses of the pistons face towards the front of the unit.

OPERATING VALVE

Insert the operating valve into the casing, ensuring that the hemispherical end engages on the flat of the small cam on the operating shaft. Drop in the $\frac{5}{16}$" dia. (7.93 mm.) ball, plunger and spring. Screw in and tighten the operating valve plug, ensuring that the copper washer is located correctly.

OIL FILTER

Fit the two magnetic rings in the recess in the casing and then insert the filter. A further two magnetic rings are fitted in the recess of the plug. Screw in the plug together with the copper washer and, ensuring that the filter is located at either end, tighten up.
The front casing, less solenoid, is now complete and ready for assembly to the rest of the unit.

REAR CASING AND ANNULUS

Press the front bearing into the rear casing using Tool No. L.303 ensuring that its outer track abuts against the shoulder of the casing and then fit the retaining circlip. Support the inner race of the bearing using Churchill Tool No. L.303 and then press in the annulus until the bearing abuts on the locating shoulder. Fit the speedometer driving gear and using Churchill Tool No L.303, press the rear bearing onto the tail shaft and into the casing simultaneously. Press in the rear oil seal using Tool No. L.305 until it is flush with the end of the rear casing. Press on the coupling flange after first fitting the bolts and then fit the washer and slotted nut. Tighten to a torque of 1200-1560 lb. in. (13.82-22.11 kg. cm.) and fit the split pin. Insert the speedometer pinion gear and bush after ensuring that the "O" ring is serviceable.

Turn the annulus to engage the gear if necessary, align the holes in the casing and bush. Fit the locating screw and copper washer.

Assembling and Fitting Uni-directional Clutch
Assemble the spring into the roller cage of the uni-directional clutch. Fit the inner member into the cage and engage it on the other end of the spring. Engage the slots of the inner member with the tongues on the roller cage and ensure that the spring rotates the cage so that, when the rollers are fitted, they will be propelled up the inclined faces of the inner member. The cage is spring loaded anti-clockwise when viewed from the front.
Place the assembly, front end downwards, into the special assembly ring, Churchill Tool No. L.178, and fit the rollers through the slots in the tool, turning the clutch clockwise until all the rollers are in place, see Fig. 29.
Replace the uni-directional clutch assembly using the special tool to enter the rollers into the outer member in the annulus. Fit the oil thrower and retaining clip.

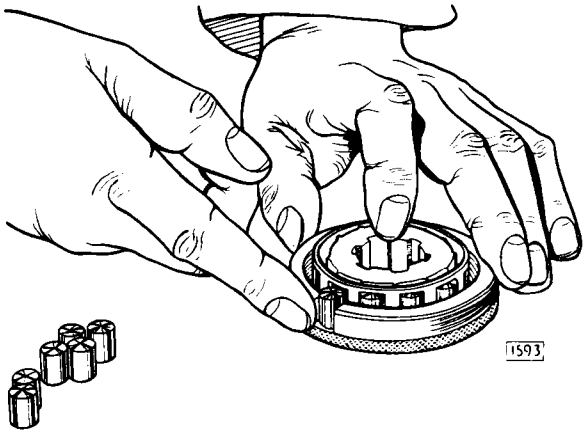


Fig. No. 29 *Assembling the uni-directional clutch using Tool No. L.178*

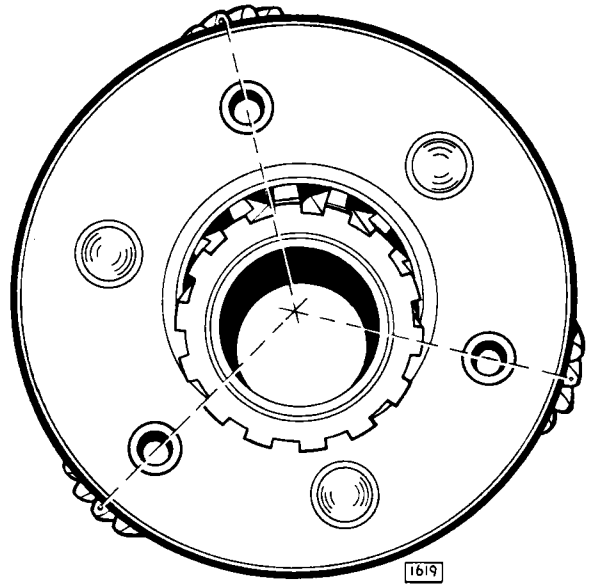


Fig. No. 30 *Assembling the planet gears—Note the positions of the marked teeth*

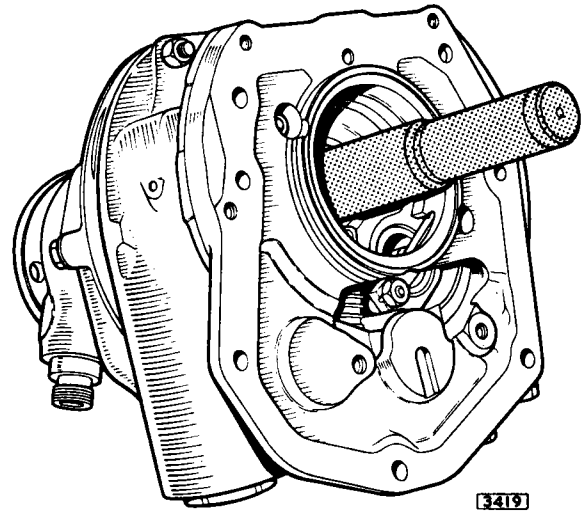


Fig. No. 31 *Using the dummy mainshaft Tool No. L.185A*

PLANET CARRIER AND GEAR TRAIN

Special care must be taken when re-assembling the planet carrier assembly to the annulus and sun-wheel. Turn each gear respectively until a dot marked on one tooth of the large gear is positioned radially outwards (see Fig. 30).
Insert the sunwheel to mesh with the planet gears, keeping the dots in the same position, and then insert this assembly to mesh with the internal gear in the annulus. Insert the dummy mainshaft Churchill Tool No. L.185A engaging in the planet carrier and uni-directional clutch splines.

CLUTCH SLIDING MEMBER

Press the thrust bearing into the thrust ring and press this assembly onto the hub of the clutch sliding member taking care not to damage the linings. Secure the assembly in position by fitting the circlip on the hub of the sliding member. Slide this assembly onto the sunwheel splines until the inner lining is in contact with the annulus and then fit the corrugated washer and circlip.

FINAL ASSEMBLY

Fit the retaining plate over the bolts of the thrust ring bearing assembly. Smear liquid jointing compound onto both faces of the brake ring flange and tap this home into the front casing. Insert the clutch return springs in the front casing. Offer up the front casing and brake ring to the rear casing, ensuring that the thrust ring bolts pass through the holes in the front casing without binding. The clutch spring pressure will be felt as the two casings go together and the four nuts should be progressively tightened until the faces meet Fit the two bridge pieces, nuts and new tab washers.

Fit the solenoid plunger in the fork of the operating lever and, after fitting a gasket to the solenoid flange, fasten the solenoid to the casing by means of the two securing screws.

Adjust the solenoid operating lever as described below. Secure solenoid gasket and cover plate with four setscrews and lockwashers.

The overdrive is now complete and ready for fitting to gearbox.

REFITTING THE OVERDRIVE TO THE GEARBOX

Place the overdrive unit upside down in a vice.

Remove the dummy mainshaft from the overdrive. The splines will now be correctly lined up and it is most important that the coupling flange is not turned until the unit has been fitted to the gearbox.

Check that the cam is not unduly worn and that the flat spring ring on the gearbox mainshaft is not distorted and does not protrude above the crown of the splines.

Rotate the shaft to position the cam with its highest point uppermost. The lowest point will now coincide with the overdrive pump roller. The mainshaft should not be turned again until the overdrive has been fitted and it is advisable to engage bottom gear.

Fit a new paper joint to the overdrive front face. Fit the gearbox carefully to the overdrive ensuring that the pump roller rides on the cam which is chamfered for this purpose, and that the overdrive pushes right up to the face of the adaptor by hand pressure only. If the overdrive will not meet the adaptor face by about $\frac{5}{8}$" (15.88 mm.) it means that the splines have become misaligned. In such a case remove the overdrive again and re-align the splines by rotating the inner member of the uni-directional clutch in an anti-clockwise direction. This can be done with a long screwdriver. Recheck by inserting the dummy mainshaft again.

When the overdrive has been fitted, tighten up the four nuts on the front casing flange and also the two nuts on the long studs which go right through the rear casing.

THE OPERATING VALVE

DESCRIPTION

The valve plug is located at the bottom of the unit on the same side as the solenoid and it is accessible from beneath the car. Unscrew the valve plug with a $\frac{5}{8}$" A/F spanner; if very tight, a sharp tap on the head will facilitate. Remove the spring, plunger and ball. The operating valve can be removed by inserting a piece of stiff wire in the central bore and drawing it down. Care must be taken to avoid damaging the seating at the bottom of the valve. Near the top of the valve will be seen a small hole breaking through the central bore (Fig. 32.) This is for the exhaust of oil from the operating cylinders. Ensure that this is not choked.

SOLENOID ADJUSTMENT

The operating valve is lifted by a cam on a transverse shaft. The solenoid operates a lever attached to this shaft. When the solenoid is operated, the valve must be fully opened.

The solenoid box is located on the left hand side of the unit and is accessible from beneath the car.

Remove the rectangular solenoid cover plate which is secured by four screws. The solenoid lever which has a $\frac{3}{16}$" dia. (4.76 mm.) hole for setting purposes is now disclosed.

Move the lever until a $\frac{3}{16}$" dia (4.76 mm.) pin pushed through the hole in the lever registers the hole in the casing.

Screw the nut on the plunger until when the plunger is pushed right home in the solenoid, the nut just contacts the fork of the lever.

Remove the $\frac{3}{16}$" (4.76 mm.) dia, pin.

Recheck by energising the solenoid and checking the alignment of the holes. When the solenoid is energised the correct consumption should be about 1 ampere. If it is 15-20 amperes it is an indication that the solenoid plunger is not moving far enough to switch from the operating to the holding coil of the solenoid and the lever must be adjusted.

THIS IS IMPORTANT AS HIGH CURRENT WILL CAUSE SOLENOID FAILURE.

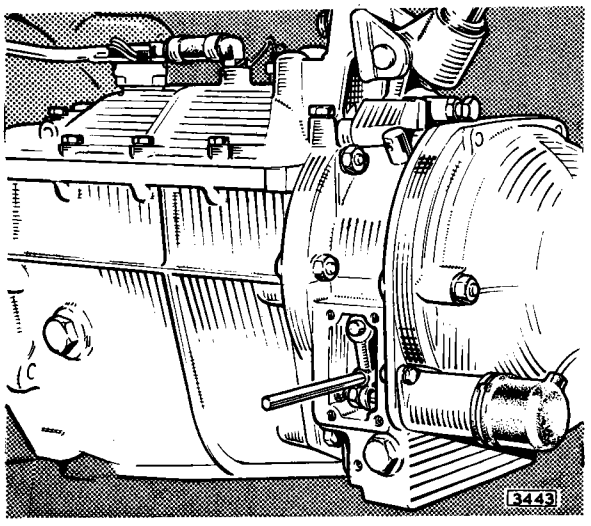


Fig. No. 32 *Solenoid adjustment*

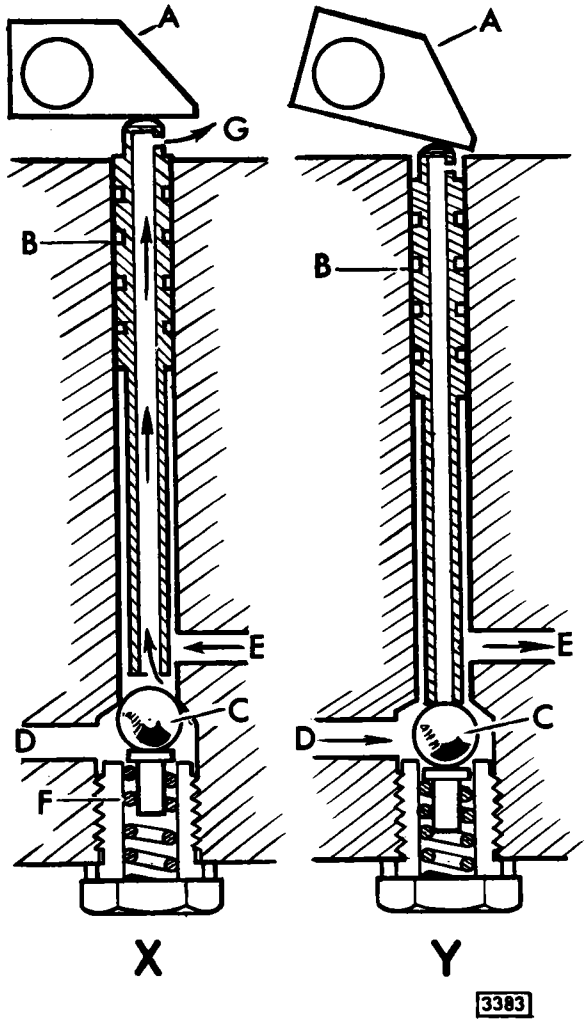


Fig. No. 33 *The operating valve*

"X" shows the position of the operating valve in direct drive. In this position the ball C is held on the seat in the casing by the valve spring F and isolates the supply D from the operating cylinders E.

"Y" shows the position of the operating valve in the overdrive position. The valve has been lifted by action of the solenoid causing the cam A to rotate, moving the ball off the seat in the casing and sealing off the top of the valve. This allows oil under pressure to transfer from port D to the operating cylinders E.
On returning to direct drive, the oil is exhausted down the hollow stem of the valve B and through the restrictor G.

STICKING CLUTCH

If an overdrive cannot be disengaged after carrying out the procedure outlined on Page E.24 this is probably due to a sticking cone clutch. This trouble can be experienced with a new unit due to insufficient "bedding-in" of the clutch, but it is unlikely to occur on a unit which has been in service for some time.
The clutch can usually be freed by giving the brake ring several sharp blows with a hide mallet. This can be done from underneath when the car is on a hoist.

THE ELECTRICAL CIRCUIT

As many operational failures are due to corroded terminals and faulty wiring, wiring and connections should be checked first.
Good earth connections are essential on all earthed components. This applies particularly to the solenoid because of the heavy current passed momentarily each time the overdrive is engaged.
Incorrect adjustment of the solenoid, resulting in the failure of the main winding contacts to open, may cause damage to the solenoid.
Check that the in-line fuse has not blown (this fuse is located behind the side facia panel). Replace with an 8 amp. fuse if necessary.
Switch on reverse light and check that main fuse, No. 8, has not blown.
If neither fuse has blown, check that current is available at the solenoid. Disconnect the cable at the solenoid junction and connect a test lamp in circuit. Switch on overdrive. If current is available as indicated by test bulb illumination, renew the solenoid unit.
If current is **NOT** available, reconnect the solenoid and short out the top gear switch terminals. Renew the switch if the solenoid now operates.
If the solenoid does not operate, replace the control switch by substitution and recheck. Renew the control switch if faulty.

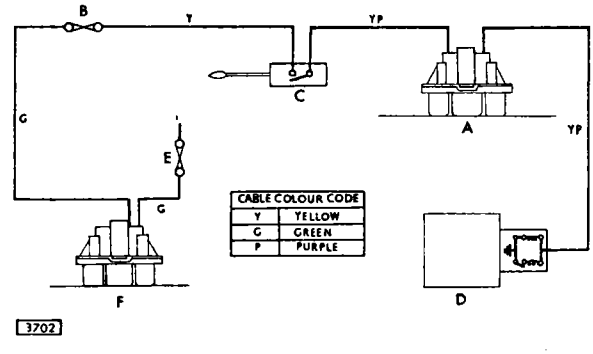


Fig. No. 34 *Overdrive circuit diagram*

TESTING OIL PRESSURE

Release the hydraulic pressure by switching on the ignition, engaging top gear and operating the overdrive switch several times. Remove the operating valve plug and replace it with the hydraulic test equipment, which has a pressure gauge reading to 800 lb./sq. in. (56.24 kg./sq. cm.).
Jack up the rear wheels of the car securely, start the engine, engage top gear and run up to about 20 m.p.h. (32 k.p.h.) on the speedometer. Hydraulic pressure should then be recorded. Check the pressure in direct and overdrive.
Failure to register pressure with overdrive selected may indicate that the pump non-return valve requires cleaning and re-seating.
Hydraulic pressure should be 540-560 lb./sq. in. (37.966/39.372 kg./sq. cm.).

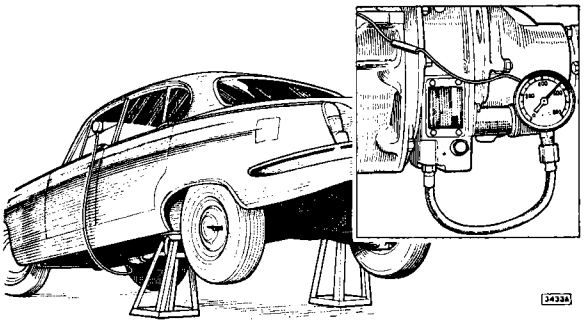


Fig. No. 35 *Testing the oil pressure*

THE PUMP VALVE

If the unit fails to operate after re-seating the operating valve, check that the pump is working. Jack up the rear wheels of the car securely, remove the operating valve plug and, using a clean receptacle, catch any oil which may spill from the valve chamber.
Start up the engine, engage top gear, and with the engine running slowly, watch for oil being pumped into the valve chamber. If none appears the pump is not functioning and its non-return valve should be cleaned.
A flow of oil does not necessarily mean that the hydraulic pressure is correct.
It is most important that any oil lost from the valve chamber is poured back into the gearbox when the operating valve plug has been replaced.
The pump valve is accessible from underneath the unit when the centre plug is removed. Unscrew the valve body, carefully clean the ball and the valve seating. Reseat the ball by tapping it sharply on to its seating.

SPECIAL TOOLS

Description
Dummy Mainshaft (L.185A)*
Pump Body Remover (Main Tool—L.183A)*
Pump Body Remover Adaptor (L.183A-2)*
Assembly Ring for Uni-directional Clutch (L.178)*
Annulus Bearing Replacer (L.303)*
Accumulator Piston Replacer (L.304)*
Rear Casing Oil Seal Replacer (L.305)*
Pump Non-Return Valve Key (L.213)*
* Churchill Tool Number.

FAULT FINDING

When an overdrive unit does not operate properly it is advisable to check the level of the oil and, if below the low level mark, top up with fresh oil and test the unit again before making any further investigations.
Faulty units should be checked for defects in the order listed below.
If the electrical control does not operate, the electrical circuit should be checked from the diagram.

OVERDRIVE DOES NOT ENGAGE

(a) Insufficient oil in the gearbox.
(b) Solenoid not operating due to fault in electric system.
(c) Solenoid operating lever out of adjustment.
(d) Insufficient hydraulic pressure due to pump non-return valve incorrectly seating (probably dirt on the seat).
(e) Insufficient hydraulic pressure due to worn accumulator.
(f) Pump not working due to choked filter.
(g) Pump not working due to damaged pump roller or cam.
(h) Leaking operating valve due to dirt on ball seat.
(i) Damaged parts within the unit requiring removal and inspection.

OVERDRIVE DOES NOT DISENGAGE

Important: If the overdrive does not release, do NOT reverse the car, otherwise extensive damage may be caused.
(a) Fault in electrical control system.
(b) Solenoid sticking.

(c) Blocked restrictor jet in operating valve.
(d) Solenoid operating lever incorrectly adjusted.
(e) Sticking clutch.
(f) Damaged gears, bearing or sliding parts within the unit.

CLUTCH SLIP IN OVERDRIVE

(a) Insufficient oil in gearbox.
(b) Solenoid lever out of adjustment.
(c) Insufficient hydraulic pressure due to pump non-return valve incorrectly seating (probably dirt on the seat).
(d) Insufficient hydraulic pressure due to worn accumulator.
(e) Operating valve incorrectly seated.
(f) Worn or glazed clutch lining.

Clutch slip in reverse or free wheel condition on overdrive

(a) Solenoid operating lever out of adjustment.
(b) Partially blocked restrictor jet in operating valve.
(c) Worn or burnt inner clutch lining.

Note: Before removing any of the valve plugs it is essential to operate the solenoid several times in order to release all hydraulic pressure from the system. To do this, engage top gear, switch on the ignition and operate the overdrive control switch several times.

AUTOMATIC TRANSMISSION

SECTION F

INDEX

GENERAL DATA

GEAR RATIOS

Maximum ratio of torque converter	2.00 : 1
1st gear reduction	2.40 : 1
2nd gear reduction	1.46 : 1
3rd gear	1.00 : 1
Reverse gear reduction	2.00 : 1

SHIFT SPEEDS

Selector Position	Throttle Position	Upshifts 1—2	Upshifts 2—3	Upshifts 3—2	Downshifts 3—1	Downshifts 2—1
			M.P.H.			
D1	Minimum	6.5 to 7.5	11 to 13	6.5 to 12.5	—	3.5 to 6.5
	Full	33 to 38.5	58 to 62	19.5 to 32.5	—	—
	Kickdown	45 to 49	70.5 to 77.5	63 to 71	17 to 21	17 to 21
D2	Minimum	—	11 to 13	7 to 13	—	—
	Full	—	58—62	19.5 to 32.5	—	—
	Kickdown	—	70.5 to 77.5	63 to 71	—	—
L	Zero	—	—	ANY	—	10 to 18
			K.P.H.			
D1	Minimum	10.5 to 12	18 to 21	10.5 to 12	—	6 to 10
	Full	53 to 62	93 to 100	31 to 52	—	—
	Kickdown	72.5 to 79	113 to 125	100 to 114	27 to 34	27 to 34
D2	Minimum	—	18 to 21	11 to 21	—	—
	Full	—	93 to 100	31 to 52	—	—
	Kickdown	—	113 to 125	100 to 114	—	—
L	Zero	—	—	ANY	—	16 to 29

Note: Shift points are approximate and not absolute values. Reasonable deviations from the above values are permissible.

IMPORTANT NOTICE

ANY QUERIES ON THE USE, UPKEEP OR REPAIR OF THIS TRANSMISSION UNIT MUST BE REFERRED TO THE WORKS SERVICE DIVISION. COVENTRY, AND **IN NO CIRCUMSTANCES** TO THE MANUFACTURERS OF THE TRANSMISSION. SPARE PARTS ARE **NOT** AVAILABLE FROM THE TRANSMISSION MANUFACTURERS.

TIGHTENING TORQUE FIGURES

	lb. ft.	kgm.
Front pump to transmission case bolts	17 — 22	2.35 — 3.04
Front servo to transmission case bolts	30 — 35	4.15 — 4.70
Rear servo to transmission case bolts	40 — 45	5.53 — 6.22
Centre support to transmission case bolts	20 — 25	2.76 — 3.46
Upper valve body to lower valve body bolts	4 — 6	0.55 — 0.83
Control valve body to transmission case bolts	8 — 10	1.11 — 1.38
Pressure regulator assembly to transmission case bolts	17 — 22	2.35 — 3.04
Extension assembly to transmission case bolts	28 — 33	3.87 — 4.56
Oil pan to transmission case bolts	10 — 13	1.38 — 1.80
Case assembly-gauge hole plug	10 — 15	1.38 — 2.07
Oil pan drain plug	25 — 30	3.46 — 4.15
Rear band adjusting screw lock nut	35 — 40	4.70 — 5.53
Front band adjusting screw lock nut	20 — 25	2.76 — 3.46
Detent lever attaching nut	35 — 40	4.70 — 5.53
Companion flange nut	90 —120	12.44 —16.58
Bearing retainer to extension housing bolts	28 — 33	3.87 — 4.56

AUTOMATIC TRANSMISSION

TIGHTENING TORQUE FIGURES

	lb. in.	kgm.
Front pump cover attaching screws	25 — 35	0.29 — 0.40
Rear pump cover attaching screws $\frac{1}{4}$"	50 — 60	0.60 — 0.72
Rear pump attaching screws Nos. 10 — 24	20 — 30	0.24 — 0.35
Governor inspection cover attaching screws	50 — 60	0.60 — 0.72
Governor valve body to counterweight screws	50 — 60	0.60 — 0.72
Governor valve body cover screws	20 — 30	0.24 — 0.35
Pressure regulator cover attaching screws	20 — 30	0.24 — 0.35
Control valve body screws	20 — 30	0.24 — 0.35
Control valve body plug	10 — 14	0.11 — 0.16
Control valve lower body plug	7 — 15	0.08 — 0.17

SPECIAL SERVICE TOOLS

Service tools are not available from Borg-Warner Limited. Distributors and Dealers should obtain the following tools illustrated in this manual from Messrs. V. L. Churchill & Co. Ltd., London Road, Daventry, Northants.

Description

Mainshaft end play gauge (CB.W.33)
Rear clutch spring compressor (C.B.W.37A used with W.G.37)
Hydraulic pressure test gauge equipment (C.B.W.1A used with adaptor C.B.W.1A-5A)
Spring beam torque wrench (used in conjunction with the following adaptor) (C.B.W.547A-50)
Rear band adjusting adaptor (C.B.W.547A-50-2)
Torque screwdriver (used in conjunction with the following adaptor) (C.B.W.548)
Front band adjusting adaptor (C.B.W.548-2)
Front band setting gauge (C.B.W.34)
Circlip pliers (used with "J" points) (7066)
Bench cradle (C.W.G.35)
Rear clutch piston assembly sleeve (C.W.G.41)
Front clutch piston assembly sleeve (C.W.G.42)
Rear pump discharge tube remover (C.W.G.45)

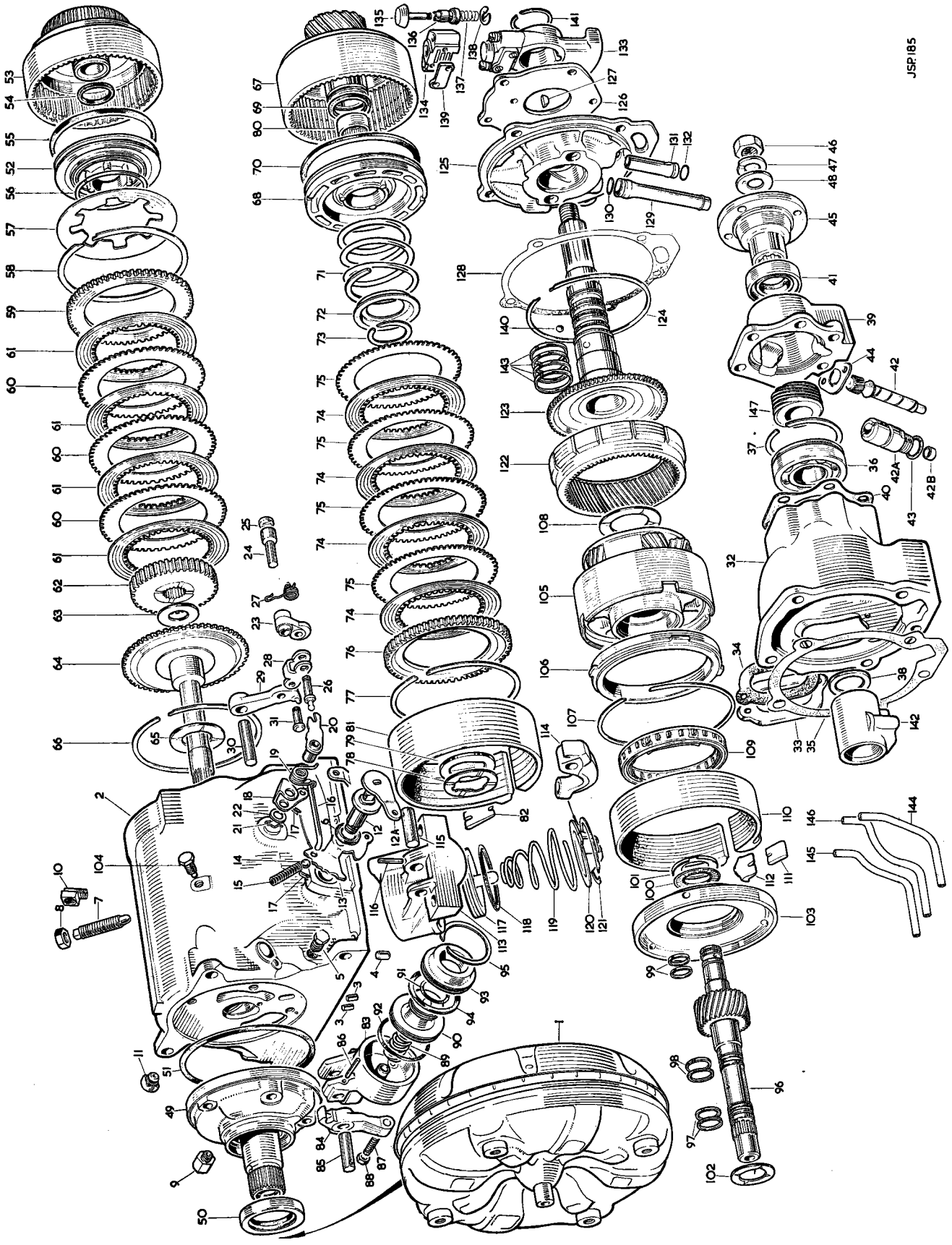


Fig. No. 118 *Exploded view of the Model 8 transmission unit*

1 Converter
2 Transmission case
3 Plug
4 Dowel
5 Plug
6 Oil seal
7 Screw
8 Nut
9 Union
10 Union
11 Breather
12 Manual control
13 Lever
14 Ball
15 Spring
16 Link
17 Clip
18 Torsion lever
19 Spring
20 Forked lever
21 Clip
22 Washer
23 Toggle lever
24 Toggle pin
25 Plug
26 Ball pin
27 Spring
28 Link
29 Pawl
30 Pivot pin
31 Pin
32 Extension case
33 Cover plate
34 Gasket
35 Gasket
36 Bearing
37 Snap ring
38 Spacing washer
39 Speedo driven gear housing
40 Gasket
41 Oil seal
42 Speedo driven gear
43 "O" ring
44 Plate
45 Flange
46 Nut
47 Lockwasher
48 Special washer
49 Front pump
50 Oil seal
51 Sealing ring
52 Piston
53 Cylinder
54 Sealing ring
55 Sealing ring
56 Split ring
57 Spring
58 Snap ring
59 pressure plate
60 Clutch plate
61 Clutch plate
62 Hub
63 Thrust washer
64 Input shaft
65 Thrust washer
66 Snap ring
67 Front drum
68 Piston
69 Sealing ring (inner)
70 Sealing ring (outer)
71 Spring
72 Spring seal
73 Snap ring
74 Clutch plate (friction)
75 Clutch plate (drive)
76 Pressure plate
77 Snap ring
78 Thrust washer
79 Thrust washer
80 Needle bearing
81 Brake band (front drum)
82 Servo strut
83 Front servo body
84 Lever
85 Pivot pin
86 Roll pin
87 Screw
88 Nut
89 Return spring
90 Piston
91 "O" ring (small)
92 "O" ring (large)
93 Piston sleeve
94 Sealing ring
95 Snap ring
96 Forward sun gear
97 Sealing ring (front)
98 Sealing ring (centre)
99 Sealing ring (rear)
100 Thrust bearing
101 Thrust bearing race
102 Thrust washer (bronze)
103 Centre support
104 Screw
105 Planetary gears and drum
106 Outer race
107 Snap ring
108 Thrust washer
109 One-way clutch
110 Brake band (rear drum)
111 Servo strut
112 Anchor strut
113 Body (rear servo)
114 Lever
115 Shaft
116 Roll pin
117 Piston
118 "O" ring
119 Return spring
120 Plate
121 Snap ring
122 Ring gear
123 Main shaft
124 Snap ring
125 Rear pump
126 Plate
127 Key
128 Gasket
129 Oil inlet tube
130 "O" ring
131 Oil outlet tube
132 "O" ring
133 Governor
134 Governor body
135 Governor weight
136 Governor valve
137 Spring
138 Retainer
139 Cover plate
140 Ball
141 Snap ring
142 Oil collector sleeve
143 Piston ring
144 Oil collector tube (front)
145 Oil collector tube (intermediate)
146 Oil collector tube (rear)
147 Speedometer drive gear

AUTOMATIC TRANSMISSION

Description
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Rear clutch piston assembly sleeve (C.W.G.41)
Front clutch piston assembly sleeve (C.W.G.42)
Rear pump discharge tube remover (C.W.G.45)

DESCRIPTION AND OPERATION

The Model 8 automatic transmission incorporates a fluid torque converter in place of the usual flywheel and clutch. The converter is coupled to a hydraulically operated planetary gearbox which provides three forward ratios and reverse. All forward ratios are automatically engaged in accordance with accelerator position and car speed.
Overriding control by the driver is available upon demand for engine braking by manual selection of "L".

TORQUE CONVERTER

The feature of using a hydraulic converter in conjunction with a three-speed automatic gearbox provides a means of obtaining a smooth application of engine power to the driving wheels and additional engine torque multiplication to the 1st and 2nd gears of the gearbox.
The converter also provides extreme low-speed flexibility when the gearbox is in 3rd gear and, due to the ability of multiplying engine torque, it provides good acceleration from very low road speed without having to resort to a down-shift in the gearbox.
Torque multiplication from the converter is infinitely variable between the ratios of 2 : 1 and 1 : 1. The speed range, during which the torque multiplication can be achieved, is also variable, depending upon the accelerator position.
The hydraulic torque converter for use in conjunction with the automatic gearbox has a mean fluid circuit diameter of 11" (27.9 cm.).
It is of the single-phase, three-element type, comprising an impeller connected to the engine crankshaft, a turbine connected to the input shaft of the gearbox, and a stator mounted on a sprag-type one-way clutch supported on a fixed hub projecting from the gearbox case.

THE GEAR SET

The planetary gear set consists of two sun gears, two sets of pinions, a pinion carrier, and a ring gear. Helical, involute tooth forms are used throughout. Power enters the gear set via the sun gears. In all forward gears power enters through the forward sun gear; in reverse power enters through the reverse sun gear. Power leaves the gear set by the ring gear. The pinions are used to transmit power from the sun gears to the ring gear. In reverse a single set of pinions is used, which causes the ring gear to rotate in the opposite direction to the sun gear. In forward gears a double set of pinions is used to cause the ring gear to rotate in the same direction as the sun gear. The carrier locates the

Selector Position		Ratio	Applied	Driving		Held
L	Lock-up	1st	Front Clutch Rear Band Sprag Clutch	Forward	Sun	Planet Carrier
D1	Drive One	1st	Front Clutch Sprag Clutch	Forward	Sun	Planet Carrier
L D1 D2	Lock-up Drive One Drive Two	2nd 2nd	Front Clutch Front Band	Forward	Sun	Reverse Sun
D1 D2	Drive One Drive Two	3rd	Front Clutch Rear Clutch	Forward Secondary	Sun Sun	
R	Reverse	Reverse	Rear Clutch Rear Band	Reverse	Sun	Planet Carrier

pinions in their correct positions relative to the sun gears and the ring gear (and also forms a reaction member for certain conditions). The various mechanical ratios of the gear set are obtained by the engagement of hydraulically operated multi-disc clutches and brake bands.

CLUTCHES

Multi-disc clutches operated by hydraulic pistons connect the converter to the gear set. In all forward gears the front clutch connects the converter to the forward sun gear; for reverse the rear clutch connects the converter to the reverse sun gear.

BANDS

Brake bands, operated by hydraulic servos, hold elements of the gear set stationary to effect an output speed and a torque increase. In Lockup the rear band holds the planet carrier stationary and provides the 1st gear ratio of 2.40 : 1 and, in reverse, a ratio of 2.00 : 1. The front band holds the reverse sun gear stationary to provide the 2nd gear ratio of 1.46 : 1.

ONE-WAY CLUTCH

In D1, a one-way clutch is used in place of the rear band to prevent anti-clockwise rotation of the planet carrier, thus providing the 1st gear ratio of 2.40 : 1. This one-way clutch, allowing the gear set to freewheel in 1st gear, provides smooth ratio changes from 1st to 2nd, and vice versa.

MECHANICAL POWER FLOW

First Gear (Lockup selected)

The front clutch is applied, connecting the converter to the forward sun gear. The rear band is applied, holding the planet carrier stationary, the gear set providing the reduction of 2.40 : 1. The reverse sun gear rotates freely in the opposite direction to the forward sun gear.

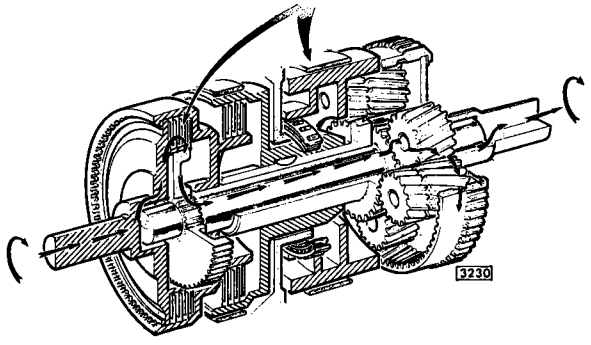

Fig. No. 1 *Mechanical power flow—First gear (Lock-up) selected*

First Gear (Drive 1 selected)

The front clutch is applied, connecting the converter to the forward sun gear. The one-way clutch is in operation, preventing the planet carrier from rotating anti-clockwise; the gear set provides the reduction of 2.40 : 1. When the vehicle is coasting the one-way clutch over-runs and the gear set freewheels.

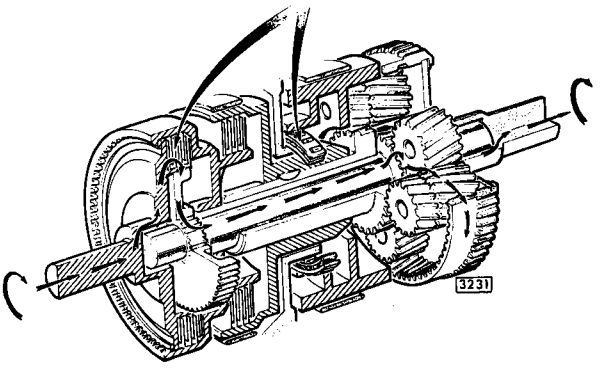

Fig. No. 2 *Mechanical power flow — First gear (Drive 1) selected*

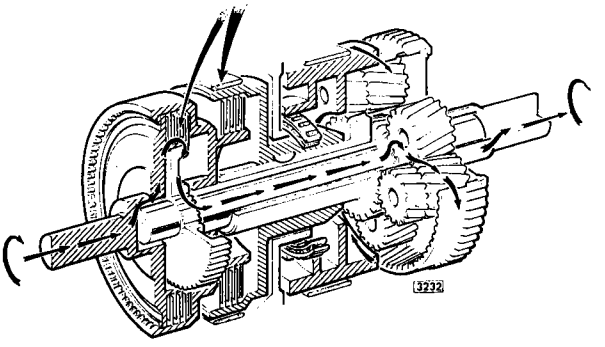

Fig. No. 3 *Mechanical power flow — Second gear (Lock-up or Drive 2) selected*

Second Gear (Lockup or Drive 2 selected)

Again the front clutch is applied, connecting the converter to the forward sun gear. The front band is applied, holding the reverse sun gear stationary; the gear set provides the reduction of 1.46 : 1.

Third Gear

Again the front clutch is applied, connecting the converter to the forward sun gear. The rear clutch is applied, connecting the converter also to the reverse sun gear; thus both sun gears are locked together and the gear set rotates as a unit, providing a ratio of 1 : 1.

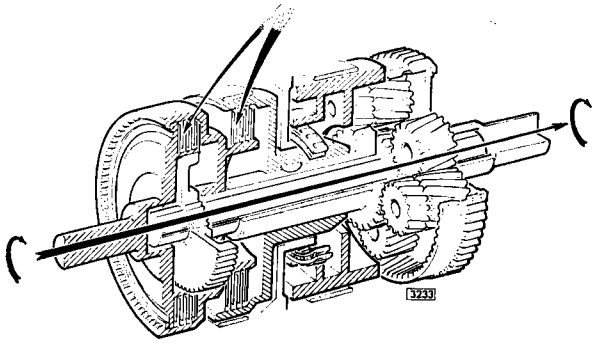

Fig. No. 4 *Mechanical power flow — Third gear (D1) selected*

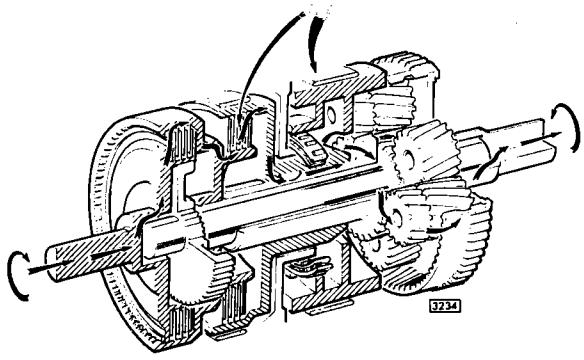

Fig. No. 5 *Mechanical power flow — Reverse gear (R) selected*

Neutral and Park
In neutral the front and rear clutches are off, and no power is transmitted from the converter to the gear set. The front and rear bands are also released. In "P" the Front Servo Apply and Release and Rear Servo circuits are pressurised while the engine is running, so that the rear band is applied.

Reverse Gear
The rear clutch is applied, connecting the converter to the reverse sun gear. The rear band is applied, holding the planet carrier stationary, the gear set providing the reduction of 2.00 : 1 in the reverse direction.

THE HYDRAULIC SYSTEM
The hydraulic system contains a front and rear pump, both of the internal/external gear pattern, picking up fluid from the oil pan through a common strainer. Shift control is provided by a centrifugally operated hydraulic governor on the transmission output shaft. This governor works in conjunction with valves in the valve body assembly located in the base of the transmission. These valves regulate fluid pressure and direct it to appropriate transmission components.

The Front Pump
The front pump, driven by the converter impeller, is in operation whenever the engine is running. This pump, through the primary and secondary regulator valves supplies the hydraulic requirements of the transmission with the engine running when the vehicle is stationary, as well as at low vehicle speeds before the rear pump becomes effective.

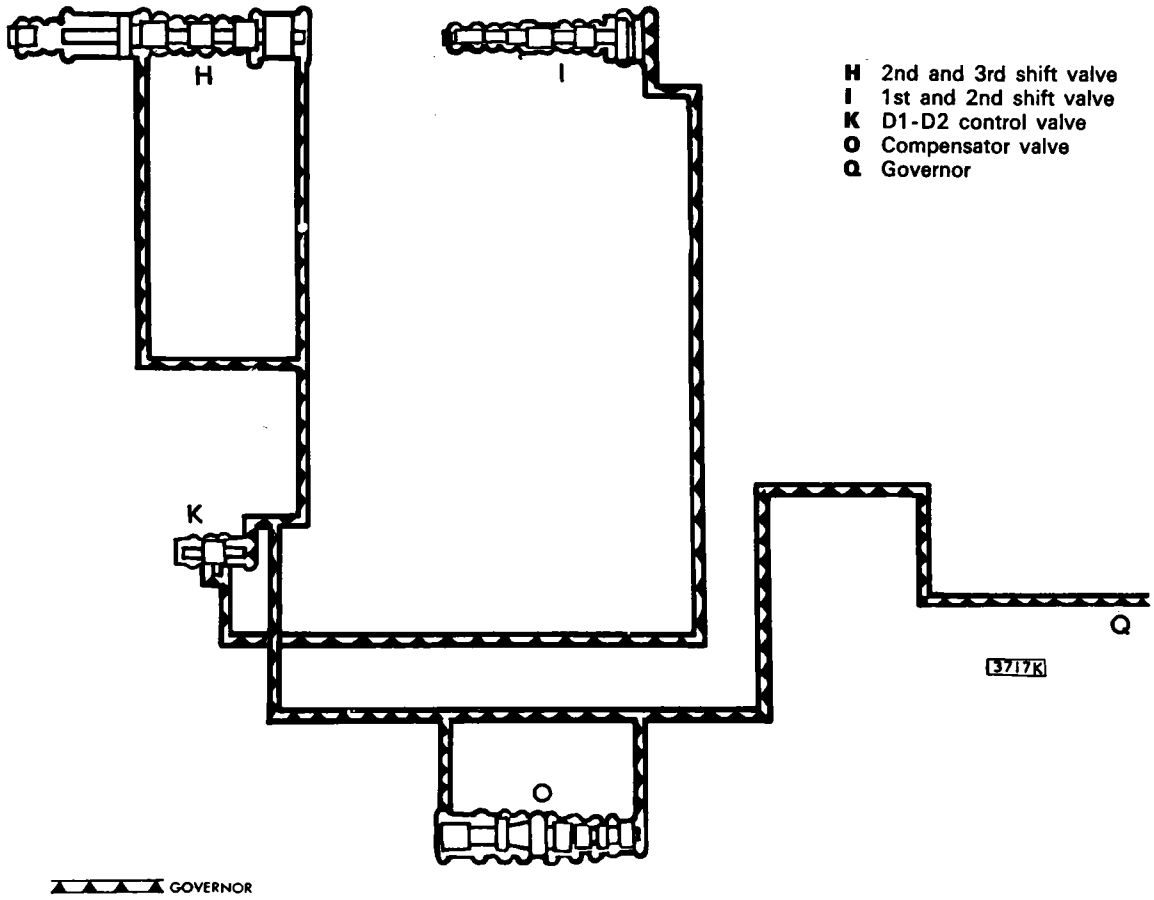

Fig. No. 6 *Governor Circuit*

The Rear Pump

The rear pump is driven by the output shaft of the transmission. It is fully effective at speeds above approximately 20 m.p.h. (32 k.p.h.) and then supplies most of the hydraulic requirements.

If, due to a dead engine, the front pump is inoperative, the rear pump, above approximately 20 m.p.h. (32 k.p.h.) can provide all hydraulic requirements, thus enabling the engine to be started through the transmission.

The Governor

The governor, revolving with the output shaft, is essentially a pressure regulating valve which reduces line pressure to a value which varies with output shaft speed. This variable pressure is utilised in the control system to effect up and down shifts through the 1-2 and 2-3 shift valves. Rotation of the governor at low speeds causes the governor weight and valve to be affected by centrifugal force. The outward force is opposed by an opposite and equal hydraulic force produced by pressure acting on the regulating area of the governor valve. The governor valve is a regulating valve and will attempt to maintain equilibrium. Governor pressure will rise in proportion to the increase in centrifugal force caused by higher output shaft speed.

As rotational speed increases the governor weight moves outward to rest on a stop in the governor body, and can move no further. When this occurs, a spring located between the counter weight and the valve becomes effective. The constant force of this spring then combines with the centrifugal force of the governor valve and the total force is opposed by governor pressure. This combination renders governor pressure less sensitive to output shaft speed variations.

It can be seen from the above, that the governor provides two distinct phases of regulation, the first of which is a fast rising pressure for accurate control of the low speed shift points.

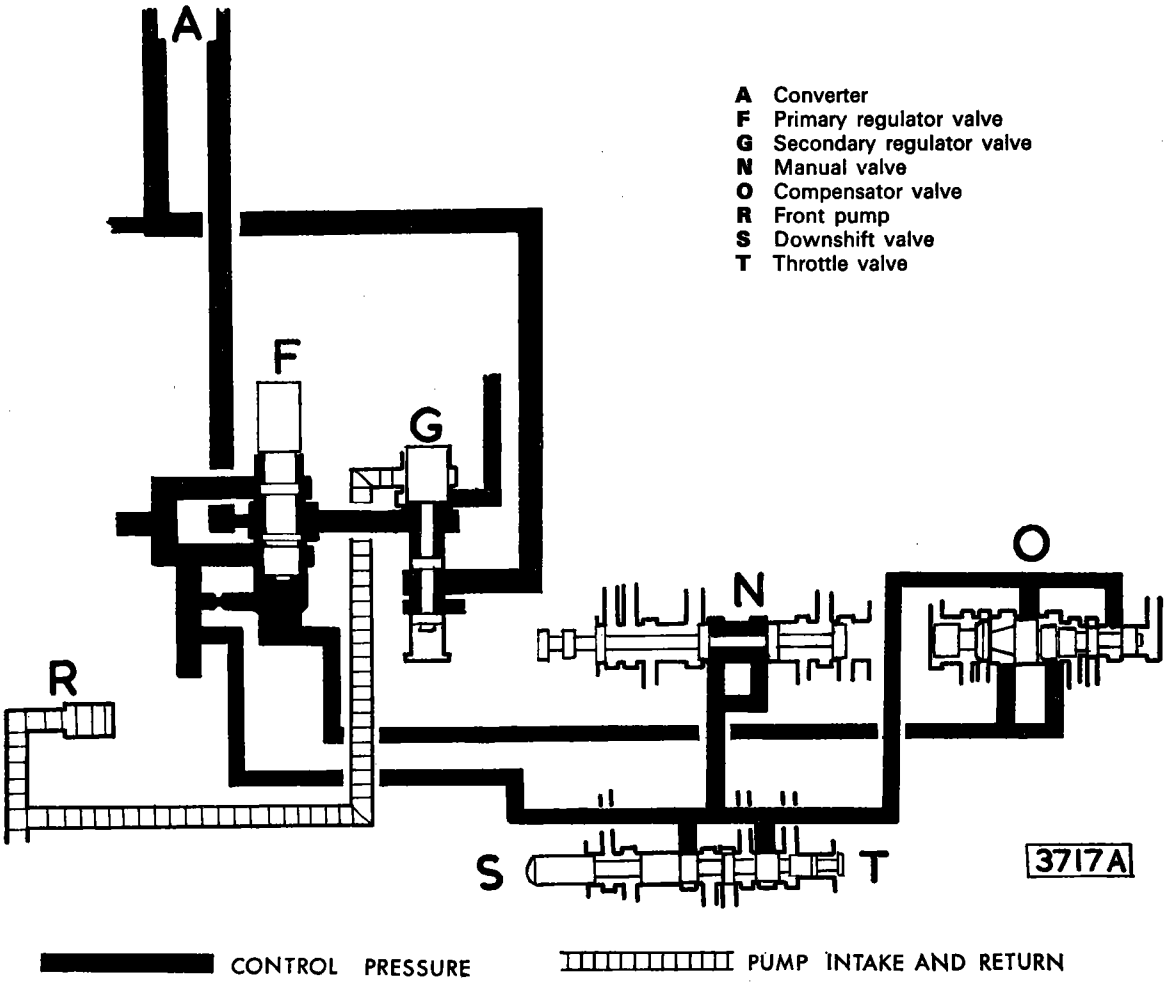

Fig. No. 7 *Hydraulic circuit — Neutral*

THE CONTROL SYSTEM

Neutral—Engine Running (See Fig. 7)

When the selector is moved to the neutral position, the manual control valve is positioned so that control pressure cannot pass through the manual valve to the clutches or servos; therefore, the clutches and servos cannot apply. There is no transmission of power through the transmission in the neutral position.

The pressure regulation system, however, is functioning. With the engine running, the front pump is driven and fluid is picked up from the pan by the front pump inlet. Fluid, circulated by the front pump, is directed to the control pressure regulator. The primary regulator valve will maintain correct control pressure by expelling the excess fluid to feed the secondary regulator valve. The secondary regulator valve maintains correct pressure for converter feed and lubrication, then forces the excess fluid back to the pump inlet.

Control pressure is directed to the manual control valve, where it is blocked by two lands on the valve. Control pressure is also directed to the throttle valve and the downshift valve and, with the valve closed (accelerator at idle position), it is blocked by lands on the valves. Control pressure to the compensator valve is regulated by that valve, and compensating pressure is directed to the primary regulator valve.

First Gear, D1 Range (See Fig. 8)

When the selector lever is placed in the D1 position, with the car standing still, and the engine running, the manual control valve is moved to admit control pressure to apply the front clutch.

Control pressure is also directed to the governor, but with the car standing still, the control pressure is blocked at the governor valve.

Control pressure from the manual valve is directed through another passage to the apply side of the front servo and the 1-2 shift valve.

From the 1-2 shift valve pressure then passes to the servo orifice control valve and the front servo release valve where it is blocked.

Control pressure is then directed from the servo orifice control valve via the 2-3 shift valve and again through the control valve to the release side of the front servo. Pressure is also present at the transition valve where it is blocked.

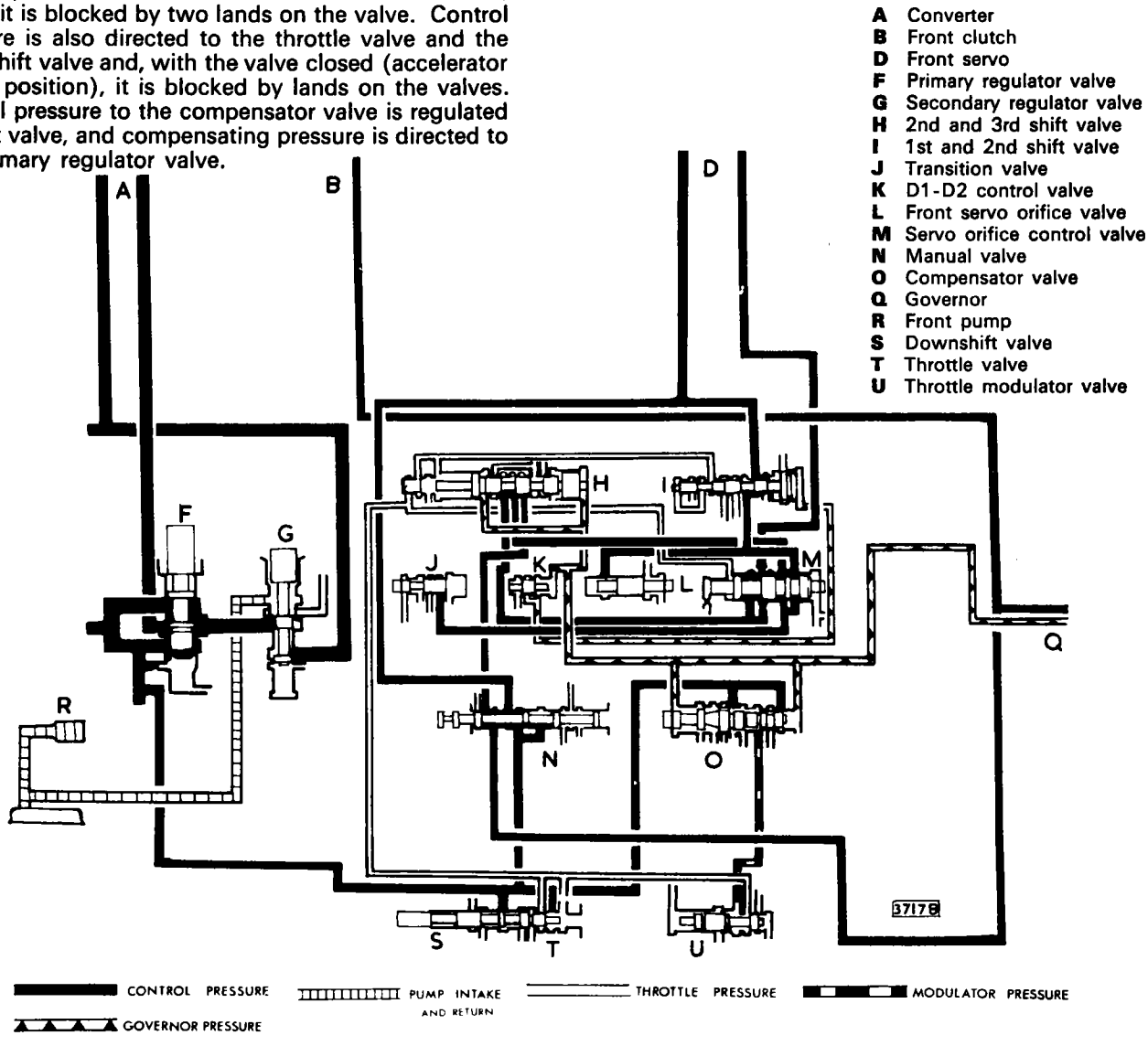

Fig. No. 8 *Hydraulic circuit — 1st gear (D1 range)*

With pressure on both sides of the front servo piston, the servo is held in a released position. The one-way clutch takes the reaction torque on the rear drum, thus eliminating need for rear servo action.

The front pump supplies the pressure to operate the transmission and this pressure is controlled as it was in the neutral position.
When the accelerator is depressed and the car starts to move, centrifugal force, acting on the governor weight and valve, moves the valve to regulate governor pressure, which is directed to the 1-2 shift valve, 2-3 shift valve, and plug, and the compensator valve. Movement of the accelerator also opens the throttle valve so that throttle pressure is directed to the modulator valve, orifice control valve, and the shift plug on the end of the 2-3 shift valve. Throttle pressure to the modulator valve is re-directed to the compensator valve to increase control pressure.

Throttle pressure to the shift plug on the 2-3 shift valve is reduced, and the reduced pressure is directed to the ends of the 1-2 shift valve and the 2-3 shift valve. This reduced pressure on the shift valves opposes governor pressure.

Second Gear, D1 Range (Fig. 9)
As the car speed increases, the governor pressure builds up until it can overcome the opposite force of the 1-2 shift valve spring and reduced throttle pressure on the end of the valve and so moves the valve.
When the 1-2 shift valve moves, control pressure as the valve is shut off and the front servo release pressure is exhausted, first slowly through a restricting orifice and then fast through the front servo release orifice valve. This leaves the front clutch and the front band applied.

A Converter
B Front clutch
D Front servo
F Primary regulator valve
G Secondary regulator valve
H 2nd and 3rd shift valve
I 1st and 2nd shift valve
K D1-D2 control valve
L Front servo orifice valve
M Servo orifice control valve
O Compensator valve
P Rear pump
Q Governor
R Front pump
S Downshift valve
T Throttle valve
U Throttle modulator valve

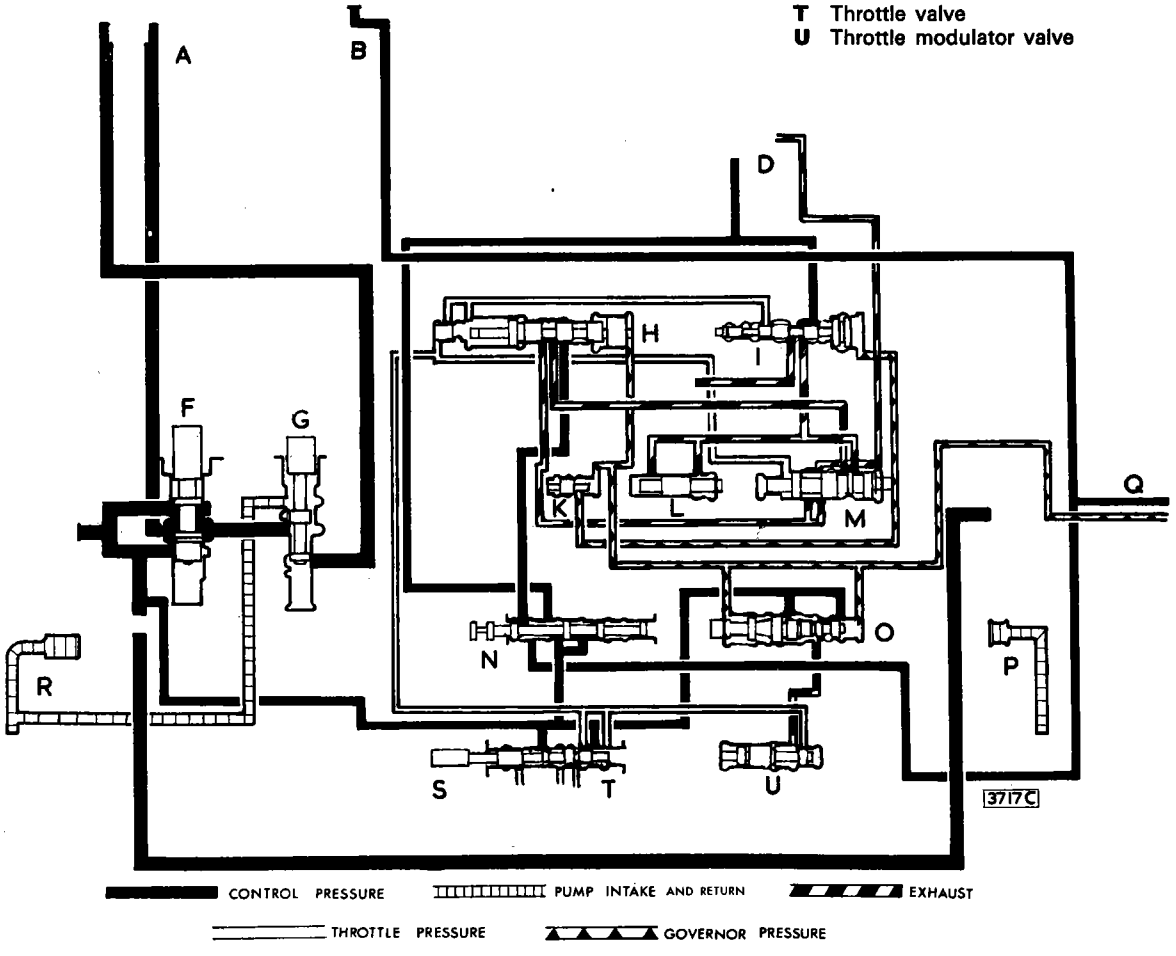

Fig. No. 9 *Hydraulic circuit — 2nd gear (D1 range)*

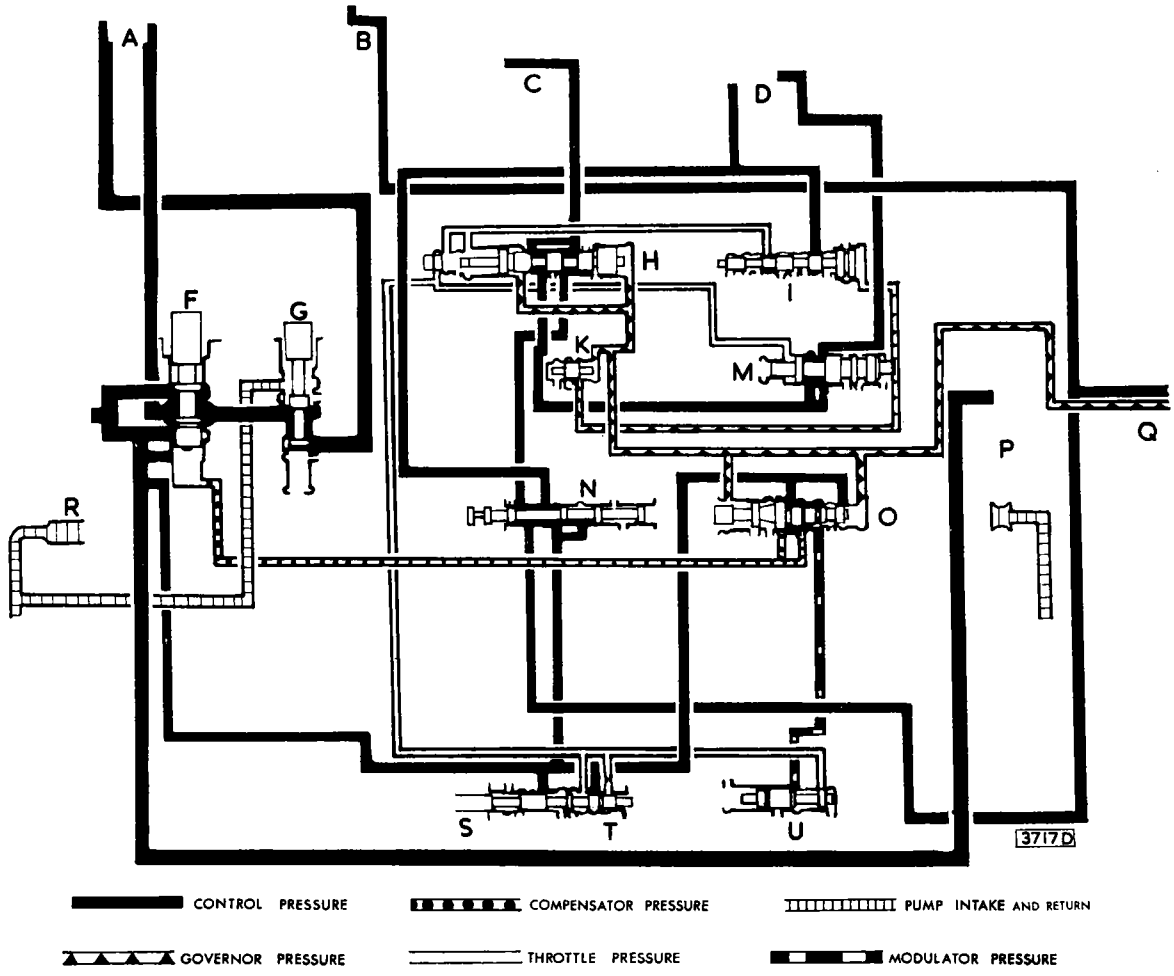

Fig. No. 10 *Hydraulic circuit — 3rd gear (D1 or D2 range)*

A Converter
B Front servo
C Rear clutch
D Front clutch
F Primary regulator valve
G Secondary regulator valve
H 2nd and 3rd shift valve
I 1st and 2nd shift valve
K D1-D2 control valve
M Servo orifice control valve
N Manual valve
O Compensator valve
P Rear pump
Q Governor
R Front pump
S Downshift valve
T Throttle valve
U Throttle modulator valve

Third Gear, D1 or D2 Range (Fig. 10)
As the car speed continues to increase, the governor pressure also increases until it overcomes the 2-3 shift valve spring and the reduced throttle pressure on the end of the 2-3 shift valve, thus causing the valve to move. When the valve moves, control pressure is admitted to the rear clutch and through the annulus of the servo orifice control valve to the release side of the front servo, thus applying the rear clutch and placing the front servo in the released position. This leaves the front clutch and the rear clutch applied.
As the governor pressure continues to increase, it acts against modulator pressure at the compensator valve to increase compensator pressure and decrease control pressure through the movement of the valve in the primary regulator.

Second Gear, D2 Range (Fig. 11)
When the selector lever is placed in the D2 (drive) position, with the car standing still and the engine running, control pressure passes through the manual valve to the D1 and D2 control valve, overcomes any governor pressure acting on this valve and passes through the valve to the governor pressure area of the 1-2 shift valve, thus positioning it in 2nd gear position. Pressure is exhausted from the release side of the front servo, which results in the front clutch and front band being applied.
All upshifts from 2nd gear ratio direct will be similar to description of 3rd gear D1 range.

2-1 Kickdown, D1 Range (Fig. 12)
As car speeds up to approximately 20 m.p.h. (32 k.p.h.) after the transmission has shifted from 1st to 2nd or 3rd gear, the transmission can be downshifted to 1st gear by depressing the accelerator pedal beyond the wide open throttle position.
Movement of the accelerator to kickdown position causes the throttle cable to move the downshift valve to allow control pressure to pass through the downshift valve to another land on the 1-2 shift valve. The combination of control pressure and the 1-2 shift valve spring is sufficient to overcome governor pressure and return the valve to the 1st gear position. In this position, control pressure is admitted to the release side of the front servo. This places the front servo in the released position, leaving the front clutch applied and the one-way clutch holding the rear drum.

A Converter
B Front servo
D Front clutch
F Primary regulator valve
G Secondary regulator valve
H 2nd and 3rd shift valve
I 1st and 2nd shift valve
K D1-D2 control valve
L Front servo orifice valve
M Servo orifice control valve
N Manual valve
O Compensator valve
P Rear pump
Q Governor
R Front pump
S Downshift valve
T Throttle valve
U Throttle modulator valve

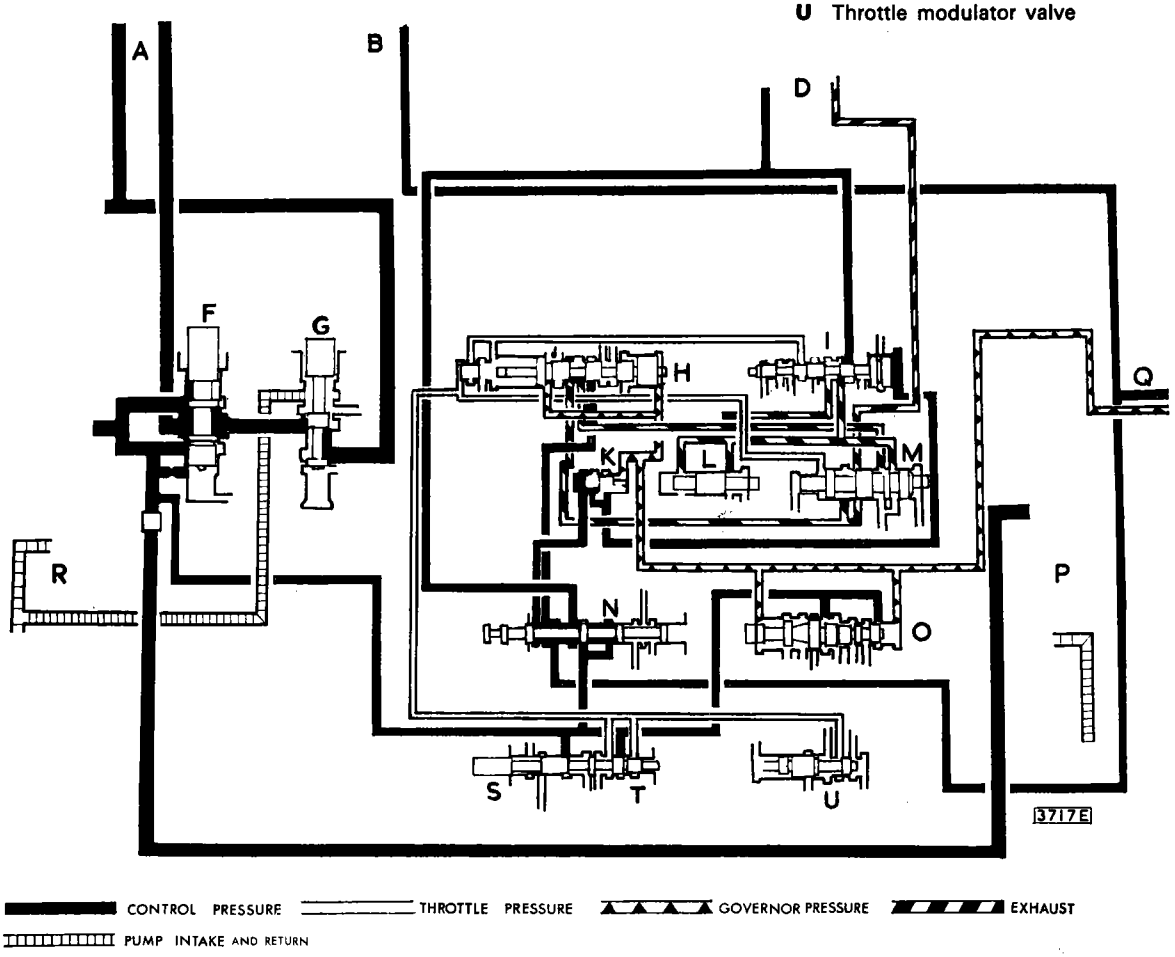

Fig. No. 11 *Hydraulic circuit — 2nd gear (D2 range)*

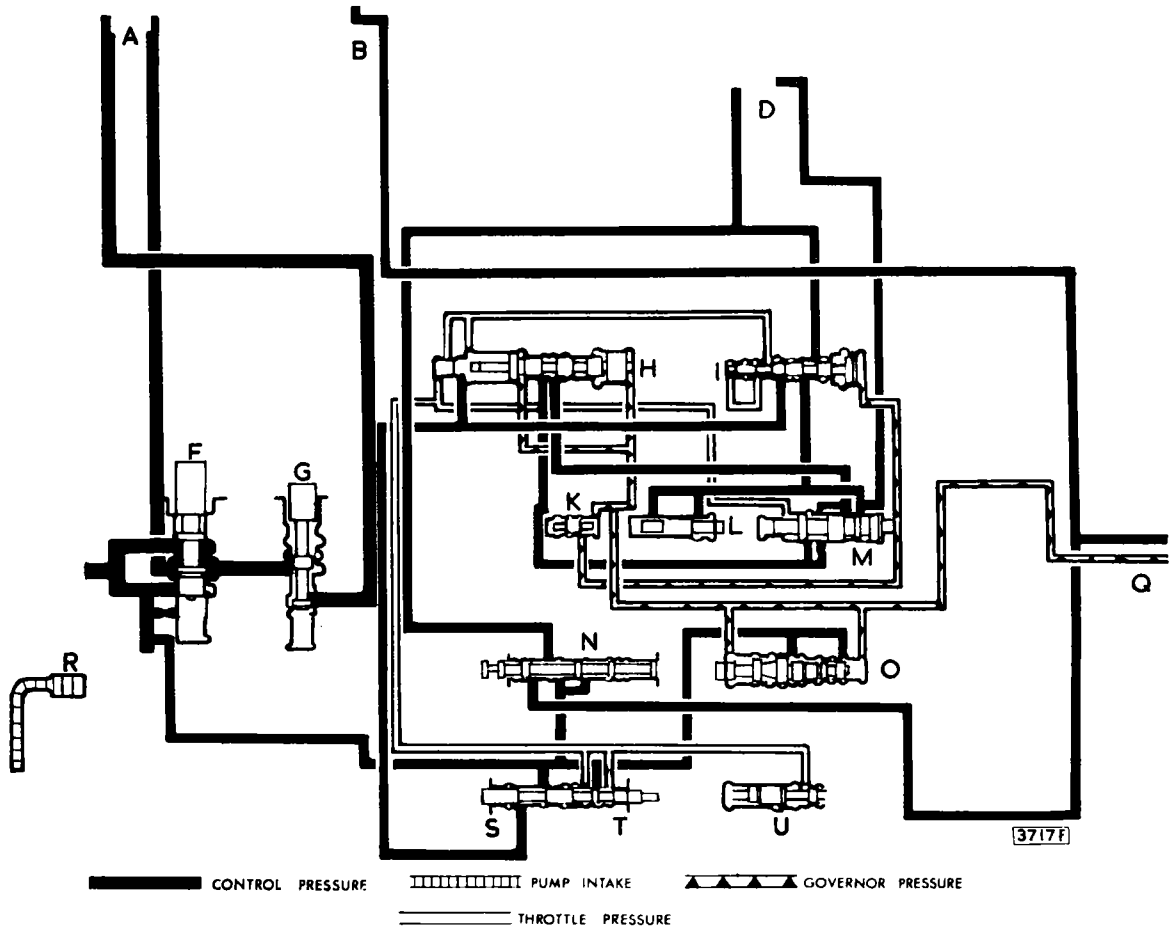

Fig. No. 12 *Hydraulic circuit — 2-1 Kick-down (D1 range)*

A Converter
B Front servo
D Front clutch
F Primary regulator valve
G Secondary regulator valve
H 2nd and 3rd shift valve
I 1st and 2nd shift valve
K D1-D2 control valve
L Front servo orifice valve
M Servo orifice control valve
N Manual valve
O Compensator valve
Q Governor
R Front pump
S Downshift valve
T Throttle valve
U Throttle modulator valve

3-2 Kickdown, D1 or D2 Range (Fig. 13)
At car speeds between approximately 22 to 66 m.p.h. (35 to 106 k.p.h.) after the transmission has shifted to 3rd gear, the transmission can be downshifted from 3rd gear to 2nd gear by depressing the accelerator pedal beyond the wide open throttle position.

Movement of the accelerator causes the throttle cable to move the downshift valve to allow control pressure to pass through the downshift valve to the spring end of the 2-3 shift valve. The combination of control pressure at the end on the 2-3 shift valve and 2-3 shift valve springs is sufficient to overcome governor pressure to move the valve. When the valve is in 2nd gear position, control pressure to the rear clutch and through the servo orifice control valve to the release side of the front servo is shut off. The rear clutch circuit exhausts through the exhaust port of the manual control valve, whereas the front servo release circuit exhausts through the 1-2 shift valve orifice and front servo release orifice valve. This leaves the front clutch and front band applied.
If the accelerator is left in the kickdown position, governor pressure will increase as the car speed increases until the governor pressure is greater than the combined pressures on the 2-3 shift valve, and the transmission will again upshift to 3rd gear.
At speeds above approximately 66 m.p.h. (106 k.p.h.) the governor pressure is so great that the combined pressures on the 2-3 shift valve cannot overcome the governor pressure; therefore, there is no kickdown.

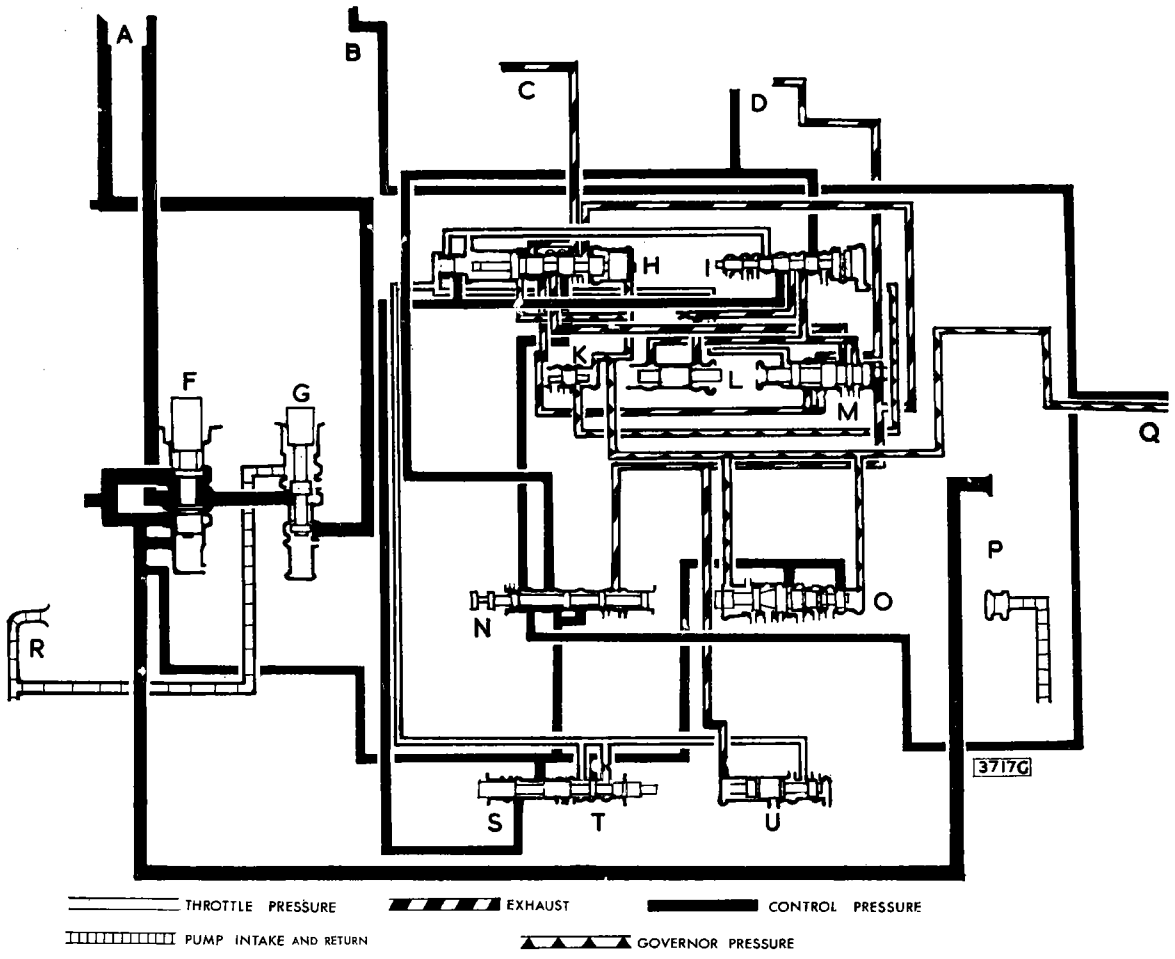

Fig. No. 13 *Hydraulic circuit — 3-2 Kick-down (D1 or D2 range)*

A Converter
B Front clutch
C Rear clutch
D Front servo
F Primary regulator valve
G Secondary regulator valve
H 2nd and 3rd shift valve
I 1st and 2nd shift valve
K D1-D2 control valve
L Front servo orifice valve
M Servo orifice control valve
N Manual valve
O Compensator valve
P Rear pump
Q Governor
R Front pump
S Downshift valve
T Throttle valve
U Throttle modulator valve

Lockup—First Gear (Fig. 14)
When the selector lever is placed in the Lockup position, the manual control valve is moved to admit through one port, control pressure to the governor feed and to apply the front clutch. Another port supplies both sides of the front servo which is held in the released position and also to the rear servo to apply the rear band through the servo orifice control and transition valves. A third port supplies pressure to move the transition valve and to an additional land on the 1-2 shift valve.
In this position, there is no automatic upshift to a higher gear ratio, since the combination of control pressure on the 1-2 shift valve and the 1-2 shift valve spring is greater than governor pressure acting against the valve, so that the valve cannot move. The combination of control pressure on the 2-3 shift valve and the 2-3 valve spring is also greater than the governor

pressure acting against the valve so that the 2-3 shift valve cannot move.

Lockup—Second Gear

In L the manual control valve opens to exhaust the rear clutch and front servo release circuit from 2-3 shift valve. This causes a downshift from 3rd gear whenever L is selected at speed. In this condition, governor pressure will have moved the 1-2 shift valve; the result is that supply to the rear servo through the servo orifice control valve and transition valve is blocked and as front servo release pressure also exhausts through the 2-3 shift valve, the front band will be applied. This band, in conjunction with the front clutch, provides 2nd gear.

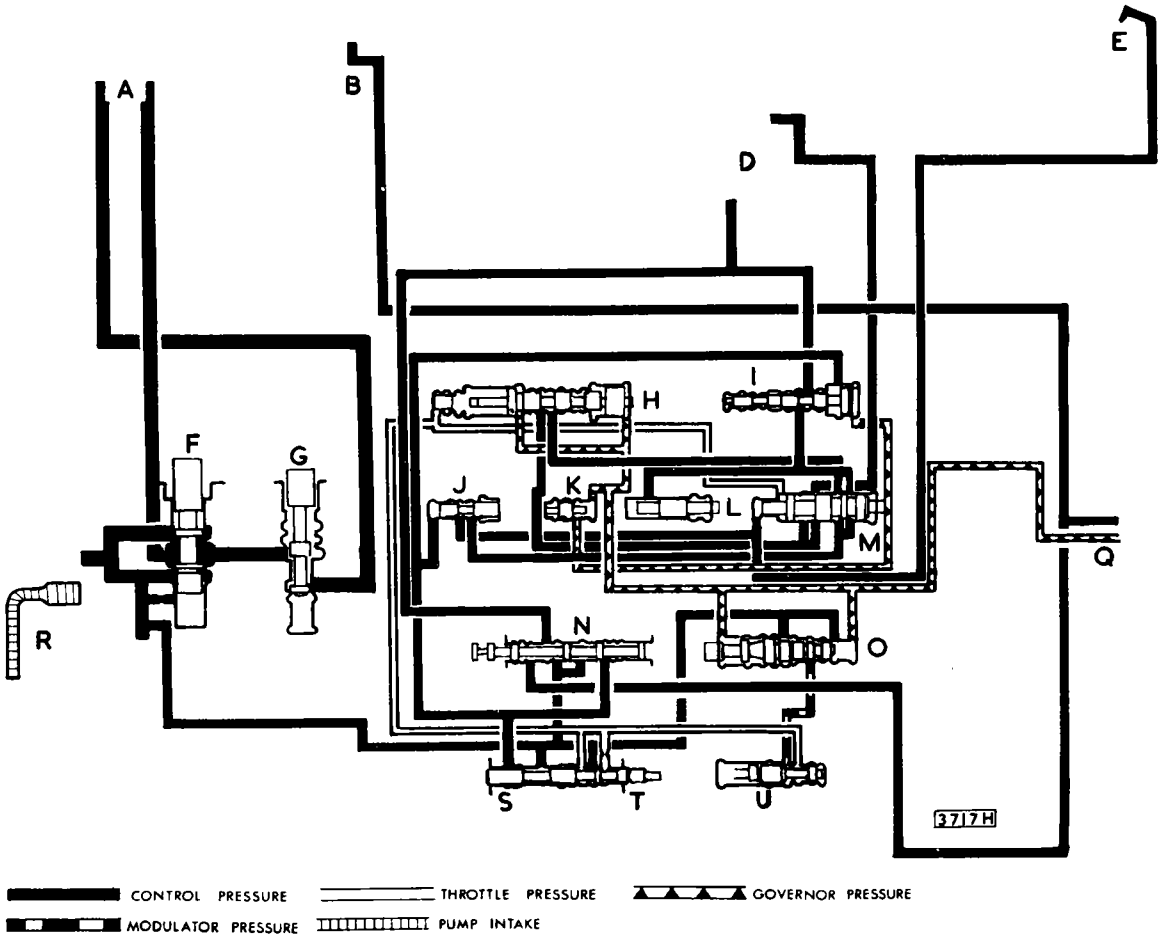

Fig. No. 14 *Hydraulic circuit — Lock-up (1st gear)*

A Converter
B Front clutch
D Front servo
E Rear servo
F Primary regulator valve
G Secondary regulator valve
H 2nd and 3rd shift valve
I 1st and 2nd shift valve
J Transition valve
K D1-D2 control valve
L Front servo orifice valve
M Servo control valve
N Manual valve
O Compensator valve
Q Governor
R Front pump
S Downshift valve
T Throttle valve
U Throttle modulator valve

Reverse (Fig. 16)
When the selector lever is placed in the reverse position, the manual control valve moves to admit control pressure to the rear clutch, both sides of the front servo and the rear servo. This applies to the rear clutch and the rear band.

Control pressure is also directed to the modulator valve to move the valve so when the throttle valve is opened by depressing the accelerator, the throttle pressure passes through the modulator valve to two lands on the compensator valve to reduce compensating pressure, thus increasing control pressure.
High control pressure is desired in reverse, since the reaction forces increase appreciably and higher pressure is required to hold the rear drum.

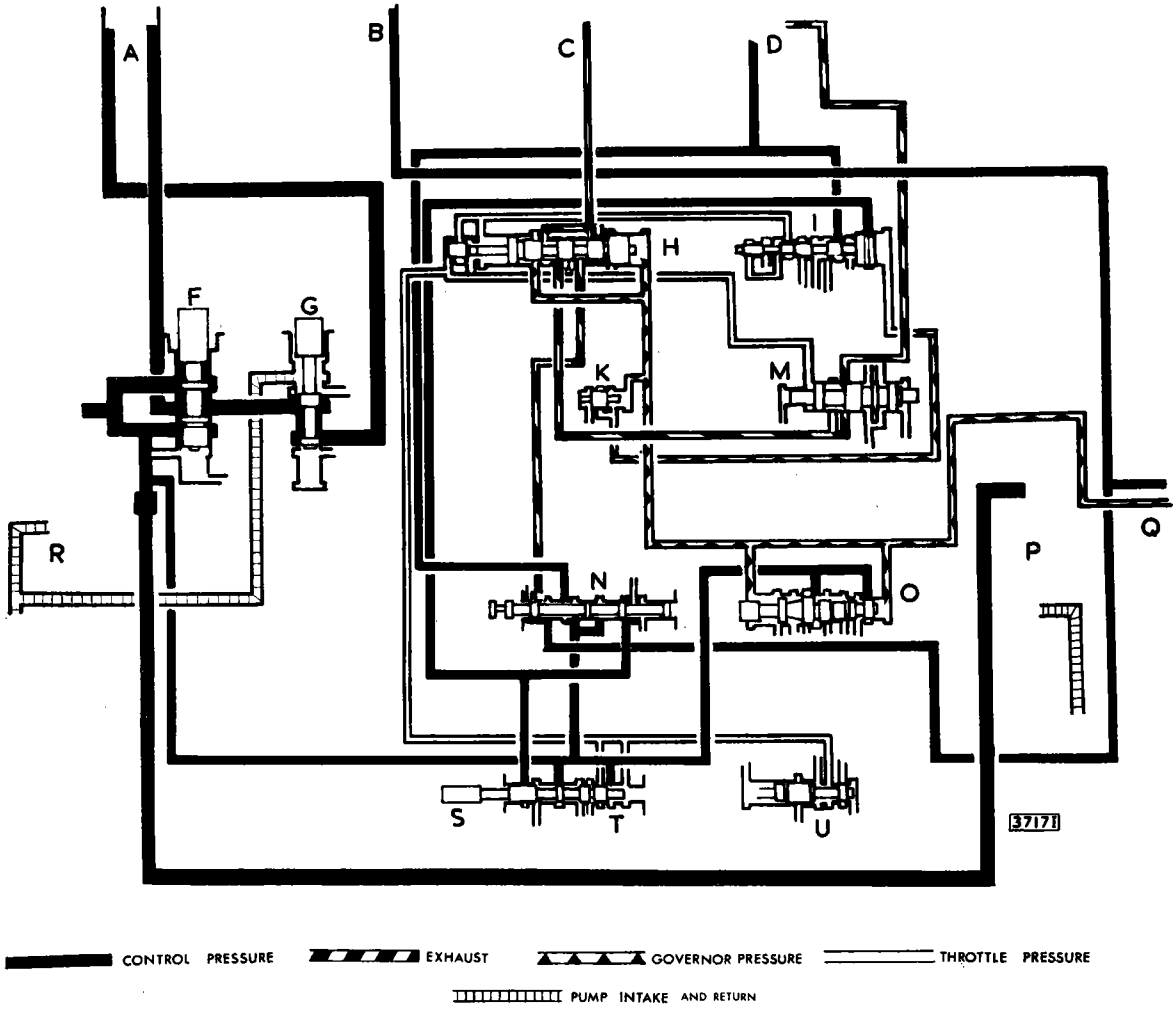

Fig. No. 15 *Hydraulic circuit — Lock-up (2nd gear)*

A Converter
B Front clutch
C Rear clutch
D Front clutch
F Primary regulator valve
G Secondary regulator valve
H 2nd and 3rd shift valve
I 1st and 2nd shift valve
K D1-D2 control valve
M Servo orifice control valve
N Manual valve
O Compensator valve
P Rear pump
Q Governor
R Front pump
S Downshift valve
T Throttle valve
U Throttle modulator valve

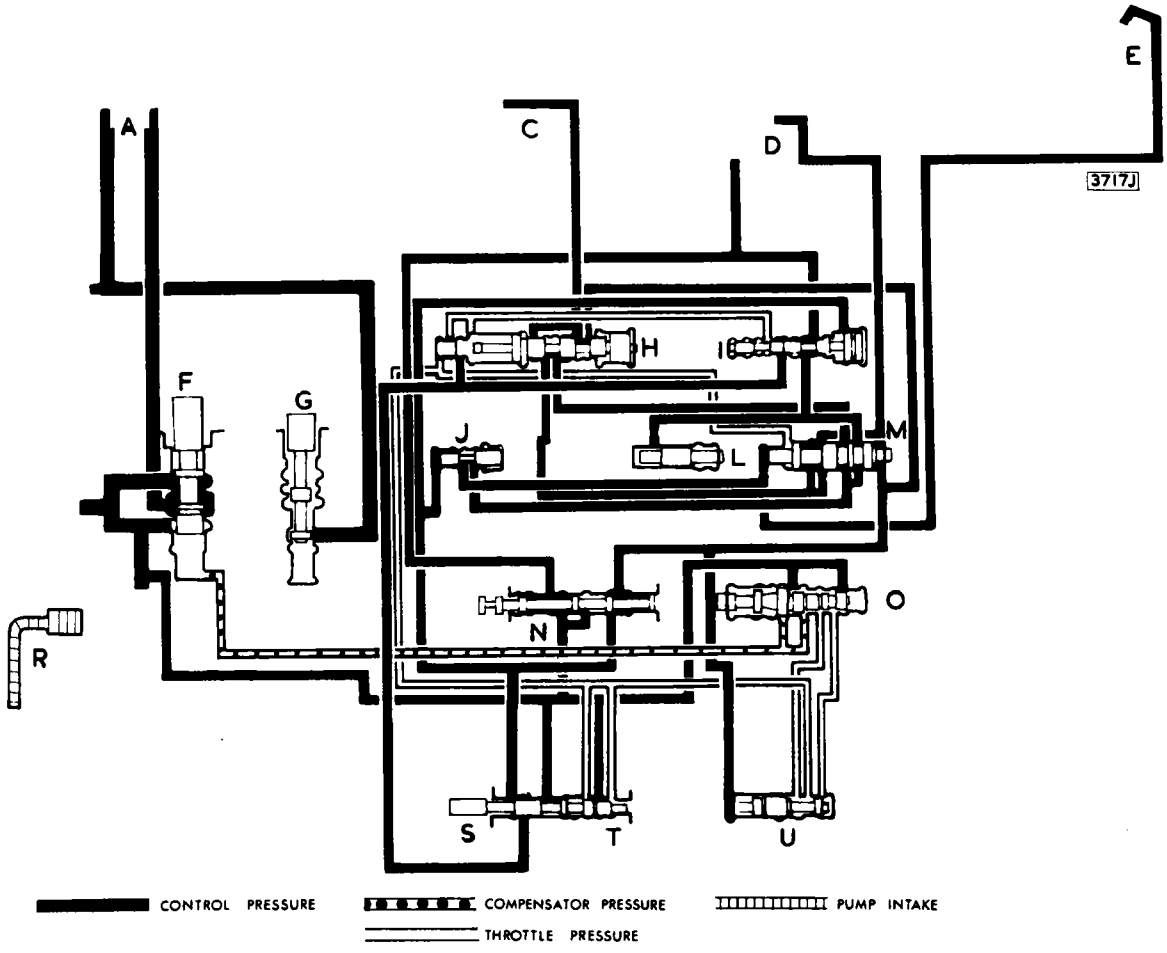

Fig. No. 16 *Hydraulic circuit — Reverse*

A Converter
C Rear clutch
D Front servo
E Rear servo
F Primary regulator valve
G Secondary regulator valve
H 2nd and 3rd shift valve
I 1st and 2nd shift valve
J Transition valve
L Front servo orifice valve
M Servo orifice control valve
N Manual valve
O Compensator valve
R Front pump
S Downshift valve
T Throttle valve
U Throttle modulator valve

MAINTENANCE

It is most IMPORTANT that the following maintenance instructions are closely followed and absolute cleanliness is maintained when topping-up or filling the transmission.
It is **vitally important** when checking the fluid level that no dirt or foreign matter enters the transmission, otherwise trouble will almost certainly arise. Before removing the transmission dipstick, the surrounding area must be cleaned off to prevent dirt from entering the dipstick aperture. When filling the transmission with fluid ensure that the fluid container and funnel are perfectly clean.
In countries where ambient temperatures are unusually high, dust and/or mud must not be allowed to decrease the effective areas of the stoneguards in the converter housing or the slots in the transmission case. Also any foreign matter on the oil pan must be removed as it would act as a temperature insulator.

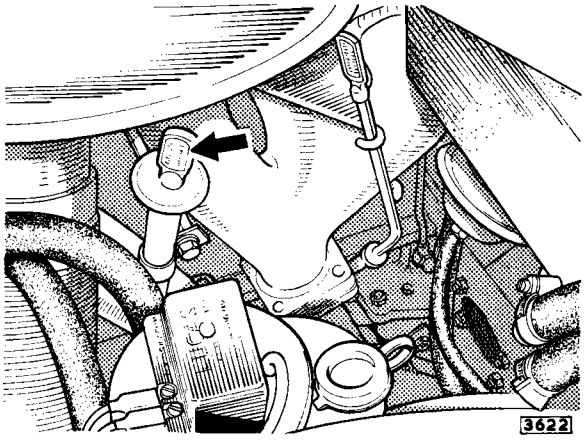

Fig. No. 17 *Automatic transmission dipstick*

EVERY 3,000 MILES (5,000 KM.)
Check Transmission Fluid Level
The transmission filler tube is located on the right-hand side of the engine under the bonnet just forward of the bulkhead. Check the fluid level every 3,000 miles (5,000 km.).
Before checking the fluid level, the car should be on level ground and the transmission should be at the normal operating temperature.
Set the handbrake firmly and select P position.
The engine should be at normal idle.
When the engine is running, remove the dipstick, wipe clean and replace in the filler tube in its correct position. Withdraw immediately and check.
If necessary, add fluid to bring the level to the FULL mark on the dipstick. The difference between FULL and LOW marks on the stick represents approximately 1½ pints (2 U.S. pints or 0.75 litres).

Be careful not to overfill.
If fluid is checked with transmission cold, a false reading will be obtained and filling to the FULL mark will cause it to be overfilled.

If it is found necessary to add fluid frequently, it will be an indication that there is a leakage in the transmission and it should be investigated immediately to prevent damage to transmission.
Total fluid capacity (including cooler) 16 Imperial pints from dry (19 U.S. pints, 9 litres).

EVERY 21,000 MILES (35,000 KM.)
Fluid Changing and Band Adjustment
Drain the oil. Remove the oil pan and wash out. Adjust the front and rear bands as detailed on page F.24. Refit the oil pan and refill with oil.
Recheck the oil level as detailed previously.

If these recommended lubricants are not available, only a transmission fluid conforming to the following specification should be used:—
Automatic Transmission Fluid, Type "A" or Type "A" Suffix "A" (AQ-ATF)
Fluid Capacity
Automatic transmission unit (from dry):—
16 Imperial pints, 19 U.S. pints, 9 litres.

Recommended Automatic Transmission Fluids

Mobil	Castrol	Shell	Esso	B.P.	Duckham	Regent Caltex/Texaco
Mobil-fluid 200	Castrol T.Q.	Shell Donax T.6	Esso Automatic Transmission Fluid	Automatic Transmission Fluid Type A	Nolmatic	Texamatic Fluid

ROAD TEST AND FAULT DIAGNOSIS

TESTING THE CAR

It is important to gain as much information as possible on the precise nature of any fault. In all cases the following road test procedure should be completely carried out, as there may be more than one fault.

Check that the starter will operate only with the selector in "P" and "N" and that the reverse light operates only in "R".

Apply the brakes and, with the engine at normal idling speed, select N-D, N-L, N-R. Transmission engagement should be felt in each position selected.

Check the engine stall speed (see converter diagnosis) with the transmission in "L" and "R". Check for slip or clutch break-away.

Note: Do not stall for longer than 10 seconds, or the transmission will overheat.

With the transmission at normal running temperature, select "D". Release the brakes and accelerate with minimum throttle opening. Check for 1-2 and 2-3 shifts.

Note: At minimum throttle opening the shifts may be difficult to detect. Confirmation that the transmission is in 3rd gear may be obtained by selecting "L" when a 3-2 downshift will be felt.

At just over 30 m.p.h. (48 k.p.h.), select "N", switch off the ignition and let the car coast. At 30 m.p.h. (48 k.p.h.), switch on the ignition and select "L". The engine should start through the rear wheels, indicating that the rear oil pump of the transmission is operating.

Stop and restart, using full-throttle acceleration, i.e. accelerator at the detent. Check for 1-2 and 2-3 shifts according to the shift speed chart.

At 26 m.p.h. (42 k.p.h.), in 3rd gear, depress the accelerator to full-throttle position. The car should accelerate in 3rd gear and should not down-shift to 2nd.

At 30 m.p.h. (48 k.p.h.), in 3rd gear, depress the accelerator to the kick-down position, i.e. through the detent. The transmission should down-shift to 2nd gear.

At 18 m.p.h. (29 k.p.h.) in 3rd gear, depress the accelerator to the kick-down position. The transmission should down-shift to 1st gear.

Stop and restart, using forced throttle acceleration (i.e. accelerator through the detent). Check for 1-2 and 2-3 shifts according to shift speed chart.

At 40 m.p.h. (64 k.p.h.) in 3rd gear, release the accelerator and select "L". Check for 3-2 down-shift and engine braking. Check for inhibited 2-1 down-shift and engine braking.

Stop, and with "L" still engaged, release the brakes and, using full throttle, accelerate to 20 m.p.h. (32 k.p.h.). Check for no slip or clutch break-away noise and no up-shifts.

Stop and select "R". Release the brakes and reverse, using full throttle if possible. Check for no slip or clutch break-away noise.

Stop on brakes facing downhill on gradient and select "P". Release the brakes and check that the parking pawl will hold the car. Re-apply brakes before disengaging the parking pawl. Repeat with car facing uphill.

Check that the selector is trapped by the gate in "Park" position.

At 30 m.p.h. (48 k.p.h.), in 3rd gear, D1, coast to a stop. Check roll out shifts for quality and speed in m.p.h. or k.p.h.

The front pump can be checked, with the selector in neutral, by revving the engine between idle and 2,000 r.p.m. A high pitched whine indicates a noisy front pump, a restricted front pump suction line, or a dirty oil screen.

At idle or slightly above idle speed in neutral, a gear whine indicates dragging front clutch plates. A tendency for the car to creep in neutral is a further indication of dragging front clutch plates. Check carefully, to avoid confusing this with front pump or engine noises.

PRESSURE TESTS

See "Throttle Cable Adjustment" section and ascertain correct adjustment of throttle cable and engine idle. The pressure gauge is used to check transmission pressures, which should correspond to values given below.

Note: Figures give in table are normal for transmission temperatures from 150° to 185°F. only (65.5°C. to 85°C.).

Selector Position	Control Pressure Idle r.p.m.	Control Pressure Stall r.p.m.
D2	50 — 60	150 — 185
D1	50 — 60	150 — 185
L	50 — 60	150 — 185
R	50 — 60	190 — 210
N	55 — 60	—

Recording stall speed and stall pressures at the time the converter is being checked will reduce the overall stalling time, which should be kept to a minimum.

Pressures which have been recorded should be analysed as follows: Low pressure indicates leakage in the circuit tested. Low pressure in all selector positions would indicate leakage, faulty pump or incorrect pressure regulation. High pressures, in all selector positions, indicates faulty pressure regulation, incorrect cable adjustment or stuck valves.

FAULT DIAGNOSIS

Converter

If the general vehicle performance is below standard, check the engine stall speed with the revolution indicator by applying maximum pressure on the foot brake pedal, selecting lock-up, and fully depressing the accelerator. If the engine stall speed is up to 300 r.p.m. below normal, the engine is not developing its full power.

Inability to start on steep gradients combined with poor acceleration from rest indicates that the converter stator one-way clutch is slipping. This condition permits the stator to rotate in an opposite direction to the turbine and torque multiplication cannot occur. Check the stall speed, and if it is more than 600 r.p.m. below normal the converter assembly must be renewed.
Below standard acceleration in 3rd gear above 30 m.p.h. (48 k.p.h.), combined with a substantially reduced maximum speed, indicates that the stator one-way clutch has locked in the engaged condition. The stator will not rotate with the turbine and impeller, therefore the fluid flywheel phase of the converter performance cannot occur. This condition will also be indicated by excessive overheating of the transmission, although the stall speed will remain normal. The converter assembly must be replaced.
Stall speed higher than normal indicates that the converter is not receiving its required fluid supply or that slip is occurring in the clutches of the automatic gearbox.
Note: When checking stall speeds ensure that the transmission is at normal operating temperature. Do not stall for longer than 10 seconds, or the transmission will overheat.
The torque converters are sealed by welding and serviced by replacement only.
The stoneguards in the converter housing must be unobstructed.

Stall Speed Test
This test provides a rapid check on the correct functioning of the converter as well as the gearbox. The stall speed is the maximum speed at which the engine can drive the torque impeller while the turbine is held stationary. As the stall speed is dependent both on engine and torque converter characteristics, it will vary with the condition of the engine as well as with the condition of the transmission. It will be necessary, therefore, to determine the condition of the engine in order to correctly interpret a low stall speed.
To obtain the stall speed, allow the engine and the transmission to attain normal working temperature, set the handbrake, chock the wheels and apply the footbrake. Select "L" or "R" and fully depress the accelerator. Note the reading on the revolution indicator.
NOTE: To avoid overheating, the period of stall test must not exceed 10 seconds.

R.P.M.	Condition Indicated
Under 1,000	Stator free wheel slip
1,600 - 1,700	Normal
Over 2,100	Slip in the transmission gearbox

Clutch and Band Checks
To determine if a clutch or band has failed, without removing a transmission, check as detailed below.
Refer to the chart on page F.5, showing the clutches and bands applied in each gear position.
Apply the handbrake and start the engine.
Engage each gear ratio and determine if drive is obtained through the component to be checked. If a clutch or band functions in one selector position it is reasonable to assume that the element in question is normal and that trouble lies elsewhere. If the clutch or band is tried in two positions and no drive is obtained in either position, it can be assumed that the element is faulty.

Air Pressure Checks
Air pressure may be used to test various transmission components on the bench. Care should be exercised when air pressure checks are being made to prevent oil blowing on the clothing or into the eyes.
Knowledge of various circuits should be acquired referring to Figs. 6 to 16 inclusive. It is necessary to remove the valve body to complete these checks.
Apply air to the front clutch passage and the governor should click about the same time the clutch applies with a different sounding click. Both front clutch and governor feed are on the same circuit.
Apply air to the rear clutch circuit and listen for the rear clutch to apply with a click.
Servo action may be watched as air is applied to apply circuits to each servo.
It can be assumed, that if air pressure checks indicate that clutches and servos are being applied normally with air pressure, then the trouble lies in the hydraulic system.

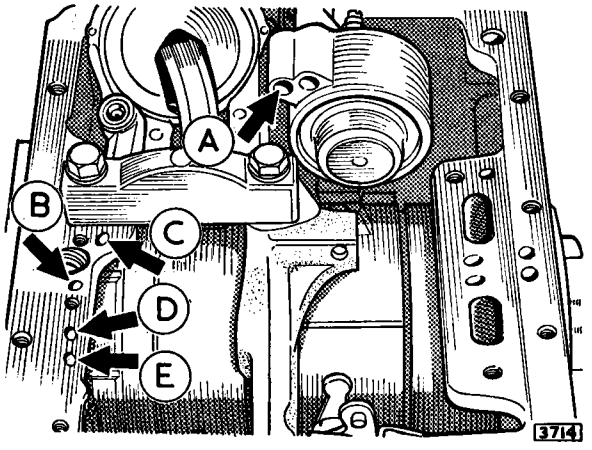

Fig. No. 18 *Showing pressure passages with valve body removed*

FAULT DIAGNOSIS

	In Car	On Bench
ENGAGEMENT		
Harsh	B, D, c, d	2, 4
Delayed	A, C, D, E, F, a, c, d	b
None	A, C, a, c, d	b, 9, 10, 11, 13
No forward	A, C, a, c, d	B, 1, 4, 7
No reverse	A, C, F, a, c, j, k, h	b, 2, 3, 6
Jumps in forward	C, D, E, F	4, 7, 8
Jumps in reverse	C, D, E	2
No neutral	C, c	2
UPSHIFTS		
No. 1-2	C, E, a, c, d, f, g, h, j,	b, 5, 17
No. 2-3	C, a, c, d, f, g, h, k, l	b, 3, 17
Shift points too high	B, C, c, d, f, g, h, j, k, l	b
Shift points too low	B, c, f, g, h, l	B
UPSHIFT QUALITY		
1-2 slips or runs up	A, B, C, E, a, c, d, f, g, k	b, 1, 5
2-3 slips or runs up	C, a, c, d, f, g, h, k, l	b, 3, 5
1-2 harsh	B, C, E, c, d, f, g, h	1, 7, 8
2-3 harsh	B, C, E, s, d, f	4
1-2 Ties up or grabs	F, c	4, 7, 8
2-3 Ties up or grabs	E, F, C	4
DOWNSHIFTS		
No. 2-1	B, C, c, h, j	7
No. 3-2	B, c, h, k	4
Shift points too high	B, C, c, f, h, j, k, l	b
Shift points too low	B, C, c, f, h, j, k, l	b
DOWNSHIFT QUALITY		
2-1 Slides		7
3-2 Slides	B, C, E, a, c, d, f, g	b, 3, 5
2-1 Harsh		b, 1, 7
3-2 Harsh	B, E, c, d, f, g, 5	3, 4, 5
REVERSE		
Slips or chatters	A, B, F, d, c, g	b, 2, 3, 6
LINE PRESSURE		
Low idle pressure	A, C, D, a, c, d	b, 11
High idle pressure	B, c, d, e, f, g	
Low stall pressure	A, B, a, c, d, f, g, h	b, 11
High stall pressure	B, c, d, f, g	
STALL SPEED		
Too low (200 r.p.m. or more)		13
Too high (200 r.p.m. or more)	A, B, C, F, a, c, d, f	b, 1, 3, 6, 7, 9, 13
OTHERS		
No push starts	A, C, E, F, c	12
Transmission overheats	E, F, e	1, 2, 3, 4, 5, 6, 13, 18
Poor acceleration		13
Noisy in neutral	m	2, 4
Noisy in park	m	14
Noisy in all gears	m	2, 4, 14, 16
Noisy during coast (30-20 m.p.h.)		16, 19
Park brake does not hold	C, 15	15

KEY TO THE FAULT DIAGNOSIS CHART

1. Preliminary Checks in Car

A. Low fluid level.
B. Throttle cable incorrectly assembled or adjusted.
C. Manual linkage incorrectly assembled or adjusted.
D. Engine idle speed.
E. Front band adjustment.
F. Rear band adjustment.

2. Hydraulic Faults

a. Oil tubes missing or broken.
b. Sealing rings missing or broken.
c. Valve body screws missing or not correctly tightened.
d. Primary valve sticking.
e. Secondary valve sticking.
f. Throttle valve sticking.
g. Compensator or modulator valve sticking.
h. Governor valve sticking, leaking or incorrectly assembled.
i. Orifice control valve sticking.
j. 1-2 shift valve sticking.
k. 2-3 shift valve sticking.
l. 2-3 shift valve plunger sticking.
m. Regulator.

3. Mechanical Faults

1. Front clutch slipping due to worn plates or faulty parts.
2. Front clutch seized or plates distorted.
3. Rear clutch slipping due to worn or faulty parts.
4. Rear clutch seized or plates distorted.
5. Front band slipping due to faulty servo, broken or worn band.
6. Rear band slipping due to faulty servo, broken or worn band.
7. One-way clutch slipping or incorrectly installed.
8. One-way clutch seized.
9. Broken input shaft.
10. Front pump drive tangs on converter hub broken.
11. Front pump worn.
12. Rear pump worn or drive key broken.
13. Converter blading and/or one-way clutch failed.
14. Front pump.
15. Parking linkage.
16. Planetary assembly.
17. Fluid distributor sleeve in output shaft.
18. Oil cooler connections.
19. Rear pump.

SERVICE ADJUSTMENTS

THROTTLE/KICKDOWN CABLE ADJUSTMENT

The importance of correct throttle cable adjustment cannot be over-emphasised. The shift quality and correct shift positions are controlled by precise movement of the cable in relation to the carburetter throttle shaft movement.

Preliminary Testing

Test the car on a flat road.
With the selector in the D1 or D2 position and at a minimum throttle opening, the 2-3 upshift should occur at 1,100 - 1,200 r.p.m.
A "run-up" of 200-400 r.p.m. at the change point indicates LOW pressure.
At full throttle opening, a jerky 2-3 upshift or a sharp 2-1 downshift (in D1 when stopping the car) indicates HIGH pressure.
Install a pressure gauge, 0-200 lb./sq. in. (0-14 kg./sq. cm.) in the line pressure point at the left hand rear face of the transmission unit. Start the engine and allow to reach normal operating temperature.
Select D1 or D2, apply the handbrake firmly and increase the idling speed to exactly 1,250 r.p.m.
The pressure gauge reading should be 72.5 $\pm$ 2.5 lb./sq. in. (5.097 $\pm$ .175 kg./cm. sq.).

Adjustment

If road and pressure tests indicate that the throttle/kickdown cable setting is incorrect, adjustment MUST be made at the fork end (see Fig. 20). Do NOT adjust the length of the connecting link between the jack shaft and the carburetter spindles to regulate the pressure.
Remove the bonnet, battery and battery tray.

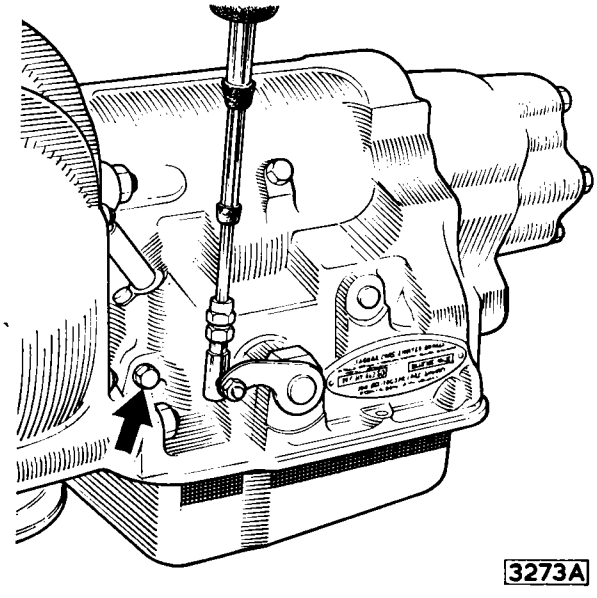

Fig. No. 19 *Transmission pressure take-off point*

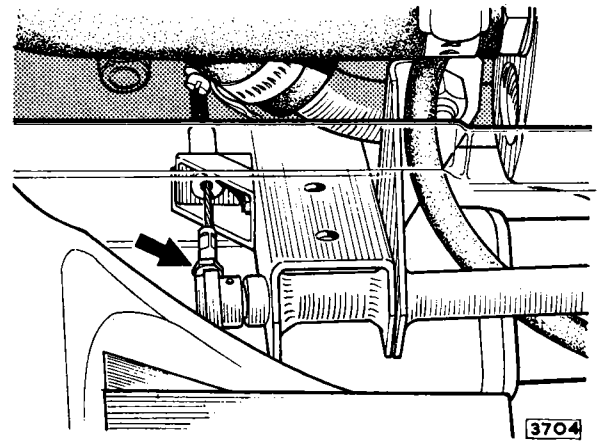

Fig. No. 20 *Kick-down cable adjustment*

Place the battery on the floor and reconnect into the circuit with a pair of leads.
Release the fork end locknut, remove the split pin and fork end clevis pin.
To LOWER the pressure, turn the fork end clockwise: to RAISE the pressure, turn anti-clockwise.
Note: One full turn will alter the setting by 9 lb./sq. in. (.63 kg./sq. cm.) approximately.
Slight adjustment only should be necessary; excessive adjustment will result in loss of "kickdown" or an increase in shift speeds.
Refit the fork end joint pin and split pin and tighten the locknut.
Restart the engine and check the pressure at 1,250 r.p.m.
Check that the carburetter butterfly valves are closed at idling speed after adjustment is completed. Adjust by means of the nut and locknut on the connecting link between the jackshaft and the carburetter spindles.
If, after repeated attempts to stabilize the change points, the pressure still fluctuates, the throttle/kickdown inner cable may be binding or kinked and the cable should be replaced.

Throttle/Kickdown Cable Renewal

Remove the jackshaft bracket from the inlet manifold studs.
Disconnect the cable at the fork end.
Remove the cable retaining clip after withdrawing the setscrew.
Lift the carpets and the underfelts from the gearbox tunnel on the left hand side below the radio speaker grille in the console.
Remove six drive screws and detach the aperture cover plate now exposed.
Remove the Allen-headed screw and washer retaining the outer cable.
Withdraw the outer cable and locate the spring clip securing the inner cable to the control rod operating the kickdown cam in the transmission unit.

Spring the clip open with a small screw driver and withdraw the inner cable.
Refitting is the reverse of the removal procedure.
Adjust the length of the operating cable to $3\frac{5}{16}$" (84.1 mm.) between the centre line of the clevis and the end of the outer cable.
Check that the carburetter butterfly valves are closed before commencing adjustments described under the previous heading.

MANUAL LINKAGE ADJUSTMENT

(See Fig. 23)
Place the selector lever in the D2 indicator position on the steering column (an assistant will be required to hold the lever in this position). Underneath the car at the gearbox selector lever, loosen the linkage cable locknut and remove the cable from the selector lever. Place the gearbox lever in the D2 detent position. This is most easily accomplished by moving the lever all the way to Lockup position and then moving back two detent positions. Adjust the cable end to fit freely onto the gearbox lever. Temporarily re-attach the cable to the lever. Next move the selector lever at the column through the various positions, checking that the indicator points to the correct selection. Check very carefully that the gating at L, R and P positions does not interfere with the gearbox lever setting at the detent positions. Always keep in mind that for correct operation, the gearbox detents must locate the gearbox lever positively. Once correct adjustment is established, be sure the linkage cable is secured to the gearbox lever and the locknut is tightened.

REMOVAL OF OIL PAN

Prior to front band adjustment or a check of internal parts, the gearbox fluid must be drained and the oil pan removed. When this is done an inspection should be made. A few wear particles in the dregs of the fluid in the pan are normal. An excess of wear particles, whether ferrous or non-ferrous metal, or pieces of band lining material, would indicate that further checking should be done. A new gasket should be used when refitting the pan and the 14 attaching screws torqued to 10-15 lb. ft. (1.382-2.073 kgm.). Always use fresh fluid when refilling.

FRONT BAND ADJUSTMENT

(See Fig. 21)
The front band should be adjusted after the first 1,000 miles (1,600 km.) of operation and at 21,000 mile (35,000 km.) intervals thereafter.
Drain the oil by removing the oil filler connection and remove the oil pan. Loosen the adjusting screw locknut on the servo, apply lever and check that the screws turn freely in the lever. Install a $\frac{1}{4}$" (6.4 mm.) thick gauge block between the servo piston pin and the servo adjusting screw, then tighten the adjusting screw with a suitable torque wrench or adjusting tool until 10 lb. ins. (0.12 kgm.) is reached. Retighten the adjusting screw locknut to 20-25 lb. ft. (2.76-3.46 kgm.) Remove the $\frac{1}{4}$" (6.4 mm.) spacer.

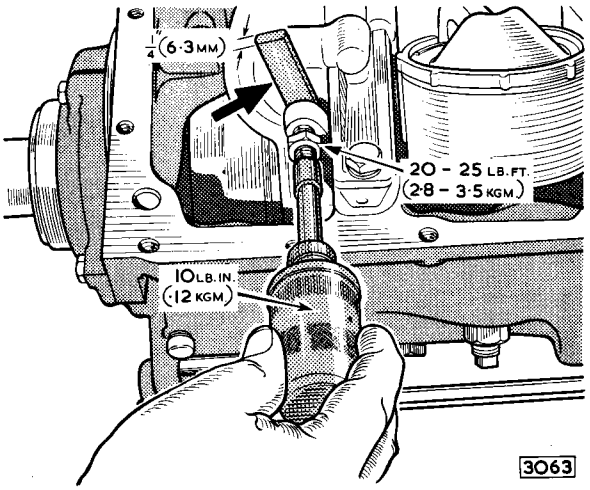

Fig. No. 21 *Front band adjustment*

REAR BAND ADJUSTMENT

The rear band adjustment at the 1,000 mile free service and at 21,000 mile (35,000 km.) intervals is made externally, thus there is no need to remove the oil pan. To make the adjustment, first loosen and back off the adjusting screw locknut three or four turns and then make sure that the adjusting screw works freely in the threads in the case. Turn the adjusting screw in with a torque wrench or special tool for this purpose to 10 lb. ft. (1.382 kgm.) torque reading. Back the adjusting screw off $1\frac{1}{2}$ turns exactly, then retighten the locknut to 35-40 lb. ft. (4.70-5.53 kgm.). The adjusting screw is on the right-hand side of the casing and an access hole is provided in the transmission cowl.

GOVERNOR

The governor can be inspected without removal of the oil pan. Remove the inspection cover and gasket. This will expose the governor, but the output shaft may have to be turned to position the governor head at the opening. First check for freedom of the valve by pushing and pulling on the governor weight. If removal of the governor body is desired, take out the two screws which retain it, being careful that they are not dropped inside the extension housing. After removal of the body, dismantle it completely and clean all parts. When re-assembling the governor, torque the governor body plate screws to 20-30 lb. in. (0.24-0.36 kgm.). When replacing the governor body on to the transmission, torque the screws which retain it to 50-60 lb. in. (0.60-0.72 kgm.). Replace the governor inspection cover, using a new gasket and torque its retaining screws to 50-60 lb. in. (0.60-0.72 kgm.).
It should be noted that if any of the four governor screws mentioned above are loose, the governor will not function correctly.

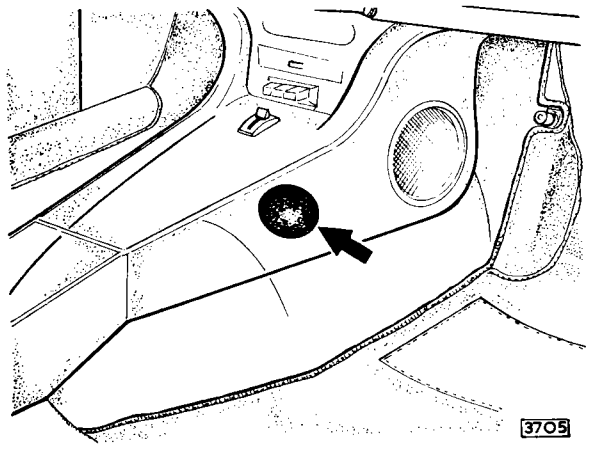

Fig. No. 22 *Rear band adjustment. Access to the adjuster is by way of the grommeted hole indicated by the arrow. It is first necessary to remove the console as detailed in Section N.*

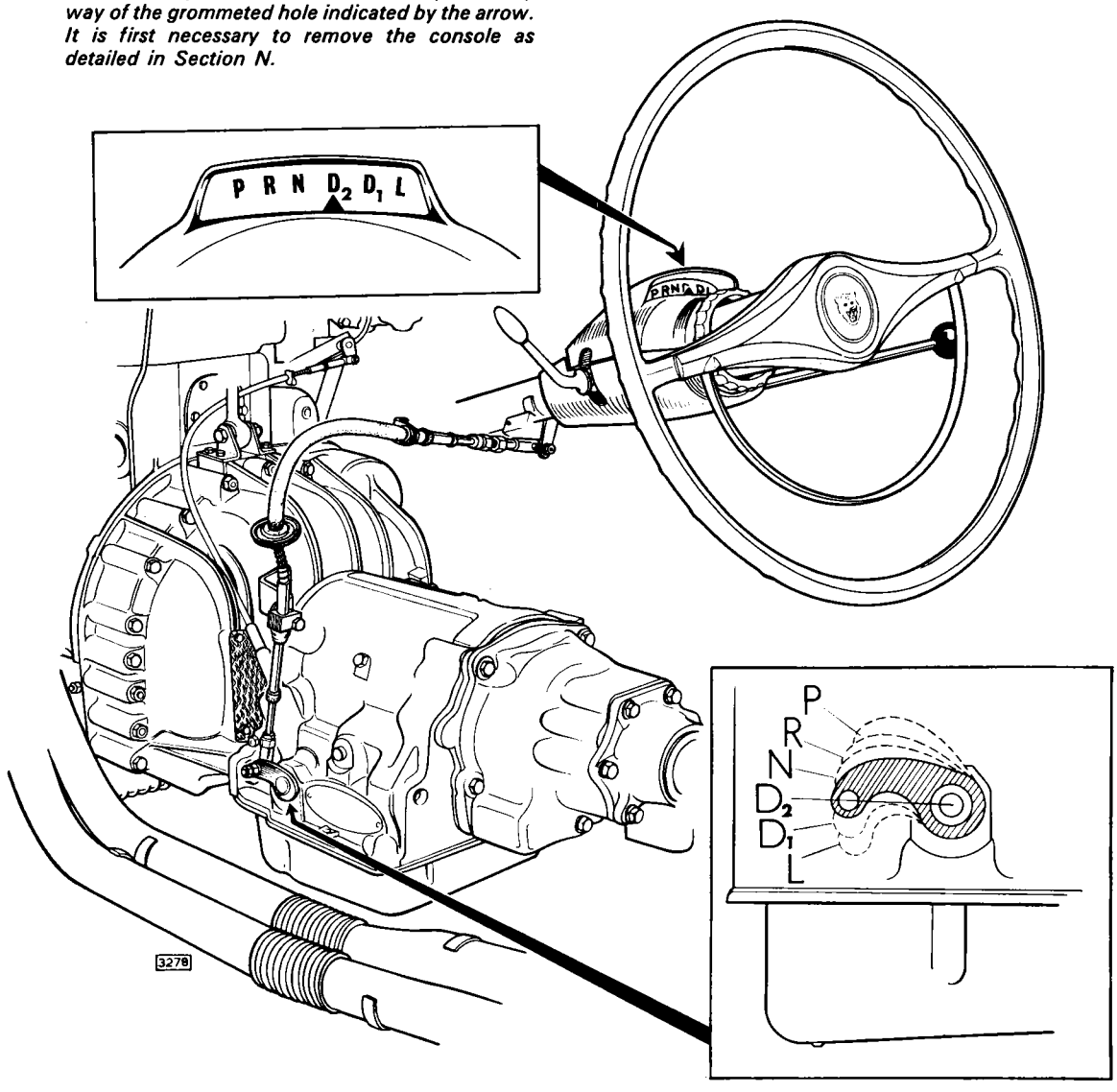

Fig. No. 23 *Manual selector linkage adjustment*

TRANSMISSION UNIT
Removal and Refitting

To remove the transmission unit the engine can either be (A) removed from the car as a unit or (B) raised from the mountings at an angle of approximately 45°.
Method "A" must be used if a transmission hoist is not available.
Method "B" can be used if a transmission hoist is available.

REMOVAL
Disconnect the battery.
Remove the bonnet.
Drain the engine sump.
Release the filler cap and drain the cooling system by turning the radiator tap remote control and the cylinder block drain tap. Conserve the coolant if an anti-freeze is in use.
Remove the water drain plug from the automatic transmission oil cooler beneath the radiator.
Release the hose clips and disconnect all hoses connecting the radiator and oil cooler to the engine and header tank.
Remove the radiator as detailed on page C.5.
Disconnect all engine units, mountings and propeller shaft as detailed on pages A.31 and A.32.
Disconnect the compressor clutch unit cable and remove the compressor from the mounting bracket (if air conditioning equipment is fitted).
Tie the unit away from the engine.
Warning: Do NOT disconnect the pipe unions from the compressor. Disconnecting these unions will necessitate recharging the system. See Fig. 24.
Sling the engine from the two loops between the cylinder head studs.
Note: If a single block and tackle only is available, position the hook above the front loop.
Remove the rear mounting as detailed on page A.31.
Remove the engine front mounting bolts.
Remove the self-locking nut and stepped washer from the stabiliser between the rear of the cylinder head and the bulkhead.
Lower the rear of the engine until the stabiliser bolt can be withdrawn.
Position the transmission hoist, if available, beneath the transmission unit.
Disconnect the oil cooler pipes from the oil cooler beneath the radiator and the transmission unit.
Raise the front of the engine and lower the rear until the unit is supported on the hoist.
Remove the split pin, washers and joint pin, detach the outer cable from the support bracket and disconnect the kickdown cable from the operating shaft.
Remove the setscrews and washers and withdraw the unit from the bell housing.
Place a clean tray beneath the torque converter to catch the oil which will drain away as the unit is removed.
If the engine is to be removed as a unit, complete the removal as detailed on page A.32.

REFITTING
Refitting is the reverse of the removal procedure, as detailed on page A.32.
Check the throttle cable adjustment and the setting of the manual linkage as described on page F.24.

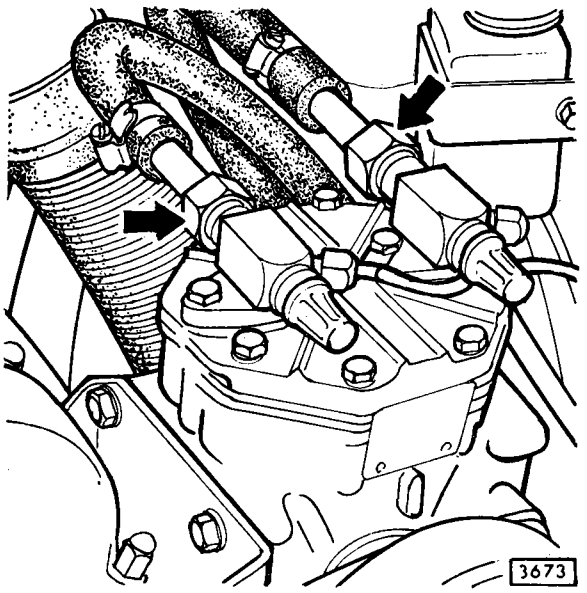

Fig. No. 24 *Showing compressor unions (air conditioning equipment)*

TRANSMISSION
Dismantling and Assembly

TRANSMISSION — DISMANTLING
Dismantling should not begin until the transmission exterior and work area have been thoroughly cleaned.
Place the transmission (bottom side up) on a suitable stand or holding fixture.
Remove the oil pan bolts, oil pan and oil pan gasket.
Remove the oil screen retaining clip, lift the oil screen off the regulator; then lift and remove the screen from the rear pump suction tube. (Fig. 25).

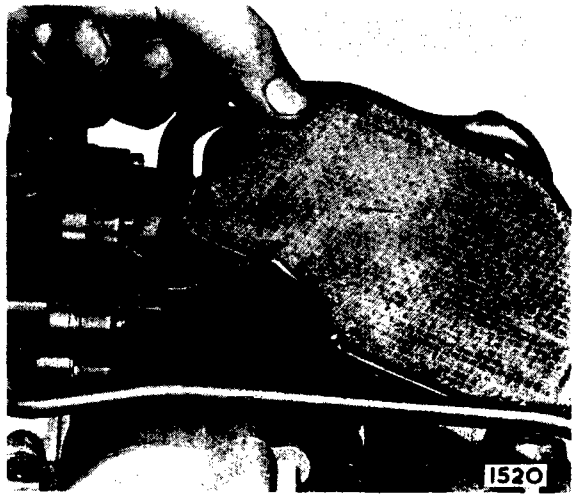

Fig. No. 25 *Removing the screen from the rear suction tube*

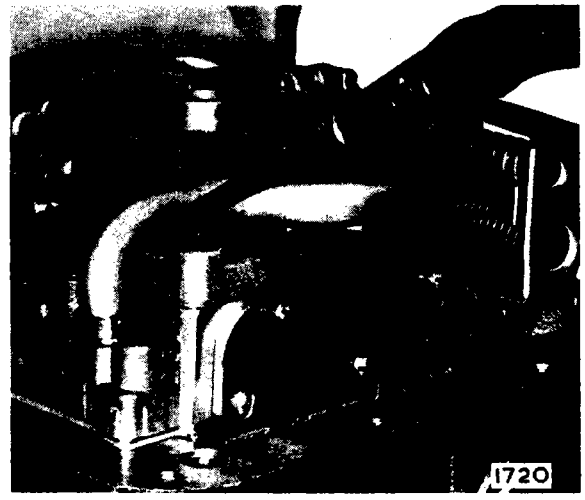

Fig. No. 27 *Removing the control line pressure tube*

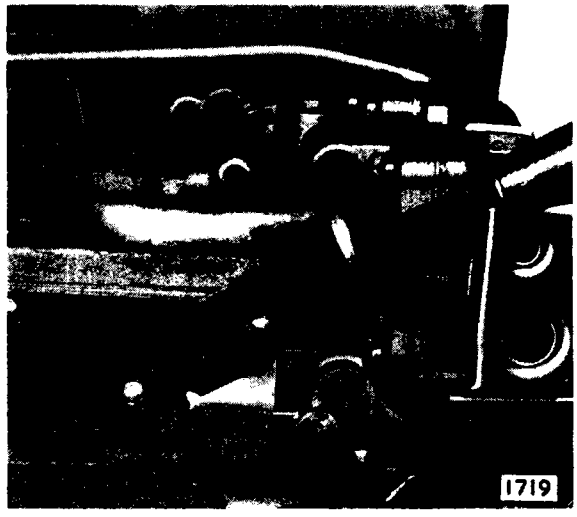

Fig. No. 26 *Removing the compensator tube*

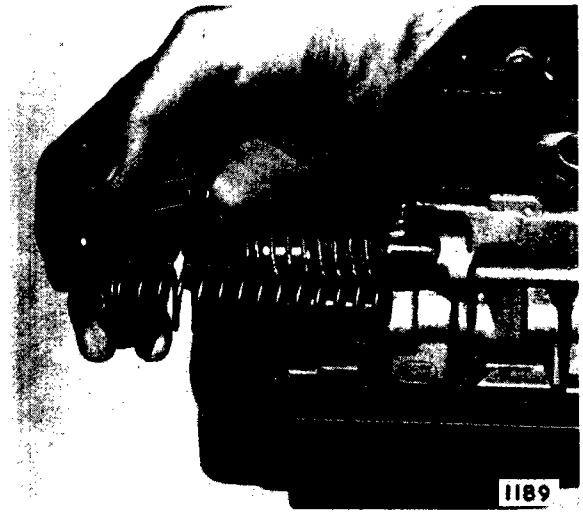

Fig. No. 28 *Removing the pressure spring retainer*

Use a screwdriver to pry the compensator tube from the valve body and regulator assemblies (Fig. 26).
The control pressure tube should be prised from the valve body, then removed from the regulator (Fig. 27).
Remove the rear pump suction tube by pulling and twisting it at the same time.
Carefully remove the pressure regulator spring retainer. Maintain pressure on the retainer to prevent distortion of the retainer, and sudden release of the springs (Fig. 28).
Remove springs and spring pilots, but do not remove the regulator valves at this time. The valves will be protected as long as they remain in the regulator body.
Remove the two regulator attaching capscrews and lockwashers, then lift the regulator assembly from the transmission case (Fig. 29).

Loosen the front and rear servo adjusting screw locknuts and adjusting screws. This will aid in dismantling, and later, in assembling the transmission.
Remove the three valve body attaching capscrews and lockwashers (Fig. 30).
Loosen the front servo to case capscrew and lockwasher approximately $\frac{5}{16}$" (7.94 mm.) (Fig. 31).
Place the manual selector lever in park or reverse position. Lift the valve body until the throttle control rod will clear the manual detent lever, then remove the hook from the throttle cam using the index finger or a screwdriver.
Lift the valve body and servo until the valve body will clear the linkage and slide it off the servo apply and release tubes (Fig. 32).

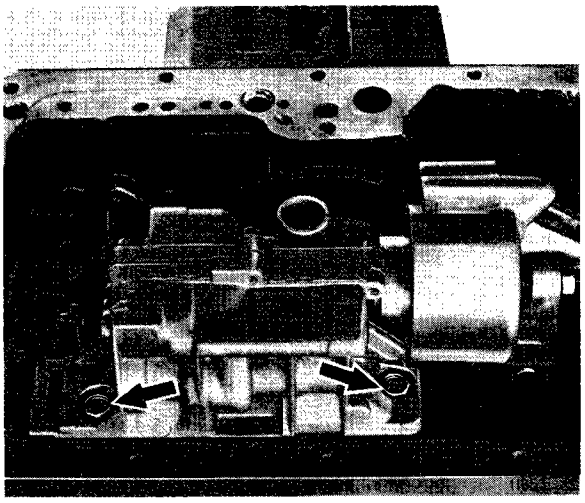

Fig. No. 29 *The regulator retaining screws*

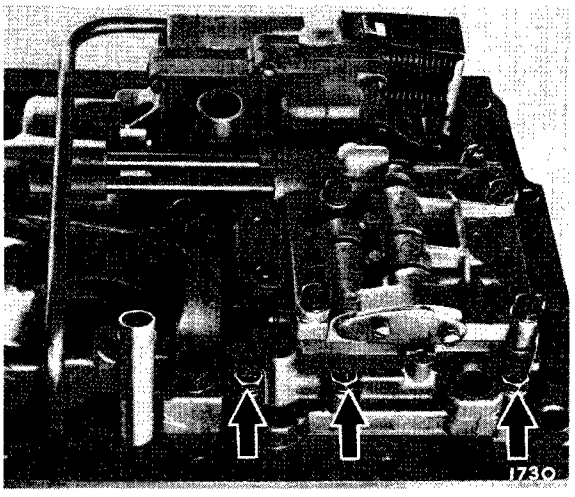

Fig. No. 30 *The valve body attaching screws*

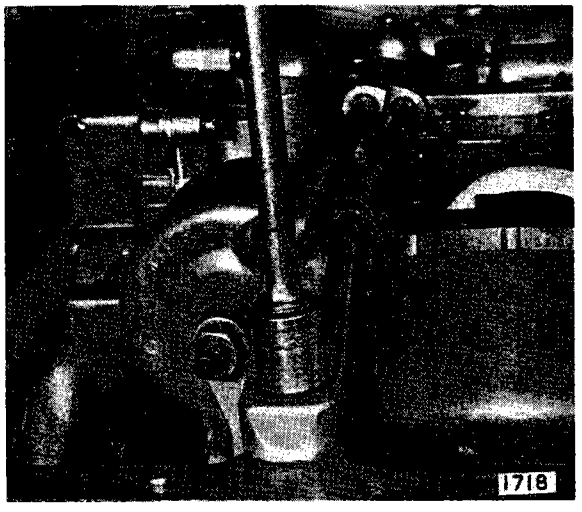

Fig. No. 31 *Slackening the front servo screw*

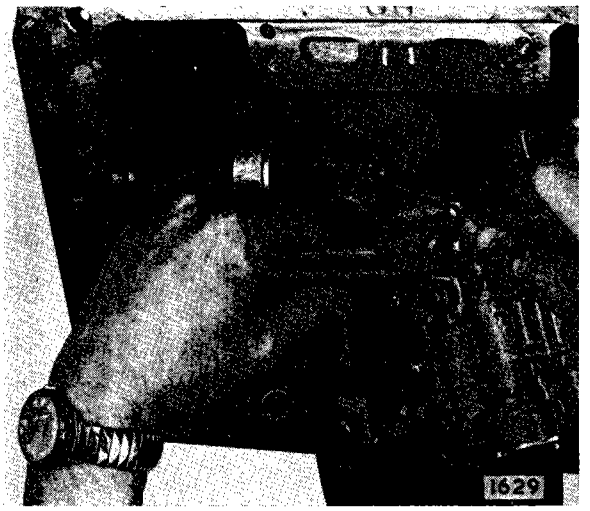

Fig. No. 32 *Lifting the valve body to clear the front servo*

Remove the front servo apply and release tubes (Fig. 33).

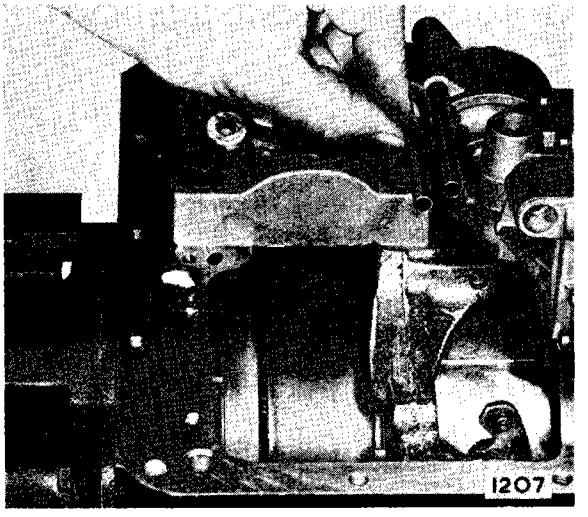

Fig. No. 33 *Withdrawing the apply and release tubes*

Remove the front servo bolt and lift the servo from the transmission, catching the servo strut with the index and middle finger of the left hand (Fig. 34).
Remove the two rear servo attaching capscrews and lockwashers, then lift the rear servo assembly from the transmission (Fig. 35).
Remove the rear band apply and anchor struts.
Remove the rear pump outlet tube, using special extractor tool Part No. CWG.45 (Fig. 36).
Check the end play at this time. Should the end play need correcting it will be done during assembly of the transmission. See Fig. 37. Place an indicator against the end of the input shaft. Pry between the front of the case and the front clutch to move clutch assemblies to their extreme rearward position.

Set the indicator to "O". Pry between the planet carrier and the internal gear with a screwdriver to move the clutches to their extreme forward position. Read the end play on the indicator. The allowable limits are 0.008"- 0.044" (0.2 - 1.1 mm.). It is preferable to have approximately 0.020" (0.5 mm.). Should correction be necessary, remove the output shaft, extension housing and companion flange as an assembly so that the selective washer can be changed.
Selective thrust washers are available in the following thicknesses :—

0.061" - 0.063"	0.081" - 0.083"
(1.53 - 1.58 mm.)	(2.03 - 2.08 mm.)
0.067" - 0.069"	0.092" - 0.094"
(1.68 - 1.73 mm.)	(2.3 - 2.35 mm.)
0.074" - 0.076"	0.105" - 0.107"
(1.85 - 1.90 mm.)	(2.63 - 2.68 mm.)

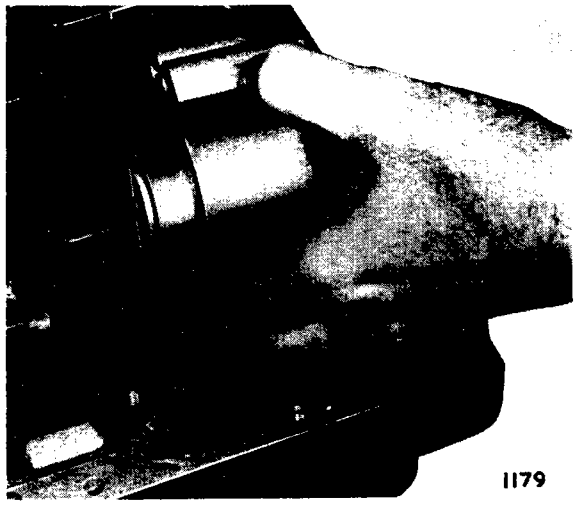

Fig. No. 34 *Removing the front servo*

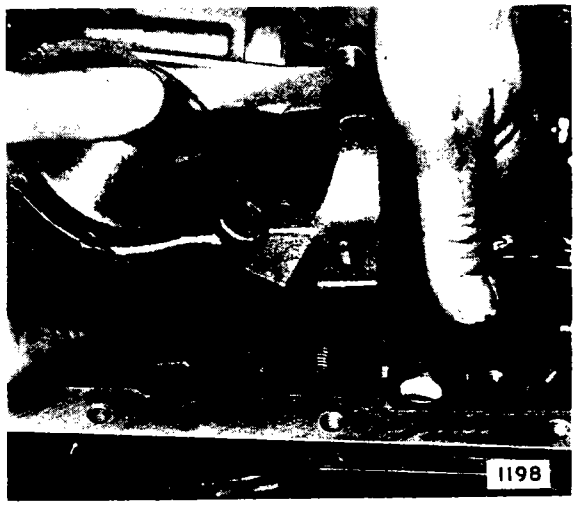

Fig. No. 35 *Removing the rear servo*

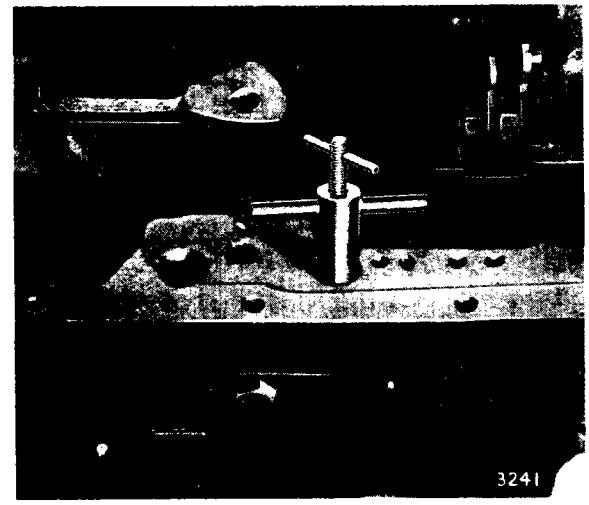

Fig. No. 36 *Removing the rear pump outlet tube (Extractor Tool Part No. CWG45)*

Place the shift selector in park position to hold the output shaft, then remove the companion flange nut, lockwasher, flat washer and flange.
Remove the bearing retainer capscrews, the bearing retainer and the bearing retainer gasket.
Slide the speedometer drive gear off the output shaft.
Remove the governor inspection cover and gasket.
Remove the five extension housing capscrews and remove the output shaft and extension housing assembly.
Remove the two hook type seal rings from the rear of the primary sun gear shaft.

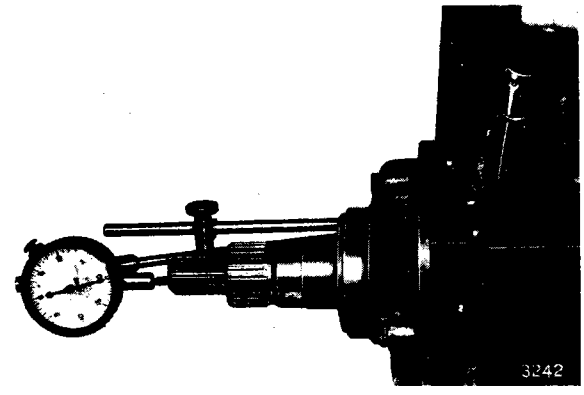

Fig. No. 37 *Checking the end play*

Remove the selective thrust washer from the rear of the planet carrier (Fig. 38).

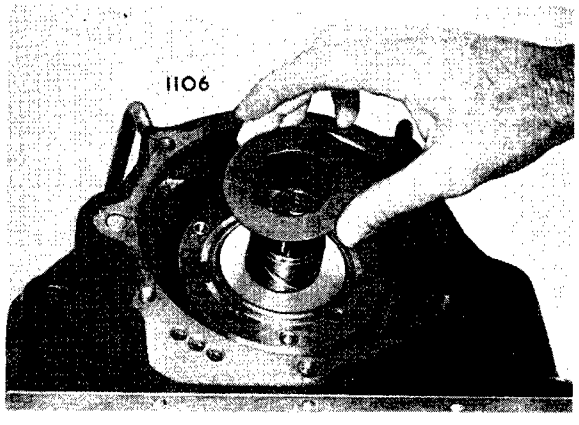

Fig. No. 38 *Removing the selective thrust washer*

Pull the planet carrier from the transmission (Fig. 39).

Fig. No. 39 *Removing the planet carrier*

Pull the rear band through the rear opening of the transmission. Hold the two ends of the band together with the left hand while pulling rearward through the rear of the case with the right hand (Fig. 40).

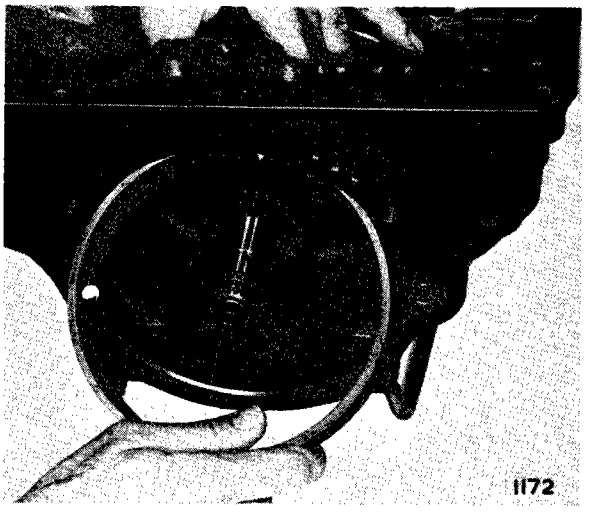

Fig. No. 40 *Removing the rear band*

Remove the two centre support bolts; one from each side of the case (Fig. 41).

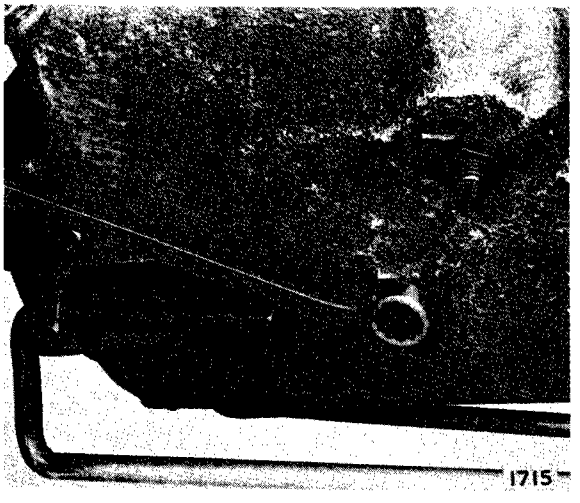

Fig. No. 41 *Removing one of the centre support bolts*

Remove the centre support, push on the end of the input shaft to start the rearward movement of the centre support.

Remove the front and rear clutch assemblies, placing them in a suitable stand for dismantling, Fig. 42. (The planet carrier can be used as a stand for dismantling and assembling the clutches).

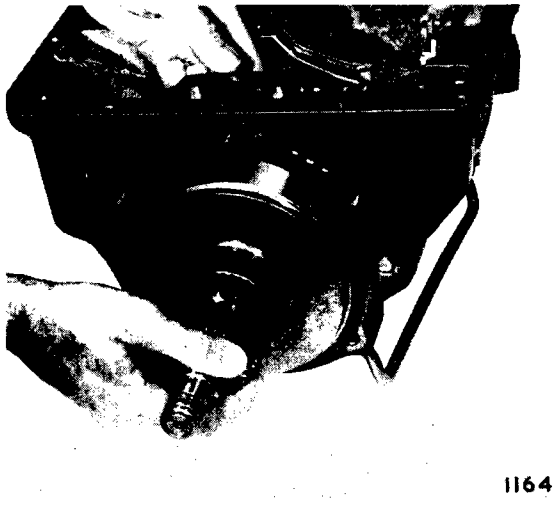

Fig. No. 42 *Removing the clutch assemblies*

Remove the front band (up and out of the case).
Remove the front pump oil seal. Use a seal puller or punch.
Remove the four front pump attaching capscrews and lift off the front pump (Fig. 43).

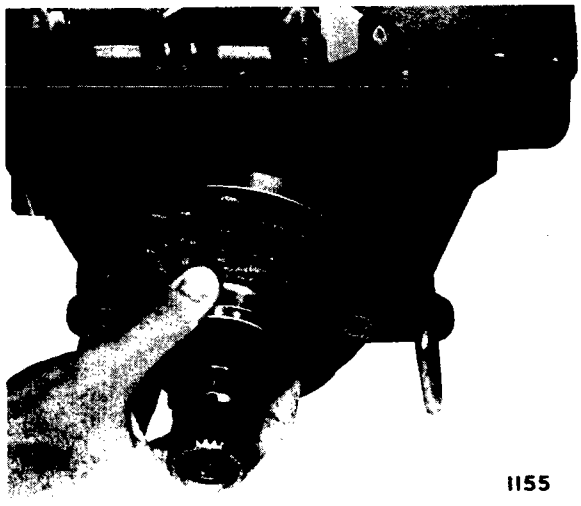

Fig. No. 43 *Removing the front pump*

Remove the front pump oil seal ring from the case.

Front Pump — Dismantling
Remove the stator support attaching screw and remove the stator support (Fig. 44). Mark the top of the internal and external gears with marking ink or a crayon. Lift the gears from the pump body.

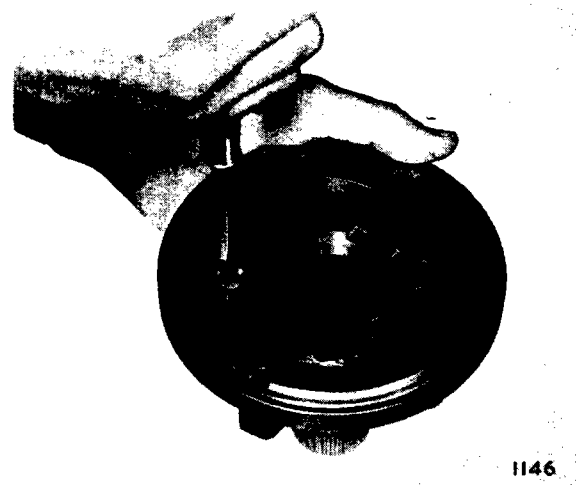

Fig. No. 44 *Removing the stator support attaching setscrew*

Inspect the pump body, the internal and external tooth gears, and stator supports for scores, scratches and excessive wear.
Minor scratches and scores can be removed with crocus cloth or jeweller's rouge. However, parts showing deep scratches, scores or excessive wear should be replaced. If excessive wear or scoring is observed, replace the complete pump assembly (since the gears and body are carefully matched when built, these parts should not be interchanged or individually replaced).

Front Pump — Assembling
Drive a new seal into the pump body until it bottoms. Lubricate all pump parts with transmission fluid before assembly. Install the internal and external gears in the pump body with marks previously made in the upward position. Insert the stator support on the pump body and install the retaining screw. Torque the screw to 25-35 lb. in. (0.29 - 0.40 kgm.). Check the gears for free movement.

Manual Linkage — Dismantling
Pull the retainer clip from the forward end of the linkage rod (Fig. 45). Disconnect the rod from the manual valve detent lever. Release the detent ball and spring by rocking the manual valve lever to the extreme of its travel. The ball will be released with considerable force, but can be caught in a shop towel or even in the hands. Remove the manual lever locknut, the manual detent lever, and then pull the manual control lever from the transmission. Prise the manual level oil seal from the transmission case with a screwdriver.

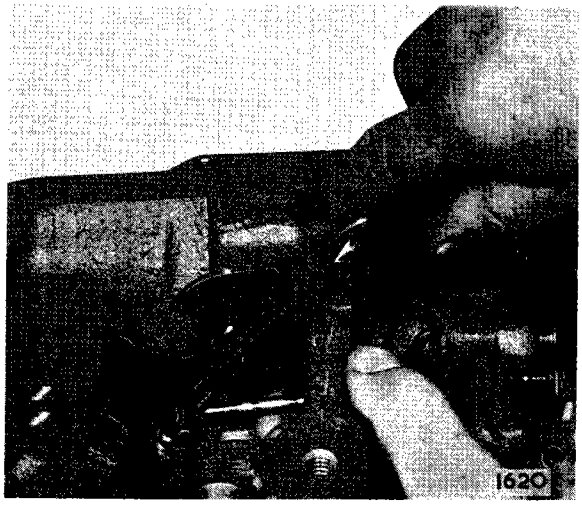

Fig. No. 45 *Removing the retaining clip from the linkage rod*

Manual Linkage — Assembling

Install a new manual lever oil seal. Assemble the manual control lever through the transmission case boss. Place the manual valve detent lever and locknut on the manual control lever shaft. Rock the manual valve lever to its extreme travel, then install the detent spring. Place the ball in position on the spring, then using the lubrication tube to depress ball and spring (Fig. 46), rock the manual valve lever back over the ball and spring. Connect the linkage rod and insert the retainer spring clip.

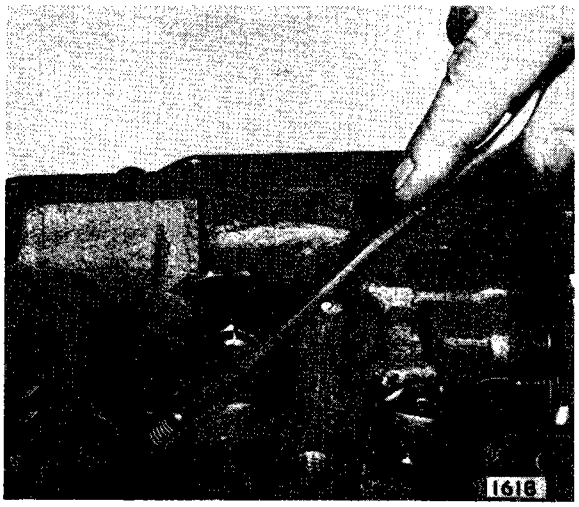

Fig. No. 46 *Releasing the detent ball*

Park Linkage — Dismantling

Pull the retainer clip from the rear of the parking brake linkage rod. Disconnect the linkage rod from the torsion lever. Remove the retainer spring from the torsion lever pin and slide the washer with the torsion lever off the pin. Tap the toggle lever rearward to loosen the pin retainer (Fig. 47), then pull the retainer using snap ring pliers (Fig. 48). The toggle lever pin and toggle lever can now be removed. A magnet may be used to pull the parking pawl anchor pin from the transmission case. The parking pawl is now free to be removed.

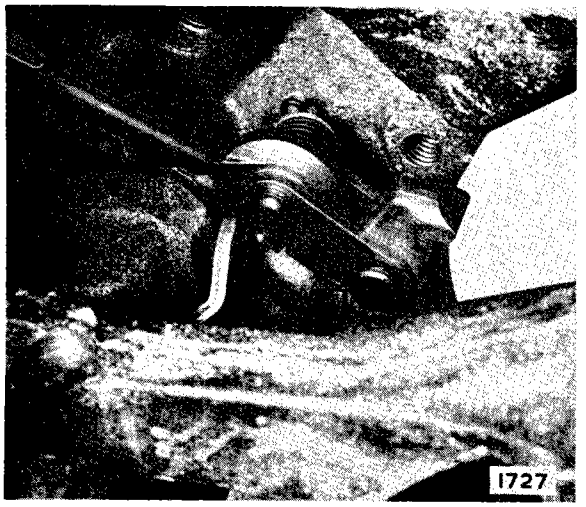

Fig. No. 47 *Tapping the toggle lever rearwards*

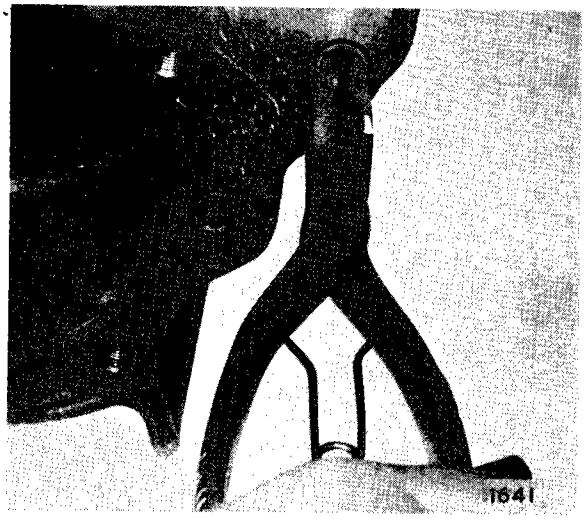

Fig. No. 48 *Removing the toggle lever pin retainer*

Parking Linkage — Assembling

Assemble the parking pawl and shaft. Use a new toggle lever retainer to assemble the toggle lever and toggle pin. Assemble the torsion lever pin, then the washer, and then place the retainer spring on the torsion lever pin. Connect the linkage rod to the torsion lever and insert the spring clip.

Clutches — Dismantling

Place the clutch pack in a suitable stand. The planet carrier will work very well for this purpose.

Lift the complete front clutch assembly from the rear clutch and forward sun gear.

Remove the snap ring and lift the input shaft from the clutch cylinder. (The clutch hub thrust washer may stick to the input shaft).

Lift the clutch hub and thrust washer from the clutch assembly.

Lift the front clutch plates and the pressure plate from the assembly.

Remove the clutch return spring snap ring and then the return spring. It is not necessary to compress the spring to remove the snap ring.

Compressed air applied to the clutch feed hole in the clutch hub will force the piston from the clutch cylinder (Fig. 49).

Remove the rubber seal rings from the clutch hub and clutch piston.

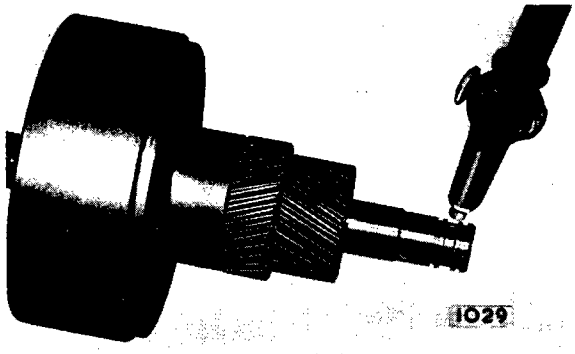

Fig. No. 49 *Applying compressed air to the clutch feed hole*

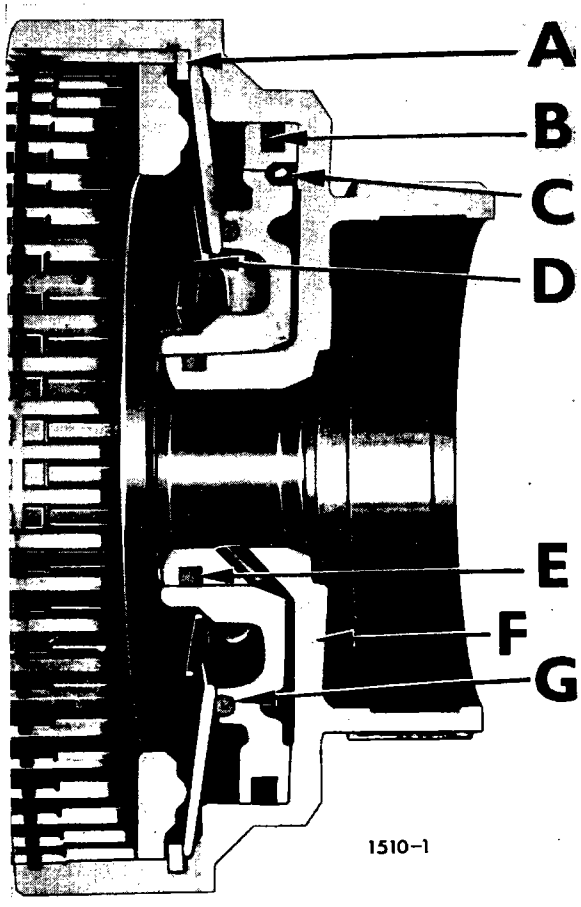

Fig. No. 50 *Sectioned view of the front clutch drum*

A Clutch spring ring
B Sealing ring
C $\frac{3}{16}$" steel ball
D Clutch spring
E Sealing ring
F Cylinder
G Piston

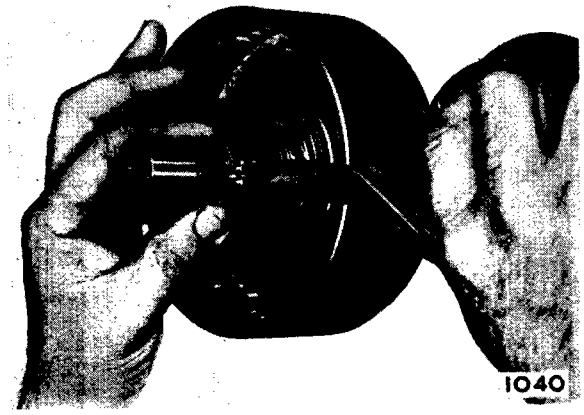

Fig. No. 51 *Removing the two front clutch sealing rings*

Remove the two front clutch sealing rings from the forward sun gear shaft (Fig. 51).

Remove the thrust washer and thrust plate from the shoulder of the rear clutch hub.

Lift the rear clutch assembly up and off the forward sun gear shaft.

Remove the rear clutch ring.

Remove the clutch pressure plate and the clutch plates.

Use the service tool, Churchill Tool No. CBW.37A), to compress the clutch return spring, then remove the spring retainer snap ring. Release the spring, but do not permit the spring retainer to catch in the snap ring groove as the spring is being released (Fig. 52).

Replace the forward sun gear shaft in the clutch hub, being careful not to break the cast iron sealing rings. The clutch piston can now be removed from the clutch cylinder by blowing compressed air through the rear clutch passage of the forward sun gear.

Remove the forward sun gear from the clutch cylinder and remove the two rear clutch sealing rings from their grooves in the shaft.

Remove the rubber seal rings from the clutch hub and the clutch piston.

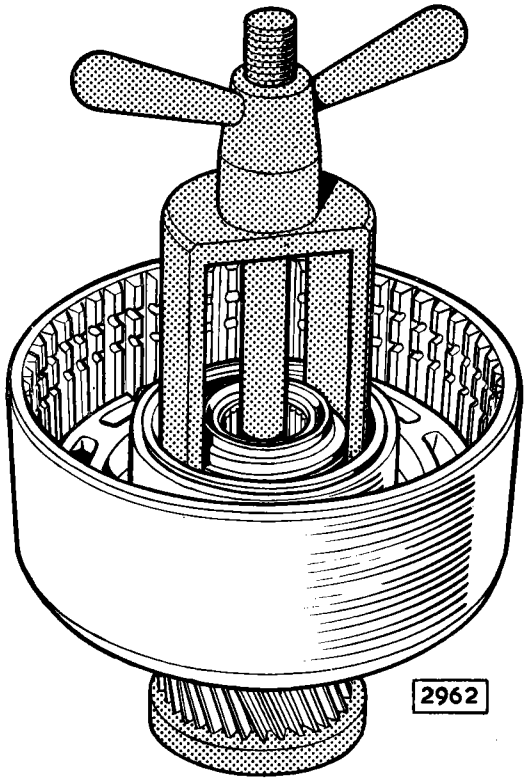

Fig. No. 52 *Dismantling the clutch using the special tool (Part No. CBW37A)*

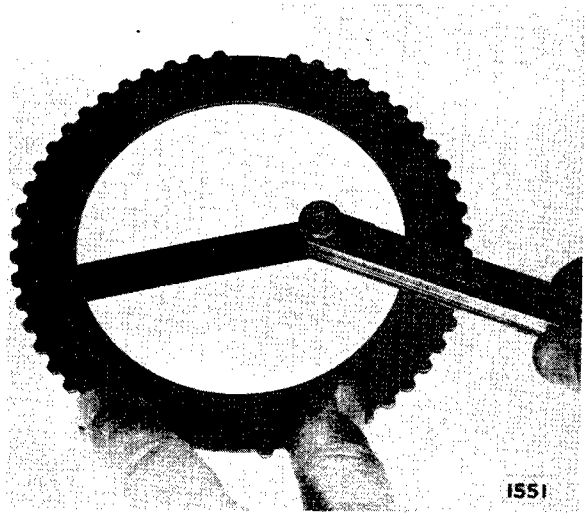

Fig. No. 53 *Checking a clutch plate*

Inspection of Clutches

Inspect all parts for burrs, scratches, cracks and wear. Check all the front clutch plates and the rear clutch friction plates for flatness. Check the rear clutch steel plates for proper cone. Lay plates on a flat surface when checking for flatness and cone. Cone should be 0.010" to 0.020" (0.25 to 0.5 mm.). Replace friction plates when wear has progressed so that the grooves are no longer visible. Replace all warped plates. Replace complete set of steel or friction plates in any clutch. Do not replace individual plates (Fig. 53).

Inspect the band surfaces of the drum for wear. If only slightly scored the drum may be refaced. Renew if excessive.

Inspect the clutch bushing and the needle bearing for wear and brinelling and for scores. The cast iron sealing rings are normally replaced. If the transmission is being rebuilt and has had little service, the rings may be re-used if they have not worn excessively and are not scratched or distorted.

Inspect the forward sun gear for broken or worn teeth. Inspect all journals and thrust surfaces for scores. Inspect all fluid passages for obstruction or leakage. Inspect the front clutch lubrication valve for freedom (Fig. 54).

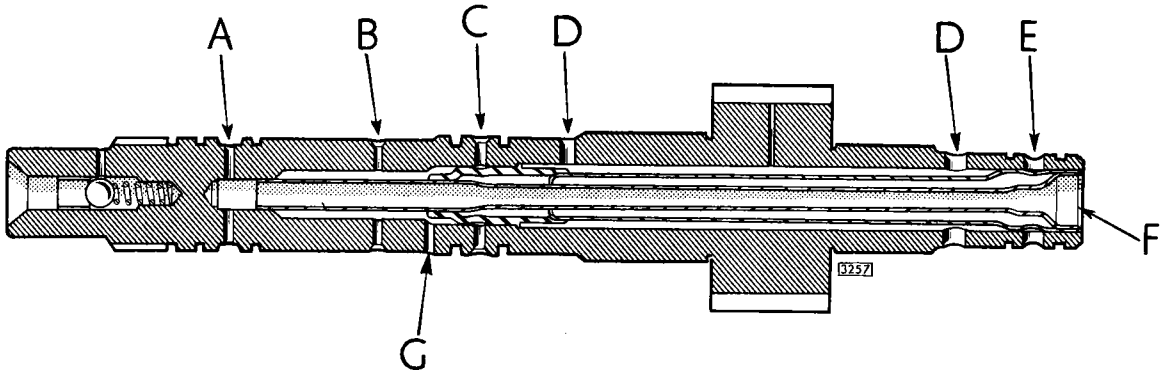

Fig. No. 54. *Longitudinal section of the forward sun gear showing oil ways*

A, F Front clutch **C, E** Rear clutch **B, D, G** Lubrication

Clutches — Assembling

Place the planet carrier on the assembly bench.
Place the forward sun gear in the carrier. Be sure the thrust washer is on the shaft (Fig. 55).
Assemble the rubber "O" ring in its groove on the rear clutch hub (Fig. 56).

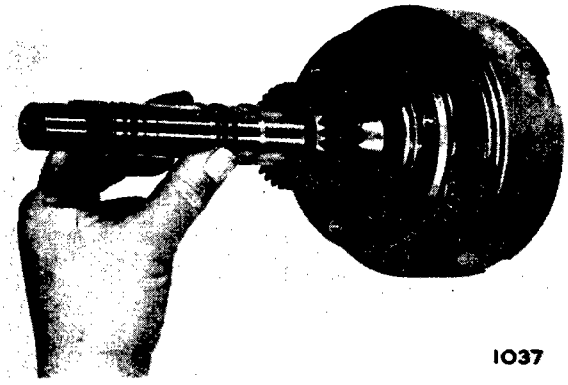

Fig. No. 55 *Placing the forward sun gears on the carrier*

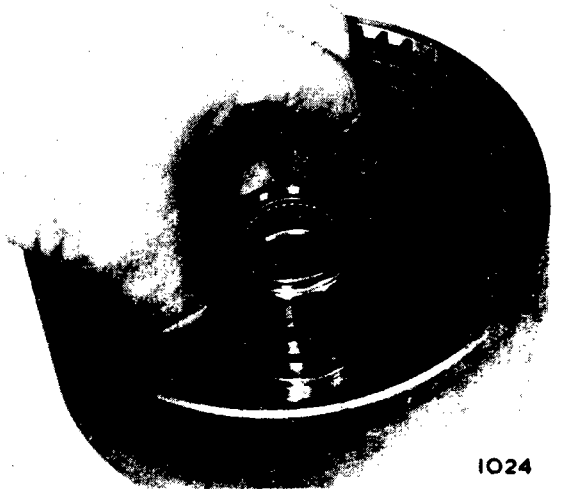

Fig. No. 56 *Fitting the "O" ring on the rear clutch hub*

Assemble the square section rubber seal ring in its groove on the rear clutch piston (Fig. 57).

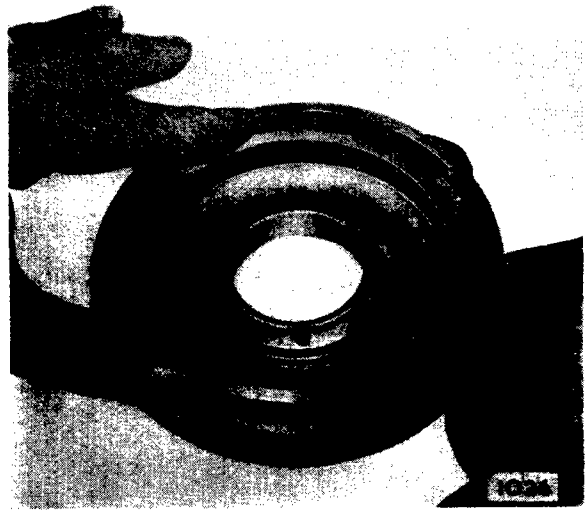

Fig. No. 57 *Fitting the rear clutch piston sealing ring*

Assemble the clutch piston in the rear clutch cylinder using Tool Part No. CWG.41 to force it into position. Be sure to lubricate the seal rings so that they will assemble easier.
Place the rear clutch return spring and spring retainer in position on the clutch piston. The rear clutch spring fixture is then used to compress the spring, then the snap ring is assembled in its groove in the clutch.
Install the rear clutch cast iron sealing rings in their grooves on the forward sun gear. Be sure that the rings are free in their grooves. Centre each ring in its groove, so that ends do not overlap edges of groove.
Place the rear clutch piston and cylinder assembly over the forward sun gear and gently slide it down over the sealing rings (Fig. 58).

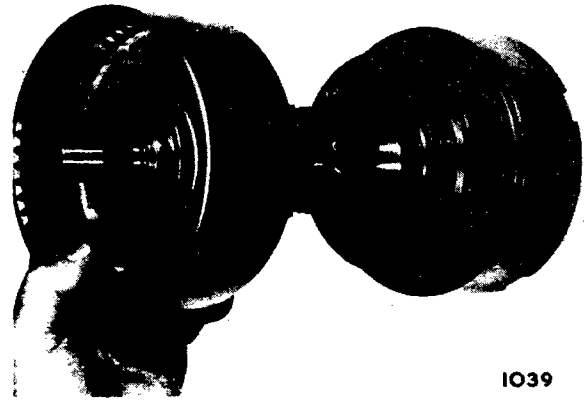

Fig. No. 58 *Assembling the rear clutch over the primary sun gear ring*

Install a rear clutch steel plate with its concave face up or forward facing in the transmission. Note that these plates are identified by missing teeth on the O.D. and are not interchangeable with front clutch steel plates (Fig. 59).

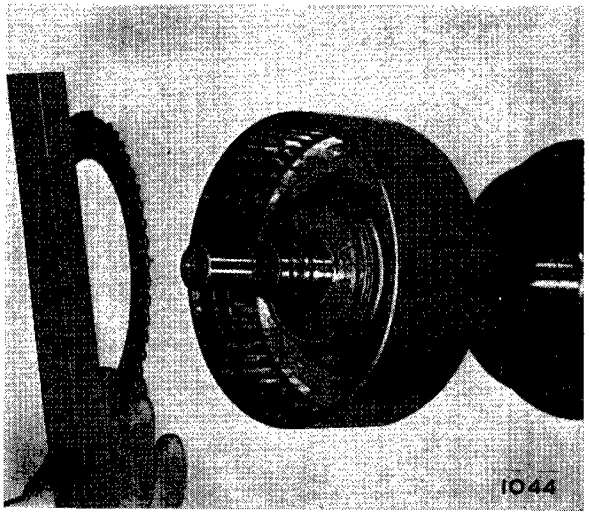

Fig. No. 59 *Fitting a rear clutch steel plate*

Install a rear clutch friction plate, then alternating with first a steel and then a friction plate, complete the clutch pack. (Fig. 60).

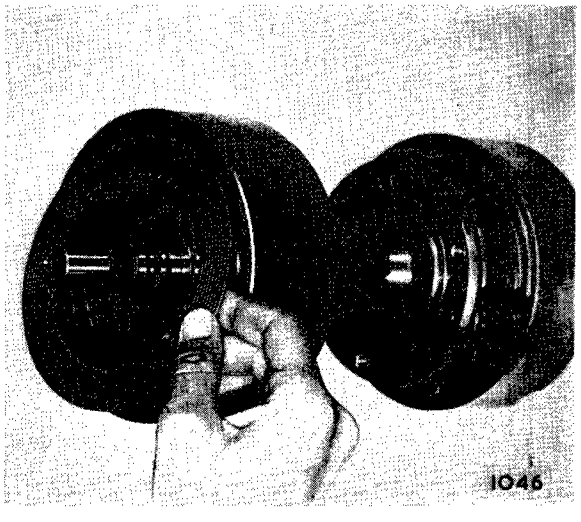

Fig. No. 60 *Fitting a rear clutch friction plate*

Install the rear clutch pressure plate.
Install the rear clutch snap ring. This ring has one tanged end (Fig. 61).

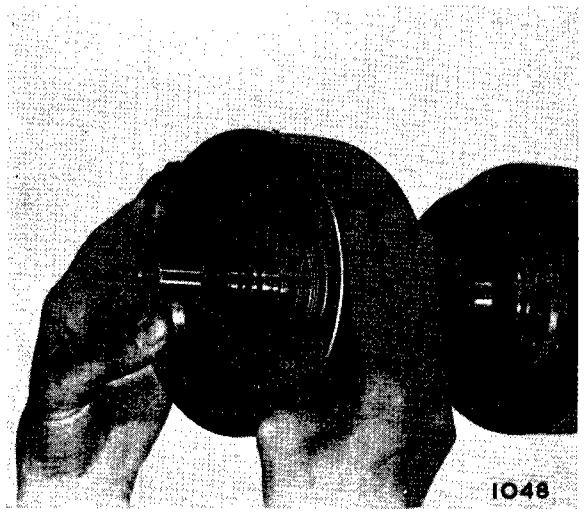

Fig. No. 61 *Fitting the rear clutch snap ring*

Install the front clutch cast iron sealing rings in their grooves on the forward sun gear. Centre each ring in its groove so that ends do not overlap edges of the groove (Fig. 62).

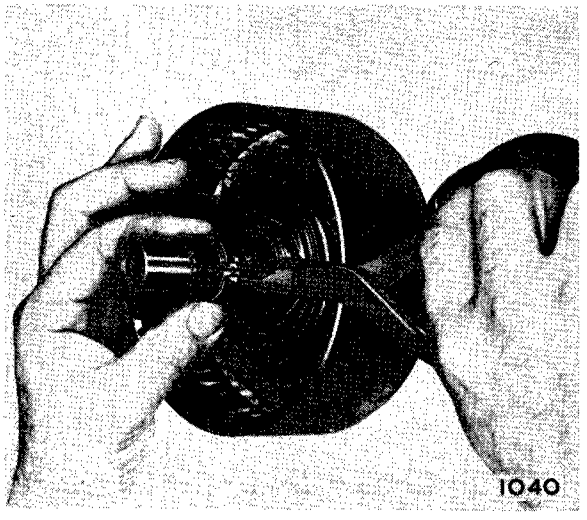

Fig. No. 62. *Fitting the sealing rings*

Install the front clutch cylinder thrust plate (Fig. 63). Be sure flats on the washer match flats on shaft.

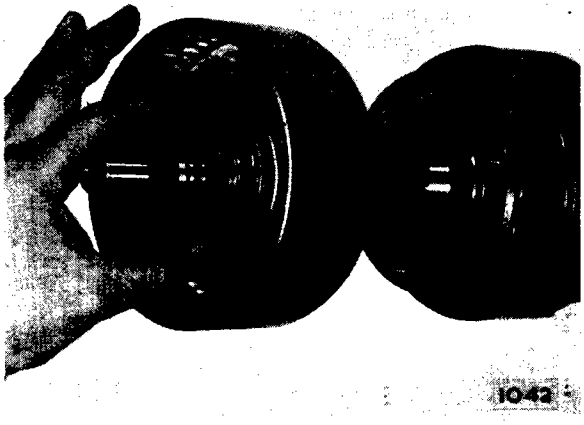

Fig. No. 63 *Fitting the front clutch thrust plate*

Install the front clutch cylinder thrust washer (Fig. 64).

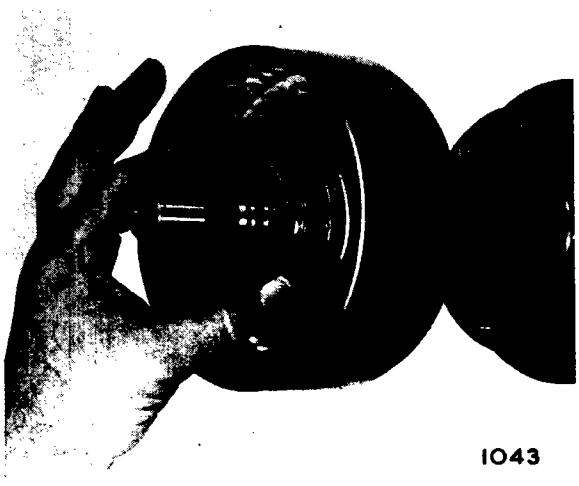

Fig. No. 64 *Fitting the front clutch cylinder thrust washer*

Assemble the front clutch hub "O" ring into its groove in the clutch hub.
Assemble the front clutch piston square section rubber sealing ring in the groove of the clutch piston.

Install the clutch piston into the clutch cylinder after thoroughly lubricating the parts. Press the piston into position using Tool Part No. WG.42.
Install the front clutch belleville spring and snap ring. This snap ring is thicker than the other two clutch snap rings and has two tanged ends instead of one.
Assemble the front clutch assembly over the forward sun gear shaft and into the rear clutch, being careful not to distort or break the cast iron sealing rings. Use a short oscillating movement to engage splines of the rear clutch friction plates (Fig. 65).

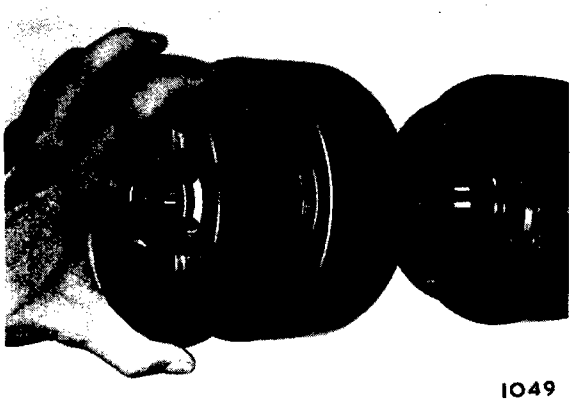

Fig. No. 65 *Assembling the front clutch*

Install the front clutch pressure plate (Fig. 66).

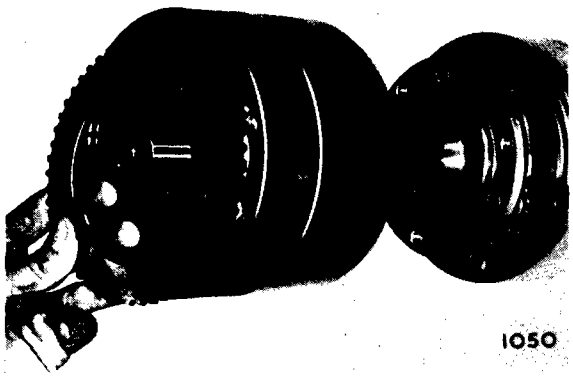

Fig. No. 66 *Fitting the front pressure plate*

Install the front clutch hub, followed by front clutch hub thrust washer (Fig. 67).

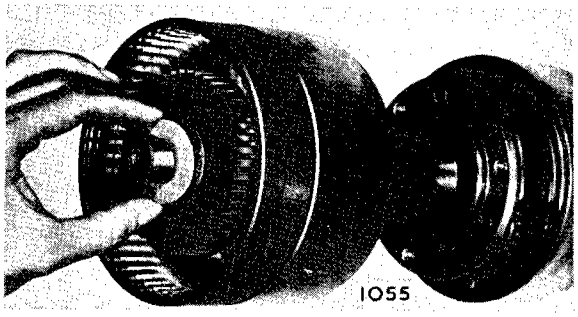

Fig. No. 67 *Fitting the front clutch hub thrust washer*

Install a front clutch friction plate over the splines of the hub (Fig. 68). Next, install a front clutch outer plate, meshing splines in the cylinder, alternating as above, complete assembly of plates (Fig. 69).

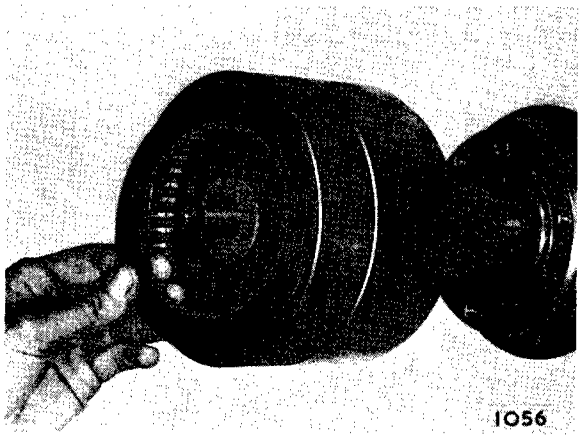

Fig. No. 68 *Fitting a front clutch friction plate*

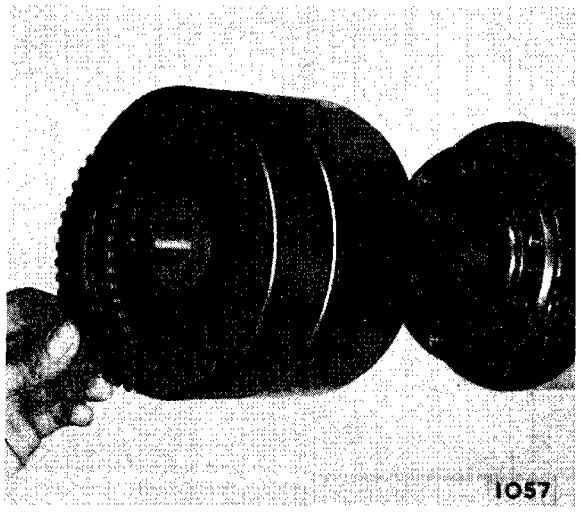

Fig. No. 69 *Fitting a front clutch outer plate*

Assemble the input shaft to the front clutch cylinder. Assemble the snap ring that holds the input shaft in place (Fig. 70).

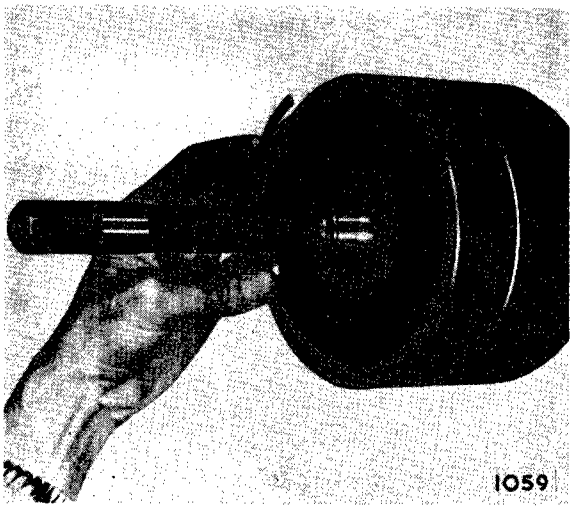

Fig. No. 70 *Fitting the input shaft snap ring*

Place the thrust washer on the input shaft and the clutch assemblies are complete (Fig. 71)

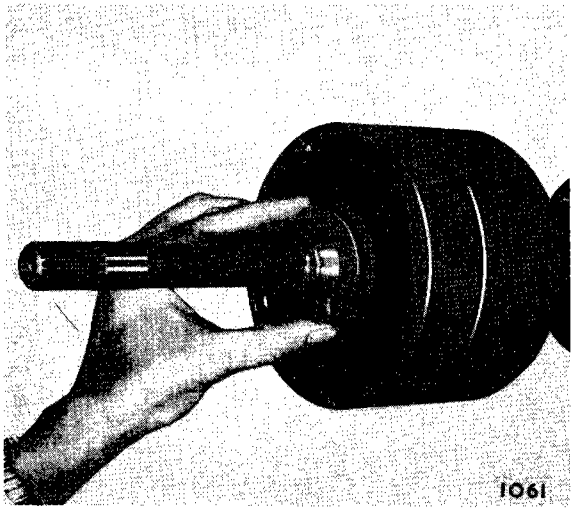

Fig. No. 71 *Placing the thrust washer in position on the input shaft*

Centre Support

The centre support is serviced as an assembly. Therefore, there is no disassembly or assembly procedure. Inspect the support for burrs or distortion, the race bearing surface for scores or scratches.

Pinion Carrier Assembly
The pinion carrier is serviced as an assembly. Therefore there is no disassembly or assembly procedure.
Inspect the band surface and the inner and outer bushing for scores. Rotate pinions on their shafts to check for freedom of movement and for worn or broken teeth. Use a feeler gauge to check pinion end play. End play should be 0.010" to 0.020" (0.25 to 0.5 mm.). Inspect pinion shafts for tightness to the planet carrier.

Sprag Clutch
A sprag-type one-way clutch assembly is incorporated in the planet carrier assembly and is held in place by a snap ring.
When installing the sprag clutch, the flange side of the sprag cage is located down into the outer race of the planet carrier assembly with the copper tension springs towards the centre support.
After the planet carrier and sprag assembly are installed in the case, the planet carrier will freewheel when turned counterclockwise and lock when turned clockwise (from the rear).

Output Shaft
Remove the extension housing and bearing from the output shaft by lifting the housing and tapping with a heavy plastic hammer.
Remove the bearing spacer washer.
Slide the oil collector and tubes from the shaft.
Remove the four sealing rings.
Remove the governor snap ring, governor and governor drive ball from the output shaft.
Lift the rear pump from the shaft and remove the rear pump drive key.
The snap ring may be removed and the output shaft removed from the ring gear; however, this is not necessary unless replacing one of these parts.
Inspect the output shaft thrust surfaces and journals for scores and the internal gear for broken teeth. Check the ring grooves, splines and gear teeth for burrs, wear or damage. The output shaft is a two-piece assembly and is serviced separately. Inspect the distributor and sleeve mating surfaces for excessive wear and for burrs, scores or leakage.

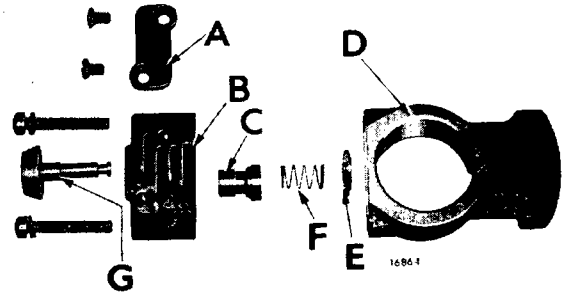

Fig. No. 72 *Exploded view of the governor*

A Governor body cover plate
B Governor body
C Valve
D Counter weight
E Spring retainer
F Spring
G Governor weight

Governor
Remove the governor body cover plate attaching screws and remove the plate (Fig. 72). Remove the governor body attaching screws, then remove the body from the counterweight. Slide the spring retainer from the stem of governor weight and remove the spring. Remove the valve and weight from the governor body. Inspect the governor weight, valve and bore for scores. Minor scores may be removed with crocus cloth. Replace the governor valve, weight or body if deeply scored. Check for free movement of the weight and valve in the bore. Inspect all fluid passages in the governor body and counterweight for obstruction. All fluid passages must be clean. Inspect the mating surfaces of the governor body and counterweight for burrs and distortion. Check governor spring retainer washer for burrs. The mating surfaces must be smooth and flat.
Re-install governor body cover plate, torqueing screws to 20-30 lb. in. (0.24 to 0.35 kgm.).
Install the governor valve in the bore of the body. Install the weight in the governor valve. Compress the spring and slide the retainer onto the stem of the weight and release the spring tension. Install the governor body on the counterweight.
Note: Make sure the fluid passages in the body and counterweight are aligned.
Torque the governor body attaching screws to 50-60 lb. in. (0.58 to 0.69 kgm.).

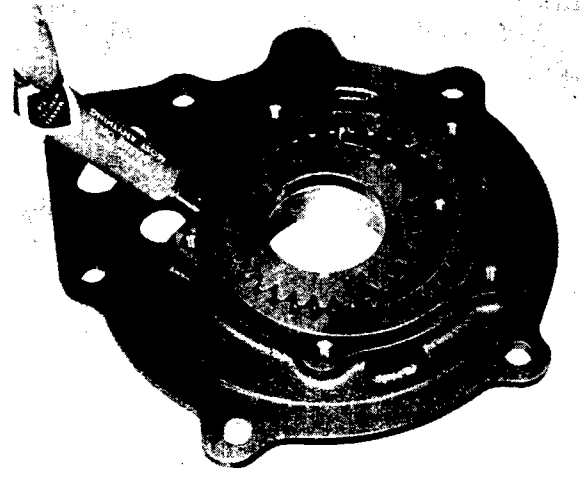

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Fig. No. 73 *Marking top face of gears of rear pump*

Rear Pump
Withdraw the five $\frac{1}{4}$" screws, also the No. 10 U.N.C. screw and remove the cover. Mark the top face of the gears with marking ink or a crayon to assure correct re-installation of gears upon assembly (Fig. 73).

Remove the drive and driven gears from the pump body. Inspect the gear pockets and crescent of the pump body for scores or pitting. Inspect the bushing and drive and driven gear bearing surfaces for scores. Check all fluid passages for obstructions and clean if necessary. Inspect the mating surfaces, gear teeth, pump body and cover for burrs. If any pump parts are defective beyond minor burrs or scores, which cannot be removed with a crocus cloth, replace complete pump as a unit.
Lubricate parts with transmission fluid and replace both gears with the marks facing upward. Install the pump cover, attaching screws and lock-washers. Tighten the $\frac{1}{4}$" screws to 50-60 lb. in. (0.58 to 0.69 kgm.) torque and the number 10 screw to 20-30 lb. in. (0.24 to 0.35 kgm.) torque (Fig. 74).

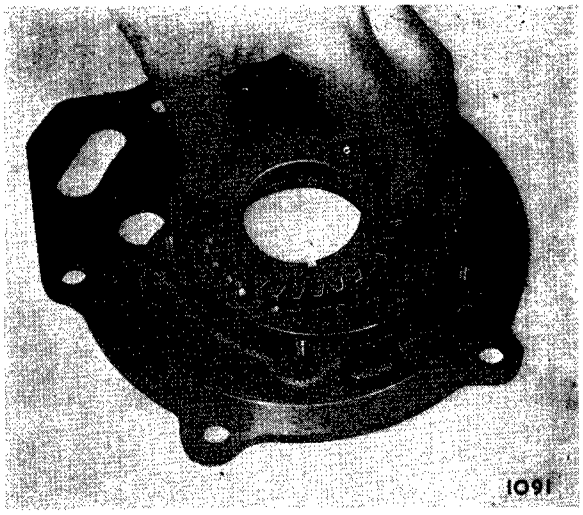


Fig. No. 74 *Replacing the gears*

Check the pump for free movement of the gears.

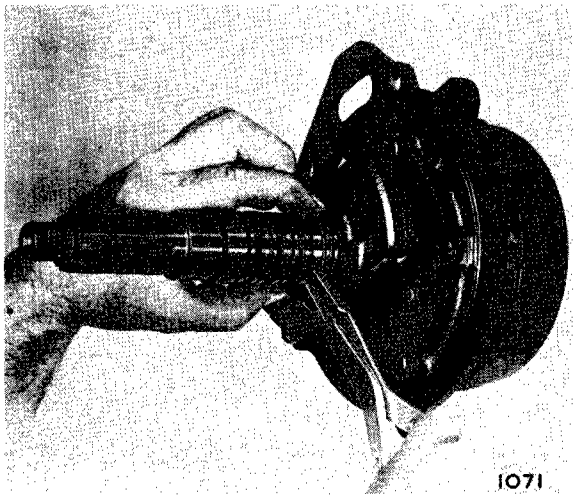


Fig. No. 75 *Fitting the snap ring*

Output Shaft and Rear Pump — Assembling
Install the rear pump drive key in the output shaft.
Install rear pump assembly over the shaft.
Install the governor drive ball into the recess in the output shaft, using a spot of petrolatum to hold in place.
Install governor assembly, with plate on the governor body down (facing pump assembly). Install snap ring to lock governor in place (Fig. 75).
Install the four output shaft sealing rings, making sure they are free in their grooves (Fig. 76).

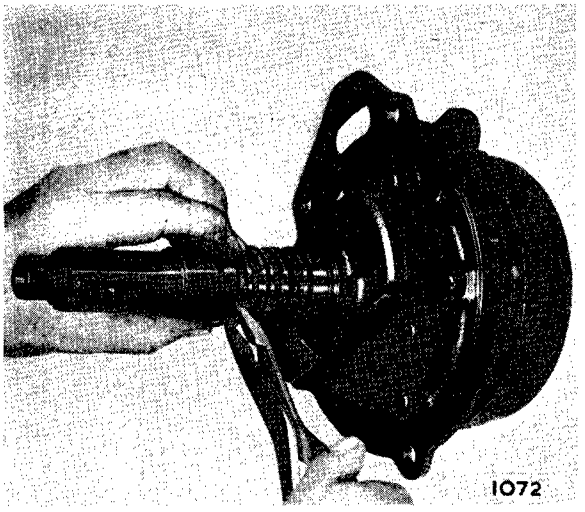


Fig. No. 76 *Fitting the output shaft sealing rings*

Install oil collector sleeve and tube assembly. Compress each ring with the fingers and carefully slide the sleeve over them (Fig. 77).

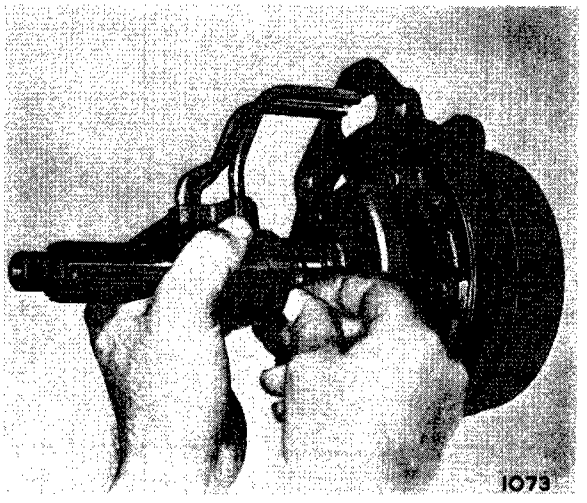


Fig. No. 77 *Installation of the oil collector sleeve and tube*

Assemble the bearing spacer washer against the shoulder on the output shaft (Fig. 78).

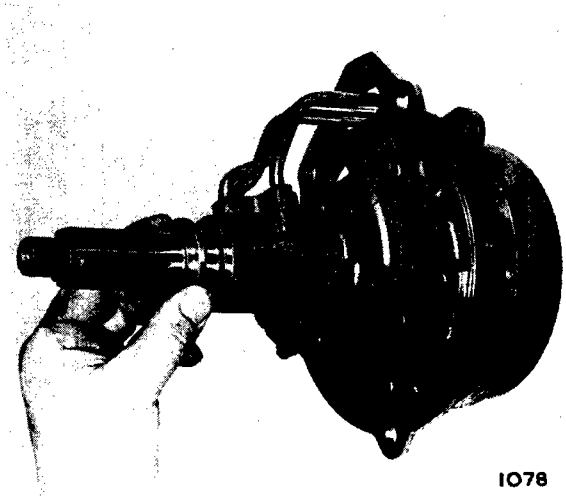


Fig. No. 78 *Fitting the bearing spacer washer*

Front Servo — Assembling
Assemble the servo lever, pivot pin and the roll pin.
Assemble the sealing rings on the sleeve and piston.
Assemble the piston to the sleeve, place the spring in the piston, and assemble the sleeve, piston and spring into the housing.
Replace the snap ring.

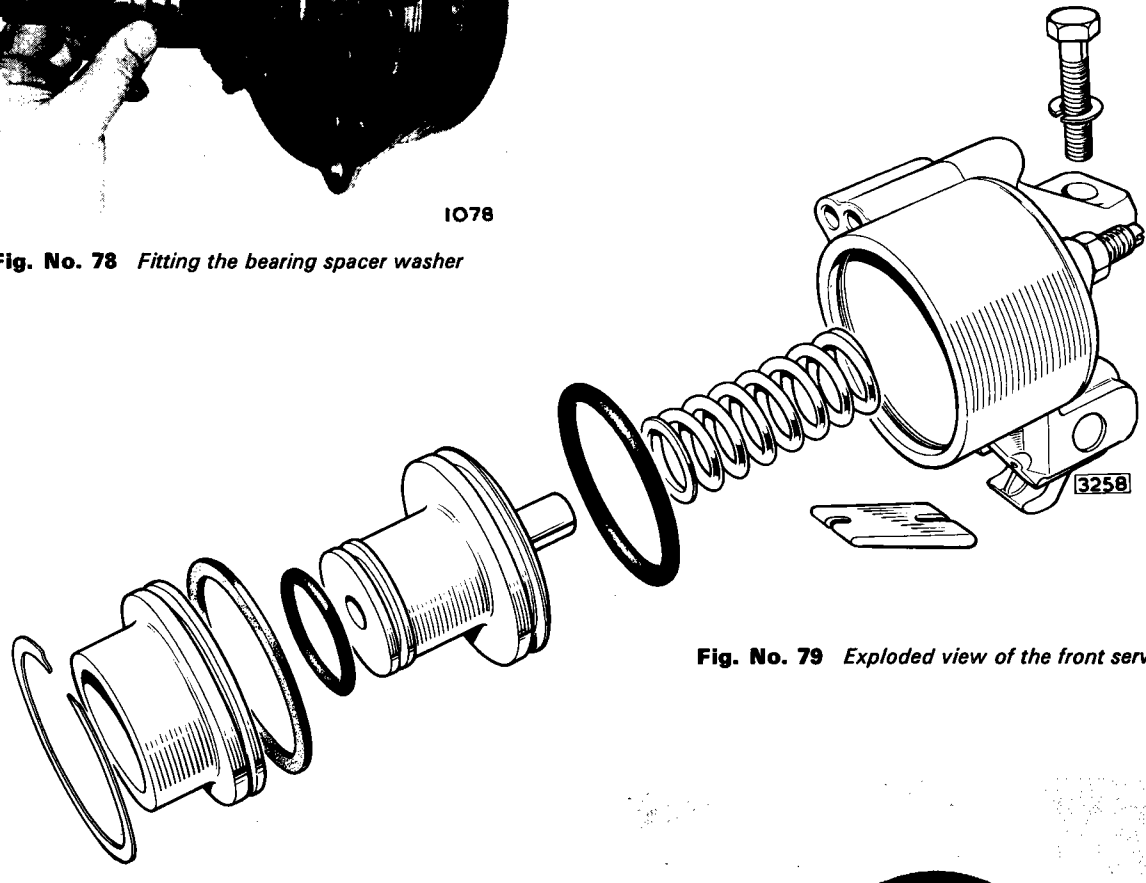


Fig. No. 79 *Exploded view of the front servo*

Front Servo — Dismantling
Use a small screwdriver to remove the snap ring. (Fig. 80).
Pull the sleeve and piston from the servo body.
Remove the piston from the servo sleeve.
Remove all sealing rings.
If the servo lever needs attention, it may be removed by first driving the roll pin from the servo and then removing the pivot pin and lever. Use a $\frac{1}{8}$" (3.1 mm.) drift punch to remove the roll pin.
Inspect the servo parts for cracks, scratches and wear.
Check the adjusting screw for freedom in the lever.
Check the lever for freedom of movement.

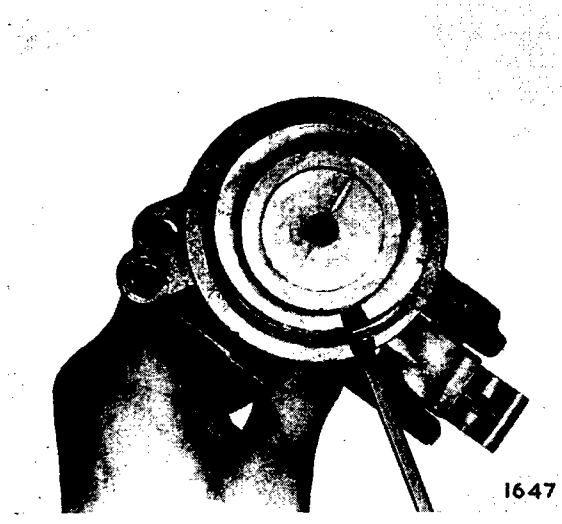


Fig. No. 80 *Removing the snap ring*

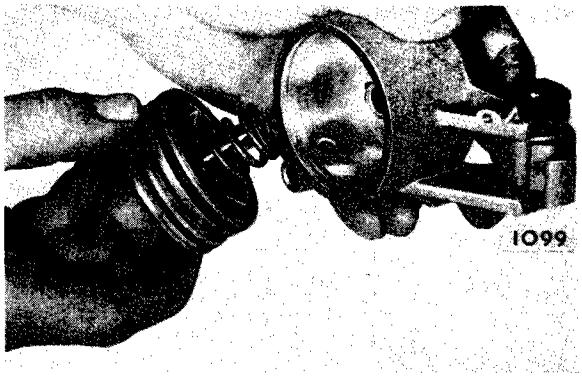


Fig. No. 81 *Assembling the front servo*

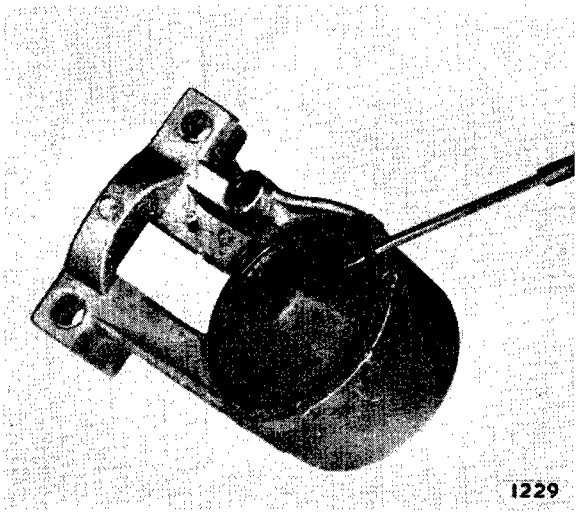


Fig. No. 83 *Removing the rear servo snap ring*

Rear Servo — Dismantling

Remove the actuating lever roll pin with a $\frac{1}{8}$" (3.1 mm.) drift punch (Fig. 82).
Remove the lever and shaft.
Depress the spring retainer while removing the snap ring (Fig. 83).
Remove the servo release spring, piston and rubber "O" ring.
Inspect the servo body for cracks, burrs and obstructed passages and the piston bore and stem for scores. Inspect the actuating lever and shaft for wear and brinnelling.

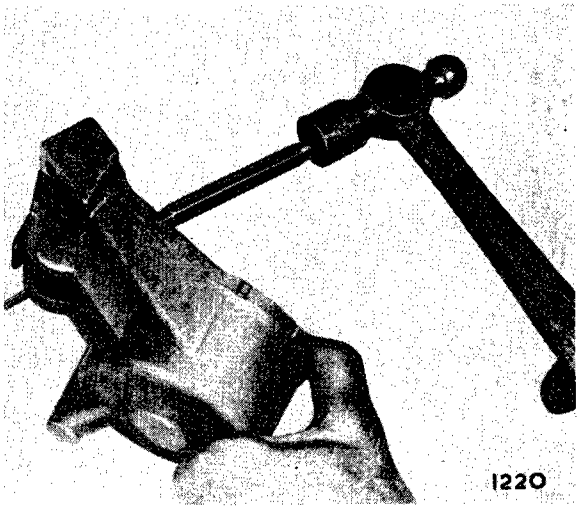


Fig. No. 82 *Removing the rear servo roll pin*

Rear Servo — Assembling

Lubricate all parts of the servo with transmission fluid before starting assembly.
Install a new "O" ring and then install piston in the servo body.
Install the release spring, retainer and snap ring.
Replace the servo lever, shaft and roll pin (Fig. 84).

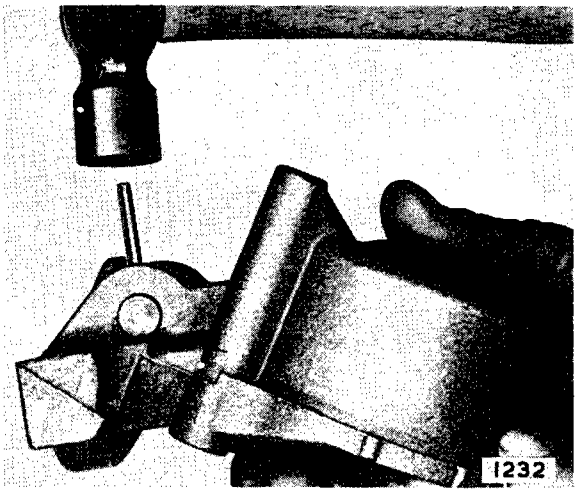


Fig. No. 84 *Replacing the roll pin*

Pressure Regulator

Remove the valves from the regulator body. Remove the regulator body cover attaching screws and remove the cover. Remove the separator plate from the regulator body.

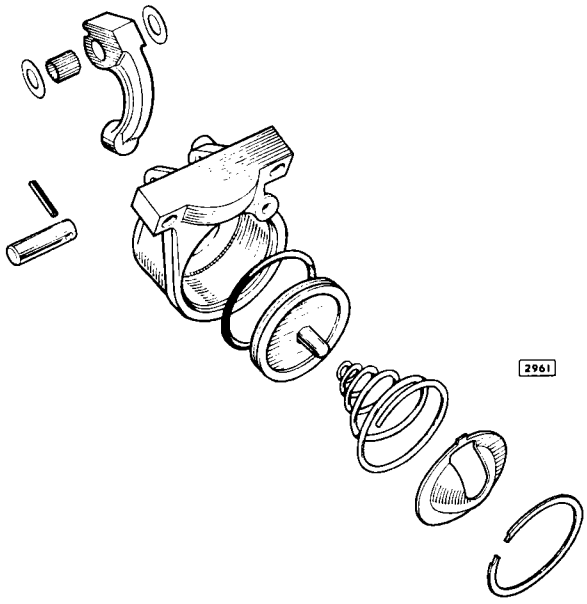


Fig. No. 85 *Exploded view of the rear servo*

Wash all parts thoroughly in cleaning solvent and dry with compressed air. Inspect the regulator body and cover mating surfaces for burrs. Check all fluid passages for obstructions. Inspect the control pressure and converter pressure valves and bores for burrs and scores. Remove all burrs carefully with crocus cloth. Check free movement of the valves in their respective bores. The valves should fall freely into the bores when both the valve and bore are dry. Inspect the valve springs for distortion.

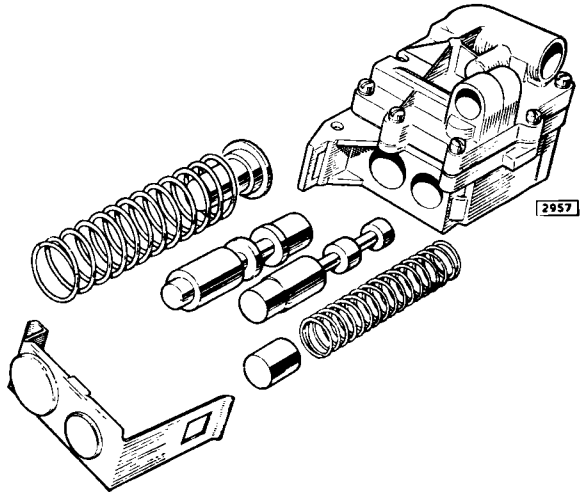


Fig. No. 86 *Regulator assembly. Valves, springs and retainer shown exploded*

When assembling, be careful to avoid damaging the parts. Replace the separator plate and then the cover on the regulator body. Install and torque the attaching screws to 20-30 lb. in. (0.24-0.35 kgm.).
Insert the valves in the pressure regulator body.

Valve Body — Dismantling
During dismantling of the control valve assembly, avoid damage to the valve parts and keep the parts clean. Place the valve parts and the assembly on a clean surface while performing the dismantling operation.
Remove the manual valve from the upper valve body.
Remove the four cap screws that retain the valve bodies.
Remove the cover and separator plates from the valve bodies. The body plate is attached to the lower valve body by a cheese head screw and to the upper valve body by a cheese head and a flat head screw. The separator plate and the lower valve body cover are held together by two cheese head screws.
Remove the front upper valve body plate retained by two screws. Remove the compensator valve plug, sleeve, springs and valve. Remove the modulator valve and spring assembly. The outer spring is retained to the modulator valve by a stamped retainer. The spring may be removed by tilting and pressing outward on the retainer.
Remove the downshift valve and spring.
Remove the rear upper valve body plate and throttle return spring retained by three screws to the body. Then remove the compensator cut back valve and the throttle valve.
Remove the four screws that retain the end body to the lower body. Remove the 2-3 shift valve inner and outer springs and the 2-3 shift valve. Remove the orifice control valve and spring and the transition valve spring and valve. Remove the orifice control valve plug and the 2-3 shift valve plug from end body. The end body plate should be removed for cleaning the end body.
Remove the four cheese head screws that retain the lower valve body side plate. Remove the 2-3 governor plug, the D1 and D2 control valve spring and valve.
The rear pump check valve, spring and sleeve generally should not be removed. The sleeve may be removed with snap ring pliers, if necessary.
Remove the end plate from the lower valve body cover. Then remove the 1-2 shift valve and spring and the front servo release orifice valve and spring.
Note: When removing all plates, be sure to hold the plates until screws are removed and release slowly as they are spring loaded.

Inspection
Clean all parts thoroughly in a cleaning solvent, then dry them with compressed air. Inspect all fluid passages for obstructions. Inspect the check valve for free movement. Inspect all mating surfaces for burrs and distortion. Inspect all plugs and valves for burrs and scores.
Note: Crocus cloth can be used to polish the valves and plugs if care is taken to avoid rounding the sharp edges.

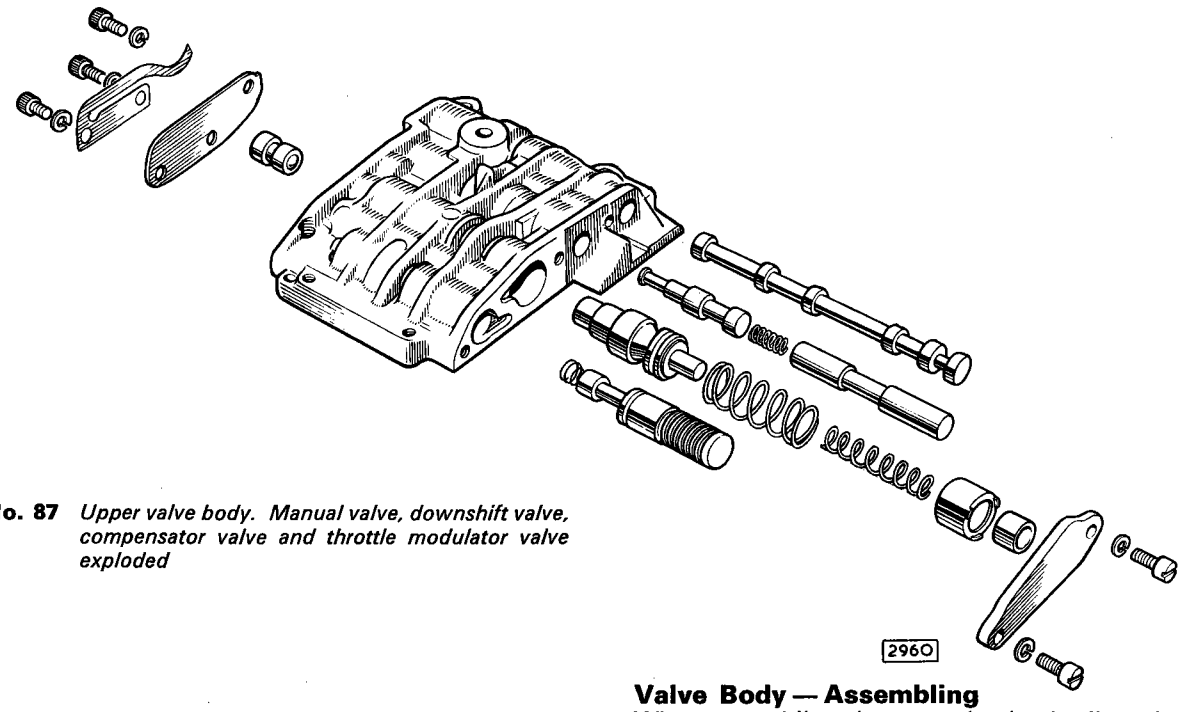


Fig. No. 87 *Upper valve body. Manual valve, downshift valve, compensator valve and throttle modulator valve exploded*

Valve Body — Assembling

When assembling the control valve bodies, always use the following procedure:

Install the valve body plate on the upper valve body (retained by one cheese head and one flat head screw). Do not tighten the screws. If the rear pump check valve sleeve, valve and spring were removed from the lower valve body, install them, carefully staking the sleeve in the bore with the smooth end against the valve.

Place the upper body on the lower body and install the cheese head screw, but do not tighten the screw.

Place the lower valve body separator plate and cover on the lower valve body and install the two cheese head screws, leaving them loose.

Install the four cap screws and lockwashers; torque the four screws to 72 lb. in. (.84 kgm.), then tighten the cheese head screws and flat head screw to 20-30 lb. in. (0.23-0.35 kgm.).

Try all valves dry in their respective bores, rotating them to make sure that they are free before final assembly in the valve body. If any sticking or binding occurs, the valve bodies will have to be separated and each surface lapped on crocus cloth, using a surface plate or a glass

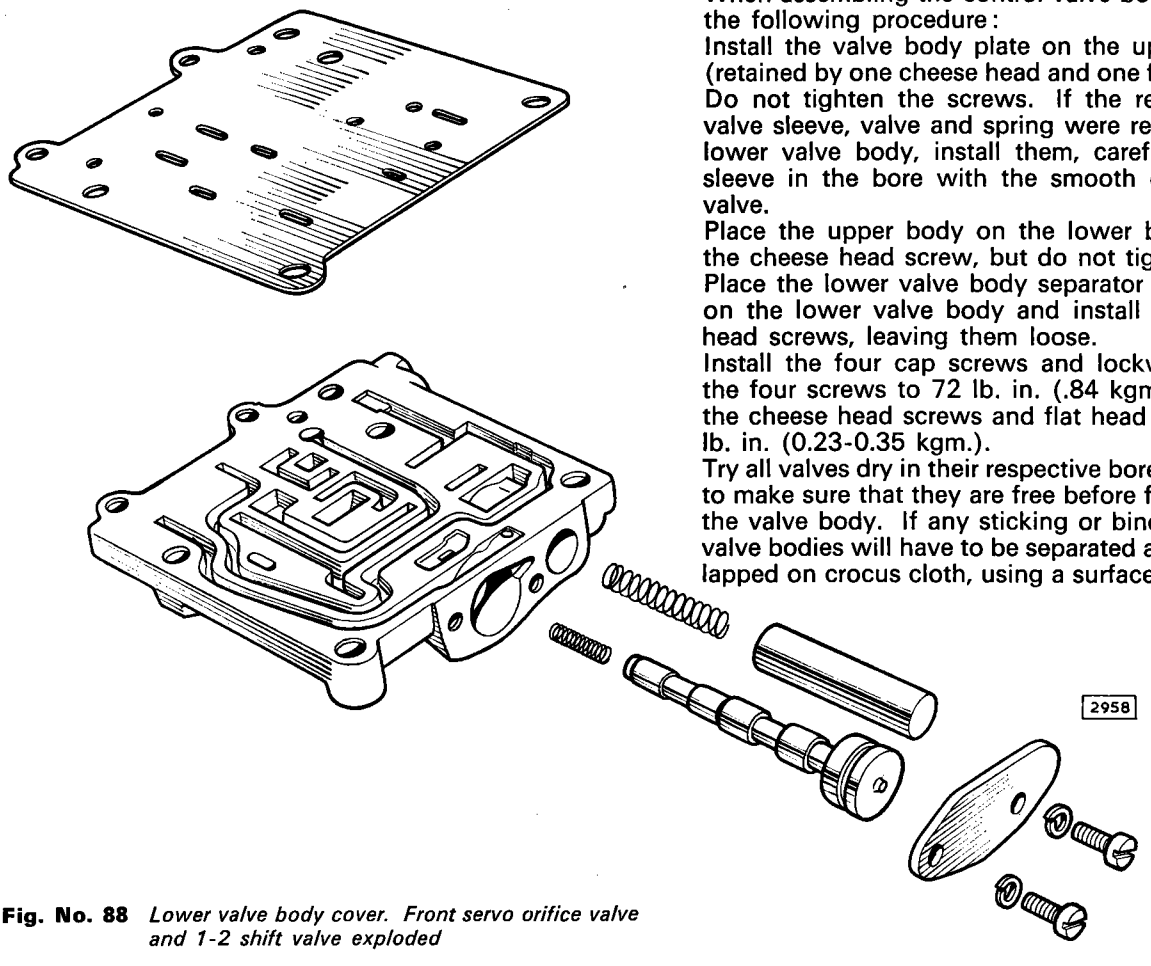


Fig. No. 88 *Lower valve body cover. Front servo orifice valve and 1-2 shift valve exploded*

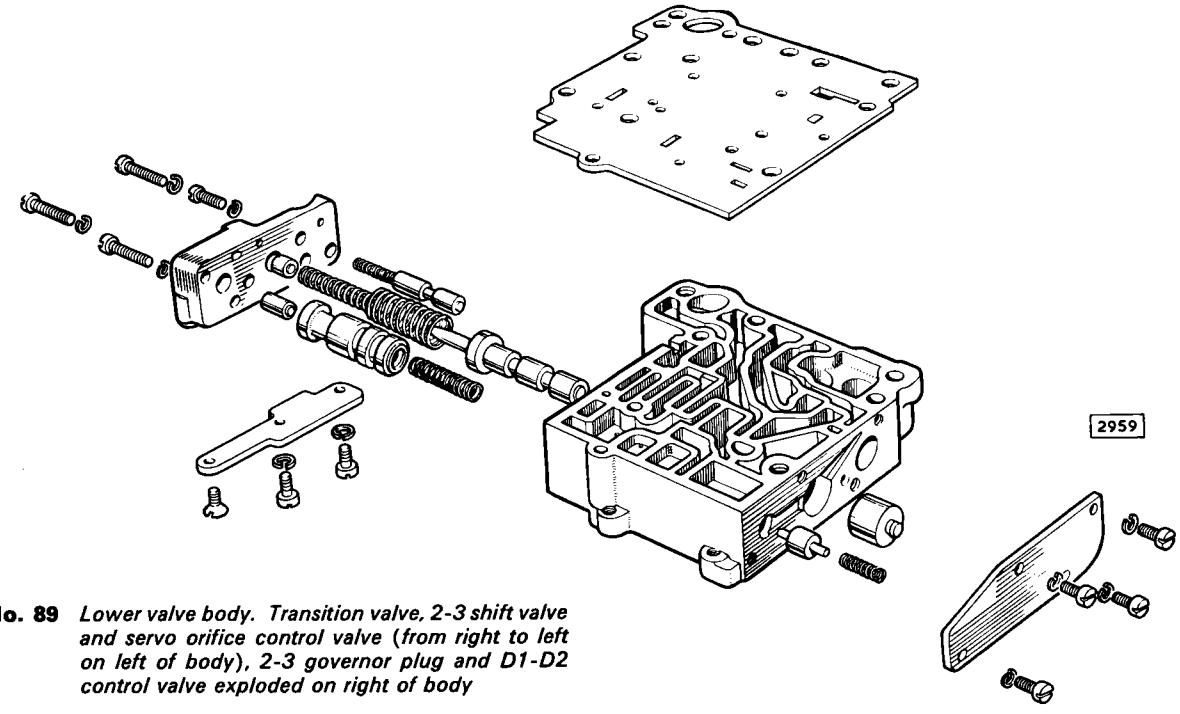


Fig. No. 89 *Lower valve body. Transition valve, 2-3 shift valve and servo orifice control valve (from right to left on left of body), 2-3 governor plug and D1-D2 control valve exploded on right of body*

plate, to ensure against low or high spots or a warped condition.

Note: Lubricate all valves and plugs with automatic transmission fluid before final assembly in their respective bores.
Install the 1-2 shift valve spring and valve in the lower valve body cover. Install the front servo release orifice valve spring and valve and the cover end plate with two cheese head screws.
Install the range control valve and spring, the governor plug, and then install the side plate with four cheese head screws.

Install the orifice control valve spring and valve, the 2-3 shift valve, the 2-3 shift valve inner and outer springs, the transmission valve, and spring in the lower valve body.
Replace the end body plate using one flat head and two cheese head screws and torque to 20-30 lb. in. (0.23-0.35 kgm.). Install the orifice control valve plug and the 2-3 shift valve plug in the lower valve body. Install the end body to the lower valve body, guiding the 2-3 shift valve inner spring into the 2-3 shift valve plug. Three long and one short special cheese head screws are used to retain the end body.

Note: Make sure the inner spring is piloted on the 2-3 shift valve plug.
Install the modulator valve and spring assembly. Install the compensator valve, compensator inner and outer springs, compensator plug and sleeve (be sure end of sleeve with the three protrusions is towards the plate and the smooth end to the spring in the upper valve body). Assemble the plate which is retained by two cheese headed screws.
Install the compensator cut-back valve in the rear end of the upper body. Install the rear plate so that the edge of the plate fits into the band of the throttle valve and install one screw to hold the rear plate in place. Install the throttle return spring and install the two remaining cheese headed screws.
Install the manual valve. Torque on all cheese headed screws should be 20-30 lb. in. (0.23 to 0.35 kgm.).

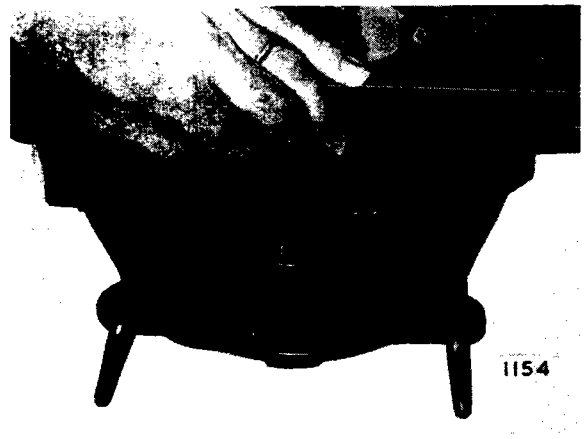


Fig. No. 90 *Fitting a front pump gasket*

TRANSMISSION ASSEMBLING

Lubricate all parts as they are assembled, with the same fluid used for filling the transmission. Petrolatum can be used sparingly to hold gaskets or thrust washers in position during assembly.

Wash the transmission case and dry with compressed air.

Install a new front pump to case gasket, then install the front pump. Torque the four attaching cap screws to 17-22 lb. ft. (2.35 to 3.04 kgm.).

Install the front band through the bottom of the case, positioning the band so that the anchor end is aligned with the anchor in the case.

Install the front clutch, rear clutch and forward sun gear assembly in the case. Handle the clutch assemblies in a manner that will prevent the clutches being pulled apart.

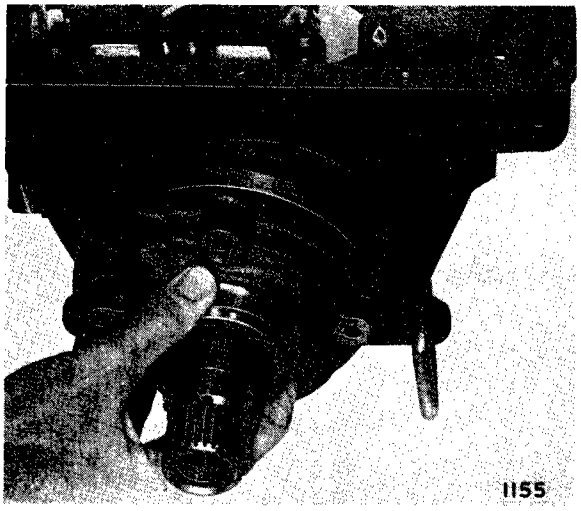


Fig. No. 91 *Installing the front pump*

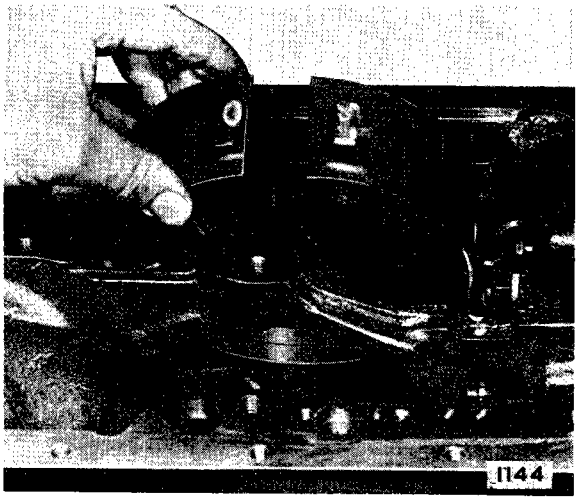


Fig. No. 92 *Installing the front band*

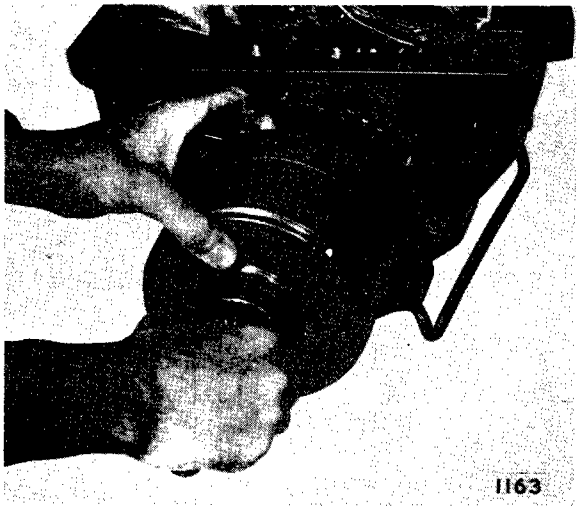


Fig. No. 93 *Installing the front clutch, rear clutch and forward sun gear*

Install the centre support in the transmission case with the three positioning holes aligned with the holes in the case.

Install the centre support cap screws with the rolled edge of each lockwasher towards the case. Torque to 20-25 lb. ft. (2.76 to 3.46 kgm.).

Install the rear band through the rear of the case. Be sure that the end with the depression or dimple is placed toward the adjusting screw.

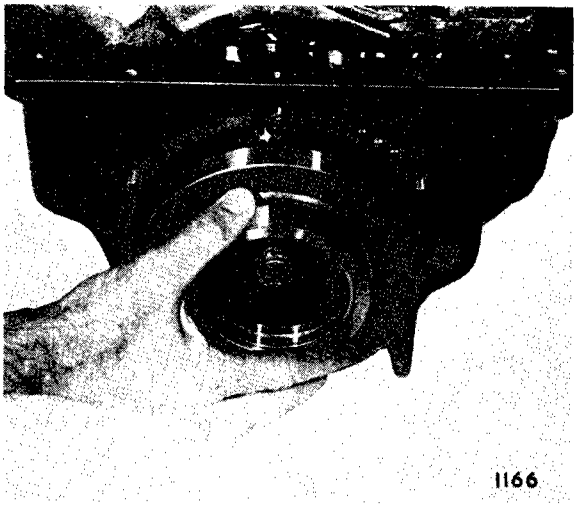


Fig. No. 94 *Installing the centre support*

Use petrolatum sparingly to hold the forward sun gear thrust plate and needle bearing in the planet carrier, while the carrier is assembled over the sun gear.

Install the hook type seal rings on the rear of the forward sun gear. Check the rings for free movement in their grooves.

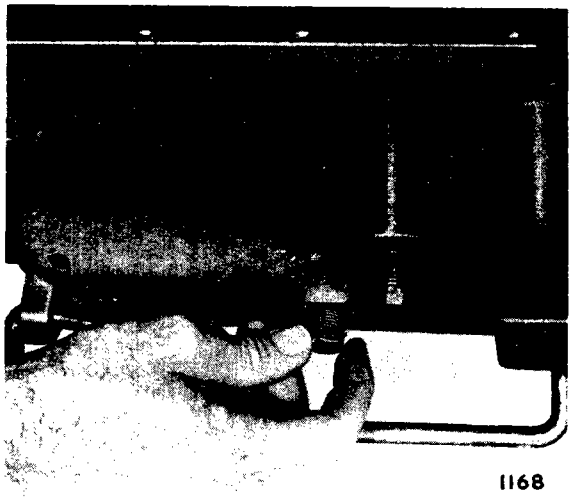


Fig. No. 95 *Fitting the centre support cap screws*

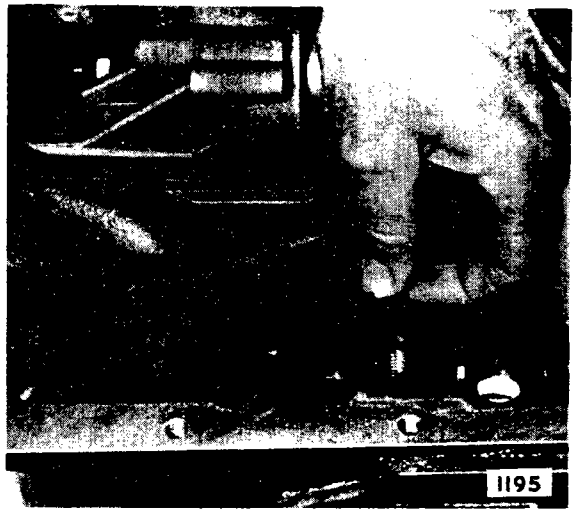


Fig. No. 96 *Fitting the rear band*

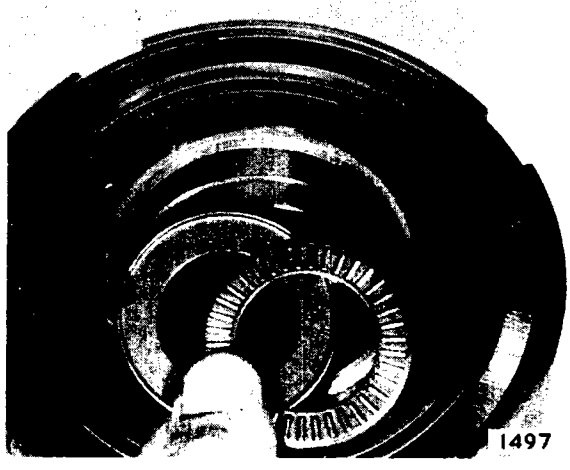


Fig. No. 97 *Fitting the thrust plate and needle bearing*

Choose a selective washer to give the correct end play (end play determined during dismantling is used to determine the need for a different thrust washer). Install washer on the rear of the planet carrier.
Use petrolatum to hold the rear pump to case gasket to rear of the case.
Install the ring gear and output shaft assembly. Align the three oil tubes as the assembly is fitted and tap them in position.
Place the rear pump to extension housing gasket in position, then assemble the extension housing. Torque the five extension housing cap screws to 28-33 lb ft. (3.87 to 4.56 kgm.).
Install the bearing snap ring, and then tap the ball bearing into position in the extension housing and on the output shaft (be sure spacer washer is on shaft ahead of bearing).
Slide the speedometer drive gear on the output shaft. Install rear seal in bearing retainer. Assemble the bearing retainer in its gasket.
Install the companion flange, flat washer, lockwasher and nut. Torque the nut to 90-120 lb. ft. (12.44-16.58 kgm.).

Fig. No. 98 *Assembling the carrier over the sun gear*

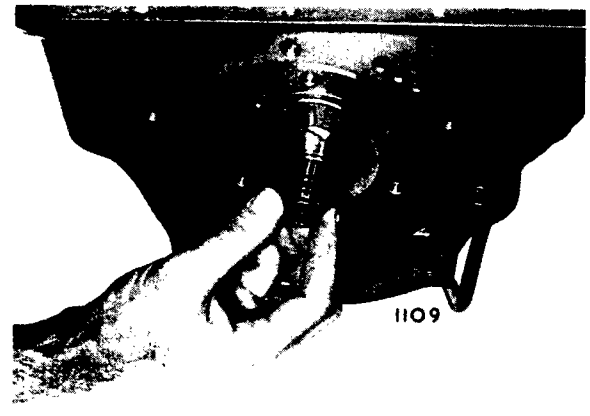


Fig. No. 99 *Fitting the sealing rings*

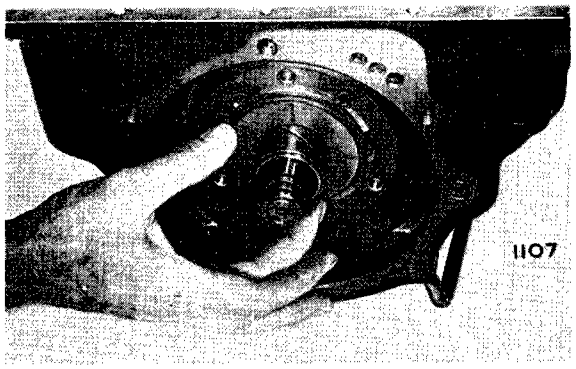


Fig. No. 100 *Fitting washer on rear of planet carrier*

Front Servo Installation

Rotate the front band into position so that the anchor end is positioned over the anchor pin in the case.
Position the servo strut with the slotted end aligned with the servo actuating lever, and hold it in position with the middle and index fingers of the left hand.
Engage the end of the band with the small end of the strut then position the servo over the dowel pin.
Install the attaching cap screw but do not screw it in more than two or three threads at this time.

Rear Servo Installation

Position the servo anchor strut over the adjusting screw, then rotate the rear band to engage this strut.
Place the servo actuating lever strut with the notched end to the band and lift the other end with index finger or screwdriver, while locking the servo lever over the strut.
Install the long pointed bolt in the forward servo hole so that it will engage the centre support.
The other shorter bolt is used in the rear position.
Torque the bolts to 40-50 lb. ft. (5.53-6.91 kgm.).

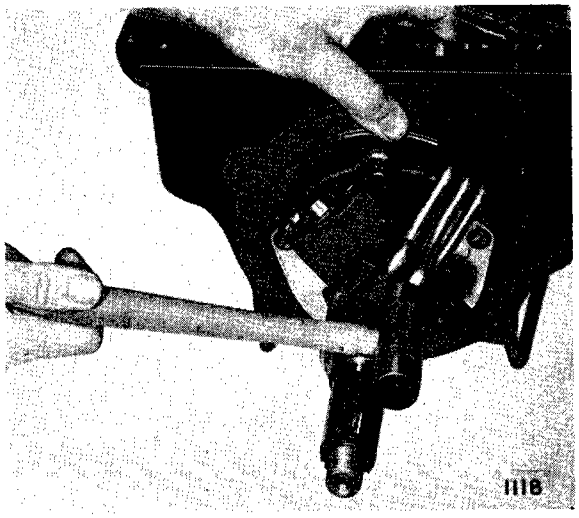


Fig. No. 101 *Tapping the output shaft assembly into position*

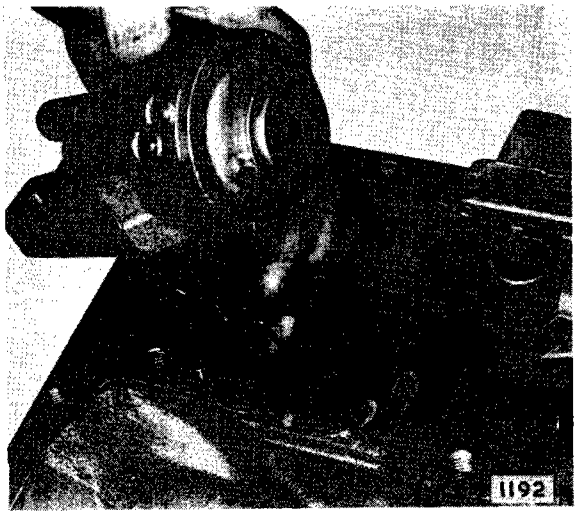


Fig. No. 102 *Installing the front servo*

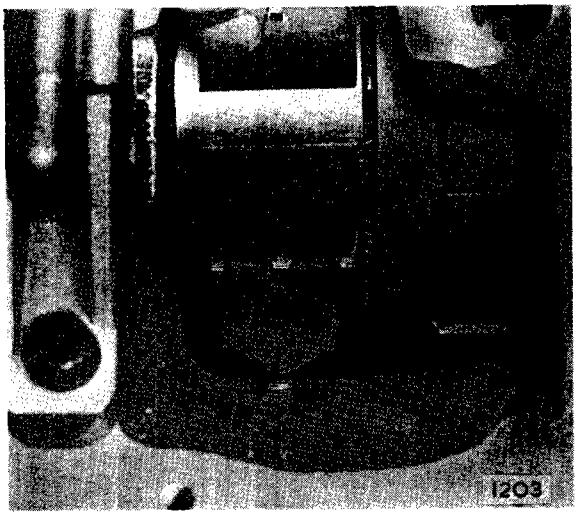


Fig. No. 103 *Engaging the servo anchor strut*

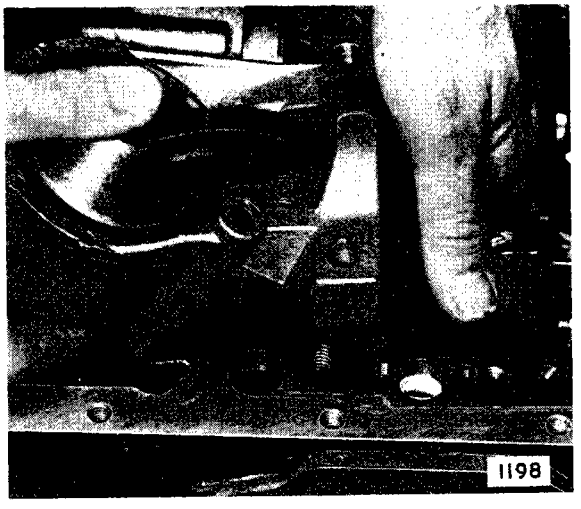


Fig. No. 104 *Fitting the rear servo*

Valve Body Installation
Place the manual selector in park or reverse position. Carefully align the valve body with the servo tubes and gently slide the valve body further onto the tubes.
The front servo must be pulled up off the dowel to allow easy assembly. Be careful at this point — the servo apply strut may become disengaged from the servo. Before seating the valve body on the case, install the nipple end of the throttle cable into the throttle cam.
Next, align the manual valve with the inside lever pin and the valve body will then drop into position. Torque the three valve body attaching cap screws to 8-10 lb. in. (0.09-0.12 kgm.).

Torque the front servo attaching cap screw to 30-35 lb. ft. (4.15-4.84 kgm.) and adjust the front servo.
Replace the control pressure tube, by first assembling the long straight end into the regulator, then rocking the tube downward into the control valve body. If too much resistance is encountered, it will help to loosen the control body attaching cap screws until the tube can be assembled.

Pressure Regulator Installation
Assemble the regulator, with the valves in position in their bores, to the case with the attaching cap screws. Torque cap screws to 17-22 lb. ft. (2.35-3.04 kgm.).

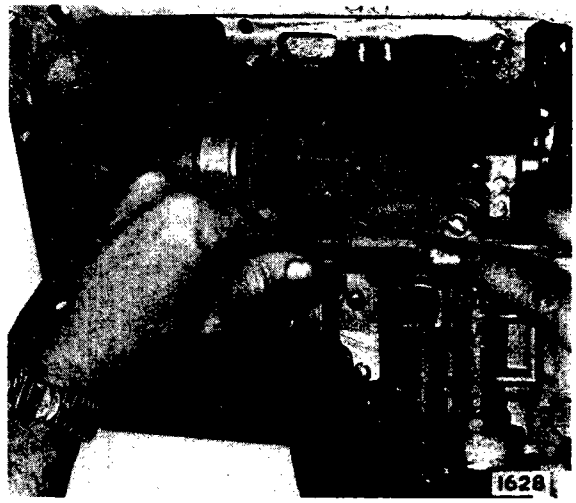


Fig. No. 105 *Fitting the servo tubes*

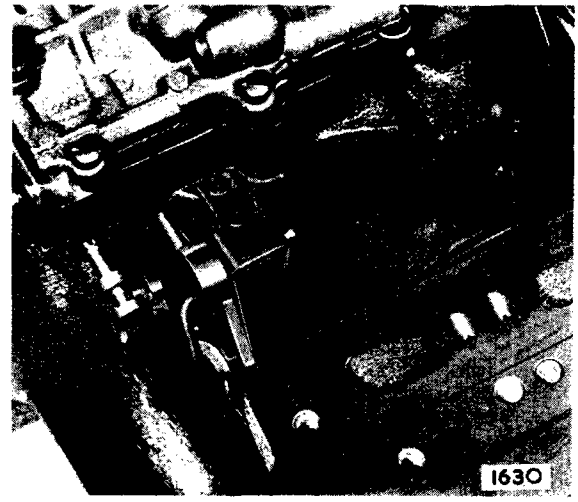


Fig. No. 107 *The valve body in position*

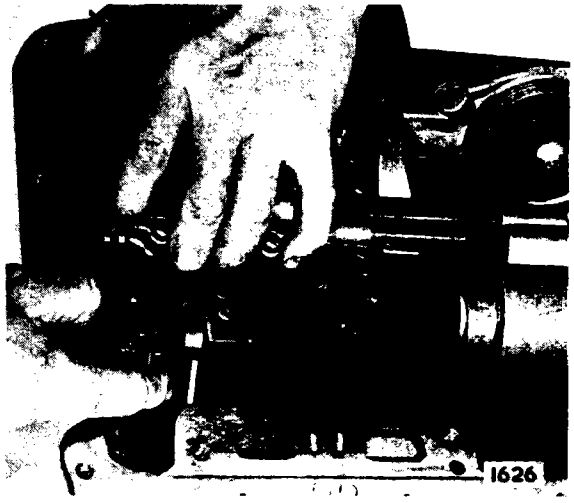


Fig. No. 106 *Positioning the valve body*

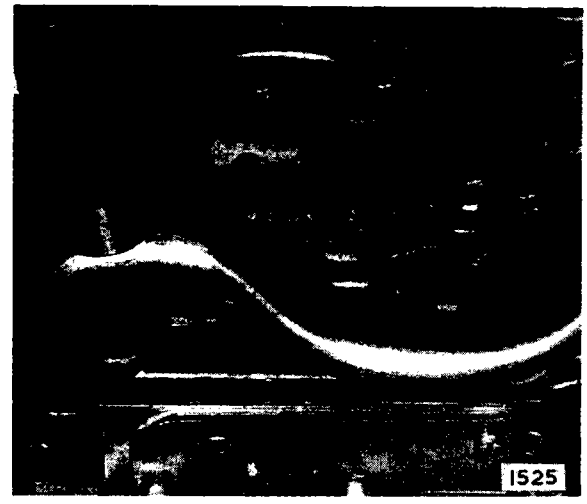


Fig. No. 108 *Replacing the control pressure tube*

Install both springs and guides, then install the spring retainer.
Install the front servo apply and release tubes in the servo.

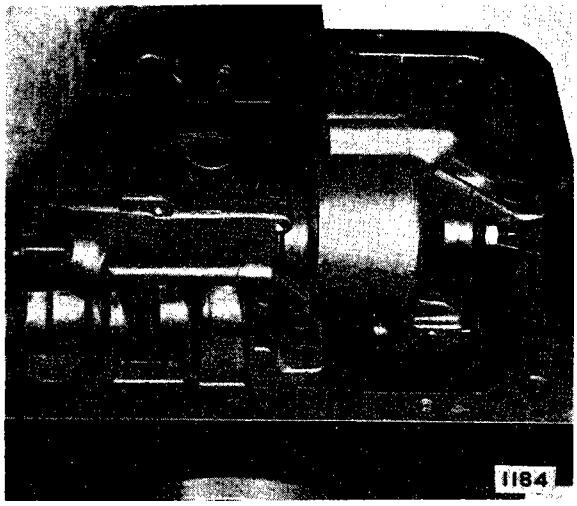


Fig. No. 109 *The pressure regulator installed*

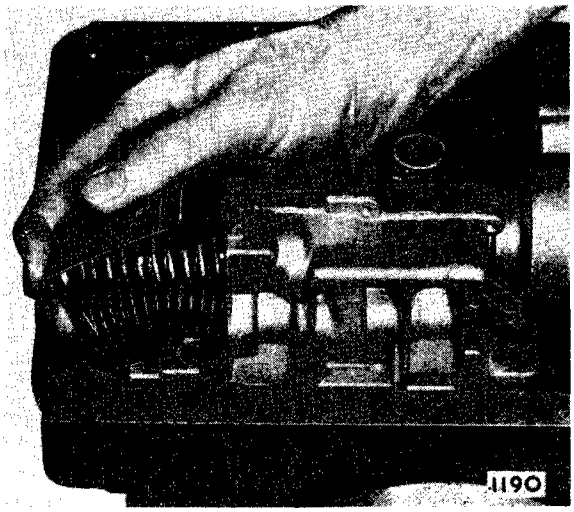


Fig. No. 110 *Fitting the pressure regulator springs*

Install the rear pump inlet and outlet tubes, using new "O" rings.
Replace the compensator tube by aligning one end with the pressure regulator and the other end with the control valve body and then tap it into position.
Assemble the long end of the lubrication tube into the rear pump, then rock the other end into position and tap it into the pressure regulator assembly.

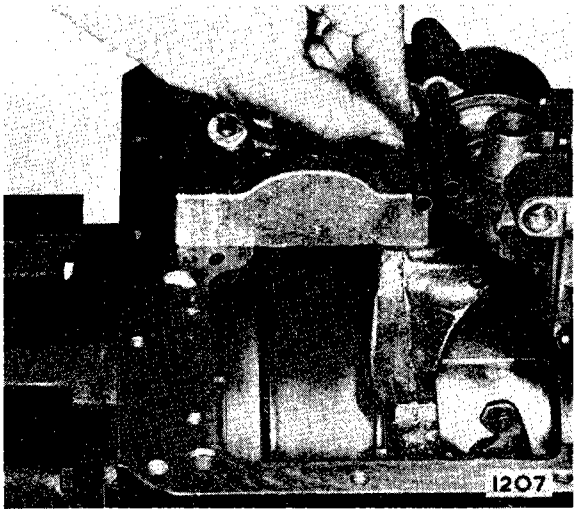


Fig. No. 111 *Fitting apply and release tubes*

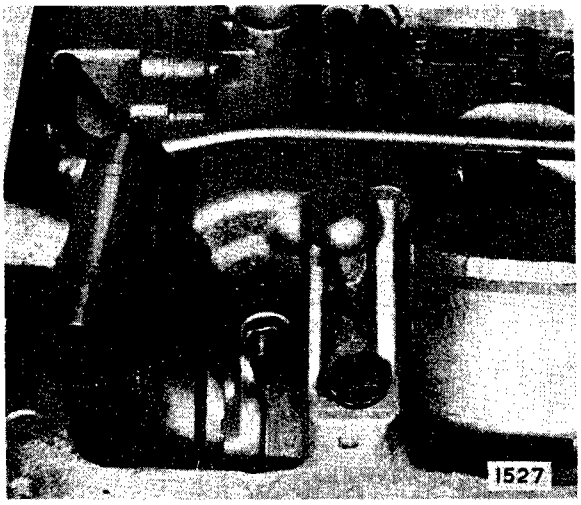


Fig. No. 112 *Fitting the lubrication tube*

Replace the front band lubrication tube. Be sure the tube is aligned so that the open end will direct oil onto the front drum surface at the front band gap. Tube should point at approximately the centre of the gap.
Assemble the oil screen assembly onto the rear pump inlet tube and then rock into position over the front pump inlet on the pressure regulator assembly. Hook the screen retainer under the lubrication tube, lay across screen, and snap onto compensator tube.
Install the oil pan gasket, the oil pan and torque, the 14 cap screws to 10-20 lb. ft. (1.38-2.76 kgm.).
Adjust the rear band.

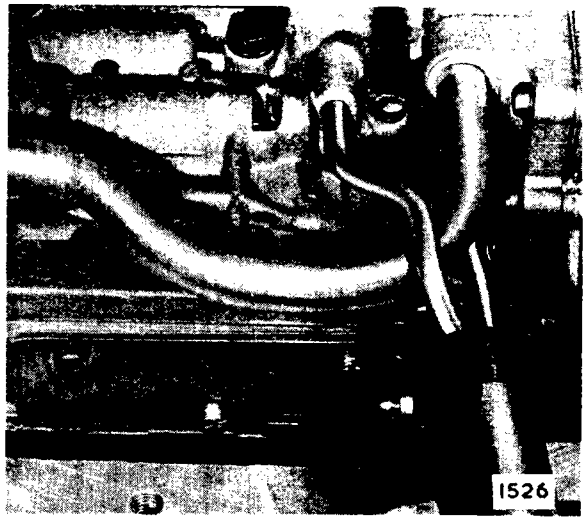


Fig. No. 113 *Fitting the compensator tube*

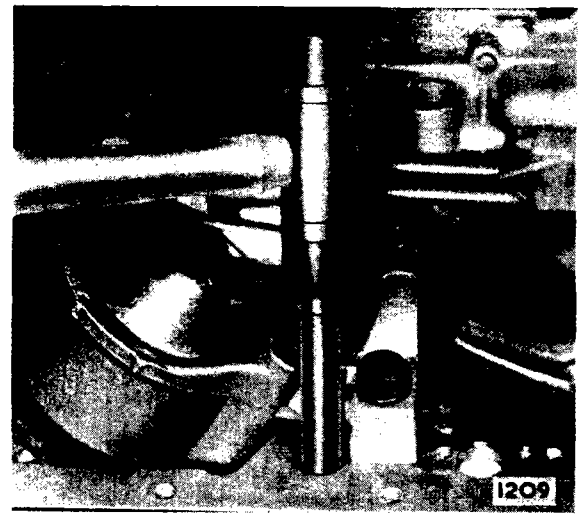


Fig. No. 114 *Fitting the rear pump inlet tube*

CONVERTER AND CONVERTER HOUSING

When installing the converter housing, the maximum allowable runout should not exceed 0.010" (0.25 mm.) for bore or face indicator readings relative to crankshaft centre line; however, it is preferable to have less than 0.006" (0.015 mm.) reading for both.

When installing the transmission to the converter housing and converter assembly, be certain that the converter lugs are properly aligned with the front pump drive gear, so that the parts will not be damaged by forcing impeller hub drive tangs against the pump drive gear lugs.

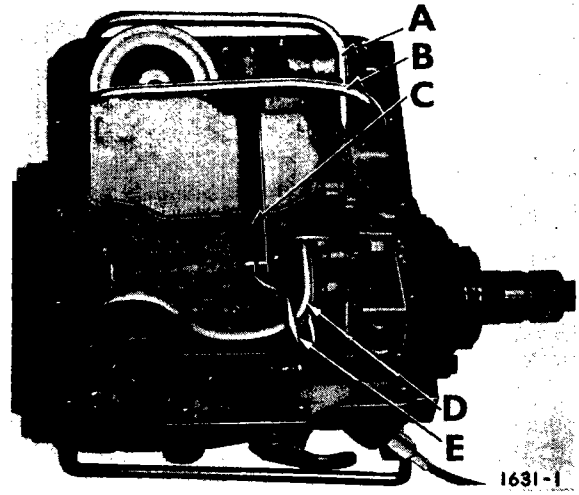


Fig. No. 115 *View of the Model 8 Transmission unit inverted with the oil pan removed showing tube location*

A Front brake band oil tube
B Rear pump to regulator oil tube
C Retaining clip
D Control pressure oil tube
E Compensator oil tube

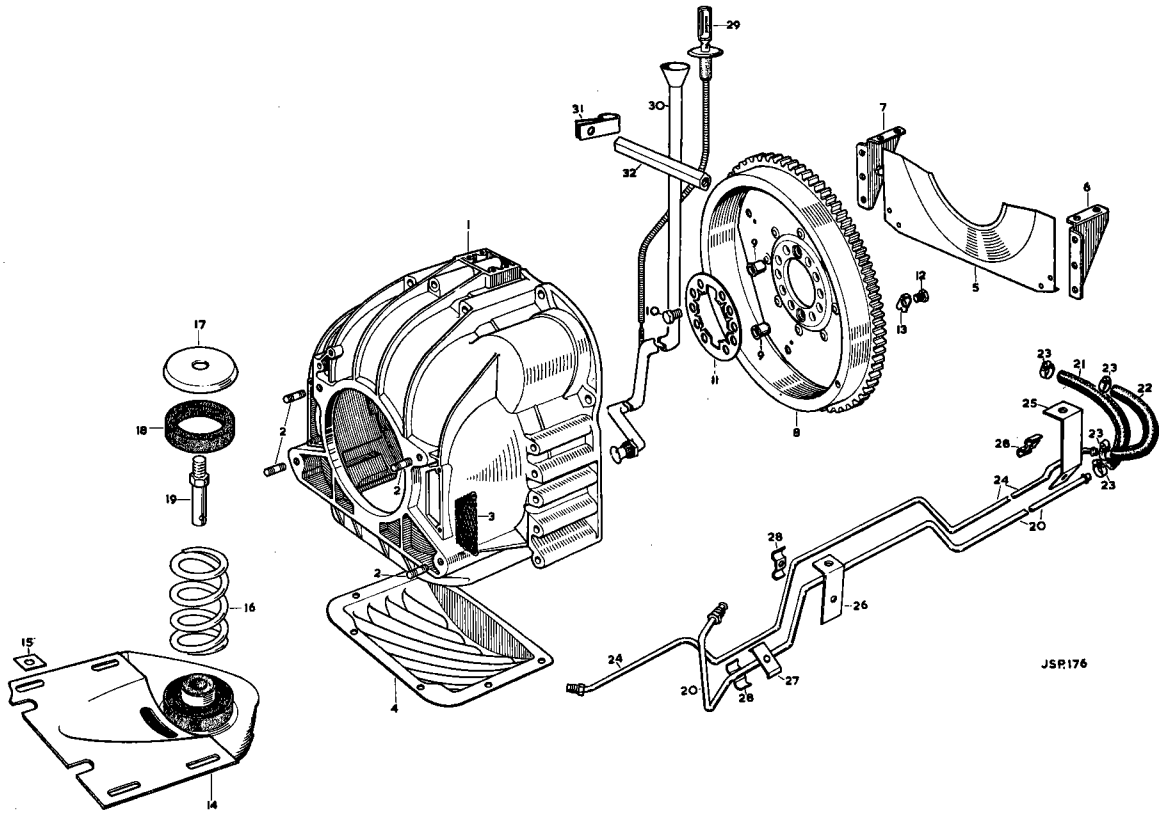


Fig. No. 116 *Exploded view of the converter housing and transmission mounting*

1 Converter housing	**17** Retainer
2 Stud	**18** Spring seat
3 Stoneguard	**19** Pin
4 Bottom cover	**20** Cooler pipe (outlet)
5 Front cover	**21** Flexible hose
6 Support bracket, R.H.	**22** Flexible hose
7 Support bracket, L.H.	**23** Hose clip
8 Drive plate	**24** Oil return pipe
9 Dowel	**25** Bracket
10 Setscrew	**26** Bracket
11 Locking plate	**27** Clamp
12 Screw	**28** Clip
13 Tab washer	**29** Dipstick
14 Mounting bracket	**30** Dipstick tube
15 Spacer	**31** Clip
16 Coil spring	**32** Support bar

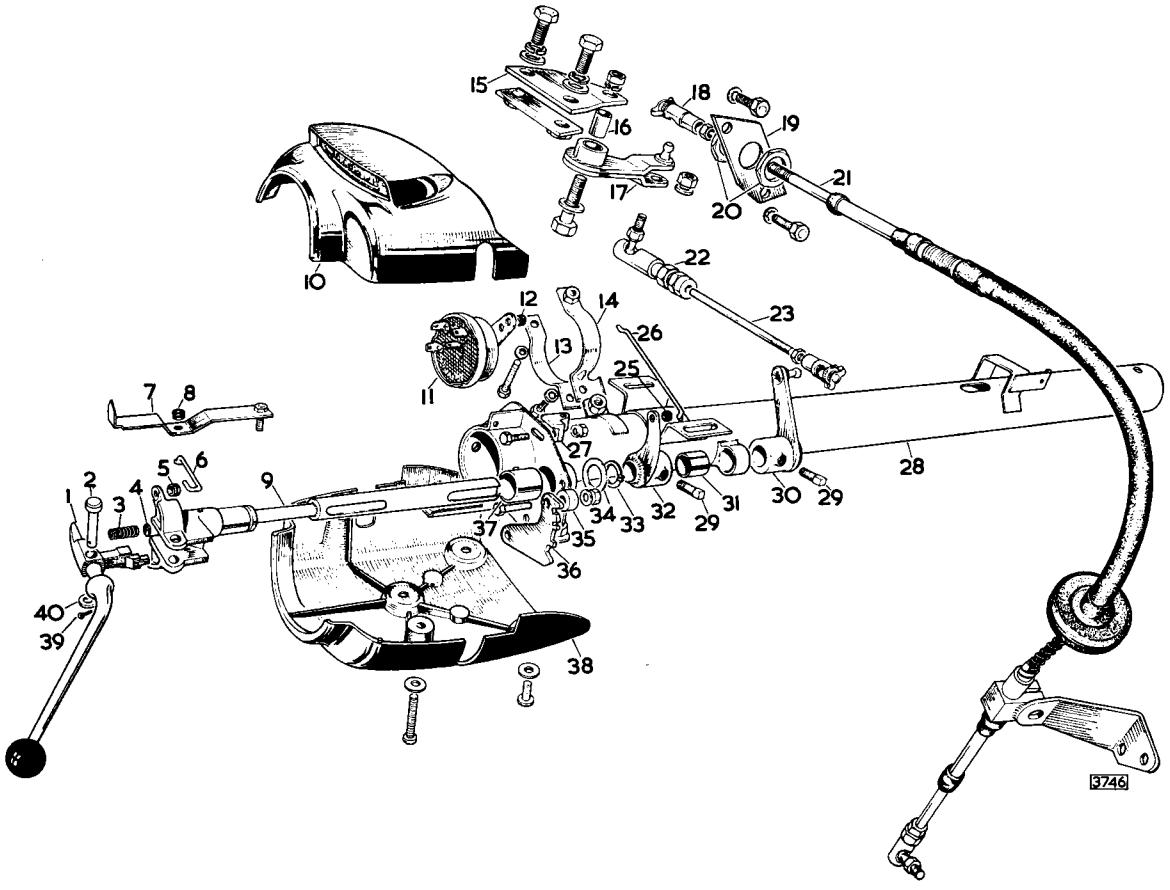


Fig. No. 117 *The automatic transmission controls*

1 Selector lever
2 Pin
3 Spring
4 Shim
5 Grommet
6 Link
7 Indicator arm
8 Grommet
9 Housing and shaft assembly
10 Upper switch cover
11 Inhibitor switch
12 Grommet
13 Lower half clip
14 Upper half clip
15 Mounting bracket
16 Distance piece
17 Transfer lever
18 Ball joint
19 Abutment plate
20 Nut
21 Control cable
22 End fitting
23 Link
25 Grommet
26 Link
27 Bracket
28 Column outer tube
29 Lock screw
30 Lever
31 Bush
32 Switch operating lever
33 Circlip
34 Washer
35 Spacer
36 Gate
37 Bush
38 Lower switch cover
39 Split pin
40 Washer

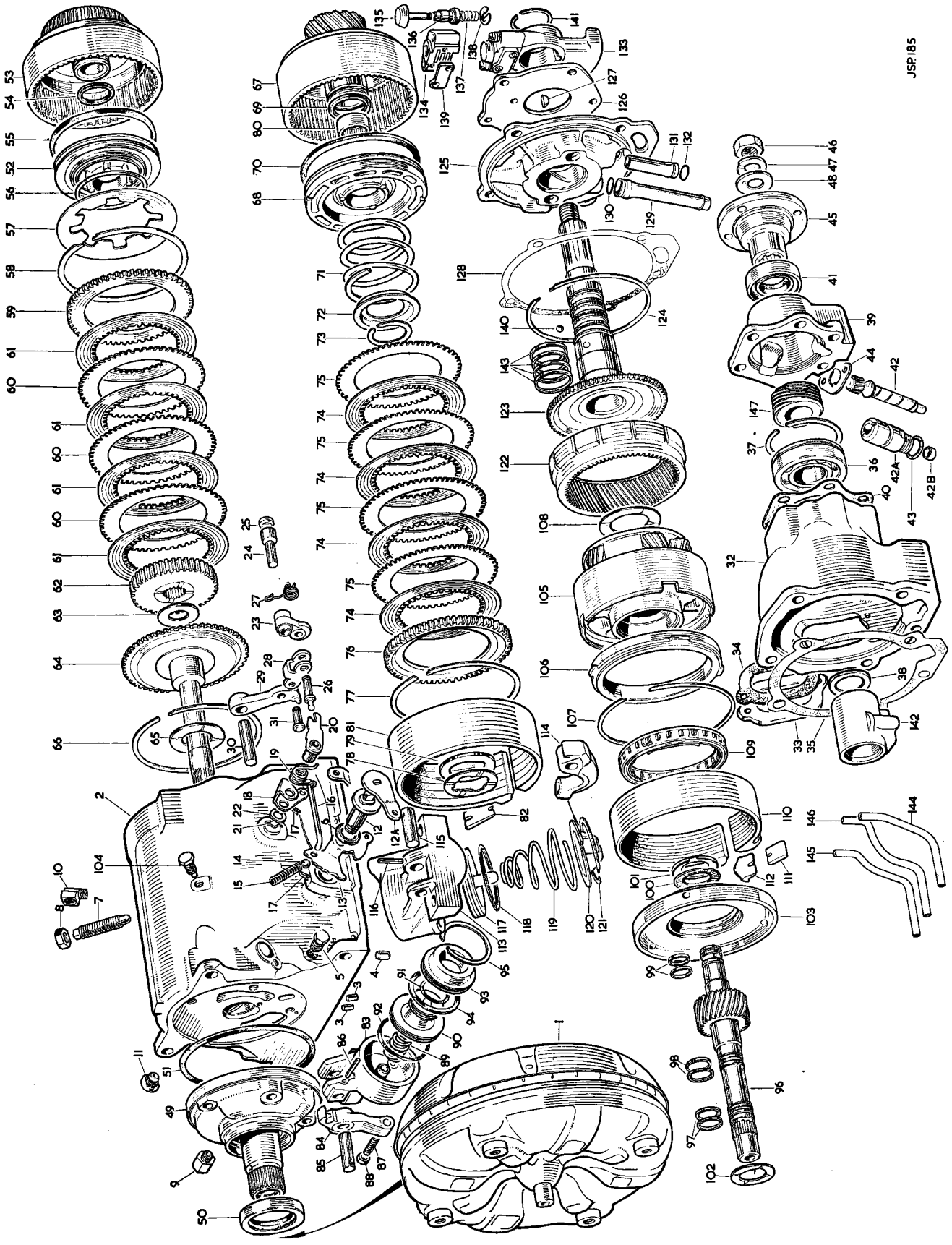


Fig. No. 118 *Exploded view of the Model 8 transmission unit*

1 Converter
2 Transmission case
3 Plug
4 Dowel
5 Plug
6 Oil seal
7 Screw
8 Nut
9 Union
10 Union
11 Breather
12 Manual control
13 Lever
14 Ball
15 Spring
16 Link
17 Clip
18 Torsion lever
19 Spring
20 Forked lever
21 Clip
22 Washer
23 Toggle lever
24 Toggle pin
25 Plug
26 Ball pin
27 Spring
28 Link
29 Pawl
30 Pivot pin
31 Pin
32 Extension case
33 Cover plate
34 Gasket
35 Gasket
36 Bearing
37 Snap ring
38 Spacing washer
39 Speedo driven gear housing
40 Gasket
41 Oil seal
42 Speedo driven gear
43 "O" ring
44 Plate
45 Flange
46 Nut
47 Lockwasher
48 Special washer
49 Front pump
50 Oil seal
51 Sealing ring
52 Piston
53 Cylinder
54 Sealing ring
55 Sealing ring
56 Split ring
57 Spring
58 Snap ring
59 pressure plate
60 Clutch plate
61 Clutch plate
62 Hub
63 Thrust washer
64 Input shaft
65 Thrust washer
66 Snap ring
67 Front drum
68 Piston
69 Sealing ring (inner)
70 Sealing ring (outer)
71 Spring
72 Spring seal
73 Snap ring
74 Clutch plate (friction)
75 Clutch plate (drive)
76 Pressure plate
77 Snap ring
78 Thrust washer
79 Thrust washer
80 Needle bearing
81 Brake band (front drum)
82 Servo strut
83 Front servo body
84 Lever
85 Pivot pin
86 Roll pin
87 Screw
88 Nut
89 Return spring
90 Piston
91 "O" ring (small)
92 "O" ring (large)
93 Piston sleeve
94 Sealing ring
95 Snap ring
96 Forward sun gear
97 Sealing ring (front)
98 Sealing ring (centre)
99 Sealing ring (rear)
100 Thrust bearing
101 Thrust bearing race
102 Thrust washer (bronze)
103 Centre support
104 Screw
105 Planetary gears and drum
106 Outer race
107 Snap ring
108 Thrust washer
109 One-way clutch
110 Brake band (rear drum)
111 Servo strut
112 Anchor strut
113 Body (rear servo)
114 Lever
115 Shaft
116 Roll pin
117 Piston
118 "O" ring
119 Return spring
120 Plate
121 Snap ring
122 Ring gear
123 Main shaft
124 Snap ring
125 Rear pump
126 Plate
127 Key
128 Gasket
129 Oil inlet tube
130 "O" ring
131 Oil outlet tube
132 "O" ring
133 Governor
134 Governor body
135 Governor weight
136 Governor valve
137 Spring
138 Retainer
139 Cover plate
140 Ball
141 Snap ring
142 Oil collector sleeve
143 Piston ring
144 Oil collector tube (front)
145 Oil collector tube (intermediate)
146 Oil collector tube (rear)
147 Speedometer drive gear

PROPELLER SHAFT

SECTION G

INDEX

PROPELLER SHAFT

DESCRIPTION

All models are fitted with a fixed length propeller shaft with a universal joint at each end and a sliding spline, encased in a rubber gaiter, at the front end.

ROUTINE MAINTENANCE

The propeller shaft universal joints and sliding spline are of the "sealed for life" type which do not require periodic maintenance.

In the rare event of wear in the cross holes of either the yokes or flange yokes, the units must be replaced. In the case of wear in the cross holes of the fixed yoke (which is part of the shaft) the shaft must be replaced. Check for excessive movement of the splined shaft in the splined sleeve yoke. If circumferential movement, measured on the outside diameter of the spline exceeds .004" (.1 mm.), replace the complete propeller shaft.

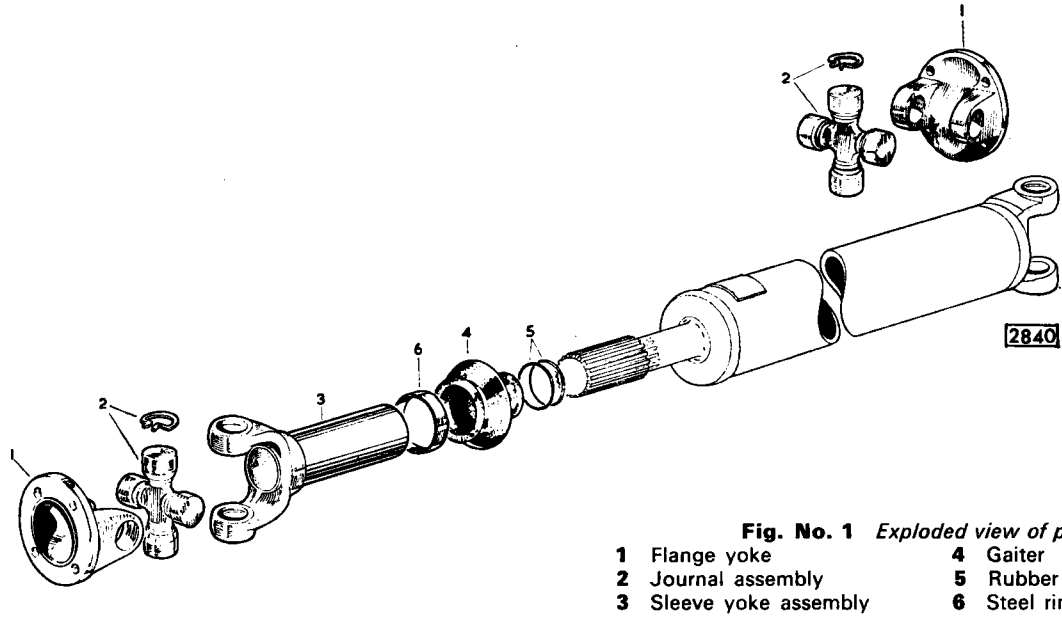


Fig. No. 1 *Exploded view of propeller shaft*

1	Flange yoke	**4**	Gaiter
2	Journal assembly	**5**	Rubber ring
3	Sleeve yoke assembly	**6**	Steel ring

Removal

Remove the rear engine mounting as described on page A.31.

Separate the propeller shaft from the gearbox and the rear axle by removing the four bolts at each attachment flange.

Compress the shaft at the sliding spline and withdraw.

Refitting

Reverse the removal procedure to refit.

UNIVERSAL JOINTS

Check for Wear

The parts most likely to show signs of wear after long usage are the bearings and the journals. Should looseness, load markings or distortion be observed, renew the complete journal assembly.

Dismantling

Release the rubber gaiter retaining ring and remove the sliding joint from the splined shaft. Clean thoroughly.

Remove the snap rings from their grooves in the yokes. If a ring does not snap out of its groove readily, tap the bearing to relieve the pressure against the ring.

Tap the yoke lug as shown in Fig. 2 with a soft nosed hammer and the top bearing will gradually emerge. It can be finally removed by hand.

If great difficulty is encountered in tapping out the bearing, it may be driven out from inside using a small diameter drift. See Fig. 3.

Repeat the operation for the opposite bearing and withdraw the yoke. Rest the two exposed trunnions on a block of wood and tap the yoke with a soft nosed hammer to remove the two remaining bearings.

Wash all parts thoroughly in petrol.

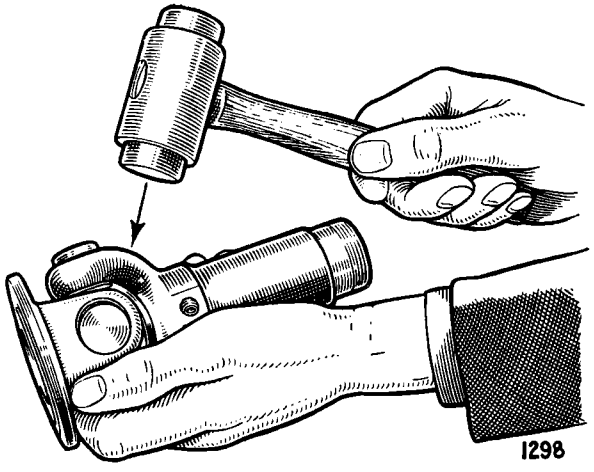


Fig. No. 2 *Tapping the yoke to remove the bearing*

Assembling

Prior to assembling, fill each journal trunnion reservoir with the recommended grease and half fill each bearing with similar lubricant.

Fit the rubber seals to the inner end of each bearing.

Insert the journal into the flange yoke. Fit one of the bearings in the bore of the yoke and, using a drift approximately $\frac{1}{32}$" (.08 mm.) smaller than the bearing diameter, tap the bearing into position. Locate the retaining circlip securely in its groove. Repeat this operation for the remaining three bearings and wipe off any superfluous grease.

Finally recheck that all circlips are seated correctly and that the journals are free in movement.

IMPORTANT

When replacing the sliding joint, it must be refitted with its yoke in line with the fixed yoke at the other end of the shaft. Arrows are stamped on the two parts to facilitate alignment.

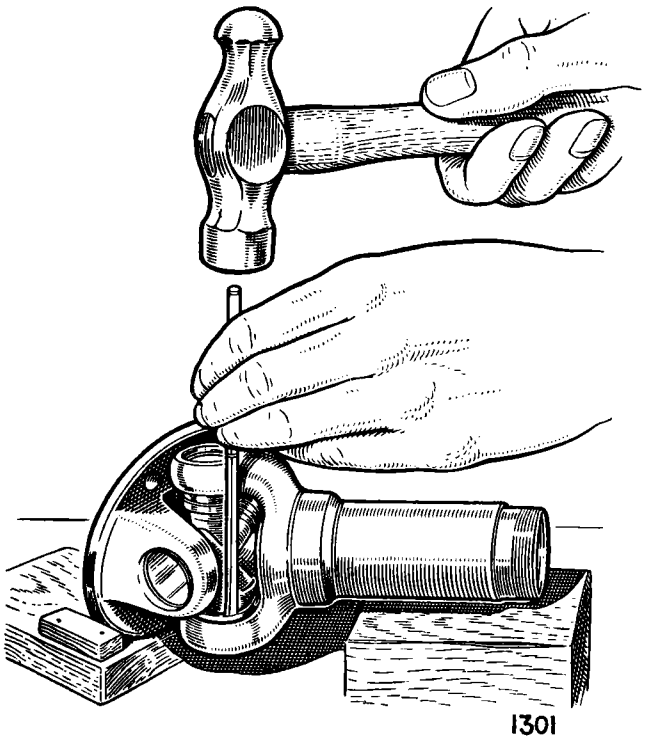


Fig. No. 3 *Tapping out a bearing with a small diameter rod*

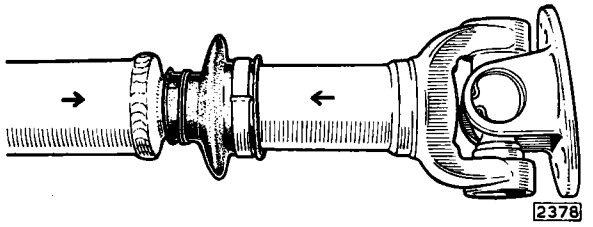


Fig. No. 4 *Showing the arrows on the sliding joint*

FINAL DRIVE UNIT

SECTION H

INDEX

FINAL DRIVE UNIT

DESCRIPTION

The final drive unit is the Salisbury 4.HU. Mounted independently from the hubs, it is fitted with a Thornton "Powr-Lok" differential unit. Short drive shafts with universal joints at each end are coupled to the final drive output shafts. These output shafts also provide mounting points for the discs of the inboard rear brakes. The final drive gear ratio is stamped on a tag attached to the assembly by one of the rear cover screws. The final drive serial number is stamped on the underside of the gear carrier housing.

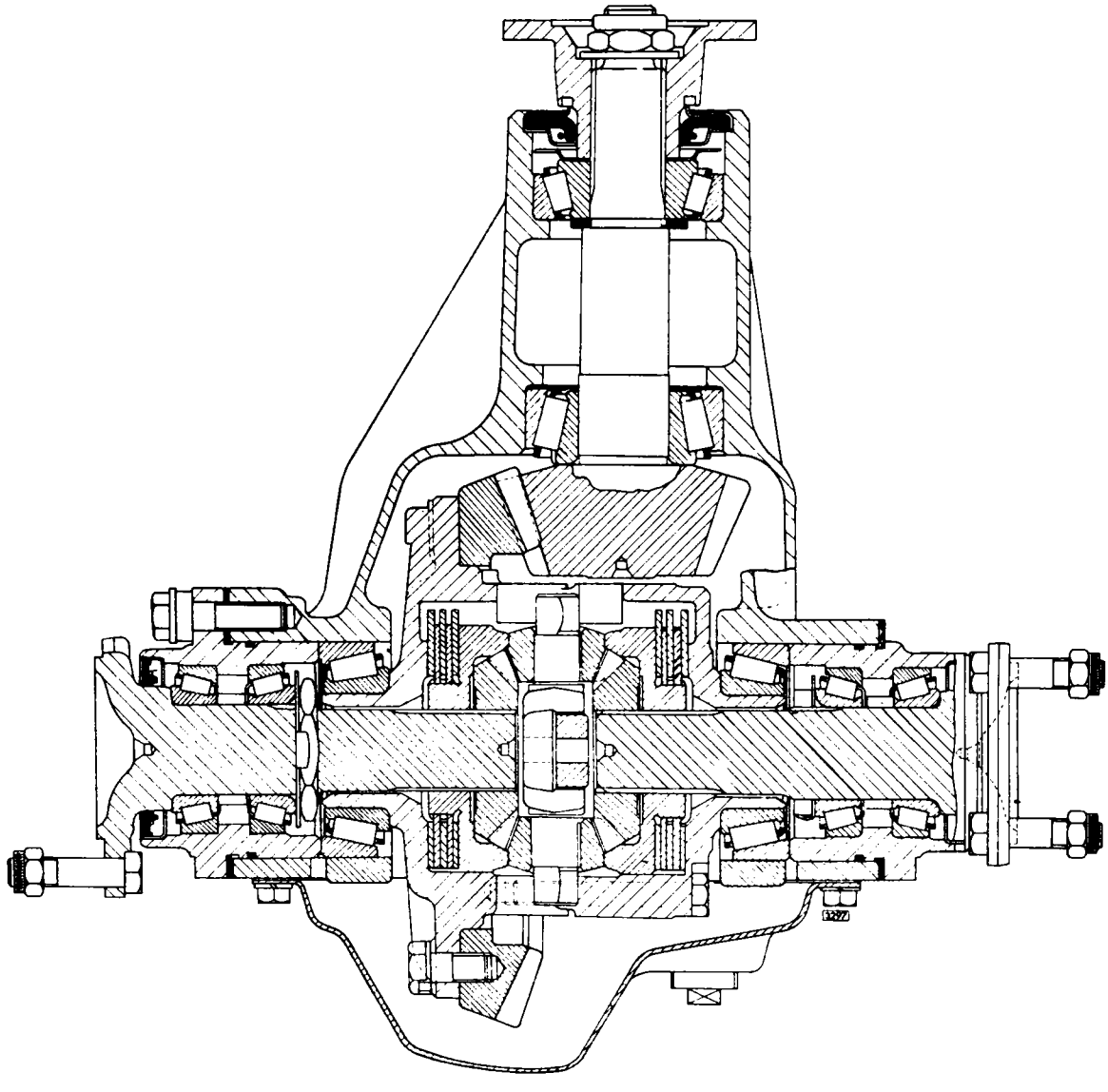


Fig. No. 1 *Sectioned view of the final drive unit*

THE THORNTON "POWR-LOK" DIFFERENTIAL

DESCRIPTION

A conventional differential will always drive the wheel which is easier to turn as the torque is divided equally between both driving wheels. A limited slip differential directs greater driving force to the wheel with better traction thus eliminating the major disadvantage of a conventional differential.

The limited slip differential has two pinion shafts with two bevel pinion mate gears to each shaft.

When the driving force is applied to the differential case, the pinion shaft, pinion mates and differential side gears splined to the driving shafts, rotate as a unit.

The pinion shafts are mounted at right angles to each other but do not make contact at their intersection. Double ramps with flat surfaces at each end of the pinion shafts mate with similar shafts in the differential case. Clearance in the differential case permits slight peripheral movement at the ends of the pinion shafts. The driving forces move the cross pins "B", Fig. 2, up the ramp of the cam surfaces, "C", applying load to the clutch rings, "D", and restricting turning of the differential through the friction clutches, "E". This provides a torque ratio between the axle shafts which is based on the amount of friction in the differential and the amount of load that is being applied to the differential.

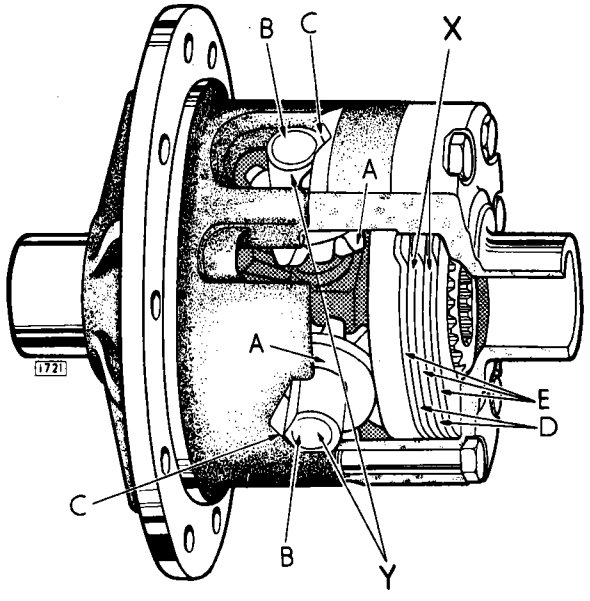


Fig. No. 2 *The operation of the limited slip differential (straight ahead driving)*

- **A** Pinion mates
- **B** Cross pins
- **C** Cam surfaces
- **D** Clutch rings
- **E** Friction clutches
- **X** Clutch rings engaged (both sides)
- **Y** Pins move up ramps under load

When turning a corner, this process is, in effect, reversed. The differential gears become a planetary set with the gear on the inside of the curve becoming the fixed gear of the planetary.

The outer gear of the planetary over-runs as the outside wheel on the curve has a greater distance to travel. With the outer gear over-running and the inner gear fixed, the pinion mates "A", Fig. 3, are caused to rotate but, inasmuch as they are restricted by the fixed gear, they must first move the pinion mate shafts "B" back down the cam surfaces "C" relieving the thrust loads on the clutch plates "E". Thus when turning a corner, for all practical purposes, the limited slip differential is similar to the conventional type, and the wheels are free to rotate at different speeds.

On straight ahead driving, the clutches are engaged and thus prevent momentary spinning when poor traction is encountered. In corners, the load is relieved from the clutch plates so that wear is reduced to a minimum.

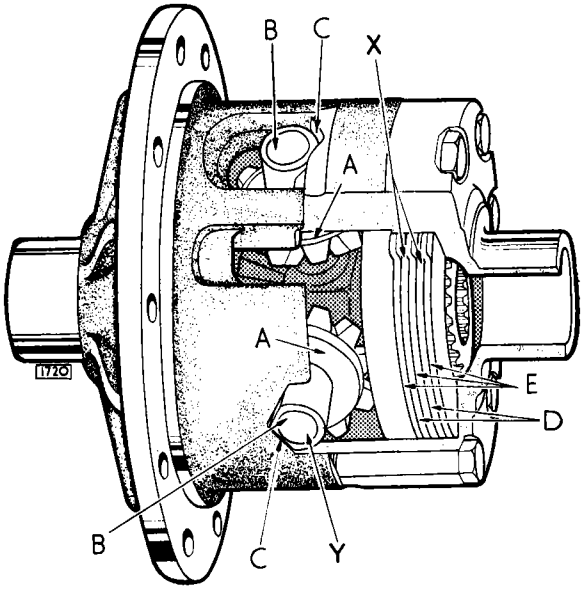


Fig. No. 3 *The operation of the limited slip differential (cornering) X—Engaging force released*

POWER FLOW IN FORWARD DRIVING

Under normal starting and operating conditions the torque or power flow in both the limited slip and conventional type differential is transmitted equally to each axle shaft and wheel. However, when sudden patches of ice, loose gravel or oil are encountered, the limited slip differential will not permit the wheel with the lesser traction to spin, gain momentum and swerve the car when a dry surface is regained.

POWER FLOW IN TURNS

In turning, the limited slip differential gives normal differential action and permits the outer wheel to turn faster than the inner wheel. At the same time the differential applies the major driving force to the inside rear wheel, improving stability and cornering.

ACTION ON ROUGH ROADS

Bumps do not adversely affect wheel action when wheels are controlled by the limited slip differential. The free wheel does not spin and gain momentum. There is no sudden wheel stoppage to cause car swerve or tyre scuffing, and wheel hop is reduced.

DATA

Output shaft end float	0.001"—0.003" (0.02—0.07 mm.)
Differential bearing preload	0.006"—0.010" (0.15—0.25 mm.) total shim allowance
Pinion bearing preload	8—12 lb. in. (0.09—0.14 kgm.)
Backlash	As etched on drive gear 0.004" (0.10 mm.) minimum
Tightening torque	
—Drive gear bolts	70—80 lb. ft. (9.7—11.1 kgm.)
—Differential bearing cap bolts	60—65 lb. ft. (8.3—9.0 kgm.)
—Pinion nut	120—130 lb. ft. (16.6—18.0 kgm.)
Thornton "Powr-Lok" bolts	40—45 lb. ft. (5.5—6.2 kgm.)

FINAL DRIVE RATIOS

Standard model	3.31 : 1
Overdrive model	3.77 : 1
Automatic transmission model	3.31 : 1

Reconditioning Scheme (Great Britain only)

Although full servicing instructions for the final drive unit are given in the following pages, it is recommended that, wherever possible, advantage is taken of the factory reconditioning scheme, particularly in view of the intricate adjustments and the number of special tools required.

Reconditioned final drive units are supplied on an exchange basis. They comprise a final drive unit less half shafts, hubs and brake details: final drive units for exchange should, therefore, be returned in this condition.

New final drive units, or, units which have been stripped down for overhaul should be filled initially with special oil Part No. 9991.

This oil is obtainable from the Works Spares Division in 1 quart tins (1.14 litres).
The oil change period remains as stated under "Routine Maintenance".

In those countries to which it is not practicable to send quantities of this oil, Distributors and Dealers should use a reputable limited slip differential oil.

RECOMMENDED LUBRICANTS

Component	Mobil	Castrol	Shell	Esso	B.P.	Duckham	Regent Caltex/Texaco
Final Drive Unit	Mobilube GX 90	Castrol Hypoy	Spirax 90 EP	Esso Gear Oil GP90/140	Gear Oil SAE 90EP	Hypoid 90	Multigear Lubricant EP 90

Capacities

Imperial	U.S.	Litres
$2\frac{3}{4}$ pints	$3\frac{1}{4}$ pints	1.5

SPECIAL SERVICE TOOLS

Multi-purpose hand press (SL.14*).
Pinion bearing inner race remover (SL.14-1*).
Differential side bearing cone remover (SL.14-3*).
Rear hub outer bearing inner race remover (J.16B*).
Hub remover (JD.IC*).
Multi-purpose handle (550*).
Differential side bearing cone replacer (SL.550-1*).
Pinion outer bearing cup replacer (SL.550-4*).
Pinion inner bearing cup replacer (SL.550-5*).
Pinion cone setting gauge (SL.3*).
Pinion oil seal replacing collar (SL.4*).
* Churchill Tool Number.

ROUTINE MAINTENANCE

EVERY 3,000 MILES (5.000 KM.)

Checking Final Drive Oil Level

Check the level of the oil in the final drive unit with the car standing on level ground.
A combined filler and level plug is fitted in the rear of the casing and is accessible from underneath the car. Clean off any dirt from around the plug before removing. The oil level should be to the bottom of the filler and level plug hole. USE ONLY HYPOID OIL OF THE CORRECT GRADE.
Since different brands of oil do not mix satisfactorily, draining and refilling is preferable to replenishing when the brand of oil in the final drive unit is unknown.

EVERY 12,000 MILES (20,000 KM.)

Changing the Final Drive Oil

Draining of the final drive unit should be carried out at the end of a run when the oil is hot and will, therefore, flow more freely. The drain plug is situated in the base of the differential casing.
Refill with the correct grade of oil.

FINAL DRIVE UNIT OIL CHANGING

Do NOT drain and refill the final drive unit at the first 1,000 miles (1,600 km.) free service. Change the oil after the car has completed 6,000 miles (10,000 km.) and thereafter at the recommended intervals.

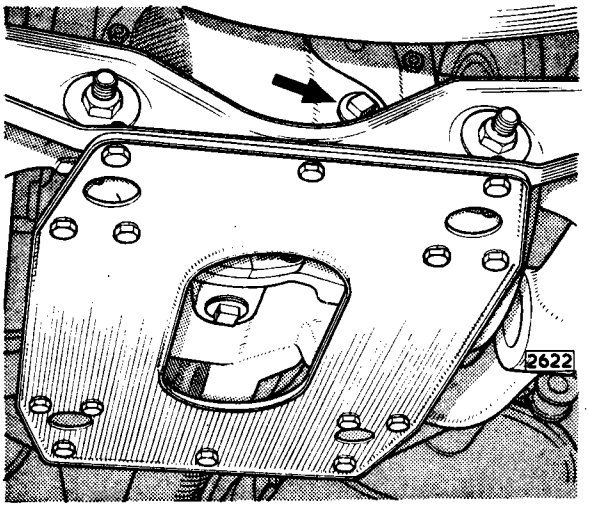


Fig. No. 4 *Final drive unit level and filler plug*

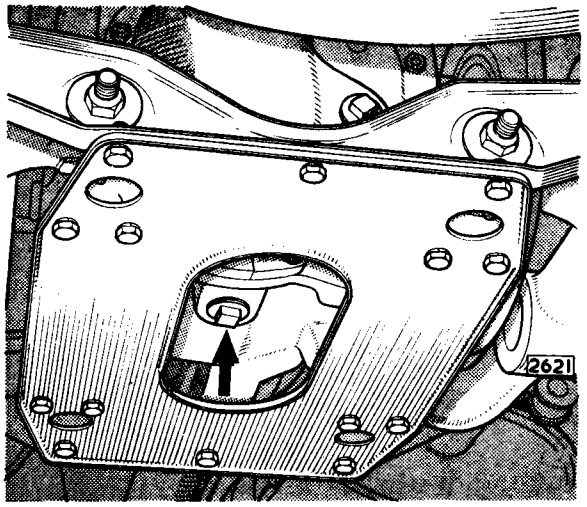


Fig. No. 5 *Final drive unit drain plug*

REMOVAL

Note: The following removal and refitting instructions are detailed assuming that the rear suspension has been removed from the car as described on page K.4.
Invert the suspension assembly on the bench and remove the 14 bolts securing the tie plate. Disconnect the four hydraulic dampers and road springs. Remove the four self-locking nuts securing the half-shaft inner universal joint to the brake disc and final drive output flange. Withdraw the half-shaft from the bolts noting the number of camber shims.
Remove one self-locking nut from the inner wishbone fulcrum shaft and drift out the shaft. Withdraw the hub, half-shaft, wishbone and radius arm assembly. Repeat the operation for the opposite side.

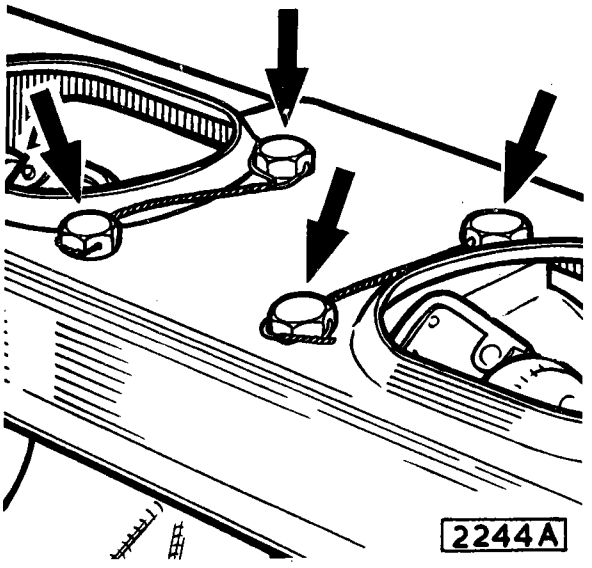


Fig. No. 6 *Showing final drive unit top mounting bolts*

Disconnect the hydraulic feed pipes at the brake calipers.
Turn the assembly over and remove the locking wire from the four differential carrier bolts. Unscrew the bolts and remove the cross beam from the carrier by tilting forward over the nose of the pinion.

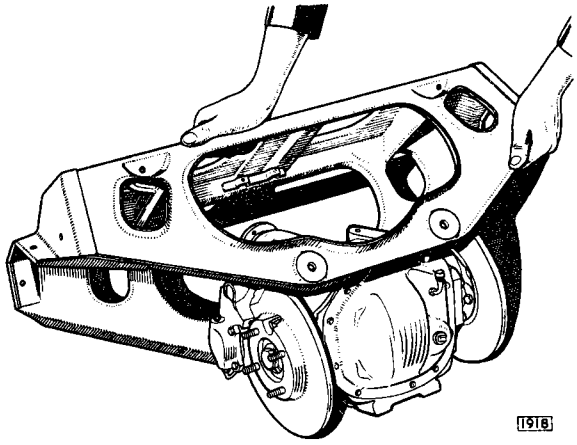


Fig. No. 7 *Removing the cross beam from the final drive unit*

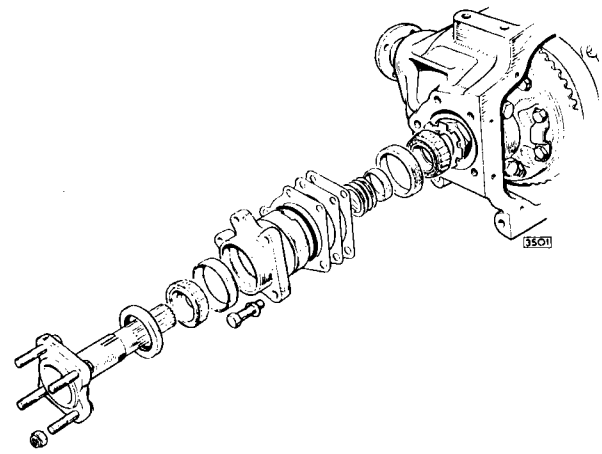


Fig. No. 8 *The drive shaft components*

REFITTING

Refitting is the reverse of the removal procedure. The inner wishbone fulcrum shaft self-locking nut must be tightened to a torque of 55 lb. ft. (7.6 kgm.). Tighten the four differential carrier mounting bolts to a torque of 75 lb. ft. (10.4 kgm.).
Owing to heat dissipation of the rear brakes IT IS MOST IMPORTANT that the locknuts fitted to the output shaft flange studs are of metal and not the nylon self-locking type.

DISMANTLING

The Drive Shafts

Remove the brake calipers and brake discs as detailed on pages L.13 and L.15.
Unscrew the five bolts securing each drive shaft bearing housing, remove the brake caliper adaptor plates, and withdraw the drive shaft assemblies.
Note the number of shims fitted between the flange of the bearing housing and differential case.
Knock back the tab washer and remove the nut from the drive shaft. Press the drive shaft through the bearing housing. Collect the inner bearing inner race, spacing collar, and bearing shims. The outer bearing inner race and oil seal will remain on the drive shaft. If the outer bearing is to be replaced, the oil seal must also be renewed, as withdrawing the bearing from the shaft will damage the seal.
The bearing outer races may be driven from the housing.

The Differential Unit

Drain the lubricant from the gear carrier and remove the rear cover.

Withdraw the four bolts securing the two differential bearing caps and remove the caps.

Fit the stretching fixture (Churchill Tool No. SL 1). The fixture should be adjusted by means of the turn-buckle until it is hand tight; then spread the case by using a spanner. DO NOT OVER-SPREAD OR THE CASING WILL BE DAMAGED BEYOND REPAIR. The correct spread does not exceed half a turn on the turn-buckle and this figure should not be exceeded even if the differential is still difficult to remove.

Prise out the differential assembly with two levers, one on each side of the differential case opening. Use suitable packing between the levers and the gear carrier.

If no stretching fixture is available, the differential unit may be removed with two levers as described above, but care must be exercised not to tilt the assembly which may only result in it becoming wedged in the case.

Using Churchill Tool No. SL 14 with adaptor, Tool No. SL 14-3, withdraw the differential bearings from each half of the differential case.

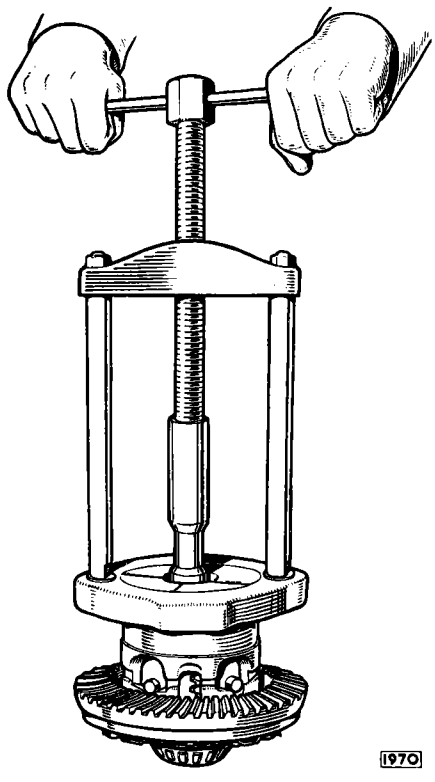
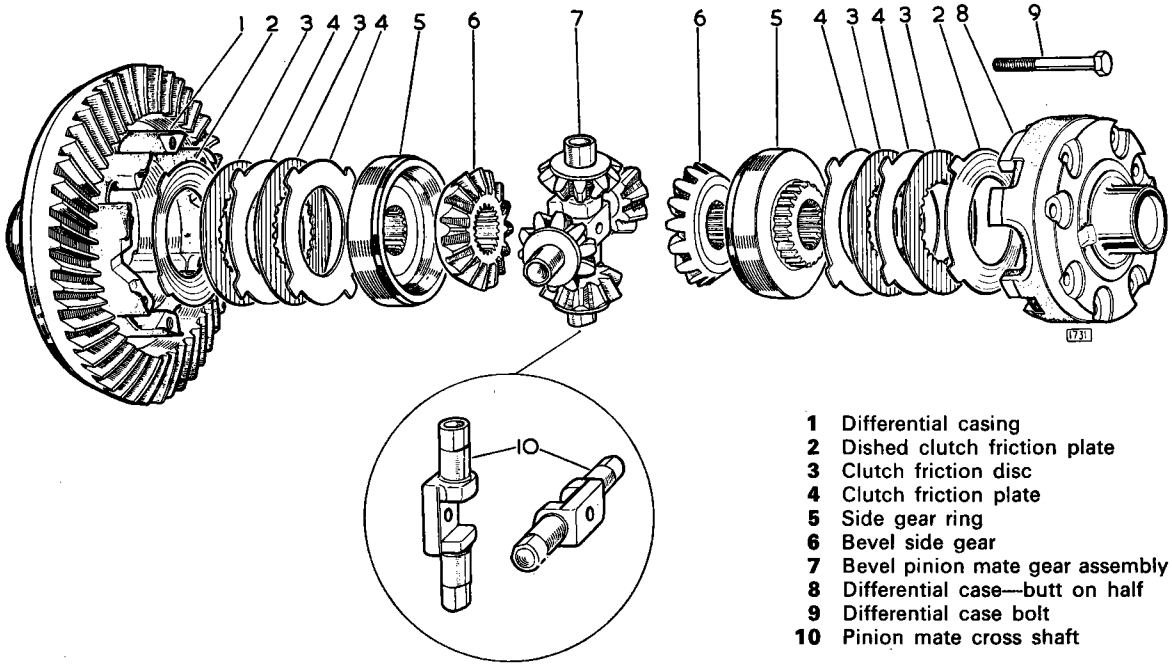


Fig. No. 9 *Withdrawing a differential bearing using Churchill Tool No. SL 14 with adaptor No. SL 14-3*

Knock back the locking tabs from the crown wheel securing setscrews. Remove the setscrews and tap the crown wheel from the differential case with a rawhide mallet.
In the absence of any mating or aligning marks, scribe a line across the two half casings to facilitate assembly.
Remove the eight bolts (9, Fig. 10) securing the two halves of the differential casing.
Split the casing and remove the clutch discs (3) and plates (2 and 4) from one side.
Remove the differential side gear ring (5).
Remove the pinion side gear (6) and the pinion mate cross shafts complete with the pinion mate gears (7).
Separate the cross shafts (10).
Remove the remaining side gear and the side gear ring.
Extract the remaining clutch disc and plates.

The Pinion

Remove the pinion nut and washer. Withdraw the universal joint companion flange with a suitable puller.
PRESS the pinion out of the outer bearing. It is important that the pinion should be pressed out, not driven out, to prevent damage to the outer bearing. The pinion having been pressed from its outer bearing may now be removed from the differential casing.
Note: Keep all shims intact.



1 Differential casing
2 Dished clutch friction plate
3 Clutch friction disc
4 Clutch friction plate
5 Side gear ring
6 Bevel side gear
7 Bevel pinion mate gear assembly
8 Differential case—butt on half
9 Differential case bolt
10 Pinion mate cross shaft

Fig. No. 10 *Exploded view of the "Powr-Lok" differential*

Remove the pinion oil seal together with the oil slinger and outer bearing race. Examine the outer bearing for wear and if replacement is required, extract the bearing outer race. If the correct tool is not available and the bearing cup is to be scrapped it is possible to drive out the cup, the shoulder locating the bearing being recessed to facilitate this operation. Remove the pinion inner bearing outer race if the bearing requires replacement or adjustment of the pinion setting is to be undertaken. Take care of the shims fitted between the bearing cup and the housing abutment face. If the inner bearing is to be replaced it may be driven out but the correct service tool should be used when the bearing is removed in order to carry out pinion setting adjustment.

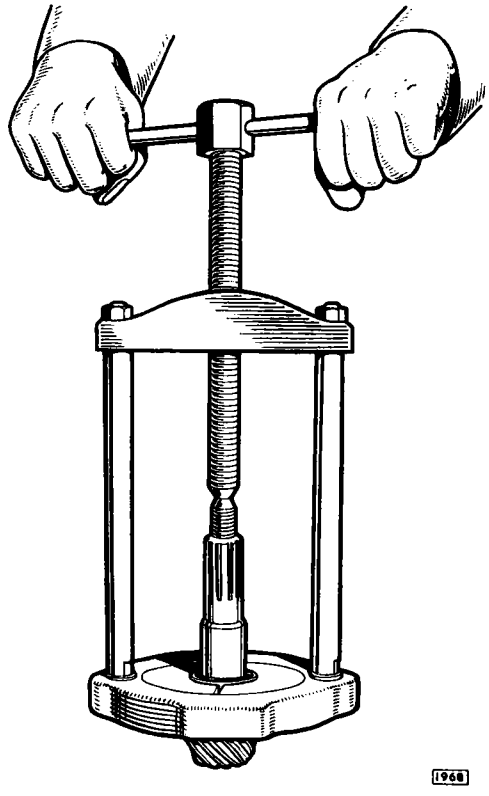


Fig. No. 11 *Withdrawing the pinion inner bearing using Churchill Tool No SL 14 with adaptor No. SL 14-3*

ASSEMBLING

The Pinion

Refit the pinion outer bearing outer race using Tool 550 with the adaptor, SL 550-4 as shown in Fig. 12. Refit the pinion inner bearing outer race with the original shims in position between the outer race and its abutment shoulder.

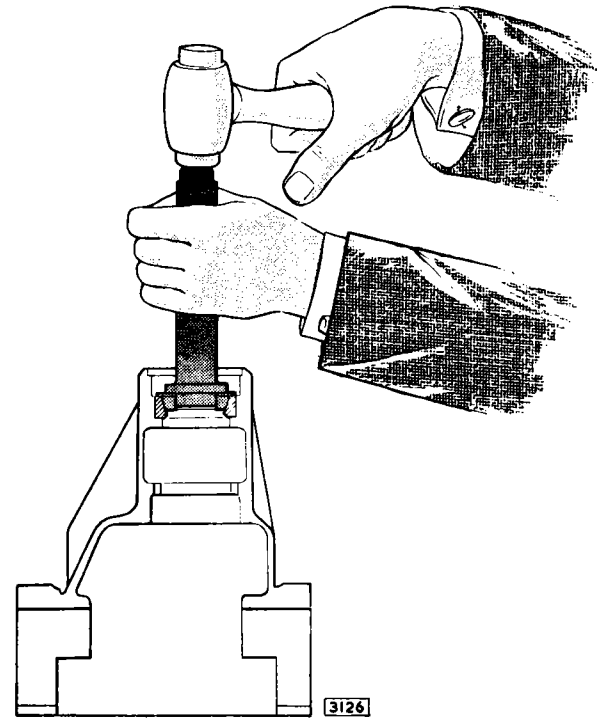


Fig. No. 12 *Replacing a pinion outer bearing outer race using Churchill Tool No. 550 with adaptor No. SL 550-4*

Press the inner bearing inner race onto the pinion using a hand press and a length of tube. Ensure that the tube contacts only the inner portion of the race and not the roller retainer. Place the pinion in position, turn the gear carrier over and support the pinion with a suitable block of wood. Fit the original outer bearing shims to the pinion shank so that they seat on the shoulder of the shank.

Fit the outer bearing inner race, companion flange, washer and nut only, omitting the oil slinger and oil seal assembly and tighten the nut.

It will now be necessary to check the pinion cone setting as follows:—

Pinion Cone Setting

The correct pinion cone setting is marked on the ground end of the pinion as shown on the inset in Fig. 13. The serial number of the matched crown wheel and pinion assembly is marked above the cone setting, it is most important that similarly marked crown wheels and pinions are kept in their matched sets as each pair is lapped together at the factory. The letters on the left and right of the pinion should be disregarded.

Hold the gear carrier so that the ground end of the pinion is uppermost. Take the pinion cone setting gauge (Tool No. SL 3) and remove the magnetic keeper from the gauge post. Using the setting block on a surface plate as shown in Fig. 13 set the dial test gauge to zero on the 4 HA setting.

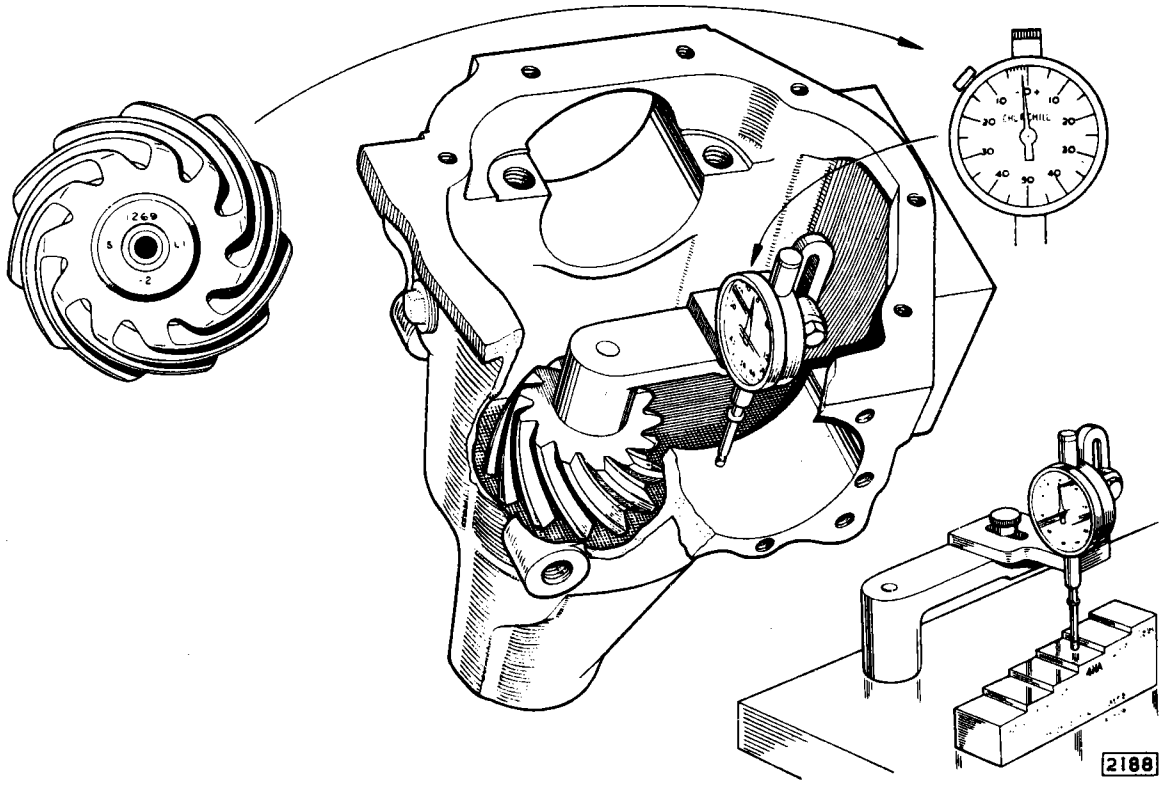


Fig. No. 13 *Checking the pinion cone setting using Churchill Tool No. SL 3. Note the pinion setting marks located on the end of the pinion.*

Place the dial gauge post on the end of the pinion so that the plunger of the dial gauge registers in the differential bearing bore. Check the pinion cone setting by moving the gauge plunger in the differential bore; the actual reading being the minimum obtained. If the cone setting is correct, the reading on the dial gauge will be the same as the figure marked on the pinion end. For example, if the setting marked on the pinion is —2 then the reading on the dial gauge must also be —2.

If the pinion setting is incorrect, it will be necessary to remove the pinion assembly and remove the pinion inner bearing outer race. Withdraw the shim pack and add or remove shims as necessary. Adding shims to the pack will decrease the gauge reading, that is, increase the number on the gauge of negative (—) and decrease the number if positive (+); removing shims will increase the reading; shims are available in 0.003", 0.005" and 0.010" (0.076, 0.127 and 0.254 mm.) thicknesses.

Example, assume the required pinion cone setting distance (marked on the pinion end) to be —2, if on checking with the dial gauge, the reading is —7 it will be necessary to remove a 0.005" (0.127 mm.) thick shim in order to reduce the gauge reading to —2.

Replace the inner bearing outer race, fit the pinion and re-check the cone setting.

When the correct pinion setting has been obtained, check the pinion bearing preload. There should be no end play in the pinion and a slight resistance to turning should be felt. The correct pinion bearing preload is given as a torque figure under "Data" on page H.5.

Inadequate preload will result in pinion deflection under load whilst excessive preload will lead to pitting and failure of the bearings.

To adjust the preload, add or remove shims at the shim

pack between the outer bearing inner race and the shoulder on the pinion shank. Removing shims will increase the preload and adding shims will decrease the preload; shims are available in thicknesses of 0.003", 0.005", 0.010" and 0.030" (0.76, 0.127, 0.254 and 0.762 mm.). It is most important that the shims behind the inner bearing outer race which control the pinion cone setting are not disturbed when setting the preload.

The Differential Unit

Fit one Belleville clutch plate (i.e. dished plate) so that the convex side is against the differential casing (flange half).

Refit the clutch plates and discs alternately into the flange of the casing (see Fig. 10).

Fit the side gear ring so that the gear teeth mesh with the serrations in the two clutch discs.

Place one of the bevel side gears into the recess of the side gear ring so the splines in both align.

Refit the pinion mate cross shafts complete with pinion mate gears, ensuring that the ramps on the shafts coincide with the mating ramps in the differential case.

Assemble the remaining bevel side gear and side gear ring so the splines in both align.

Refit the remaining clutch plates and discs.

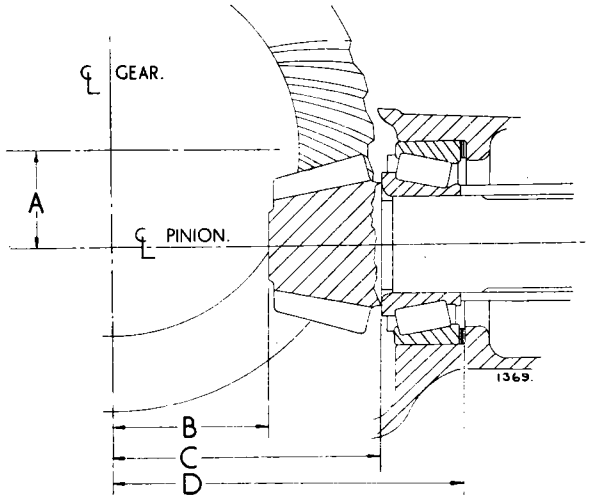


Fig. No. 14 *Pinion setting distances*

A Pinion drop 1.5" (38.1 mm.)
B Zero cone setting 2.625" (66.67 mm.)
C Mounting distance 4.312" (108.52mm.)
D Centre line to bearing house 5.495" (139.57 mm.) to 5.505" (139.83 mm.)

Offer up the butt-on half of the differential case to the flange half in accordance with the identification marks and position of the tongues of the clutch friction plates so they align with the grooves in the differential case. Assemble the butt-on half to the flange half of the differential case with eight bolts but do not tighten at this juncture.

Check the alignment of the splines in the side gear rings and side gears by inserting two drive shafts, then tighten the eight bolts to a torque of 40-45 lb. ft. (5.5 to 6.2 kgm.) while the drive shafts are in position. Failure to observe this instruction will render it difficult or impossible to enter the drive shafts after the eight bolts have been tightened.

Refit the crown wheel to the differential case, having first ensured that the locating faces are not damaged, by aligning the bolt holes on the crown wheel and case and tapping the crown wheel into position with a rawhide mallet. Fit the securing setscrews using NEW locking straps and tighten to a torque of 70 to 80 lb. ft. (9.7 to 11.1 kgm.). Knock up the tabs around the heads of the setscrews.

Using Churchill Tool No. 550 with adaptor, Tool No. SL 550-1, press on the differential bearings to each half of the differential case.

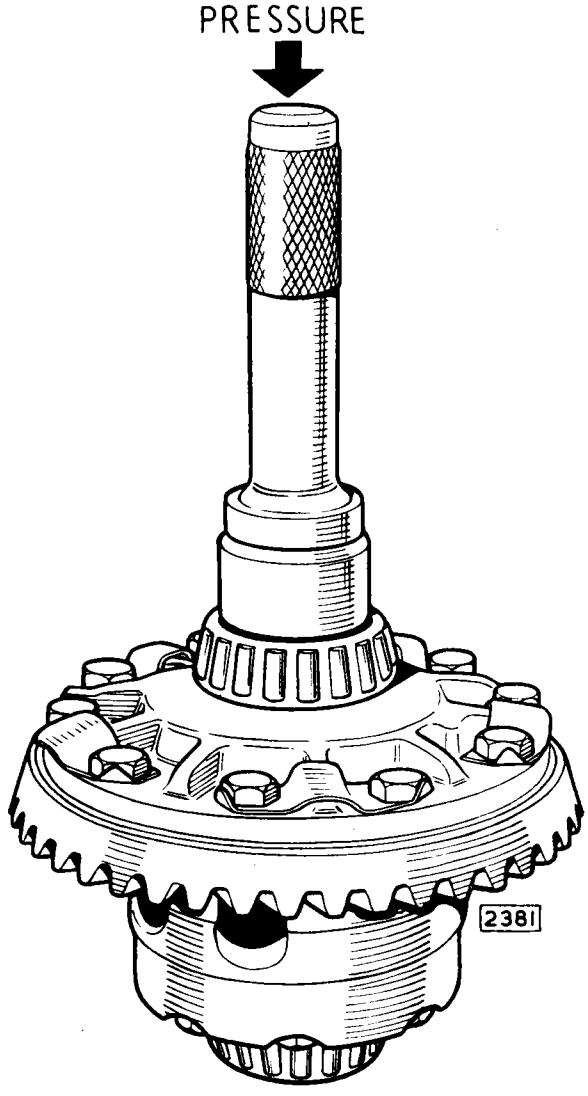


Fig. No. 15 *Replacing the differential bearing using Churchill Tool No. 550 with adaptor No. SL 550-1.*

With the pinion (less the oil seal and oil thrower) installed in the differential carrier, fit the differential assembly. Fit the differential bearing caps noting that the numerals marked on the bearings caps and the end cover face correspond as shown in Fig. 16. Fit the cap bolts and tighten to a torque of 60 to 65 lb. ft. (8.3 to 9.0 kgm.).

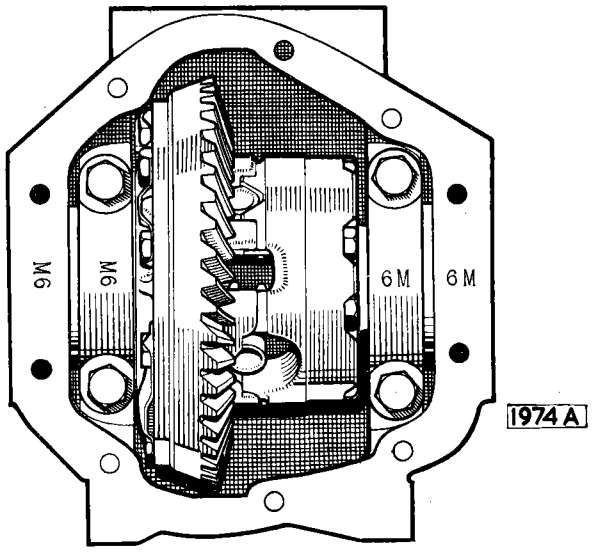


Fig. No. 16 *Differential bearing cap markings*

Mount a dial indicator on the gear carrier with the plunger of the gauge against the back face of the drive gear as shown in Fig. 17. Turn the crownwheel by hand and check the run-out on the back face which should not exceed 0.005" (0.13 mm.). If the run-out exceeds this figure, the differential assembly should be removed, the crown wheel withdrawn from the assembly and the locating surfaces on the crown wheel and differential casing cleaned and the burrs removed.

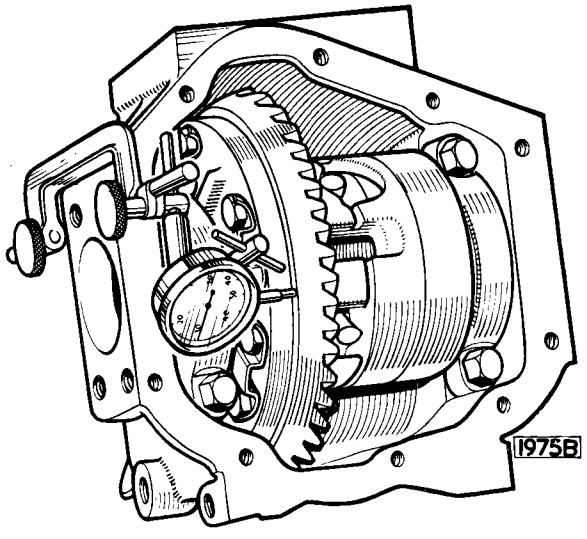


Fig. No. 17 *Checking the drive gear run-out.*

The Drive Shafts

Press the bearing outer races into the housing ensuring that they are fully home in their recesses. The races must be fitted so that the bearings are opposed.
Fit the inner races in the housing with shims and the spacing collar interposed between them. Fit the drive shaft, tab washer and nut. Tighten the nut securely. Check the end-float with a dial gauge. This should be .001"—.003" (.025—.076 mm.) and is adjusted by adding shims to increase or removing shims to reduce end-float. When correct end-float has been obtained, remove the nut and tab washer; withdraw the drive shaft ensuring that the correct number of shims is retained. Withdraw the outer bearing inner race from the drive shaft and place in position in the housing. Press a new oil seal into the housing; insert the drive shaft. Fit the shims, spacing collar, inner bearing inner race, tab washer and nut. Lock the nut with the tab washer ensuring that the tabs lie as flat as possible against the nut.
Renew the "O" ring on the bearing housing. Install the drive shafts without any shims between the shaft bearing housing and the differential carrier.

DRIVE GEAR MESH ADJUSTMENT AND DIFFERENTIAL BEARING PRELOAD

Fit three bolts evenly spaced around each bearing housing. Set up a dial indicator on the differential carrier with the plunger of the gauge against one of the crown wheel teeth as nearly in line with the direction of tooth travel as possible (as shown in Fig. 18). Move the crown wheel by hand to check the backlash; the correct backlash will be etched on the sloping face of the crown wheel. If the backlash reading is incorrect, move the crown wheel towards or away from the pinion as necessary until the correct backlash reading is obtained. To move the crown wheel in the required direction, it will be necessary to tighten the bolts in the drive shaft housing on one side of the differential carrier and slacken the bolts on the other side.

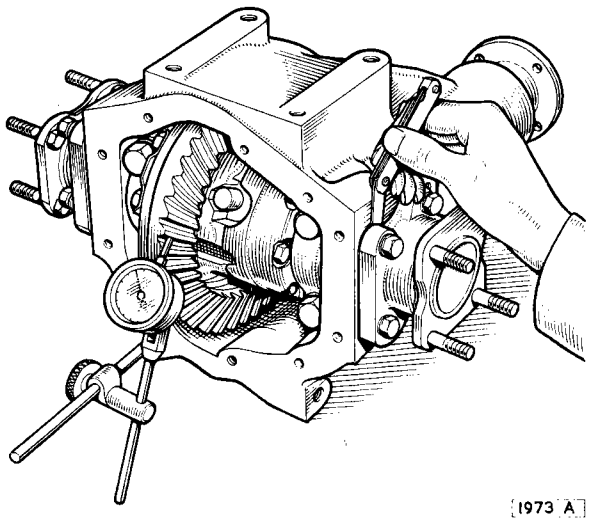


Fig. No. 18 *Checking the backlash and crown wheel location*

When the correct backlash has been obtained, measure the gap between the drive shaft bearing housing and the differential carrier on each side using a set of feeler gauges. Note the gap having first checked around the circumference of the housing to ensure that the gap is even, make up a shim pack to fill the gap on each side but subtract 0.003" (0.076 mm.) from the pack to give the correct preload on the differential bearings. The shims are available in thicknesses of 0.003", 0.005", 0.010" and 0.030" (0.076,0.127,0.254 and 0.762mm.).
For example: Assume that the backlash etched on the crown wheel is 0.007" (0.178 mm.) when this figure has been obtained as described previously, the gap on one side is 0.054" (1.37 mm.) and 0.046" (1.17 mm.) on the other, then the amount of shims to be fitted will be 0.054" — 0.003", that is 0.051" (1.30 mm.) and .046" — 0.003", that is, 0.043" (1.09 mm.) to the other side.
Finally, fit the drive shafts with the shims in position to the differential carrier, fit the five bolts to each housing and tighten up.

Checking Tooth Contact
Paint eight or ten teeth of the crown wheel sparingly with engineers blue or marking raddle. Move the pinion to mesh with the painted teeth until a good impression of tooth contact is obtained.
Fig. 19 shows the ideal tooth bearing impression on the drive and coast sides of the gear teeth. The area of contact is evenly distributed over the working depth of the tooth profile and is located nearer to the toe (small end) than the heel (large end). This type of contact permits the tooth bearing to spread towards the heel under operating conditions when allowance must be made for deflection.

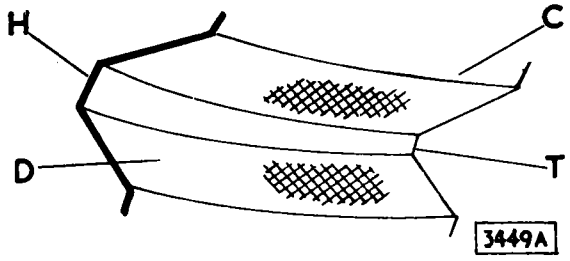


Fig. No. 19 *Ideal contact*

In Fig. 20 it will be observed that the tooth contact is heavy on the crown wheel face or addendum, that is, high tooth contact. To rectify this condition, move the pinion deeper into mesh, that is, reduce the pinion inner race setting distance, by adding shims between the pinion inner bearing outer race and the housing and adding the same thickness of preload shims between the pinion bearing spacer, or the shoulder of the pinion shank and outer bearing inner race. This correction has a tendency to move the tooth bearing towards the toe on drive and heel on coast, and it may therefore be necessary after making this change to adjust the crown wheel as described in the paragraphs on Toe Contact and Heel Contact.

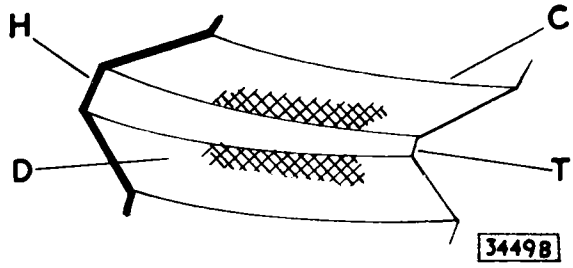


Fig. No. 20 *High tooth contact*

In Fig. 21 it will be observed that the tooth contact is heavy on the crown wheel flank or dedendum, that is, low tooth contact. To correct, move the pinion out of mesh, that is increase the pinion inner race setting distance by removing shims from between the pinion inner bearing outer race and housing, and removing the same thickness of preload shims from between the pinion bearing spacer or the shoulder on the pinion shank and the outer bearing inner race. The correction has a tendency to move the tooth bearing towards the heel on drive and toe on coast, and it may therefore be necessary after making this change to adjust the crown wheel.

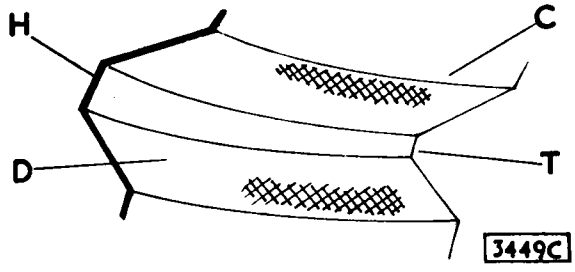


Fig. No. 21 *Low tooth contact*

Fig. 22 shows an example of toe contact which occurs when the bearing is concentrated at the small end of the tooth. To rectify this condition, move the crown wheel out of mesh, that is, increase backlash, by transferring shims to the drive gear side of the differential from the opposite end.

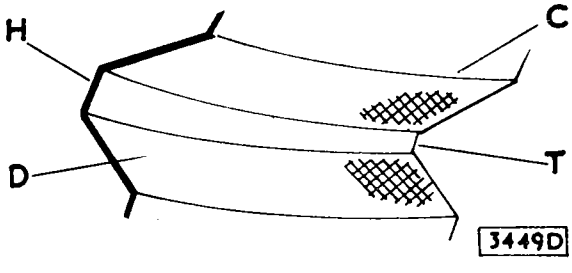


Fig. No. 22 *Toe contact*

Fig. 23 shows an example of heel contact which is indicated by the concentration of the bearing at the large end of the tooth. To rectify this condition, move the crown wheel closer into mesh, to reduce backlash, by removing shims from the drive gear side of the differential and adding an equal thickness of shims to the opposite side.

Note: Sufficient backlash for satisfactory operation must be maintained. If there is insufficient backlash the gears will at least be noisy and have a greatly reduced life, whilst scoring of the tooth profile and breakage may result. Therefore, always maintain a minimum backlash requirement of 0.004" (0.10 mm.).

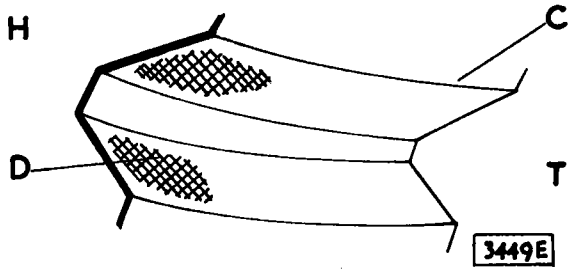


Fig. No. 23 *Heel contact*

H Heel (outer end)
D Drive
C Coast
T Toe (inner end)

FINAL ASSEMBLY

Remove the pinion flange nut, washer and the companion flange, and fit the oil thrower. Place the oil seal gasket into position in the oil seal recess, then fit the oil seal so that the lip of the seal faces inwards and the dust excluder flange is uppermost. Fit the installation collar Tool No. SL.4 and tighten down the pinion nut and washer to drive the assembly home as shown in Fig. 24. Remove the installation collar, fit the companion flange, washer and pinion nut and tighten to a torqeu of 120 to 130 lb. ft. (16.6 to 18.0 kgm.).
Fit the differential carrier rear cover gasket, renewing if necessary, fit the rear cover and secure with setscrews and spring washers. Do not omit to refit the "Powr-Lok" (P.L.) and axle ratio tags which are also secured by the cover setscrews for identification purposes. Check that the drain plug is tightened and fill the axle with one of the recommended lubricants specified on page H.5. Replace the filler plug, check the tightness of the cover setscrews and check the complete unit for oil leaks.
Refit the brake discs and calipers, centralising the calipers by means of the adjusting shims (as described on page L.13. Fit new tab washers to the mounting bolts, tighten the bolts to a torque of 55 lb. ft. (7.6 kgm.) and secure the bolt heads with the tab washers.

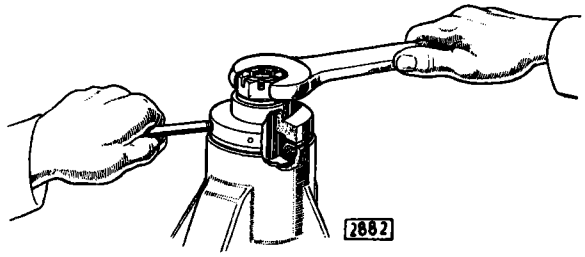


Fig. No. 24 *Fitting the pinion seal using Churchill Tool No. SL 4*

1 Gear carrier
2 Screw
3 Lockwasher
4 Carrier cover
5 Plug
6 Gasket
7 Elbow
9 Setscrew
10 Lockwasher
11 Roller bearing
12 Crown wheel and pinion
13 Setscrew
14 Lock strap
15 Roller bearing
16 Shim
17 Distance washer
18 Shim
19 Roller bearing
20 Oil slinger
21 Oil seal
22 Gasket
23 Companion flange
24 Nut
25 Washer
26 Drive shaft and flange
27 Roller bearing
28 Spacing collar
29 Shim
30 Housing
31 "O" ring
32 Nut
33 Tab washer
34 Shim
35 Bolt
36 Bolt
37 Lockwasher
38 Oil seal
39 Bolt
40 Nut
41 Breather
42 Differential case
43 Friction plate (flat)
44 Friction plate (dished)
45 Friction disc
46 Ring for side gear
47 Side gear
48 Pinion mate gear
49 Shaft
50 Bolt

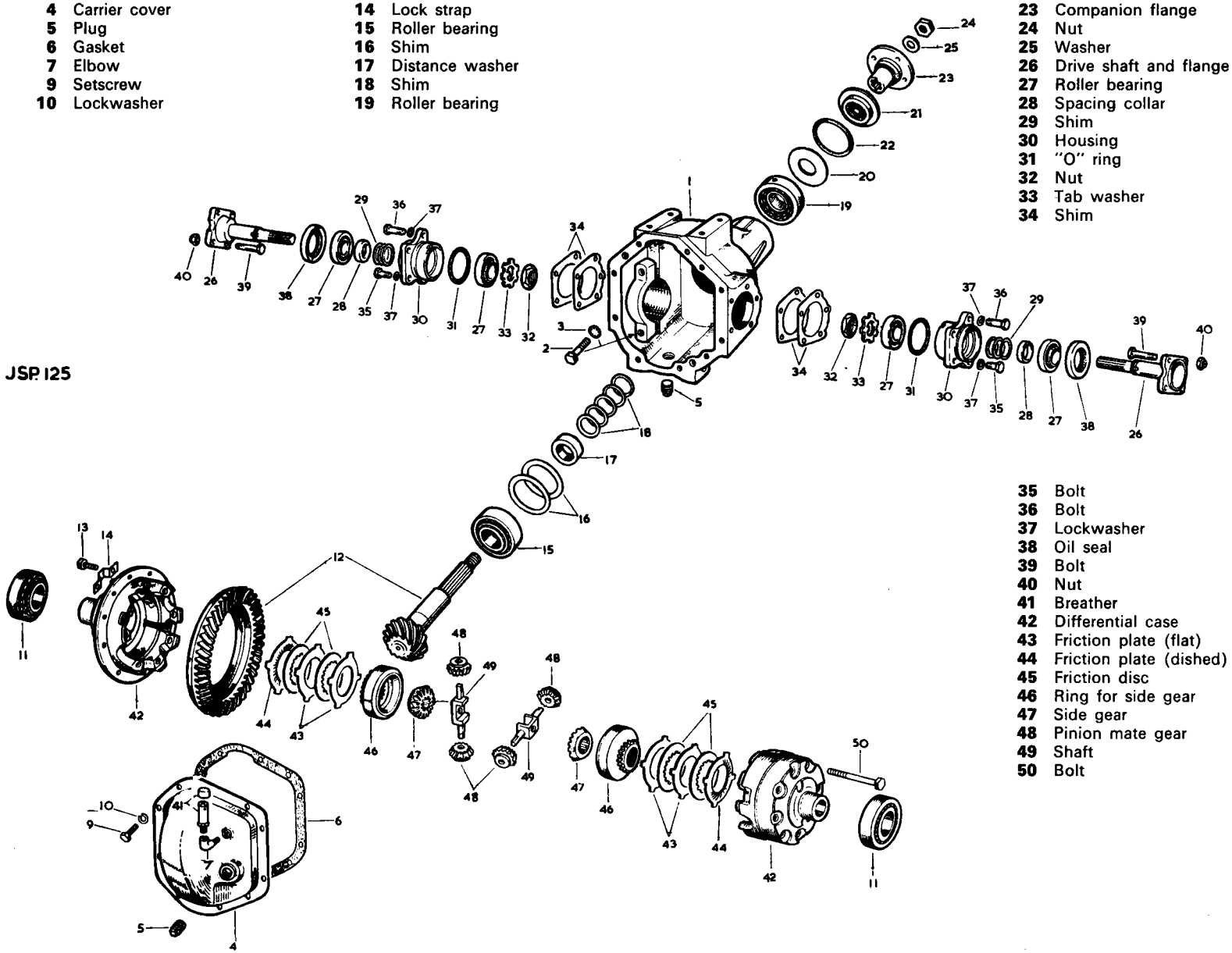


Fig. No. 25 *Exploded view of the final drive unit*

STEERING

SECTION I

INDEX

STEERING

A Burman F.3 steering unit is fitted as standard equipment. Adwest power-assisted steering is specified as an optional extra and is dealt with in Section II.

STANDARD STEERING

DESCRIPTION

The Burman F.3 steering unit is of the high efficiency recirculating ball type in which motion is transmitted from the inner column worm to the rocker shaft by means of a nut on a continuous train of steel balls.
The worm is supported at each end by a loose ball race. Adjustment of the ball races is by means of shims under the end plates at the top and bottom of the steering box.
The rocker shaft is supported in a single bush pressed into the steering box. End float of the rocker shaft is controlled by an adjusting screw and locknut fitted to the top cover plate.
The one piece drop arm is taper splined to the rocker shaft and secured by a spring washer and nut.
The drop arm and idler lever are connected by an adjustable track rod with rubber/steel end assemblies. Extensions of the track rod ends are attached to the inner ball joints of steering tie rods. The outer ball joints of the tie-rods are connected to steering arms which are bolted to the stub axle carriers.

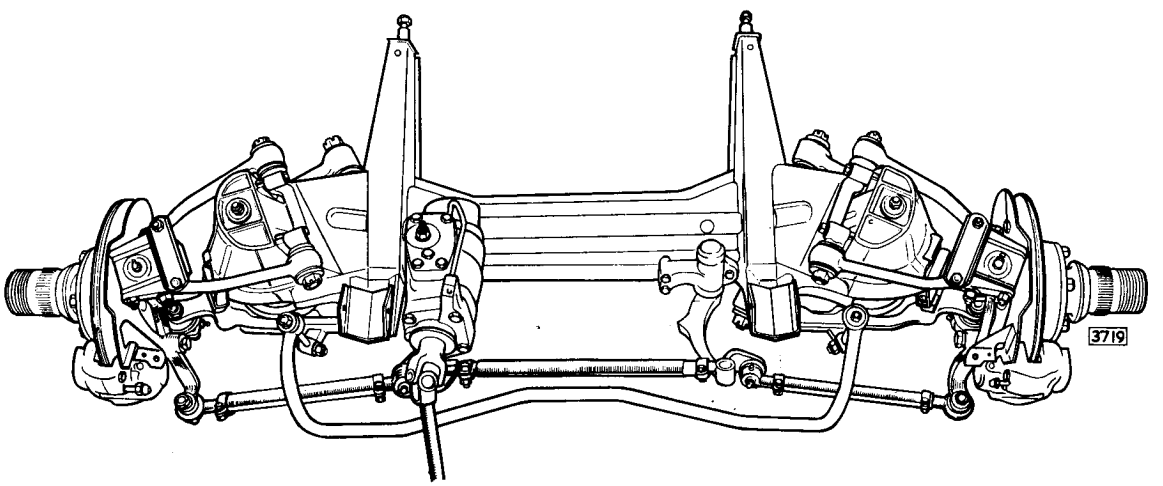


Fig. No. 1 *Steering layout (Power steering illustrated)*

DATA

Type	Recirculating ball
Steering Gear Ratio (Standard)	20.3 : 1
(Special Order)	17.6 : 1
Number of Turns—Lock to Lock	$4\frac{1}{4}$
Turning Circle	33′ 6″ (10.21 m.)
Diameter of Steering Wheel	17″ (43 cm.)
Front Wheel Alignment	Parallel to $\frac{1}{8}$″ (3.2 mm.) toe in